Journal of Ethnopharmacology 155 (2014) 857–924

Contents lists available at ScienceDirect

Journal of Ethnopharmacology

journal homepage: www.elsevier.com/locate/jep

Review

The use of plants in the traditional management of diabetes in Nigeria: Pharmacological and toxicological considerations

Udoamaka F. Ezuruike *, Jose M. Prieto [1]

Center for Pharmacognosy and Phytotherapy, Department of Pharmaceutical and Biological Chemistry, School of Pharmacy, University College London, 29-39 Brunswick Square, WC1N 1AX London, United Kingdom

ARTICLE INFO

Article history:
Received 15 November 2013
Received in revised form
26 May 2014
Accepted 26 May 2014
Available online 12 June 2014

Keywords:
Diabetes
Nigeria
Ethnopharmacology
Herb–drug interactions
WHO Traditional Medicine Strategy

ABSTRACT

Ethnopharmacological relevance: The prevalence of diabetes is on a steady increase worldwide and it is now identified as one of the main threats to human health in the 21st century. In Nigeria, the use of herbal medicine alone or alongside prescription drugs for its management is quite common. We hereby carry out a review of medicinal plants traditionally used for diabetes management in Nigeria. Based on the available evidence on the species' pharmacology and safety, we highlight ways in which their therapeutic potential can be properly harnessed for possible integration into the country's healthcare system.

Materials and methods: Ethnobotanical information was obtained from a literature search of electronic databases such as Google Scholar, Pubmed and Scopus up to 2013 for publications on medicinal plants used in diabetes management, in which the place of use and/or sample collection was identified as Nigeria. 'Diabetes' and 'Nigeria' were used as keywords for the primary searches; and then 'Plant name – accepted or synonyms', 'Constituents', 'Drug interaction' and/or 'Toxicity' for the secondary searches.

Results: The hypoglycemic effect of over a hundred out of the 115 plants reviewed in this paper is backed by preclinical experimental evidence, either *in vivo* or *in vitro*. One-third of the plants have been studied for their mechanism of action, while isolation of the bioactive constituent(s) has been accomplished for twenty three plants.

Some plants showed specific organ toxicity, mostly nephrotoxic or hepatotoxic, with direct effects on the levels of some liver function enzymes. Twenty eight plants have been identified as *in vitro* modulators of P-glycoprotein and/or one or more of the cytochrome P450 enzymes, while eleven plants altered the levels of phase 2 metabolic enzymes, chiefly glutathione, with the potential to alter the pharmacokinetics of co-administered drugs.

Conclusion: This review, therefore, provides a useful resource to enable a thorough assessment of the profile of plants used in diabetes management so as to ensure a more rational use. By anticipating potential toxicities or possible herb–drug interactions, significant risks which would otherwise represent a burden on the country's healthcare system can be avoided.

Contents

1. Introduction . . . 858
   1.1. Diabetes . . . 858
   1.2. Traditional herbal medicines in diabetes management . . . 858
2. Ethno-pharmacological data collection. . . . 859
   2.1. Method. . . . 859

Abbreviations: AAN, aristolochic acid nephropathy; ADME, absorption, distribution, metabolism and excretion; CYT P450, cytochrome P450; DPP-IV, dipeptidyl peptidase IV; GLP1, glucagon like peptide 1; GLUT4, glucose transporter 4; GSH, glutathione; GST, glutathione-S-transferase; IDDM, insulin dependent diabetes mellitus; NIDDM, non-insulin dependent diabetes mellitus; P-GP, P-glycoprotein; PPARγ, peroxisome proliferator activated receptor gamma; STZ, streptozotocin; WHO, World Health Organization

* Corresponding author. Tel.: +44 2077535871.
E-mail addresses: amaka.ezuruike@gmail.com (U.F. Ezuruike), j.prieto@ucl.ac.uk (J.M. Prieto).
[1] Tel.: +44 2077535841.

http://dx.doi.org/10.1016/j.jep.2014.05.055

2.2. Results . . . 859
3. Pharmacological evidence and its clinical implications . . . 859
3.1. *In vivo* hypoglycemic activity . . . 859
3.2. In vitro pharmacological evidence . . . 903
3.3. Bioactive compounds . . . 904
3.3.1. Nitrogen containing compounds . . . 904
3.3.2. Terpenes . . . 907
3.3.3. Phenolic compounds . . . 907
3.3.4. Hydroxylated compounds including sugars . . . 908
3.4. Clinical studies . . . 908
4. Toxicological evidence and considerations . . . 908
5. Conclusions . . . 910
Acknowledgments . . . 910
Appendix A. Supplementary information . . . 910
References . . . 910

1. Introduction

1.1. Diabetes

Diabetes is a chronic metabolic disorder characterized by high blood glucose levels. This is either as a result of insufficient endogenous insulin production by the pancreatic beta cells (otherwise known as type-1 diabetes); or impaired insulin secretion and/or action (type-2 diabetes). type-1 diabetes is an autoimmune disease characterized by T-cell mediated destruction of the pancreatic beta cells. In type-2 diabetes, there is a gradual development of insulin resistance and beta cell dysfunction, strongly associated with obesity and a sedentary lifestyle (Zimmet et al., 2001). Due to a higher incidence of the risk factors, the prevalence of diabetes is increasing worldwide, but more evidently in developing countries. Current estimates indicate a 69% increase in the number of adults that would be affected by the disease between 2010 and 2030, compared to 20% for developed countries (Shaw et al., 2010).

Administration of exogenous insulin is the treatment for all type-1 diabetic patients and for some type-2 patients who do not achieve adequate blood glucose control with oral hypoglycemic drugs. Current drugs used in diabetes management can be categorized into three groups. Drugs in the first group increase endogenous insulin availability. These include the sulphonylureas such as glibenclamide, the glinides, insulin analogs, glucagon-like peptide 1 (GLP-1) agonists and dipeptidyl peptidase-IV (DPP-IV) inhibitors. The first two members of this group act on the sulfonylurea receptor in the pancreas to promote insulin secretion. GLP-1 agonists and DPP-IV inhibitors on the other hand act on the ileal cells of the small intestine. The second group of drugs enhance the sensitivity of insulin. This includes the thiazolidinediones, which are agonists of the peroxisome proliferator-activated receptor gamma (PPARγ) and the biguanide metformin. The third group comprises the α-glucosidase inhibitors such as acarbose, which reduce the digestion of polysaccharides and their bioavailability (Chehade and Mooradian, 2000; Sheehan, 2003). All the existing therapies however have limited efficacy, limited tolerability and/or significant mechanism based side effects (Moller 2001; Rotenstein et al., 2012).

Despite the existing pharmacotherapy, it is still difficult to attain adequate glycemic control amongst many diabetic patients due to the progressive decline in β-cell function (Wallace and Matthews, 2000). In Nigeria, polytherapy with two or more hypoglycemic agents to achieve better glucose control is common practice (Yusuff et al., 2008). There is also a high incidence of diabetic complications and hyperglycemic emergencies (Gill et al., 2009; Ogbera et al., 2007, 2009). In the presence of these, the number of prescribed drugs increases to an average of four per day for each patient (Enwere et al., 2006). This need for the chronic intake of a large number of drugs with their attendant side effects in addition to their high costs which is often borne by the patients themselves is the identified reason for non-adherence to therapy amongst diabetic patients. As a result, patients often have recourse to alternative forms of therapy such as herbal medicines (Yusuff et al., 2008).

1.2. Traditional herbal medicines in diabetes management

A number of reviews on medicinal plants used in the management of diabetes in different parts of the world (Bailey and Day, 1989; Marles and Farnsworth, 1995), as well as those used specifically in certain regions, such as in West Africa (Bever, 1980), Central America (Andrade-Cetto and Heinrich, 2005) and Asia (Grover et al., 2002) exist. These reviews have highlighted the dependence of a large percentage of the world population on traditional medicine for diabetes management. This is also corroborated by the WHO fact sheet (No. 134), which estimates that about 80% of the population in African and Asian countries rely on traditional medicine for their primary healthcare (WHO, 2008). It also recognizes traditional medicine as 'an accessible, affordable and culturally acceptable form of healthcare trusted by large numbers of people, which stands out as a way of coping with the relentless rise of chronic non-communicable diseases in the midst of soaring health-care costs and nearly universal austerity' (WHO, 2013).

Ethnobotanical surveys of plants traditionally used in diabetes management in different parts of Nigeria have been carried out (Abo et al., 2008; Etuk and Mohammed, 2009; Gbolade, 2009; Soladoye et al., 2012). These medicinal plants are used either alone as a primary therapeutic choice, or in conjunction with conventional medicines. On an average, approximately 50% of diabetic patients visiting hospitals in urban cities like Lagos and Benin have used some forms of traditional medicine during the course of their disease management (unpublished results of field work conducted by first author). Unfortunately, clinicians are either unaware of their patients' herb use or the identity of the herbal product being taken. To complicate matters further, herbal practitioners are usually unwilling to divulge the identity of the constituents of their preparations to patients. Most patients are also not interested in finding this out as they consider herbal preparations to be 'safe'; thereby making it difficult to ascertain if the herb may have a significant contributory role to the efficacy or failure of the treatment.

In a systematic review of herbs and supplements clinically used for glycemic control, *Allium sativum, Aloe vera* and *Momordica charantia* were the only identified plants used in Nigeria. This inclusion was however based on clinical studies carried out outside Nigeria (Yeh et al., 2003). This indicates the lack of information about the clinical use (or monitoring thereof) of plants in diabetes management in Nigeria, despite widespread traditional use.

In line with the increasing importance of traditional medicine in various healthcare systems around the world, the WHO Traditional Medicine Strategy has recently been updated. 'The goals of the strategy for the next decade (2014–2023) are to support Member States in (a) harnessing the potential contribution of traditional medicine to health, wellness and people-centered health-care; and (b) promoting the safe and effective use of traditional medicine by regulating, researching and integrating traditional medicine products, practitioners and practice into health systems where appropriate' (WHO, 2013).

Given that diabetes is now considered as one of the main threats to human health in the 21st century (Zimmet et al., 2001), there might be an even greater reliance by diabetic patients in Nigeria on herbal medicines used in its management. Unfortunately, pharmacological and toxicological evidences validating the safety and efficacy of these medicinal plants are not readily available. The objective of this paper is to collate as much as possible, available information about medicinal plants traditionally used in diabetes management in Nigeria. In doing so, we aim to promote the rational use of these plants based on pharmacological evidence for their therapeutic use and their toxic/interaction profile.

2. Ethno-pharmacological data collection

2.1. Method

Information about medicinal plants traditionally used in the management of diabetes in Nigeria was obtained from published papers and texts on ethnobotanical studies, as well as those investigating the effect of plant(s) used in diabetes management, in which the place of use and/or sample collection was identified as Nigeria. A literature search of electronic databases such as Google Scholar, Pubmed and Scopus up to 2013 was carried out using 'Diabetes' and 'Nigeria' as keywords for the primary searches; and then 'Plant name – accepted or synonyms', 'Constituents', 'Drug interaction' and/or 'Toxicity' for the secondary searches.

In order to highlight medicinal plants traditionally used in diabetes management with the potential for integration into the healthcare system, not all identified plants were included in this paper. Only those with (1) more than one reference to its use in diabetes management in Nigeria based on ethnobotanical studies were retained; and/or (2) experimental evidence in one or more diabetes experimental models validating its activity. This review is therefore not exhaustive for all the plants used traditionally for diabetes management in Nigeria.

2.2. Results

Data for one hundred and fifteen plants traditionally used in diabetes management in Nigeria were obtained, either from previously conducted ethnobotanical studies (Abo et al., 2008; Aiyeloja and Bello, 2006; Ajibesin et al., 2008; Etuk and Mohammed, 2009; Gbolade, 2009; Igoli et al., 2005; Lawal et al., 2010; Ogbonnia and Anyakora, 2009; Okoli et al., 2007; Olowokudejo et al., 2008); or from primary research papers (as indicated in Table 1). These are tabulated according to their accepted Latin Name (based on http://www.plantlist.org). Synonyms are included for plants which were not identified with their accepted names in the primary research paper. For each of the identified plants, the family name, common name(s), identified region of use in diabetes management, experimental evidence of activity (where available), other medicinal uses, plant part(s) used, traditional method(s) of preparation, identified active constituent(s), other relevant phytochemical constituents, as well as data on interaction and toxicity studies are included [Table 1].

Out of the 115 plants reviewed in this paper, only twelve of them have no experimental evaluation of their blood sugar reducing effects, either *in vivo* or *in vitro*. In selecting studies to be included, priority was given to investigations carried out with samples collected in Nigeria. Certain publications were not included if the study design of the experimental evidence was not appropriate enough for validating the effect of the plant, such as the absence of a suitable control or the use of improper doses. Two-thirds of the identified plants with experimental evidence for their biological activity involved samples collected from Nigeria. For the remaining one-third, although the studies were not carried out with plant samples sourced from within Nigeria, these were still included, as the experimental evidence could provide some information validating their use in diabetes management, since they are widely used in Nigeria. The ethnobotanical research carried out on *Moringa oleifera* provides a rationale for including information from studies carried out in different countries, as some of these locally available plants could have been initially sourced from elsewhere (Popoola and Obembe, 2013).

In-vitro experimental studies as well as phytochemical studies carried out on the plant species regardless of the source of the plant samples were also included. These together could provide more insight into the biological activity(s) of the plant, which would in turn help to promote a more rational use of the plant in diabetes management, either in the presence or absence of other co-morbidities. For completeness, reports on the antioxidant properties of many of the identified plants have been included as this has become a popular parameter in assessing the beneficial effects of a plant in diabetes management.

3. Pharmacological evidence and its clinical implications

3.1. In vivo hypoglycemic activity

Reducing blood sugar level is the classical clinical target in all forms of diabetes. Thus, the *in vivo* sugar lowering effect of putative hypoglycemic plants is therefore a premise to infer their potential clinical efficacy. *In vivo* validation also provides an indication of the relative toxicity of the plant. Although most herbal medicines have a long history of traditional use, only their experimental validation at known doses may give a clearer idea about its safety and efficacy, in line with the objectives of the WHO Traditional Medicine Strategy (WHO, 2013).

Ninety six out of the one hundred and fifteen plants here reviewed have been evaluated in various *in vivo* animal models of diabetes, mostly using alloxan and/or streptozotocin (STZ)-induced diabetic animals, which are the most frequently used animal diabetes models worldwide (Fröde and Medeiros, 2008). These chemical agents are cytotoxic to the β-cells of the pancreatic islets, generating a state of insulin deficiency (akin to type-1 diabetes) with subsequent hyperglycemia (Szkudelski, 2001). The

Table 1
Medicinal plants used in the management of diabetes in Nigeria.

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
1	*Abelmoschus esculentus* (L.) Moench	Malvaceae	Okro/Okra; Lady's fingers	Ila (Y); Okweje (I); Kubewa (H)	SW, SS	100 and 200 mg/kg of the seed and peel powder decreased blood glucose in STZ induced diabetic rats (Sabitha et al., 2011)§; Antioxidant effects of the aqueous extract of the leaves (Tsumbu et al., 2011)	Infections, Immune-modulatory, Fevers, Spasms, Gonorrhoea, Dysentry	Fruit, Seed	Decoction, Maceration food vegetable		β-1,3-D-glucans (Sheu and Lai, 2012); Hydroxy cinnamic derivatives, Oligomeric catechins, Isorhamnetin glycosides, Quercetin, Myricetin and Kaempferol and their glycosides (Arapitsas, 2008); Abelesculin (Kondo and Yoshikawa, 2007); Rhamnogalacturonans (Deters et al., 2005), Oleic, Stearic, Palmitic, Capric, Caprylic, Lauric, Myristic, Arachidic and Linoleic acids, Gossypol (Al-Wandawi, 1983)	Water soluble fraction of the fruits decreased oral metformin absorption *in-vivo* (Khatun et al., 2011)
2	*Abrus precatorius* (L.)	Leguminosae	Cat's eye, Jequirity beans	Ojuologbo (Y), Oto-berebere (I), Idonzakara (H), Nneminua (Ib)	SW	Inhibited α-amylase and α-glucosidase enzymes and antioxidant effects (Vadivel et al., 2011); 100 and 200 mg/kg aqueous extract of the seeds produced a dose dependent decrease in STZ-induced diabetic rats (Nwanjo, 2008)	Anti-infective, Convulsion, Rheumatism, Abortifacient, Cold/Cough, Conjuctivitis, Contraceptive, Aphrodisiac, Ulcers, Anemia	Leaves, Seeds, Root	Decoction, Maceration	Trigonelline extracted from the seeds decreased blood glucose levels in alloxan induced diabetic rats (Monago and Nwodo, 2010)	Epicatechin, Syringic acid, Caffeic acid (Vadivel et al., 2011); Abruquinones (Kuo et al., 1995); Abrusosides (Choi et al., 1989); Trigonelline, Hypaphorine, Precatorine, Abrine (Ghosal and Dutta, 1971)	Abrin-Toxic component (Kirsten et al., 2003)
3	*Acacia nilotica* (L.) Delile	Leguminosae	Gum arabic, Egyptian thorn	Bagaruwa (H)	NC	50 mg/kg of the ethyl acetate fraction of the methanol extract of the leaves produced greater blood glucose reducing effect (> 50%) in alloxan-induced diabetic rats than the n-butanol fraction (Tanko et al., 2013)	Anti-parasitic, Male sterility, Inflammation, Anti-microbial, Hypertension, Anti-spasms, Insomnia	Leaves, Pods, Root, Bark, Seeds	Maceration, Infusion, Decoction		Catechin and gallic acid derivatives (Malan, 1991); Androstene steroid (Chaubal et al., 2003); D-Pinitol (Chaubal et al., 2005); Kaempferol (Singh et al., 2008); Polygalloyltannin (Jigam et al., 2010); Lupenone, Acanilol A and B (Ahmadu et al., 2010)	Co-incubation of 0.01% of the extract in Caco-2 cell monolayers decreased the integrity of the monolayer and the secretory transport of CsA indicating possible inhibition of P-gp (Deferme et al., 2003)
4	*Adansonia digitata* L.	Malvaceae	African baobab tree	Ose (Y), Kuka (H), Bokki (Fulani)	NE, SW	100 mg/kg of the methanol extract of the stem bark decreased blood glucose levels by 51% in STZ-induced diabetic rats (Tanko et al., 2008)	Anti-sickling, Galactagogue, Inflammation, Anti-pyretic, Analgesic, Anti-parasitic, Constipation, Skin lubricant, Asthma, Nutritive value	Stem bark, Leaves, Fruit pulp, Seeds			Oleic, Linoleic and Myristic acids (Eteshola and Oraedu, 1996); Epicatechin, Epicatechin procyanidins, Dihydroxy and Trihydroxy flavan-4-one glycosides, Quercetin glycosides, α-amyrin, β-amyrin palmitate, Ursolic acid, Adansonin, β-sitosterol, Stigmasterol (Refaat et al., 2013)	
5	*Aframomum melegueta* K. Schum.	Zingiberaceae	Alligator pepper, Grains of paradise	Atare (Y), Ose-orji (I), Citta (H)	SW	Inhibitory effects on α-amylase and α-glucosidase enzymes, Antioxidant activity (Adefegha and Oboh, 2012) 200 & 400mg/kg aqueous seed extract decreased blood glucose in alloxan-induced	Stimulant, Inflammation, Diarrhoea, Antifungal, Insect repellent, Skin conditions, Malaria, Analgesic	Seed, Fruits, Leaves	Maceration, Tincture		6-Gingerol, 6-shogaol, 6-paradol (Ilic et al., 2010); Linalool, 1,8-cineole, Citral, 2-heptyl acetate, 2-heptanol (Ukeh and Umoetok, 2011)	Inhibition of Cyp 3A4, 3A5 and 3A7 enzyme activity (Agbonon et al., 2010); Elevated levels of liver function enzymes with chronic dosing (Ilic et al., 2010)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						diabetic rats (Adesokan et al., 2010)						
6	*Ageratum conyzoides* (L.) L.	Compositae	Goat weed	Imi esu (Y), Urata njele (I), Ebegho-edore (Bi)	SW, NC	100, 200 and 300 mg/kg of the aqueous extract of the leaves decreased blood glucose levels in both normal rats, STZ-induced diabetic rats and glucose-loaded rats (Nyunai et al., 2009)§; 100, 200 and 400 mg/kg of the ethanol extract of the shoot decreased blood glucose levels in normal and alloxan induced diabetic rats (Egunyomi et al., 2011)	Wound ulcers, Antimicrobial, Skin infections, Analgesic, Anti-spasm, Insecticidal, Diarrhoea, Gonorrhoea, Emetic	Whole plant, Leaves	Fresh Juice extract, Infusion		Eugenol, α-pinene, 1,8-cineole, β-caryophyllene, Ocimene, Limonene, Precocene I and II, Encecalin derivatives, Coumarin, Quercetin and its glycosides, Kaempferol and its glycosides, β-sitosterol, Friedelin, Stigmasterol, Echinatine, Lycopsamine, Polymethoxylated and Polyhydroxy flavones (Okunade, 2002)	
7	*Alchornea cordifolia* (Schumach and Thonn.) Mull.Arg.	Euphorbiaceae	Christmas bush	Ipa (Y), Mbom (Ib), Upia (Ige), Uwanwe (Es), Osokpo (I)	SE, SW, SS	Antioxidant activity and hepatoprotective effects (Olaleye and Rocha, 2007, 2008); Significant decrease in blood glucose levels in STZ-induced diabetic rats administered 200, 400 and 800 mg/kg of the n-butanol fraction of the aqueous extract of the leaves (Mohammed et al., 2012a, 2012b)	Wound, Ulcers, Infections, Anti-parasitic, Liver disorders, Rheumatism, Fevers, Diuretic, Purgative, Analgesic, Gonorrhea, Cough	Stem bark, Leaves, Seeds, Root	Decoction		Alchornoic acid (Kleiman et al., 1977); Quercetin and its glycosides, Gallic acid, Triisopentenyl guanidine, Protocatechuic acid (Lamikanra et al., 1990); Ellagic acid (Banzouzi et al., 2002); Daucosterol, β-sitosterol, Acetyl aleuritolic acid, Di(2-ethylhexyl) phthalate (Mavar-Manga et al., 2008); Caryophyllene, Eugenol, Nanocosaine, Cadinol, Linalool, α-bergamonene (Okoye et al., 2011)	
8	*Allium cepa* L.	Amaryllidaceae	Onion	Alubosa (Y)	SE	100 and 300 mg/kg aqueous extract of the bulb administered for 30 days decreased blood glucose levels in alloxan-induced diabetic rabbits and restored decreased levels of antioxidant enzymes (Ogunmodede et al., 2012)	Convulsion, Rheumatism, Vermifuge, Hypertension	Bulb		Anti-diabetic effects of S-methylcysteine sulfoxide isolated from onion in alloxan-induced diabetic rats (Sheela et al., 1995)	Quercetin and its glycosides, Kaempferol, Cepaenes, S-methylcysteine sulfoxide (SMCS), β-chlorogenin (Corzo-Martínez et al., 2007); Tropeosides, Ascalonicoside, Sitosterol, Amyrin, Oleanolic acid, Taxifolin, Diosgenin, Gitogenin, Apigenin, Luteolin, Myricetin (Lanzotti, 2006)	
9	*Allium sativum* L.	Amaryllidaceae	Garlic	Aayu (Y), Ayo-ishi (I), Tafarunua (H)	SS, SE	200–300 mg/kg aqueous extract of the cloves decreased blood glucose levels in alloxan-induced diabetis rats after one week (Eyo et al., 2011); 250 and 500 mg/kg ethanol extract of the cloves administered for 14 days produced a dose-dependent decrease in serum glucose, lipid levels and liver	Hypertension, High cholesterol, Stomach ache, General debility, Hemorrhoids, Tumours, Asthma, Anti-microbial	Cloves		Anti-diabetic effects of S-allylcysteine sulfoxide isolated from garlic in alloxan-induced diabetic rats (Sheela et al., 1995)	S-allylcysteine sulfoxide (SACS), Allyl sulfides, Allicin and its breakdown products, Allixin, Eruboside B, Vitamin B_6 and B_{12} (Corzo-Martínez et al., 2007); Sativosides, Proto-desgalactotigonin, Apigenin, Quercetin, Myricetin, N-feruloyl	Components of aged garlic extract did not produce significant inhibition of Cytochrome P450 enzymes *in vitro* (Greenblatt et al., 2006); and in humans (Markowitz et al., 2003)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						function enzyme levels and increased serum insulin levels in STZ-induced diabetic rats (Eidi et al., 2006)§					tyrosine, N-feruloyl tyramine (Lanzotti, 2006)	
10	*Aloe vera* (L.) Burm.f.	Asparagaceae	Barbados aloe	Ahon erin (Y)	SE	150 mg/kg of the dried pulp extract/exudate administered to STZ-induced diabetic rats decreased fasting blood glucose levels and improved the levels of the antioxidant enzyme (Nwanjo, 2006); 1 mg/ml aloe vera whole gel extract prevented the onset of hyperglycaemia in alloxan-induced diabetic rabbits (Akinmoladun and Akinloye, 2007); 350 mg/kg of a polyphenol-rich gel extract administered to insulin resistant mice for 4 weeks improved insulin tolerance and fasting blood glucose levels (Pérez et al., 2007)§	Skin diseases, Laxative, Immune booster, Wound ulcers, Tumours, Guinea worm, Amenorrhoea	Leaves	Juice extract		Mannose-6-phosphate, Barbaloin, Emodin, Aloin, Aloe emodin, Aloesin, β-sitosterol, Diethylhexyl phthalate (Choi and Chung, 2003); Aloetic acid, Veracylglucan A, B and C, Acemannan, Anthranol, Isobarbaloin, Arabinogalactan, Cinnamic acid ester, Aloeride, Malic acid, Isorabaichromone, Neoaloesin A, Isoaloeresin D, 8-*C*-glucosyl derivatives of aloediol, aloesol, noreugenin, Ascorbic acid, β-carotene, α-tocopherol (Hamman, 2008); Myricetin, Kaempferol, Quercetin (Sultana and Anwar, 2008)	Causes an opening of the tight junction between adjascent epithelial cells thereby increasing paracellular transport, with the potential to increase oral drug absorption (Hamman, 2008)
11	*Alstonia boonei* De Wild.	Apocynaceae	Stoolwood, Devil tree, Australian fever bush	Ahun (Y), Egbu (I)	SW[c]	*In vitro* antioxidant effects (Akinmoladun et al., 2010)	Malaria, Infertility, Arthritis, Anti-infective	Stem bark	Decoction, Tincture, Maceration		B-amyrenone, β-amyrin acetate, Lupeol, Sitosterol (Faparusi and Bassir, 1972); Echitamine, Echitamidine (Kucera et al., 1972); Nα-formyl echitamidine (Oguakwa, 1984); α-amyrin and its esters, Lupeol and its esters (Rajic et al., 2000); Nα-formyl-12-methoxy echitamidine, Voacangine, Akuammidine, Ursolic acid, Loganin, Boonein (Adotey et al., 2012)	
12	*Alstonia congensis* Engl.	Apocynaceae	Pattern wood Alstonia	Egbu ora (I), Awogbo ahun (Y)	SW	Administration of 1 g/kg of a 1:1 mixture of a hydroethanolic extract of *Alstonia congensis* bark and *Xylopia aethiopica* fruits decreased blood glucose levels in normal mice (Ogbonnia et al., 2008a); *In vitro* antioxidant effects (Awah et al., 2012)	Malaria, Diuretic, Analgesic, Astringent, Hypertension	Stem bark, Root, Leaves	Decoction, Maceration		Echitamine, Echitamidine, Nor-echitamine, 17-O-acetyl nor-echitamine, Akuammicine and its 12-Methoxy derivative, Tubotaiwine, 12-methoxy tubotaiwine and its 12-methoxy derivative, Akuammidine, Angustilobine A and B, Seco angustilobine A and B, Anugustilobine-B-N-oxide (Caron et al., 1989)	Possible nephrotoxic effects; Decreased creatinine levels in normal mice (Ogbonnia et al., 2008a).
13	*Anacardium occidentale* L.	Anacardiaceae	Cashew	Kasu (Y), Sashu (I), Kanju (H)	SW, NC	Stimulated glucose uptake in C2C12 myoblasts and rat liver mitochondria (Tedong et al., 2010)§; 200 mg/kg methanol	Cough, Malaria, Skin infections, Anti-parasitic, Fevers, Anti-helminthic	Stem bark, Leaves, Seed, Nuts	Decoction, Maceration		6-Alkyl salicylic acids (Anacardic acids), 5-alkyl resorcinols (Cardols), 3-alkyl phenols	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)[°]	Region of use for diabetes[#]	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						extract of the stem bark administered to rats alongside a high-fructose diet prevented the onset of hyperglycaemia (Olatunji et al., 2005); 100–800 mg/kg aqueous and methanol extract of the stem bark decreased blood glucose levels in both fasted normal and STZ-induced diabetic rats dose dependently (Ojewole, 2003); Inhibits α-glucosidase and aldose reductase enzymes (Toyomizu et al., 1993)[§]					(Cardanols), 2-methyl-5-alkyl resorcinol (Toyomizu et al., 1993); Stigmast-4-en-3-ol and Stigmast-4-en-3-one (Alexander-Lindo et al., 2004); Lutein, β-carotene, Zeaxanthin, α-tocopherol, γ-tocopherol, Thiamin, Stearic acid, Oleic acid and Linoleic acid (Trox et al., 2010)	
14	*Ananas comosus* (L.) Merr.	Bromeliaceae	Pineapple	Ogede oyinbo (I)	SW	The ethanolic extract at a dose of 400 mg/kg improved insulin sensitivity in diabetic dyslipidaemic rats; as well as improved glucose uptake in insulin resistant HepG2 cells (Xie et al., 2006)[§]	Inflammation, Anti-parasitic	Leaves, Fruits			Bromelain, Chlorogenic, Caffeic, Coumaroylquinic, P-coumaric and Caffeic acids, Caffeoylglycerols, Coumaroylglycerols, Ferulic acid glucuronide, Hydroferuloylglucose, Ananaflavoside B and C, Ananasate, Dicaffeoyl glycerides, Tricin, Feruloyl glycerols (Ma et al., 2007)	
15	*Anisopus mannii* N.E.Br.	Apocynaceae		Sakayau (H), Kashe zaki (H)	NW, NE	100, 200 and 400 mg/kg aqueous leaf extract decreased blood glucose levels in alloxan-induced diabetic mice (Manosroi et al., 2011); Antioxidant effect (Aliyu et al., 2010); 100–400 mg/kg of the aqueous stem extract decreased blood glucose in normal rats (Sani et al., 2009)	Analgesic, Anti-parasitic, Inflammation, Hypertension, Anti-microbial, Infertility	Stem, Leaves, Whole plant	Decoction		Anisopusine, Gingerdione, Lupen-3β-yl eicosanoate, Dehydro gingerdione, Ferulic acid (Tsopmo et al., 2009)	
16	*Annona muricata* L.	Annonaceae	Soursop, Custard apple	Sapi sapi (Y)	SW, SE	100 mg/kg aqueous leaf extract decreased blood glucose, increased serum insulin, decreased β-cell damage and possessed antioxidant effects in STZ induced diabetic rats (Adewole and Caxton-Martins, 2006); Methanol extract of the leaves inhibits α-amylase and α-glucosidase enzymes, but less potent than acarbose (Kumar et al., 2011)[§]	Hypertension, Sedative, Cancer, Emetic, Lactagogue, Anti-microbial, Anti-convulsant, Anti-parasitic, Rheumatism, Analgesic, Insecticide	Leaves, Fruit, Seeds, Bark, Root	Infusion, Decoction, Fruit juice		Reticuline, Coclaurine, Anomurine, Anomuricine, Coreximine (Lannuzel et al., 2002); Scyllitol, Oleic, Linoleic and P-coumaric acid, Procyanidins, Stigmasterol (Leboeuf et al., 1980); Annonaine, Asimilobine, Nornuciferine (Hasrat et al., 1997); Acetogenins (Carmen Zafra-Polo et al., 1998); Alkyl esters, Linalool, β-caryophyllene, Cadinene, Humulene, Caryophyllene oxide, Phellandrene, Cadinol (Fournier et al., 1999); Gallic acid, Epicatechin, Quercetin and its	Chronic intake of the fruit and infusions of the plant is thought to bring about neurodegeneration in the CNS; attributed to coreximine and reticuline alkaloids present in the plant (Lannuzel et al., 2002), as well as the acetogenin annonacin (Champy et al., 2005)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											glycosides, Catechin, Chlorogenic acid, Argentinine, kaempferol and its glycosides (Nawwar et al., 2012)	
17	*Annona senegalensis* Pers.	Annonaceae	Wild custard apple	Uburu ocha (I), Abo (Y), Gwander-daji (H), Ogoganto (Es), Ndaweewu (F)	SS, NC, NW, SW	100 mg/kg of the aqueous extract of a herbal preparation ADD-199 containing the roots of *Annona senegalesis* and three other plants decreased plasma glucose and increased plasma insulin in STZ-induced diabetic mice; as well as increased glucose uptake by isolated diaphragm (Okine et al., 2005)§; Antioxidant effects (Potchoo et al., 2008)§	Anti-parasitic, Anti-bacterial, Tumours, Erectile dysfunction, Wound-healing, Snake bites, Convulsions, Hemorrhage	Stem-bark, Root, Leaves	Decoction		Acetogenins (Carmen Zafra-Polo et al., 1998); Roemerine, Isocorydine, 8,8-Bisdihydrosiringenin, Syringaresinol (You et al., 1995); Kaurane diterpenes, Quercetin, Sitosterol, Oleic acid, Linoleic acid, Sitosterol (Leboeuf et al., 1980); Rutin, Epicatechin, Catechin, Isoquercetin (Potchoo et al., 2008); Cadinol, α-phellandrene, Z-ocimene, Limonene, α and β-pinene, Linalool, Myrcene, Caryophyllenol, 1,8-cineole (Fournier et al., 1999)	Stem bark extract inhibited P-gp mediated Rh-123 efflux (Ezuruike et al., 2012); Roemerine interacts with P-gp and enhances vinblastine cytotoxicity (You et al., 1995); ADD-199 did not interact with Cyt P-450 isozymes nor produce ay organ toxicity (Nyarko et al., 2005)
18	*Anogeissus leiocarpus* (DC.) Guill. and Perr.	Combretaceae	Axle wood, Giant fern	Orin-odan or Ayin (Y), Atara (I), Marke (H)	NC, NW, SW	Antioxidant and hepatoprotective effects (Atawodi et al., 2011); 200 mg/kg aqueous extract decreased blood glucose levels after 2 h in alloxan-induced diabetic rats (Etuk and Mohammed, 2009)	Anti-parasitic, Hemorrhoids, Asthma, Anti-microbial, Anti-sickling	Stem-bark	Decoction		Castalagin, Ellagic acid, Flavogallonic acid (Shuaibu et al., 2008); Leiocarpan A and B (Aspinall et al., 1969); Gallic acid, Chlorogenic acid, Protocatechuic acid P-comaric acid (Kone et al., 2012)	Dose-dependent toxicity of the aqueous leaf extract in rat lungs characterised by inflammation and lesions (Agaie et al., 2007)
19	*Anthocleista djalonensis* A. Chev.	Gentianaceae	Cabbage tree	Sapo (Y), Akpakoro or Uvuru (I), Putaa (H)	SS[c], SE[b], SW	≤ 111 mg/kg ethanolic root extract decreased blood glucose levels in alloxan-induced diabetic rats (Okokon et al., 2012); Alpha amylase inhibitory effects of the hydro-alcoholic extract of the leaves and stem bark as well as hypoglycaemic effect of 1 g/kg of the stem bark in alloxan-induced diabetic rats (Olubomehin et al., 2013)	Anti-microbial, Inflammation, Wound-healing, Anti-parasitic, Fevers, Sexual disordes	Stem-bark, Roots, Leaves	Decoction		Djalonenol, Djalonensone, Sweroside, Ursolic acid, Sitosterone, Sitosterol, Stigmasterol, Bornesitol, Lichexanthone (Onocha et al., 1995)	Gastrointestinal upsets (Tchacondo et al., 2011)
20	*Anthocleista vogelii* Planch.	Gentianaceae	Cabbage tree	Kwari (H), Opa oro (Y)	NC, SW	Hypoglycaemic effect of 100–800 mg/kg aqueous extract in normal and alloxan-induced rodents (Abuh et al., 1990); Hydro-alcoholic extract of the leaves and stem bark produced < 50% alpha amylase inhibitory effects (Olubomehin et al., 2013)	Purgative, Diuretic, Skin infections, Emmenagog, Anti-ulcer, Malaria	Root, Leaves, Stem-bark	Decoction		Sweroside, Vogeloside, Fagaramide (Abuh et al., 1990); Tetraoxygenated xanthones (Chapelle, 1974)	
21	*Aristolochia albida* Duch.	Aristolochiaceae	Dutchmans pipe, Hill gourd	Duuman duutse (H), Paran funfun (Y)	SW, NE, NW		Anti-parasitic, Anti-venom, Analgesic, Inflammation, Skin infections, Anti-	Leaves, Stem, Roots, Rhizome	Infusion, Decoction		Columbin (Nok et al., 2005); Aristolic acid, Aristolochic acid A, Aristolactam, 6-hydroxy	Risk of AAN (Aristolochic acid nephropathy) (Heinrich et al., 2009)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
							spasmodic, Aphrodisiac, STDs				aristolochic acid A, Aristolone (Lajide et al., 1993); Aristolochic acids I, II, IV, C and C-beta-D-glucoside, Aristolactam I-beta-D-glucoside Campesterol, Stigmasterol, Sitosterol (Choudhury and Haruna, 1994)	
22	*Aristolochia bracteolata* Lam.	Aristolochiaceae	Snake wort, Birth wort	Gadau kuka (H)	SS		Skin infections, Anti-helminthic, Anti-venom, Analgesic Stimulant, Insecticide	Leaves Roots, Seeds	Decoction		Aristolochic acid I and II, Aristolactam A (Kumar et al., 2003); Magnoflorine (El Tahir, 1991); N-acetyl nornuciferine, Aristo red, β-sitosterol (Chakravarty et al., 1988)	Risk of AAN (Heinrich et al., 2009); Chronic dosing of goats with the aqueous leaf extract resulted in toxic effects culminating in death (Barakati et al., 1983)
23	*Aristolochia repens* Mill.	Aristolochiaceae		Akoigun (Y)	SW, SS		Hemorrhoids, Rheumatism, Aphrodisiac	Stem bark	Decoction		Aristolochic acids I, II, IV, C and D, Aristolochic acid D-beta-D-glucoside, Aristolactam I-beta-D-glucoside (Michl et al., 2011)	Risk of AAN (Heinrich et al., 2009)
24	*Azadirachta indica* A.Juss.	Meliaceae	Neem, Indian lilac	Dogonyaro (Y), Ogwu akom (I)	SS, SW	25 mg/ml ethanolic leaf extract increased insulin release from the pancreas (Chattopadhyay, 1999)§; 400 mg/kg hydro-ethanolic extract of the leaves decreased blood glucose in alloxan-induced diabetic rats, and produced a synergistic effect with *Vernonia amygdalina* (Ebong et al., 2008); 500 mg/kg ethanol extract of the leaves decreased blood glucose levels and improved pancreatic lesions in STZ-induced diabetic rats (Akinola et al., 2010)	Anti-parasitic, Anti-pyretic, Anti-microbial, Anti-ulcer, Jaundice, Ringworm, Liver problems, Hemorrhoids, Inflammation, Wound-healing	Leaves, Seed, Bark, Root, Fruit, Gum	Infusion Decoction		Quercetin, Myricetin and Kaempferol glycosides (Chattopadhyay, 1999); Nimbidin, Azadirachtin, Nimbin, Nimbolide, Sodium nimbidinate, Gedunin, Mahmoodin, Gallic acid, Epicatechin, Catechin, Gallocatechin, Epigallocatechin, Cyclic trisulphide and tetrasulphide, Margolone, Margolonone, Isomargolonone, GIa, GIIa, GIIIa, GIb (Biswas et al., 2002)	Various pharmaco-toxic effects were seen with Neem oil with an LD_{50} of 14 and 24 ml/kg in rats and rabbits respectively; and more toxic than edible mustard seed oil suggesting a narrow margin of safety when used therapeutically. (Gandhi et al., 1988)
25	*Bauhinia monandra* Kurz	Leguminosae	Pink orchid, Napoleon's plume	Abafe (Y)	NW, SW	Antioxidant effects (Argolo et al., 2004); 1 g/kg stem bark extract decreased blood glucose levels in alloxan-induced and glucose loaded diabetic rats (Abo and Jimoh, 2004)	Post-natal hemorrhage, Anti-microbial, Laxative, Inflammation, Pesticidal	Leaves, Stem-bark, Pods, Root	Maceration	Rutin and Quercetin identified as the bioactive constituents for the anti-hyperglycaemic effect in alloxan-induced diabetic rats and insulin stimulatory effect in INS-1 cells (Alade et al., 2011, 2012)	Quercetin, Quercetin-3-O-rutinoside (Aderogba et al., 2006); 3,7-Di-O-α-rhamno pyranosyl quercetin (Menezes et al., 2007); BmoRoL and BmoLL lectins (Souza et al., 2011)	
26	*Bauhinia thonningii* Schum. Syn:	Leguminosae	Camel's foot	Kalgo (H), Abafe (Y)	NC, NW, SE, SW	Antioxidant effects (Taofeek, 2011); 500 mg/kg aqueous extract of the leaves decreased blood glucose as	Anti-parasitic, Anti-microbial, Malaria, Inflammation, Snake bites, Purgative	Leaves, Roots, Stem-bark	Decoction	D-3-O-methyl chiroinositol isolated from the methanol extract of	Epicatechin, (+)-pinitol, Esters of *p*-hydroxyphenyl ethanol and *p*-coumaryl alcohol, Kaur-16-en-19-oic	Co-incubation of 0.01% of the extract in Caco-2 cell monolayers decreased the integrity

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
	Piliostigma thonningii					well as improved serum lipid profile in alloxan-induced diabetic rats (Ojezele and Abatan, 2011)				the stem bark decreased blood glucose levels in alloxan-induced diabetic rats dose-dependently (Asuzu and Nwaehujor, 2013)	acid, Labd-13-en-8-0l-19-oic acid (Baratta et al., 1999); Quercetin, Quercitrin, C-methyl quercetin ethers, C-methyl kaempferol ethers, Piliostigmin (Ibewuike et al., 1997); Kaurane diterpenes (Martin et al., 1997); Griffonilide, Rhamnetin, Carotenoids (Okwute et al., 1986)	of the monolayer and the secretory transport of Cyclosporin A (CsA) indicating possible inhibition of P-gp (Deferme et al., 2003)
27	*Bauhinia tomentosa* L.	Leguminosae	Yellowbell orchid, Camel foot tree	Jinga (H), Abafe-pupa (Y)	SW	Antioxidant effects (Aderogba et al., 2008); 500 mg/kg ethanol root extract decreased blood glucose in both normal glucose-loaded rats and alloxan induced diabetic rats (Kaur et al., 2011)§	Anti-microbial, Diuretic, Vermifuge, Aphrodisiac, Anti-tumours	Roots, Leaves, Flower			Quercetin-3-O-glucoside, Quercetin-3-O-rutinoside, Kaempferol-7-O-rhamonoside, Kaempferol-3-O-glucoside (Aderogba et al., 2008); Quercetin, Isoquercetin, Lectins, Protocatechuic acid (Anju et al., 2011)	
28	*Bauhinia rufescens* Lam.	Leguminosae		Jirga (F), Matsatsagi (H)	NW, NE	Antioxidant effects (Aliyu et al., 2009; Compaoré et al., 2011); Dose dependent (200–400 mg/kg) decrease in blood glucose levels by methanol extract of the leaves in alloxan-induced diabetic rats (Aguh et al., 2013)	Anti-infective, Anti-parasitic, Wound healing, Fibrosis, Inflammation	Stem-bark, Root, Fruit	Maceration		Hyperoside, Isoquercitrin, Quercetin, Quercitrin, P-coumaric acid, Ferulic acid, Rutin, Kaempferol (Compaoré et al., 2011); Benzopyrandiol and triol derivatives (Maillard et al., 1991)	
29	*Bidens pilosa* L.	Compositae	Spanish needle, Needle grass, Black jack	Abere-oloko (Y)	SW	Acetylenic glucosides decreased blood gucose in C57BL/Ks-*db*/*db* mice, a type 2 diabetes model (Ubillas et al., 2000)§	Anti-cancer, Anti-pyretic, Anti-microbial, Inflammation, Diuretic, Anti-parasitic, Colic, Wound ulcers, Hemorrhoids, Malaria	Seeds, Leaves, Roots, Aerial parts	Decoction, Infusion	Acetylenic glucosides: 3-β-D-glucopyranosyl-1-hydroxy-6(*E*)-tetradecene-8,10,12-triyne and 2-β-D-glucopyranosyl-1-hydroxy-6(*E*)-tetradecene-7,9,11-triyne (Ubillas et al., 2000)	Polyacetylenic compounds, Pyrocatechin, Vanillin, P-hydroxybenzoic acid, Gallic acid, Salicylic acid, Protocatechuic acid, P-coumaric acid, Ferulic acid, Caffeic acid, Caffeoyl quinic acids, Eugenol, Esculetin, Chlorogenic acid, Sulfuretin, Chalcones, Apigenin and its glycosides, Luteolin and its glycosides, Quercetin and its glycosides, Kaempferol glycoside, Caryophyllene, Humulene, Lupeol, β-sitosterol, Campestrol, β-amyrin, Friedelin, α-tocopherol, Centaureidin, Centaurein (Lima Silva et al., 2011)	
30	*Bixa orellana* L.	Bixaceae	Lipstick tree, Bixa plant, Annatto, Achiote	Osun-buke (Y), Aje (Y), Uhie (I)	NE, SW, SE	80 mg/kg of the seed coat extract decreased blood glucose levels and increased plasma insulin levels and insulin binding to blood corpuscles in normoglycaemic dogs	Anti-microbial, Anti-parasitic, Skin infections, Anti-tumour, Analgesic, Anti-pyretic, Jaundice, Gonorrhea, Purgative, Snake bites	Leaves, Seeds	Decoction	Aldose reductase inhibitory effects of isoscutellarein isolated from the leaf extract (Terashima et al., 1991)	Apocarotenoids, Norbixin, Bixin, Geranylgeranyl and its acetate, octadecanoate, and formiate, Farnesyl acetone (Gutierrez et al., 2011); β-tocopherol, Vitamin E (Ponnusamy et	The carotenoid Bixin, isolated from the seed coat extract has been shown to induce Cyt P450 enzymes in the liver, kidney and lungs (Jewell and O'Brien,

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						(Russell et al., 2005)§; Methanol extract of the leaves (49 μg/ml) produced inhibitory effects against human pancreatic amylase enzyme (Ponnusamy et al., 2011)§					al., 2011); Stigmasterol, Polyprenol, Sitosterol, Ishwarane, Phytol (Raga et al., 2011); Capric, Palmitic, Stearic, Oleic and Linoleic acids (Silva et al., 2008); Gallic acid, Pyrogarrol, Isoscutellarein (Terashima et al., 1991); β-carotene, Cryptoxanthin, Lutein, Zeazanthin, Methyl bixin (Tirimanna, 1981)	1999); Bixin as well as other constituents of annato dye from the seed extract play an important role in the induction of Cyp 1A and 2B enzymes in rats (De-Oliveira et al., 2003); Seed constituents have also been found to possess opposing hyperglycaemic effects (Fernandes et al., 2002; Gutierrez et al., 2011)
31	*Blighia sapida* K. D.Koenig	Sapindaceae	Ackee apple, Breadfruit tree	Okpu ulla (I), Ishin (Y), Gwanja-kusa (H), Ila (Nu)	SW, NC	Aqueous root bark extract (100 and 200 mg/kg) decreased blood glucose in normoglycaemic rats (Saidu et al., 2012)	Wound ulcers, Malaria, Anti-parasitic, Migraine, Laxative, Diuretic, Epilepsy, Liver diseases, Anti-emetic, Snake bites	Root, Bark, Fruits, Leaves		Hypoglycaemic effect of hypoglycin A and B from the fruit was observed in rabbits, monkeys, rats and mice but not cats, dogs and pigeons with lethality at doses > 50 mg and 150 mg/kg for hypoglycin A and B respectively in mice (Chen et al., 1957)	Hypoglycin A, Hypoglycin B (Hassall et al., 1954); Glycyl-L-alanine, γ-L-glutamyl-trans-α-L-(carboxy cyclopropyl) glycine, Glyclyglycine, Diglycylglycine (Fowden and Smith, 1969); Blighinone, Stigmasterol and its fructoside, Oleanolic acid, Hederagenin and its glucosides (Garg and Mitra, 1967)	Hypoglycin A and B in the unripe fruit, although responsible for the hypoglycemic effect can lead to death due to severe fatty acid degeneration and glycogenolysis (Hassall et al., 1954; Sherratt, 1986)
32	*Bridelia ferruginea* Benth.	Phyllanthaceae		Ira or Iralodan (Y), Kirni or Kizni (H), Ola (I)	SW, SE	100 and 200 mg/kg aqueous and methanol extracts of the leaves decreased blood glucose levels in normal rats and alloxan-induced rats when pre-treated; Also daily intake of 15 mg of the extract as an infusion lowered blood glucose levels of type-2 diabetic patients in a clinical study (Iwu, 1983); Radical scavenging effects (Cimanga et al., 2001); Administration of 250 mg/kg ethanol extract of the root for 4 weeks improved glucose tolerance in high-fructose fed Wistar rats (Bakoma et al., 2011)	Inflammation, Oral thrush, Anti-parasitic, Anti-microbial, Hemorrhoids, Anti-tumour	Leaves, Stem bark, Root	Infusion, Decoction	Hypoglycaemic effect of a mixture of quercetin-3-neohesperidoside, Quercitrin, Quercetin-3-glucoside and Myricetin-3-rhamnoside isolated from the hydro-alcoholic extract of the leaves in fasted rabbits (Addae-Mensah and Munenge, 1989)	Myricetin-3-rhamnoside, Quercetin-3-glucoside, Quercitrin, Quercetin-3-neohesperidoside (Addae-Mensah and Achenbach, 1985); Kaempferol, Vitexin, Apigenin (Iwu, 1983); β-peltatin-5-O-β-D-glucopyranoside and its 5-demethoxy derivative (Rashid et al., 2000); 3-O-methyl quercetin, Rutisin, Myricetin, Ferrugin, Tetra-O-methyl myricetin, Gallocatechin-(4-O-7)-epigallocatechin (Cimanga et al., 2001)	Inhibited P-gp mediated Rh-123 efflux in Caco-2 cells (Ezuruike et al., 2012); No observed acute or chronic toxicity in rats after 6 months intake or high doses up to 5 g/kg. However aqueous extract of the leaves prolonged pentobarbitone induced sleeping time, which might indicate possible interaction with Cyp enzymes (Owiredu et al., 2011)
33	*Bridelia micrantha* (Hochst.) Baill.	Phyllanthaceae	Sweet berry, Coastal golden leaf	Iranje, Ogaofia (I), Ugoagu (I)	SW, SE	250 mg/kg of the methanol extract of the leaves decreased blood glucose in alloxan-induced diabetic rats and produced good antioxidant effects (Adika et al., 2011)	Oral gargle, Anti-microbial, Jaundice, Dysentry	Leaves, Stem bark	Decoction		Delphinidin, Gallic acid, Caffeic acid, Ellagic acid, Friedelin, Epifriedelinol Taraxerol, Taraxerone (Pegel and Rogers, 1968); Camphene, α-pinene, 1,8-cineole, Camphor, Linalool, 1-α-terpineol, α-caryophyllene oxide, 5-β-pregnene, Quinoline (Green et al., 2011)	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
34	*Bryophyllum pinnatum* (Lam.) Oken	Crassulaceae	Africa never die, Life plant, Resurrection plant	Ewe abamoda (Y)	SW	400 mg/kg of the aqueous extract of the fresh leaves produced hypoglycaemia in both normal and STZ-induced diabetic rats (Ojewole, 2005); Hypoglycemic effect of 500 mg/kg aqueous extract of the leaves in normal fasted glucose-loaded and STZ-induced diabetic rats (Ogbonnia et al., 2008c); *In vitro* antioxidant effects (Gupta and Banerjee, 2011)§	Hypertension, Analgesic, Inflammation, Wound ulcers, Anti-parasitic, Insect bites, Anti-cancer, Cough, Diarrhoea, Sedative, Diuretic, Anti-microbial, Convulsions	Leaves, Flower	Juice extract		Syringic acid, Caffeic acid, 4-hydroxy-3-methoxy cinnamic acid, 4-hydroxy benzoic acid, Hydroxy cinnamic acid, P-coumaric acid, Protocatechuic acid, Phosphoenolpyruvate, Ferulic acid, Astragalin, Friedelin, Luteolin, Quercetin glycosides, Epigallocatechin-3-O-syringate, Kaempferol glycosides, Isorhamnetin glycosides, Myricetin glycosides, α- and β-amyrin and their acetates, Glutinol, Bryophollone, Bryophynol, Bryophyllol, Bryophyllin A and B, Bryotoxin A, B and C; Bryophollenone, Patuletin and glycosides Taraxasterol, Stigmasterol, β-sitosterol, Stigmasta-dienol (Afzal et al., 2012)	Risk of cardiac glycoside poisoning due to the bufadienolides Bryotoxin A, B, C (McKenzie et al., 1987); Significant decrease in serum ALT levels in rats after daily oral dosing of 2 g/kg aqueous extract of the leaves (Ozolua et al., 2010)
35	*Calotropis procera* (Aiton) Dryand.	Apocynaceae	Sodom apple, Giant milkweed, Swallow wort, Mudar	Bomu-bomu (Y), Tumfafiya (H)	SW, NW	400 mg/kg dried latex decreased blood glucose in alloxan-induced diabetic rats, increased hepatic glycogen content and produced antioxidant effects (Roy et al., 2005)§; 250 mg/kg of different solvent extracts of the root decreased blood glucose levels in STZ-induced diabetic rats (Bhaskar and Ajay, 2009)§; Antioxidant effects (Olaleye and Rocha, 2007)	Inflammation, Hypertension, Anti-microbial, Anti-parasitic, Purgative, Convulsions, Abortifacient, Anti-cancer, Skin infections, Hemorrhoids, Anti-pyretic, Asthma, Leprosy	Leaves, Latex, Root, Stem bark, Flower	Maceration, Poultice		Calotroposide, Calotropin, Calotoxin, Calotoxoside, Calactin, Calotropain, Calotropa H genin, Proceroside, Uscharin, Uscharidin, Voruscharin, Amyrin (Oliver-Bever, 1986); Calotropterpenyl, Calotropursenyl acetate, Calotropfriedelenyl acetate, 2-propenyl-2′-hydroxy ethyl carbonate, Calotropin FI, FII, DI and DII, Uzarigenin, Ascleposide, Coroglaucigenin, Procerain (Juncker et al., 2009); Flavone-4′-O-β-glycoside, Epoxy dihydroxy methoxy cardenolide, β-anhydroepidigitoxigenin and its glycoside (Shaker et al., 2010); Calotropoceryl acetate A and B, Calotroprocerone, Calotroprocerol A, Pseudo-taraxasterol acetate, Taraxasterol, Stigmasterol, (E)-octadec-7-enoic acid (Ibrahim et al., 2012); CP-P (Apolipoprotein A-1) (Samy et al., 2012)	Cardenolides present in the plant are capable of causing death in mammals at high concentration thus caution should be exerted when extracts of the plant are being ingested (Juncker et al., 2009)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
36	*Capsicum annum* L., Syn: *Capsicum frutescens* L.	Solanaceae	Chilli, Bird pepper	Ata or Ata wewe (Y), Ose (I), Barkono (H), Asin (Es)	SW, SE	Alpha glucosidase and α-amylase inhibitory activities and antioxidant effects (Oboh et al., 2011; Kwon et al., 2007); Incorporation of 2% of the fruit powder in a high fat diet given to STZ-induced diabetic rats increased serum insulin levels (Islam and Choi, 2008)§; 100 mg/l fruit extracts possessed PPAR alpha and gamma agonistic activity (Rau et al., 2006)§	Analgesic, Antimicrobial, Inflammation, Hemorrhoids, Fevers, Dysentry, Malaria, Carminative, Stimulant	Fruit	Decoction		Capsaicinoids (Schweiggert et al., 2006); Myricetin, Kaempferol, Apigenin, Luteolin, Quercetin (Miean and Mohamed, 2001); CAY-1 (Stergiopoulou et al., 2008); Alpha tocopherol (Ching and Mohamed, 2001); Ortho hydroxyl N-benzyl 16-Methyl 11,14-diene octadecamide, 9, 12-diene-octadecanoic acid (Dastagir et al., 2012); Capsianocide VIII, IX, L, III, V, I and its methyl ester, Oxylipin, Capsidiol, Phosphatidylcholine, Loliolide, Blumenol C glucoside, 3-O-(9,12,15-octadecatrienoyl) glyceryl-β-D-galactopyranoside (De Marino et al., 2006)	
37	*Carica papaya* L.	Caricaceae	Pawpaw	Ibepe (Y), Okworo bekee or Okwere (I), Gwanda (H)	NW, SS, SW	100–400 mg/kg of the aqueous seed extract decreased blood glucose and improved serum lipid levels in normal rats (Adeneye and Olagunju, 2009); 400 mg/kg aqueous extract of the leaves decreased blood glucose in alloxan-induced diabetic rats (Maniyar and Bhixavatimath, 2012)§; Administration of 602 g of the fruit (equivalent to 50 g carbohydrate) to type 2 diabetic patients produced an increase in serum insulin levels in the patients (Fatema et al., 2003)§; Antioxidant effects of different parts of the unripe fruit (Oboh et al., 2013)	Anti-microbial, Anti-parasitic, Dyspepsia, Hemorrhoids, Hypertension, STDs, Purgative, Wound healing, Antivenin, Sickle cell anemia, Abortifacient, Anti-fertility, Cancer, Mental disorder, Malaria, Convulsion	Leaves, Fruit pulp, Seed, Latex	Infusion Decoction, Vegetable, Juice extract		Caffeoyl and Protocatechuic acid hexoside, Gallic acid deoxyhexoside, Caffeoyl hexose-deoxyhexose, Ferulic and Caffeic acids, Myricetin, Isoharmnetin, Quercetin, Kaempferol, Rutin, Lycophene, β-cryptoxanthin, β-carotene, (Rivera-Pastrana et al., 2010); Chlorogenic and P-coumaric acids, 5,7-dimethoxy coumarin (Canini et al., 2007); Papain, Chymopapain A, B and C, Peptidase A and B, Lysozyme, Carpasamine, Dehydrocarpaine I and II, Carpaine, Aryl glucosides, Carposide, Caricin, Choline, Tropaeaoline (Krishna et al., 2008)	Aqueous extract of the leaves in alloxan-induced diabetic rats delayed the hypoglycaemic activity of glimepiride but hastened that of metformin (Fakeye et al., 2007); Contraindicated in patients taking warfarin as it increased the INR of a patient (Shaw et al., 1997); Aqueous extract of the leaves inhibited P-gp efflux activity in Caco-2 cells (Oga et al., 2012)
38	*Cassia fistula* L.	Leguminosae	Indian laburnum, Golden shower	Aidantoro (Y)	SW	*In vitro* antioxidant effects (Luximon-Ramma et al., 2002; Manonmani et al., 2005); Hexane extract of the stem bark produced a dose dependent decrease in alloxan-induced diabetic rats (Nirmala et al., 2008); Ethanol and ethyl acetate extract of the bark decreased blood glucose levels in alloxan-induced diabetic rats	Liver disorders, Anti-microbial, Purgative, Astringent, Hemorrhoids, Rheumatism, Ulcers, Jaundice	Seeds, Leaves, Pods, Stem-bark		Catechin isolated from the stem bark decreased plasma gucose levels and increased the activity of glucose metabolizing enzymes in STZ-induced diabetic raats (Daisy et al., 2010)	Fistucacidin, Kaempferol, Rhein, Leucoperlagonidin derivatives, Sennoside A and B, Epiafzelechin and its 3-*O*-β-D-glucopyranoside, Epicatechin, Catechin, Procyanidin B2, Rhamnetin -3-*O*-gentibioside, Physcion, Chrysophanol, Fistulin, Fistulic acid, 3-formyl-1-	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						(Malpani and Manjunath, 2012)					hydroxy-8-methoxy anthraquinone, 3β-hydroxy 17-norpimar -8 (9)-en-15-one (Bahorun et al., 2005); 1,8-dihydroxy-6-methoxy-3-methyl anthraquinone, Tetrahydroxy dimethoxy flavone-3-*O*-α-arabino pyranoside, Trihydroxy trimethoxy flavone-3-O-α-L-rhamnosyl (1→2)-O-β-D-glucopyranoside, β-Sitosterol, Hexacosanol, Lupeol (Kanth et al., 2012); Aurantiamide acetate, Betulinic acid, Xanthone glycoside, Cyclopropenoid fatty acids, Biochanin A, Phytol, Lectins CSL-1. 2 and 3, Furfural derivatives, Fatty acids, Citreorosein, Scopoletin, Chromones and Benzyl derivatives (Danish et al., 2011)	
39	*Cassia sieberiana* DC.	Leguminosae	African laburnum, Drumstick tree	Ukosei (Es), Margaa (H), Margaje (F), Aridan-tooro (Y)	NC, NW, NE, SS,	*In vitro* antioxidant effects (Awah et al., 2012)	Veterinary, Antimicrobial, Anti-parasitic, Impotence, Convulsion, Inflammation, Analgesic, Malaria, Dys-menorrhea	Root, Leaves, Stem-bark	Decoction		Epiafzelechin (Kpegba et al., 2011); Myricetin and Quercetin 3-O-rhamnoside (Asase et al., 2008); Leucopelargonicol, Epicatechol, β-sitosterol, Stigmasterol (Tamboura et al., 2005)	Traditional use of the plant is associated with GIT side effects (Maiga et al., 2005); Liver and kidney toxicities of aqueous extracts of various parts of the plant (Toma et al., 2009; Obidah et al., 2009)
40	*Cassytha filiformis* L., Syn: Cassytha americana	Lauraceae	Love vine, Woevine	Rumfar-gada (H), Sulunwahi (F), Otetebilete (Id)	SE, NC	Administration of 600 mg/kg methanol extract of the stem bark to alloxan-induced diabetic mice decreased blood glucose levels by 46.8% (Ezeigbo and Asuzu, 2010) *In vitro* antioxidant effects (Mythili et al., 2011)§	Anti-parasitic, Uterotonic, Hypertension, Diuretic, Aphrodisiac, Hemorrhoids, Anti-cancer, Anticoagulant, Hemorrhage	Whole plant	Decoction, Dried parts are chewed before meals		Cassythidine, Cassyfiline (Cassythine) and O-methyl cassyfiline, Cassamedine, Neolitsine, Cassameridine, Actinodaphnine and N-methyl actinodaphnine, Cassythicine, Cassythidine, Dicentrine, Bulbocapnine, Nornuciferine, Launobine (Cava et al., 1968); Cathafiline, Cathaformine, Lysicamine, Cassyformine, Predicentrine, Filiformine, Isoboldine, Thalicminine, Stepharine, Pronuciferine, Ocoteine, Syringaresinol, Diasyringaresinol, Yangambin, O-methyl flavinatine, Isovanillin, Vanillin, β-sitosterol and Stigmasterol and their D-glucosides (Chang et al., 1998); Isorhamnetin,	250 mg/kg aqueous extract of the whole plant increased cholesterol levels in mice and decreased plasma ALP levels (Babayi et al., 2007) Non-selective cytotoxicity to both cancer and non-cancer cell lines (Stévigny et al., 2002)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Quercetin and Kaempferol glycosides; Isorhamnetin, Cassythic acid, O-methyl cassythine, Isofiliformine, Phenylalcohol glycoside, Salutaridine, Nicotinic acid (Tsai et al., 2008)	
41	*Catharanthus roseus* (L.) G.Don	Apocynaceae	Madagascar periwinkle			250 mg/kg methanol extract of the leaves decreased blood glucose levels in alloxan-induced diabetic rats and increased the hypoglycaemic effect of metformin but not glibenclamide (Ohadoma and Michael 2011); Juice extract of the fresh leaves of the plant gave a dose dependent (0.5–1 ml/kg) decrease in blood glucose levels in normal and alloxan-induced diabetic rats (Nammi et al., 2003)§; 500 mg/kg dichloromethane methanol (1:1) extract of the aerial parts showed a prophylactic action against STZ-induced hyperglycaemia in rats and increased the activity of some glucose metabolizing enzymes (Singh et al., 2001)§	Cancer, Malaria, Insect stings, Sore throat, Antibiotic, Diuretic, Expectorant, Wound healing, Hemorrhage, Hypertension	Whole plant, Leaves, Flower, Roots	Decoction		Hexamethyl-15-hydroxy methylene-*n*-octacostriene-10,18-diol-10-β-D-gluco pyranoside, 3-Epibetulinic acid, *n*-pentadecanyl octa-dec-19-enoate, β-Sitosterol (Chung et al., 2007); 3-*O*-glucosides and 3-*O*-(6-*O*-*p*-coumaroyl) glucosides of Hirsutin, Malvidin and Petunidin (Piovan and Filippini, 2007); Benzoic acid derivatives, Vanillic, Gallic, Cinnamic, *o*- and *p*-Coumaric, Caffeic and Ferulic acids; Hydroxy tyrosol, kaempferol, Quercetin, Syringetin glycosides (Mustafa and Verpoorte, 2007); Ursolic and Oleanolic acids (Usia et al., 2005); Ajmalicine, Serpentine, Lochnerine, Tetrahydroalstonine, Reserpine, Akuammine, Vinblastine, Vindoline, Perivine, Leurosine, Leurosidine, Virosine, Catharanthine, Vindolinine, Lochnericine, Pleurosine, Vincarodine, Catharicine, Leurocristine (Vincristine), Sitsirikine, Carosine (Svoboda et al., 1962)	Potent inhibitory effects on Cyp 2D6 of human liver microsomes of ajmalicine and serpentine isolated from the aerial parts (Usia et al., 2005); The vinca alkaloids are metabolized by Cyp3A4 and 3A5 enzymes; while vincristine and vinblastine have been identified as P-gp substrates in canine renal cells (Levêque and Jehl, 2007)
42	*Chrysophyllum albidum* G.Don	Sapotaceae	African star apple, Cherry	Agbalumo (Y), Udala (I)	SE, SW	100 and 200 mg/kg hydro-ethanol extract of the seed cotyledon given to alloxan-induced diabetic mice for 7 days decreased serum glucose levels (Olorunnisola et al., 2008)	Cancer, Miscarriage, Hemorrhoids, Asthma, Analgesic, Inflammation, Anti-microbial, Anti-parasitic	Seeds, Stem-bark, Leaves, Fruit, Root	Decoction		Eleagnine, Anacardic acid, Ascorbic acid (Idowu et al., 2006); Myricetin-3-rhamnoside (Adebayo et al., 2011)	
43	*Citrus aurantiifolia* (Christm.) Swingle	Rutaceae	Lime	Osan wewe (Y), Oroma nkilishi (I), Igbopin-nigue (Es),	SW	*In vitro* antioxidant effects (Guimarães et al., 2010)§	Worm expeller, Weight loss, Anti-microbial, Anti-cancer, Anti-parasitic, Colds, Arthritis	Fruit	Juice extract		α- and β-pinene, P-cymene, Limonene and its oxide, Linalool and its oxide, Citral, α- and β-terpineol, Myrtenol (Asnaashari et al., 2010); Isoswertisin, 6-O-α-	Bergamottin and other furanocoumarins found in citrus fruits have been identified as inducers and inhibitors of Cyt P450 enzymes (Baumgart et al., 2005)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											arabinopyranosides of vitexin and isovitexin (Veitch and Grayer, 2011); Bergamottin, Limettin, Bergapten, 5-geranyloxy-7-methoxycoumarin, Isopimpinellin, 3-methyl-1,2-cyclopentadione, 1-methoxy-cyclohexene, Corylone, Umbelliferone, 5,8-dimethoxypsoralen, Hexenone, Caryophyllene oxide, Palmitic, Linoleic, Oleic acids, Bergamotene (Sandoval-Montemayor et al., 2012); Imperatorin, Kaempferol, Myricetin, β-sitosterol, Rutin, 4,5,7-trihydroxy-3,6-dimethoxy flavones (Shalaby et al., 2011)	
44	*Citrus aurantium* L.	Rutaceae	Sour orange, Seville orange	Osan ganinganin or, Ijaganyin (Y), Oloma oyibo (I), Babban lemu (H), Ntom (Ibibio)	SS	875 mg of a mix of extracts of the fruit and *Rauvolfia vomitoria* foliage (RC tea) decreased serum glucose levels in diabetes type 2 model db/db mice and also decreased tissue lipid accumulation (Campbell et al., 2006); RC tea given daily for 4 months to type-2 diabetic patients decreased fasting and post prandial plasma glucose levels especially in patients with HbA1c levels $<7.3\%$ (Campbell-Tofte et al., 2011)	Weight loss, GIT probems, Malaria, Fibroids, Cancer, Cough	Fruit, Leaves, Root, Stem-bark, Stem-twigs	Juice extract, Decoction		Synephrine, Octopamine, Limonene, Hesperidin, Neohesperidin, Naringin, Tangaretin, Bergapten, 6,7-dihydroxybergamottin (Fugh-Berman and Myers, 2004); Linalool, Nerol, Limonin, Methyl antranilate, Rutoside, Hesperidoside, Neohesperidoside, Naringoside, Sinensetoside, Meranzin, Nobiletin, Narirutin, Rhoifolin, Citric, Ascorbic and Malic acids (Arias and Ramón-Laca, 2005); Didymin, Eriocitrin, Neoeriocitrin, Poncirin (Peterson et al., 2006)	Bergapten and 6,7-dihydroxybergamottin inhibit Cyt P450 enzymes (Malhotra et al., 2001); Risk of cardio-toxicity due to synephrine (Calapai et al., 1999)
45	*Citrus sinensis* (L.) Osbeck	Rutaceae	Orange	Osan mimu (Y), Oroma (I), Lemun misra (F), Alimo (Es)	SW[a]	Antioxidant effects (Guimarães et al., 2010)[§]; Free and bound phenolics extracted from the dried fruit peel exhibited potent dose-dependent α-amylase and α-glucosidase inhibitory effects (Oboh and Ademosun, 2011)		Fruit, Seed	Juice extract Infusion		Psoralene, Xanthotoxin, Bergapten, Imperatorin, Mamesin, Umbelliferone, Quercetin and its glycoside, 4,5,7-trihydroxy-3,6-dimethoxy flavone, Rutin, Hyperin, Hesperidin, β-sitosterol, Stigmasterol (Shalaby et al., 2011)	Bergapten has been shown to induce Cyp 3A4 (Malhotra et al., 2001)
46	*Citrullus colocynthis* (L.) Schrad.	Cucurbitaceae	Egusi melon, Desert gourd, Bitter apple, Bitter cucumber	Baala, Egusi	NW, SW	Saponin fractions of aqueous extract of the rind decreased plasma glucose at doses ≤ 50 mg/kg in fasted normoglycaemic and	Constipation, Purgative, Anti-tumour, Abortafacient, Oedema, Infections, Rheumatism	Leaves Fruit, Rind, Seed, Pulp	Infusion, Decoction		Cucurbitacin E, I, J, K and L 2-O-β-D-glucopyranosides, 3,4′-dihydroxy-3′-methoxy propiophenone, 3,4′-	Extracts of the plant have been shown to cause severe diarrhoea in animals with mortality at doses

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)[*]	Region of use for diabetes[#]	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						alloxan-induced diabetic rabbits (Abdel-Hassan et al., 2000)[§]; Plasma glucose levels and pancreatic β-cell mass were restored to normal in STZ-induced diabetic rats fed an 8% colocynth oil diet (Sebbagh et al., 2009)[§]; Antioxidant effects (Kumar et al., 2008)					dihydroxypropiophenone, Colocynthosides A and B, Khekadengoside E, Hexano cucurbitacin I 2-O-β-D-glucopyranoside, Helicid, Isovitexin, Isosaponarin, Isoorientin-3′-O-methyl ether, Benzyl and 4-hydroxybenzyl β-D-glucopyranoside, 4-(β-D-glucopyranosyloxy) benzyl alcohol (Yoshikawa et al., 2007); Isoorientin, 8-O and 6-O-*p*-hydroxybenzoyl isovitexin and its glucosdie (Maatooq et al., 1997); Oleic, Linoleic, Linolenic, Arachidonic, Palmitate, Stearic and Myristic acids (Sebbagh et al., 2009); 2-(nonan-8-one)-(1H)-4-quinolone, 2-(nonan-8-one) 4-methoxy-quinoline, (2S)-3,4-methylenedioxy-5,7-dimethoxyflavan, Hispidulin 7-(6-E-β-coumaroyl-β-D glucopyranoside (Salama, 2012)	≥200 mg/kg (Shafaei et al., 2012; Khoshvaghti and Hamidi, 2012); Possible inhibition of Cyp P450 enzymes when ethanolic extracts of the fruit were co-incubated with rat liver microsomes (Barth et al., 2002)
47	*Citrullus lanatus* (Thunb.) Mats. and Nakai	Cucurbitaceae	Water melon, Kalahari melon	Egusi bara (Y), Guna (H)		50 mg/kg globulin proteins extracted from the seeds decreased blood glucose levels when pre-administered to normal high glucose fed rats (Teugwa et al., 2013a)[§]; Antioxidant effects (Tlili et al., 2011)	Laxative, Wound ulcers, Anti-bacterial, Tumours	Leaves, Seeds, Fruit pulp	Decoction		Cucurbitacin E (Abdelwahab et al., 2011); Lycophene, Phytofluene, Neurosporene, ζ- and β-carotene, Lutein, Phytoene (Perkins-Veazie et al., 2006); Protocatechuic acid glucosides, Phloroglucinol glucuronide, Ferulic acid hexosides, Isorhamnetin, Citrulline, Salicylic acid-O-hexoside, *p*-coumaric acid glucoside, Vanillin hexosides, Rutin, Salicin-2-benzoate, Sinapic acid glucoside, Feruloyl sugars, Caffeoylshikimic acids, Caffeoylhexose, Luteolin, Calodendroside; Naringenin, Chrysoeriol Apigenin, Kaempferol, Taxifolin, Saligenin and Isolariciresinol glucosides; Hydroquinone, Isovitexin, Aviprins, Shikonine, Icariside, Leachianol G, Glehlinoside C, Ajugol,	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Dihydrophilonotisflavone, Catalposide, Obtusoside, Picrosides, Quercitrin, Coumarin, Cimifugin, (Abu-Reidah et al., 2013)	
48	*Cola acuminata* (P.Beauv.) Schott and Endl.	Malvaceae	Kolanut	Obi agada (Y), Orji (I)	SW	Antioxidant effects (Atawodi et al., 2007) 500 mg/kg of the methanol extract of the stem bark decreased blood glucose levels in alloxan induced diabetic rats after 21 days (Adediwura et al., 2011)	Stimulant, Appetite suppressants, Aphrodisiac, Respiratory infections, Hypertension, Anti-parasitic	Nuts, Stem-bark, Leaves	Decoction, Juice extract		Procyanidin B1 and B2, Catechin, Epicatechin, Caffeine (Atawodi et al., 2007); Theobromine (Niemenak et al., 2008); Chlorogenic, Quinnic and Tannic acids (Odebode, 1996)	
49	*Corchorus olitorius* L.	Malvaceae	Long fruited jute, Jew's mallow	Ewedu (Y), Ulogburu (I)	SW	Methanol extract of the leaves inhibited both α-amylase and α-glucosidase enzymes (Oboh et al., 2012a) Antioxidant effects (Azuma et al., 1999)	Purgative, Diuretic, Tumours, Analgesic, Cystitis, Measles	Leaves, Seeds	Decoction		3,5-Dicaffeoylquinic acid, Quercetin-3-galactoside, Quercetin-3-glucoside, Quercetin-3-(6-malonyl glucoside), Quercetin-3-(6-malonyl galactoside), Ascorbic acid, α-tocopherol (Azuma et al., 1999); Kaempferol glycosides, Rutin, Isoquercitrin (Sakakibara et al., 2003); Dicaffeoyl quininc acids, Caffeoyl and Dicaffeoyl quinic derivatives, Hyperoside, Chlorogenic acid, Isoquercitrin, Quercetin derivative (Ola et al., 2009); Corchorusides A and B, Capsugenin-25,30-*O*-β-diglucopyranoside (Phuwapraisirisan et al., 2009); Caffeic acid and Isorhamnetin (Oboh et al., 2012a)	Ethanol extract of the aerial parts of the plant inhibited Cyt P450 3A4 and 3A7 (Agbonon et al., 2010)
50	*Croton lobatus* L.	Euphorbiaceae	Lobed croton, Cascarilla	Eru Alamo (Y)	SW		Wound ulcers, Purgative, Malaria, Dysentry	Fruit, Stems, Leaves, Seed			4,5-*O*-dicaffeoylquinic, acid Tiliroside, Isovitexin, Vitexin, Chlorogenic acid (Lagnika et al., 2009); Geranylgeraniol, Betulinic acid, Cholestan-3-one, 9,12,15-octadecatrienoic acid methyl ester, 3-(4-methoxy phenyl)-2-phenyl acrylic acid, Tetramethyl tetraentetracosanoic acid, Octadecadienoic acid, Tetramethyl-hexadeca tetraenyl ester, Lobaceride, Cholestan-5,7-dien-3-ol, Ergosterol, 3-hydroxy-choles-5-en-7-one, N-(2-hydroxy-1-phenyl-propyl)	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)[*]	Region of use for diabetes[#]	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											benzamide (Chabert et al., 2006)	
51	*Cucumeropsis mannii* Naudin	Cucurbitaceae	White melon, African melon	Egusi-itoo (Y), Ogiri (I)	SW	50 mg/kg of globulin proteins extracted from the seed when pre-administered to high glucose fed rats did not cause a significant decrease in blood glucose levels (Teugwa et al., 2013a)[§]; Antioxidant effects (Agbor et al., 2005)	Anti-microbial, Indigestion, Infant colic	Seed, Fruit	Juice extract, Powdered seeds		Linoleic acid, Oleic acid, Linolenic acid, Myristic acid, Palmitoleic acid, Palmitic acid, Arachidic acid, Stearic acid (Kapseu et al., 1993)	
52	*Curculigo pilosa* (Schumach. and Thonn.) Engl.	Hypoxidaceae	Golden eye grass, Donkey's ear	Epakun	SW	Antioxidant effects (Sofidiya et al., 2011)	Anti-microbial, Epilepsy, Infertility, Sickle cell, Purgative, STDs	Rhizome, Fruit	Decoction		Piloside A and B, Curculigoside, Curculigine, Nyasicoside, Pilosidine (Palazzino et al., 2000); B-amylase (Dicko et al., 1999); Nyasicoside, Pilosidine, Curculigine (Cometa et al., 2001)	
53	*Curcuma longa* L.	Zingiberaceae	Turmeric	Atale pupa	SW, NC	Ethanol extract of the rhizome incorporated in the diet of type 2 diabetic KK-A^{y}/Ta mice as 0.2–1 g/100 g produced a hypoglycaemic effect compared to control and showed PPARγ binding activity (Kuroda et al., 2005)[§]; Antioxidant effects (Selvam et al., 1995)[§]; Plasma insulin levels of healthy subjects were significantly increased 2 h after ingestion of 6g turmeric powder (Wickenberg et al., 2010)[§]	Peptic ulcer, Inflammation, Anti-microbial, Cancer, Malaria, Pesticide, Hypertension, Jaundice, Depression	Rhizome, Leaves, Flower, Roots	Decoction		Curcumin, Bisdemethoxy curcumin, Demethoxy curcumin and Ar-turmerone (Kuroda et al., 2005; Roth et al., 1998); Tetrahydrocurcumin (Pari and Murugan, 2007); α and β-Pinene, Myrcene, α, β and sesqui-Phelandrene, *p*-Cymene, 1,8-Cineole, α and γ-Terpinene, Ocimene, *p*-Methylacetophenone, α-Terpinoline, Terpineol, Thymol, Linalool, ar- and γ-Curcumene, Carvacrol, α-Zingiberene, ar-Tumerone, Dehydrocurcumene, Bisaboline (Leela et al., 2002); Vanillin, Vanillic acid, Ferulic acid and Ferulic aldehyde (Appiah-Opong et al., 2007)	Methanol extracts of the rhizome inhibits CYP 3A4 activity in Caco-2 cells (Hou et al., 2007); Cuurcumin and its decomposition products inhibited CYP 1A2, 3A4, 2D6, 2C9 and 2B6 enzymes in *Escherichia coli* transfected with human plasmid cDNA (Appiah-Opong et al., 2007); Methanol extract of the rhizome enhances P-gp efflux activity but curcumin inhibits it (Hou et al., 2008)
54	*Cymbopogon citratus* (DC.) Stapf	Poaceae	Lemon grass	Koriko-oba (Y), Nche awula (I), Ihumibo (Es)	SW, SE	Aqueous extract of the leaves produced a dose dependent (125–500 mg/kg) decrease in fasting plasma gucose levels after oral administration to normal rats for 42days (Adeneye and Agbaje, 2007); Antioxidant effects (Cheel et al., 2005)	Oral thrush, Inflammation, Athlete's foot, Fever, Cough, Malaria, Jaundice, Cancer, Infections, Diuretic, Hypertension, Obesity, Sedative, Insecticidal, Aroma-therapy	Leaves	Decoction, Infusion, Juice extract	Geraniol, myrcene and citral were identified as aldose reductase inhibitors based on an in-silico approach (Vyshali et al., 2011)	Isoorientin, Isoscoparin, Swertiajaponin, Isoorientin 2′-*O*-rhamnoside, Orientin, Chlorogenic acid, Caffeic acid (Cheel et al., 2005); p-Coumaric acid, Myrcene, Limonene, α-Ocimene, α-Pinene, α-Caryophyllene, Phellandrene, Methyl heptenone, Cimbopogonol, Oxobisabolene, Geraniol, Citral, Anisaldehyde, Cinammonaldehyde, Citronelal, Valeric, Salicyaldehyde, Luteolin	Aqueous extract did not inhibit P-gp efflux activity in Caco-2 cells (Oga et al., 2012)

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											and its 6-C and 7-O-glycosides, Quercetin, Kaempferol, Apigenin, Hydroquinone, Catechol, Citronelol, 1,8-Cineole, Myrcene, Tria and Dotriacontanol, Octa and Hexacosanol, Menthol, Elemicin, Linalool, Fuco- and sitosterol (Negrelle and Gomes, 2007)	
55	*Daniellia oliveri* (Rolfe) Hutch. and Dalziel	Leguminosae	African balsam	Iya (Y), Maje (H), Ozabwa (I)	SE, NE	100, 200 and 400 mg/kg aqueous leaf extract decreased blood glucose levels in normal and alloxan-induced diabetic mice (Manosroi et al., 2011); 250 mg/kg aqueous extract of a mixture of the root with that of *Sacrocephalus latifolius* for 21 days decreased blood glucose levels and increased the activity of various glucose metabolizing enzymes in alloxan-induced diabetic rats (Iwueke et al., 2010); Antioxidant effects (Muanda et al., 2011)	Analgesic, Inflammation, Anti-infective, Aphrodisiac, Hemorrhoids, Spasms, Fevers, Diarrhea, Wound ulcers, Tumours, Sickle cell	Root, Leaves, Stem bark	Maceration		Daniellic acid, Oliveric acid (Haeuser et al., 1970); Gallic acid, Protocatechuic acid, Chlorogenic acid, Caffeic acid, *p*-Coumaric acid, Homo-orientin, Orientin, Catechin, Rutin, Quercitrin, Quercitrin glucosyl, Quercitrin dehydrate, Coumarin, Delphinidin, Ascorbic acid (Muanda et al., 2011); Caryophyllene oxide, α-and β-Hunulene, Humulene oxide, Humulenol, β-Selinene, Cadinene, Germacrene (Schwob et al., 2008); Narcissin, Quercimeritrin, Quercitrin (Ahmadu et al., 2004)	
56	*Detarium microcarpum* Guill. and Perr.	Leguminosae		Taura (H), Ogbogbo (Y), Ofo (I)	NE, SE, NC	200 and 400 mg/kg aqueous bark extract decreased blood glucose levels in normal and alloxan-induced diabetic mice after 3hrs (Manosroi et al., 2011); 100 mg/kg of the gum administered alone or incorporated in a tablet containing 400 mg/kg metformin showed good blood glucose reducing effects in STZ-induced diabetic rats (Adikwu et al., 2004)	Anti-microbial, Anti-parasitic, Molluscicidal, Hemorrhoids, Malaria, Impotence, Sickle cell, Diarrhea	Bark, Seeds, Fruit, Gum, Roots	Decoction, Seed powder		3,4-Epoxyclerodan-13*E*-en-15-oic acid, 5α,8α(2-oxokovalenic acid), 3,4-dihydroxyclerodan-13*E*-en-15-oic acid, 3,4-dihydroxy clerodan-13*Z*-en-15-oic acid, 2-oxokolavenic acid, Copalic acid (Cavin et al., 2006); Sitosterol, Lupeol, Stigmasterol, Campestrol, γ-quinide, Bornesitol, Pinitol, Myoinisitol (Akah et al., 2012); Myristoleic, Myristic and Linolenic acids (Igwenyi and Akubugwo, 2010); 1-naphthalene acetic-5-carboxy 6octahydro trimethyl acid, 1-naphthalene acetic-7-oxo-octahydro tetramethyl acid (Aquino et al., 1992)	Incorporation of 100 mg/kg of the gum extract into metformin tablets enhanced drug release from the formulation (Adikwu et al., 2004)
57	*Ficus exasperata* Vahl	Moraceae	Fig tree, Forest sandpaper	Eepin or Opoto (Y), Ogbu (I)	SW[a]	100 mg/kg aqueous extract of the leaves given for 30 days decreased blood glucose levels in obese zucker rats	Analgesic, Arthritis, Hemorrhoids, Hypertension, Arrythmias,	Leaves, Root, Fruits, Latex	Decoction		Glycerol-1,3-dilinolein, 3-*O*-glycerol acetate, Pheophorbides-a, -b and their derivatives,	High doses of the ethanol leaf extract can lead to toxic injury in

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						and spontaneously hypertensive STZ-treated rats (Adewole et al., 2011); and reversed nephrotoxic effects of STZ (Adewole et al., 2012); 250 mg/kg aqueous extract of the leaves in fructose-fed rats improved glycaemic control (Taiwo et al., 2010); α-glucosidase & α-amylase inhibitory effects (Kazeem et al., 2013) Antioxidant effects (Abotsi et al., 2010)	Abortafacient, Child birth, Insomnia, Infections, Eczema, Cancer, Fevers, Diarrhea, Ulcer, STDs				Pyropheophorbide, N-methyl pyrimidine (Bafor et al., 2013); α-Terpineol, α and β-Pinene, Sabinene, β-Patchoulene, 1,8-cineole, α-thujopsene, β-ocimene, Limonene, Linalool, β-caryophyllene, Isocaryophyllene, β-bisabolene, α-copaene, Globulol (Oladosu et al., 2009)	liver and kidneys (Ahmed et al., 2012)
58	*Ficus thonningii* Blume	Moraceae	Loin cloth or Wild fig, Chinese banyan	Cediya (H)	SW	0.5 mg/ml of the acetone extract of the leaves produced about 30% inhibitory effects against α-amylase and α-glucosidase enzymes (Olaokun et al., 2013); Dose dependent blood glucose lowering effects of the ethanol stembark extract in STZ-induced and normal diabetic rats (Musabayane et al., 2007)§	Malaria, Pain, Diarrhoea, Purgative, Anti-microbial	Leaves, Stem-bark	Decoction		Benzaldehyde, α- and β-pinene, β-caryophyllene, Zingiberene, α- and β-eudesmol, σ- and α-xylene, Phytol, Caryophyllene and Isocaryophyllene oxide (Ogunwande et al., 2008)	Possible testicular, lung and hepatic toxicities at doses ≥ 500 mg/kg (Aniagu et al., 2008)
59	*Garcinia kola* Heckel-	Clusiaceae	Bitter kola	Orogbo (Y), Agbi-ilu (I), Namiji-goro (H)	SW, SE	100 mg/kg kolaviron decreased blood sugar levels in normal and alloxan induced diabetic mice; as well as inhibited aldose reductase enzyme activity (Iwu et al., 1990a); Hypoglycaemic effect of kolaviron is due to GB1 and GB2 in normal and STZ-induced diabetic rats (Adaramoye and Adeyemi, 2006); Alpha glucosidase inhibitory effect of GB1 (Antia et al., 2010)	Cold symptoms, Anti-microbial, Diarrhea, Dysentry, Liver disorders, Aphrodisiac, Poison antidote, Sickle cell	Fruit Root, Stem-bark, Seed	Maceration	Kolaviron-Mix of GB1, GB2 and kolaflavanone (Iwu et al., 1990a)	Garcinia biflavanone (GB) 1, GB2, kolaflavanone (Cotterill et al., 1978); Apigenin-5,7,4′-trimethyl ether, Apigenin 4′-methyl ether, Amentoflavone, Fisetin (Iwu and Igboko, 1982); Conrauanalactone, Kolanone, Cycloartenol, 24-methylene cycloartenol, Manniflavanone, Garcini-flavanone (Iwu et al., 1990b); Lavender lactone, Linalol and its oxides, Methyl heptenone, Benzaldehyde, Phenylacetaldehyde, β-Myrcene, α-Terpineol, *p*-Cymen-9-ol, Geraniol, Geranial, β-Caryophyllene, Methyl phenylacetate, β-Farnesene, Manoyl oxide (Onayade et al., 1998); Garcinoic acid (Mazzini et al., 2009)	Pre-ingestion of the seeds by ten healthy volunteers 30 min prior to the administration of ofloxacin altered the serum pharmacokinetics of the antibiotic (Esimone et al., 2007); Pharmacokinetics of ciprofloxacin in rabbits was altered when co-administered with the seed extract (Esimone et al., 2002)
60	*Gongronema latifolium* Benth.	Apocynaceae	Bush buck	Utazi (I), Madumaro or Arokeke (Y), Utasi (Ef)	SE, SW, SS	Ethanol extract of the leaves decreased blood glucose levels in STZ-induced diabetic rats and increased	Anti-microbial, Anti-parasitic, Hypertension, Inflammation, Hepato-protective, GIT	Leaves, Stem, Root	Infusion Maceration, Food vegetable	The anti-hyperglycaemic effects of fractions of the methanol	β-Caryophyllene, α- and β-Pinene, Camphene, 1,8-Cineole, Linalol, α-Terpineol, Benzaldehyde,	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						activity of glucose metabolizing enzymes (Ugochukwu and Babady, 2003) Hypoglycaemic effect of 100 mg/kg of the methanol extract in alloxan-induced diabetic mice (Ogundipe et al., 2003) Antioxidant effects (Fasakin et al., 2011; Ugochukwu and Babady, 2002) 150 ml of a (1:1:1) decoction mix of the leaves of *Vernonia amygdalina*, *Ocimum gratissimum and Gongronema latifolium* decreased baseline blood glucose levels when preadministered to normal subjects 45 min before an OGTT (Ejike et al., 2013)	problems, Chewing stick, Laxative, Ulcer, Analgesic, Fevers			extract of the stem and leaves in glucose loaded rats as well as the *In vitro* glucose stimulating effects in INS-1 cells led to the isolation of α- and β-amyrin cinnamate, lupenyl cinnamate and lupenyl acetate as bioactive constituents (Adebajo et al., 2013)	Aromadendrene and its hydrate, α-Humulene, δ-Cadinene, Germacrene, α- and γ-Eudesmol, (E)-Phytol, Methyl palmitate (Edet et al., 2005); 3-*O*-[6-deoxy-3-*O*-methyl-β-D-allopyranosyl-(1→4)-β-D-canaropyranosyl-17β-mardenin and 3-*O*-[6-deoxy-3-*O*-methyl-β-D-allopyranosyl-(1→4)-β-D-oleoandropyranosyl-17β-mardenin, 11-*O*-acetyl- and 12-*O*-acetyl-3-*O*-[6-deoxy-3-*O*-methyl-β-D-allopyranosyl-(1→4)-β-canaropyranosyl]-17β-marsdenin (Schneider et al., 1993) Lupenyl acetate, Lupenyl cinnamate, β-Sitosterol, Lupeol (Ekundayo, 1980) α- and β-amyrin cinnamate (Adebajo et al., 2013)	
61	*Gossypium hirsutum* L.	Malvaceae	Cotton	Auduga (H); Ela-owu (Y); Eto-ofo (Ibibio); Owu (Ige); Ebe-oru (Bi)	NW	Aqueous extract of the leaves produced a non-significant blood glucose lowering effect of only 17% in alloxan-induced diabetic rats (Etuk and Mohammed, 2009)	Gonorrhea, Dysnetry, Sore throat, Malaria, Uterine fibroids	Leaves, Root	Decoction, Maceration		Gossypol, Condensed tannin (Chan et al., 1978); Quercetin glucosides, Gossypetin glucosides, Cyanidin-3-β-glucoside (Chrysanthemin) (Hanny, 1980); Myrcene, α- and β-pinene, Limonene, β-caryophyllene and its oxide, γ-bisabolene, Spathulenol, Gossonorol β-bisabolol (Elzen et al., 1985)	
62	*Gymnema sylvestre* (Retz.) R. Br. Ex Sm.	Apocynaceae	Cow plant		SE	GS4, a low MW component of the aqueous extract of the leaves decreased blood glucose levels and increased insulin release in rats, Type 1 and 2 diabetic patients (Shanmugasundaram et al., 1990a, 1990b; Baskaran et al., 1990)§; The action of GS4 on insulin release is by increased membrane permeability (Persaud et al., 1999)§; A high MW extract of the leaves OSA® increased plasma insulin levels *in-vitro* and in humans through a direct stimulatory effect (Al-Romaiyan et al., 2010)§;	Obesity, Anti-sweetner, Ulcer, Diuretics, Laxatives, Skin infectionsAsthma, Hepato-protective, Inflammation, Snake bites, Anti-microbial, Anti-plasmodial	Leaves, Roots	Infusion		Gymnemic acids I-XVIII, Gymnemagenin or Genin L and its acetate (β-amyrin derivative), Genins G and J, Genin K acetate, Gymnemasaponins I–V, Gymnemasins A–D, Gymnemanol, Gypenosides XXVIII, XXXVII, LV, LXII and LXIII, Gymnemasides I–VII, Oleanane-type saponins, Gurmarin, Gymnamine, Gymnemosides A–E (Porchezhian and Dobriyal, 2003); Gymnemic acids A–D (Sinsheimer et al., 1970); Choline, Betaine, Adenine,	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)[*]	Region of use for diabetes[#]	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						Antioxidant effects (Kang et al., 2012)[§]					Leucine, Valine, Amino butyric acid, Trimethylamine oxide, Isoleucine (Sinsheimer and McIlhenny, 1967); Nonacosane, Condruitol A, Hentriacontane, Tritricontane (Manni and Sinsheimer, 1965)	
63	*Hunteria umbellata* (K. Schum.) Hallier f.	Apocynaceae		Mkpokiri (I), Erin or Abeere (Y), Osu (Bi)		Aqueous extract of the seed produced a dose-dependent (50–200 mg/kg) hypoglycaemic effect in 3 diabetic models (alloxan, fructose and dexamethasone-induced) (Adeneye and Adeyemi, 2009); Antioxidant effects (Adejuwon et al., 2011); An alkaloidal fraction of the butanol extract decreased the post-absorptive glucose concentration in alloxan-induced rats (Adeneye et al., 2012)	Labour induction, Anti-pyretic, Analgesic, Obesity, Gastric ulcer, Dys-menorrhea, Anti-microbial, Anti-parasitic, Immune booster, Anti-helminthic, STDs, Hypertension	Seeds, Fruit Pulp, Bark, Roots	Maceration, Decoction, Infusion		Ikirydinium A, Ursolic acid, Serpentine, Pseudo-akuammigine, Huntrabrine methochloride, Strictosidinic acid (Ajala et al., 2011); Corymine, Isocorymine, Acetylcorymine, Dehydro-isocorymine, Umbellamine, Eripine, Erinin, Erinincin, Abereamines 1-4 (delactonized 14-isopropyl hydroxy isocorymines) (Adejuwon et al., 2012); Segunoside (Ajala and Coker, 2012)	
64	*Hymenocardia acida* Tul. (in vivo)	Phyllanthaceae	Heart fruit	Janyaro (H), Enache (Id)	SE, NC, NW	Methanol extract of the leaves decreased blood glucose levels in alloxan-induced diabetic rats at doses between 250 and 1000 mg/kg (Ezeigbo and Asuzu, 2010); Antioxidant effects (Sofidiya et al., 2009)	Anti-microbial, Anti-parasitic, Sickle cell, Ulcers, Diarrhea, Dysentry, Analgesic, Malaria, Tumours, Arthritis, Anti-fertility, Insecticidal	Bark, Fruit, Leaves	Decoction, Maceration, Infusion		Di-(2-ethylhexyl) phthalate, Homoorientin (Sofidiya et al., 2010); Friedelan-3-one, Betulinic acid, Lupeol, β-Sitosterol, Stigmasterol, Oleic acid (Igoli and Alexander, 2008); Hymenocardine (Pais et al., 1968)	
65	*Ipomoea batatas* (L.) Poir.	Convolvulaceae	Sweet potato	Ji-oyibo or Ekimako (I), Odunkun (Y), Dankali (H)	SW	Aqueous extract of fresh whole plants produced a dose-dependent (100–400 mg/kg) decrease in blood glucose in normal and STZ-induced diabetic rats (Olowu et al., 2011); Daily ingestion of 4 g by type 2 diabetic patients for 3 mths resulted in improved FBG and HbA1c levels (Ludvik et al., 2004)[§]; Improved glucose tolerance and decreased hyperinsulinemia in obese zucker fatty rats administered 100 mg/kg/day aqueous extract of the cortex (Shuichi and Abe, 2000)[§]	Anti-proliferative, Anti-microbial, Purgative, Wound ulcers, Analgesic, Hemorrhoids	Whole plant, Leaves, Bark	Juice extract, Infusion	Aldose reductase inhibitory effects of ellagic acid and 3,5-dicaffeoyl quinic acid isolated from extract of the leaves (Terashima et al., 1991); Alpha glucosidase inhibitory effect of an isolated anthocyanin Peonidin-3-*O*-[2-*O*-(6-*O*-*E*-feruloyl-β-D-glucopyranosyl)-6-*O*-*E*-caffeoyl-β-D-glucopyranoside from the root (Matsui et al., 2002)	Non-, Mono- and Diacylated structures of 3-*O*-(2-*O*-*β*-D-glucopyranosyl-*β*-D-glucopyranoside)-5-*O*-*β*-D-glucosides of Cyanidin and Penoidin (Montilla et al., 2011); Gallic, Gentisic, Caffeic, Chlorogenic, *p*-Coumaric, Sinapic, Benzoic, Anisic and Cinnamic acids; Catechin, Epicatechin, Kaempferol, Myricetin, Quercetin (Carvalho et al., 2010); 4,5-di-*O*-caffeoyldaucic acid, 3-*O*-caffeoylquinic acid (Chlorogenic acid), 3,5-di-*O*-caffeoylquinic acid, 3,4-di- *O*-caffeoylquinic acid, 3,4,5-tri-*O*-caffeoylquinic acid, Caffeic acid (Islam et	4-Ipomeanol produces an irreversible imhibition of Cyt 3A4 (Alvarez-Diez and Zheng, 2004)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											al., 2002); Ellagic acid, Caffeic acid, Scopoletin and 3,5-dicaffeoyl quinic acid (Terashima et al., 1991)	
66	*Irvingia gabonensis* (Aubry-Lecomte ex O'Rorke) Baill.	Irvingiaceae	Dikanut, African mango, Bush mango	Ogbono (I)	SE, SS, SW	Daily intake of a dikanut supplemented diet (4g/day) by type 2 diabetic patients for 1 month resulted in improved lipid profile and decreased blood glucose levels (Adamson et al., 1990) 2 g/kg administered 2 ce daily to STZ-induced diabetic rats decreased blood glucose, and lactate dehydrogenase and pyruvate kinase enzymes (Ozolua et al., 2006)	Dysentry, Wound ulcers, Liver disorders, Hemorrhage, Anti-microbial, Analgesic	Seeds, Fruit, Leaves, Stem-bark, Root	Decoction		3-Friedelanone, Betulinic acid, Oleanolic acid, Methyl gallate, Trimethyl ellagic acid, Hardwickiic acid, 3-β-acetoxyursolic acid (Donfack et al., 2010);	
						Overweight volunteers given the seed extract in a randomized double-blinded study had decreased blood glucose, adiponectin, leptin and C-reactive protein levels and improved plasma lipid profile compared to placebo (Ngondi et al., 2009)§ Antioxidant effects (Donfack et al., 2010; Awah et al., 2012)					Ellagic acid, Mono, Di and Tri-methyl ellagic acid and their glycosides, Galloyl ellagic acids, Ellagitannins, Kaempferol glucoside, Quercetin rhamnoside, Diosmetin (Sun and Chen, 2012)	
67	*Jatropha curcas* L.	Euphorbiaceae	Pignut plant, Physic nut, Purging nut, Barbados nut	Botuje or Lapalapa (Y), Binida zugu (H), Owulo idu	SW	Antioxidant effects (Igbinosa et al., 2011) 250 and 500 mg/kg of the hydro-ethanolic extract of the leaves decreased blood glucose levels in alloxan-induced diabetic rats (Mishra et al., 2010)§ 100 mg/l ethanol extract of the stipe showed PPARα, γ and δ activities (Rau et al., 2006)§ 250 and 450 mg/kg of the aqueous extract of the roots decreased fasting blood glucose levels in alloxan induced diabetic rats (Aladodo et al., 2013)	Purgative, Cancer, Abortifacient, Diuretic, Hemostatic, Anti-pyretic, Inflammation, Convulsions, Wound healing, Anti-microbial, Insecticidal, Jaundice, STDs, Anti-parasitic, Skin diseases, Molluscicidal, Chewing stick, Irregular menses, Sciatica, Paralysis	Seeds, Leaves, Root Latex, Stem-bark			Curcacycline A (van den Berg et al., 1995); Esterases, Lipase (Staubmann et al., 1999); Curcin, Curcain (Osoniyi and Onajobi, 2003); Scopaletin, Coumaroyl oleanolic acid, Methoxyanthraquinone, Heudelotinone, Tetradecyl ferulate, Podocarpatriene and Podocarpatrienone (Ravindranath et al., 2004);	Ingestion of the seeds caused severe vomiting and dehydration in children; and hemorrhage of the liver, lungs and stomach resulting in death at high doses in mice (Abdu-Aguye et al., 1986)
											Phospholipase D (Liu et al., 2010); Eicosadienoic, Oleic, Linoleic, Palmitic, Stearic and Eicosenoic acids; 12-deoxy-16-hydroxy phorbol, Riolozatrione, Jatrophol, Jatropholones A and B, Acetoxyjatropholone, Jatropherol 1, 2 and 3; Curcosones A-E, Palmarumycin, Caniojane, Heudolotione, Nobiletin,	Administration of 10 mg of the methanol extract of the seeds daily to rats resulted in changes in their hematological indices (Oluwole and Bolarinwa, 1997) Ethanol extract of the root bark of the plant inhibited Cyt P450 3A4 and 3A7 enzymes (Agbonon et al., 2010)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)[°]	Region of use for diabetes[#]	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Spirocurcasone, Ellagic acid, Jatrophalactam, Jatrogrossidione derivatives, β-amyrin, Jatrophalactone, Caffeoyl aldehyde, Syringaldehyde, Jatrophadiketone, Uracil, β-sitosterol, Jatrophalone, Taraxasterol, Stigmasterol, Daucasterol, Pyrrolidine, Curcamide, Tomentin, Coumarin compounds (Abdelgadir and Van Staden, 2013)	
68	*Khaya ivorensis* A.Chev.	Meliaceae	African, Lagos or Red mahogany	Oganwo (Y), Ono (I)	SW, SS, NC		Arthritis, Fevers, Anti-parasitic, Jaundice, SC anemia, Anti-tumour, Wound healing	Stem bark, Leaves	Maceration, Decoction, Infusion		1-*O*-deacetyl-6deoxy khayanolide E, 1-*O*-deacetyl-2α-hydroxy khayanolide E, 3-acetyl-khayalactone, 11α-acetoxy-2α-hydroxy-6-deoxy-destigloylswietenine acetate, Swiemahogin, Khayalactol, Seneganolide, Khayanolide A and B, Khayanoside (Zhang et al., 2009a); Methyl angolensate, and its 6-hydroxy derivative, 3-deacetylkhivorin, 3,7-dideacetylkhivorin, 1,3,7-trideacetylkhivorin, 7-deacetylgedunin, 7-deacetoxy-7-oxogedunin, Swietenine, 3-*O*-detigloyl-3-*O*-acetylswietenine, 3-*O*-acetylswietenolide (Abdelgaleil et al., 2001); Proceranolide and its n-butyric derivative (Vanucci et al., 1992); Khivorin, Sitosterol, 3-deacetyl khivorin, 7-deacetyl khivorin, Methyl 6-hydroxyangolensate, Swietenolide acetate, Fissinolide, Methyl ivorensate, Esters of 6-deoxyswietenolide (Adesogan and Taylor, 1970)	A herbal tonic containing a mix of extracts of the stem barks of *Khaya ivorensis, Mitragyna stipulosa and Kigela africana* modulated the activity of fat liver Cyt P450 enzymes (Martey et al., 2009) Aqueous extract of the stem bark modulates P-gp mediated efflux of Rhodamine-123 (Ezuruike et al., 2012)
69	*Khaya senegalensis* (Desv.) A.Juss.	Meliaceae	Dry-zone or African mahogany	Oganwo (Y), Ono (I), Madachi (H), Okpen (Es), Ago (Ig)	SW, SS, NC, NW	An extract of the bark in buffer solution produced moderate inhibition of α-amylase activity *in-vitro* (Funke and Melzig, 2006)	Fevers, Sickle Cell, Anti-parasitic, Anti-microbial, Anti-tumour, Hypertension, Insecticidal	Stem bark, Leaves, Seeds	Infusion, Maceration, Decoction		Rutin, Catechin, Quercetin rhamnoside, Procyanidins (Atawodi et al., 2009); 3α,7α-dideacetylkhivorin, 1-*O*-acetylkhayanolide B	

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						200 mg/kg aqueous extract of the bark produced only a 4% decrease in blood glucose levels after 2 h (Etuk and Mohammed, 2009); while the oil extract of the seeds decreased blood glucose levels by 20% after 2 h, which increased to 60% after 8hrs (Momoh and Muhammed, 2011), both in alloxan-induced diabetic rats. Antioxidant effects (Atawodi et al., 2009)					(Zhang et al., 2007); Khayanolides D and E, Khayanoside (Nakatani et al., 2002); Khayanolides A, B and C, Seneganolide, Methyl angolensate and its 6-hydroxy and 6-acetoxy derivatives (Abdelgaleil et al., 2001); Fissinolide, 2,6-dihydroxy fissinolide, Methyl-3β-acetoxy-6-hydroxy-1-oxomeliac-14-enoate (Khalid et al., 1998); 2-hydroxy mexicanolide, 6-deoxy destigloyl swietenine, 2,3-dihydroxy-3-deoxymexicanolide, Mexicanolide, 3β-hydroxy-3-deoxymexicanolide, 3β-hydroxy-3-deoxycarapin, 3-acetyl-7-keto khivorin, 3-deacetyl khivorin (Govindachari and Kumari, 1998); Methyl 1α-acetoxy tri hydroxyl-2α-methoxy-2β, 14β-epoxy tricyclomeliac-7-oate, Methyl 1α-acetoxy tetra hydroxyl-3-oxo-tricyclomeliac-7-oate, Scopoletin, β-quercitrin (Olmo et al., 1997)	
70	*Lawsonia inermis* L.	Lythraceae	Henna plant, Mehndi, Egyptian's priest	Laali (Y), Lelle (H)	SW	Alpha glucosidase inhibitory effects of the ethanol extract of the leaves (Prashanth et al., 2001)§ Increased activity of *in-vivo* antioxidant enzymes (Dasgupta et al., 2003)§ Daily administration of graded doses (100–800 mg/kg) of the ethanol extract of the leaves for 2 weeks decreased blood sugar levels in alloxan-induced diabetic rats (Inawati and Winarno, 2008)§ *In vitro* antioxidant effects of isolated constituents of the plant (Hsouna et al., 2011)§	Wound infection, Anti-microbial, Anti-parasitic, Jaundice, Nervous disorder, Arthritis, Analgesic, Ulcers, Diarrhea, Anti-pyretic, Hepato-protective, Leucorrhoea, Excessive ejaculation, Emmenagog, Skin diseases, STDs, Abortifacient, Sickle cell, Tumours, Tuberculosis, Splenomegaly, Menorrhagia	Leaves	Decoction	Lawsone and gallic acid isolated from the ethanol extract of the aerial parts inhibited the formation of glycated protein *In vitro* (Sultana et al., 2009)	β-Sitosterol glucoside, Gallic acid, Coumarins, Xanthones, Lawsoniaside, Lalioside, Luteolin glucosides, 1,2-dihydroxy-4-glucosyloxy naphthalene (Takeda and Fatope, 1988); Vomifoliol, Lawsonicin, Lawsonadeem (Siddiqui et al., 2003); Isoplumbagin, Hexenol, Linalool, β-Ionone, α- and γ-Terpineol, Terpinolene, δ-3-Carene, Benzaldehyde, Isocaryophyllene, Methyl salicylate, Naphthalene, Eugenol, Germacrene D, Farnesene, Bisabolene, β-Elemene, Isophytol, δ-Cadinene, Cadalene, Geranyl isobutyrate, Methyl cinnamate (Oyedeji et al., 2005);	Administration of henna leaf extract to mice for 21days resulted in increased activity of cytochrome b_5 reductase enzyme and the phase 2 enzymes GST and DDT (Dasgupta et al., 2003) Topical application to skin lesions in G6PD deficient patients resulted in hemolytic anemia (Kök et al., 2004)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Mannitol, Hennatannic acid, Lawsone (2-hydroxy 1,4-naphtoquinone), Behenic, Oleic, Linolenic, Arachidic, Palmitic and Stearic acids, Laxanthone I, II and III, Apigenin glycosides, Stigmasterol, Acacetin, Cosmosiin, *p*-Coumaric acid, Fraxetin, Hennadiol, Scopoletin, Esculetin, Apiin, Lupeol, Betulin, Betulinic acid, Lawsoshamim, 2-methoxy-3-methyl naphthaquinone, 24β-ethyl cholest-4-enol, Esters of Lawnermis acid (Chaudhary et al., 2010) Trihydroxy acetophenone and naphthalene gluco-pyranosides (Hsouna et al., 2011)	
71	*Mangifera indica* L.	Anacardiaceae	Mango	Mangoro	SS, SE	1 g/kg of the aqueous extract of the leaves decreased blood glucose levels in normal and glucose loaded mice, but not in STZ-induced diabetic mice (Aderibigbe et al., 2001) Alpha glucosidase inhibitory effects of the ethanol extract of the bark (Prashanth et al., 2001)§ 200 mg/kg aqueous extract of the leaves decreased blood glucose levels in alloxan-induced diabetic rats (Etuk and Mohammed, 2009) Dipeptidyl peptidase IV inhibitory activity of the methanol extract of the leaves (Yogisha and Raveesha, 2010)§ Antiooxidant effects (Badmus et al., 2011)	Malaria, Analgesic, Inflammation, Anti-microbial, Anti-helminthic, Diarrhoea, Menorrhagia, Hypertension, Insomnia, Asthma, Scabies, STDs, Anemia, Malaria	Leaves Stem-bark, Kernel, Fruits	Decoction		Tannic acid, Gallic acid, Epicatechin, Ellagic acid, Gallocatechin, n-butyl cyanidin (Arogba, 2000); 3,4-dihydroxy benzoic acid, Benzoic acid, Methyl gallate, Propyl gallate, Mangiferin, Catechin, Benzoic acid propyl ester (Núñez Sellés et al., 2002) Violaxanthin dibutyrate, β-Carotene, 9-*cis*- and *trans*-violaxanthin, Luteoxanthin, Mutatoxanthin, Neochrom, Xanthophyll palmitic and myristic acid esters (Pott et al., 2003); Isomangiferin, Quercetin and its glycosides, Kaempferol-3-*O*-glucoside, Rhamnetin-3-*O*-glycoside, Mangiferin and Isomangiferin gallate (Schieber et al., 2003; Berardini et al., 2005)	Stem bark extract of the plant, mangiferin and its metabolite norathyriol as well as quercetin, constituents of the plant showed dose-dependent modulation of P-gp activity in HK-2 and Caco-2 cell lines (Chieli et al., 2009) The stem bark extract also showed inhibitory effects for Cyp1A, 2D and 3A4 enzymes of human liver microsomes (Rodeiro et al., 2009)
72	*Manihot esculenta* Crantz, Syn: *Manihot utilissima* Pohl	Euphorbiaceae	Cassava, Tapioca	Gbaguda or Ege (Y), Akpu or Abacha (I), Rogo (H)	SE, SW	Increased intake of cassava leaves in diet decreases the risk of metabolic syndrome in Type-2 diabetic patients (Mvitu Muaka et al., 2010)§ Antioxidant effects of the aqueous extract of the leaves (Tsumbu et al., 2011)§	Arthritis, Gonorrhea, Burns, Ulcer	LeavesTubers	Decoction		β-Sitosterol glucoside, Stigmast-4-en-3-one, Galactosyl diacylglyceride, Galactocerebroside, Scopoletin, Isoscopoletin, Scoparone, Esculetin, Ayapin, Umbelliferone, Scopolin, Esculin, β-Carotene (Bayoumi et al.,	Although intake of a cassava tuber rich diet has been implicated in the aetiology of pancreatitic diabetes (Kamalu, 1991); experiments have shown that it only aggravates diabetes in

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											2010); Cyanidin and Delphinidin 3-*O*-(6″-*O*-α-rhamno pyranosyl-β-glucopyranoside) (Byamukama et al., 2009); Rutin, Kaempferol-3-*O*- and 4′-*O*-rutinoside, Ferulic acid, Amentoflavone (Ola et al., 2009); Caproic, Caprylic, Capric, Lauric, Myristic, Palmitic, Oleic, Linoleic, Arachidic, Behenic and Lignoceric acids (Raja and Ramakrishna, 1990); Linamarin, Lotaustralin (Ogunsua, 1980)	low-protein diets (Yessoufou et al., 2006; Manwa et al., 2010) Risk of toxic effects on organs due to high cyanide content (Soto-Blanco and Górniak, 2010)
73	*Momordica charantia* L.	Cucurbitaceae	African cucumber, Bitter melon, Bitter guord, Bitter squash, Karela	Ejirin (Y), Ebe isiugwu (Bi), Urakhanye (Es), Daddagu (H)	SW, SS, NW	Daily administration of 10 ml/kg of the fruit juice extract to STZ-induced diabetic rats for 10wks decreased blood glucose levels and increased plasma insulin levels and the number of insulin positive islet cells. There was decreased glucose uptake by the brush border vessicles of the jejunum in extract treated rats compared to control. *In vitro*, 5 μg/ml of the extract increased glucose transport into L6 myotubes (Ahmed et al., 2004) Several clinical studies in type-2 diabetic patients given extracts of the plant produced hypoglycaemic effects (Leung et al., 2009)§	Anti-fertility, Malaria, Anti-helminthic, Anti-microbial, Insecticidal, Weight loss, Abortifacient, Skin infections, Inflammation, Purgative, Dysentry, Fevers, Burns, Colic	Fruit, Leaves, Root, Seeds	Decoction, Juice extract		Esters, Alcohols and Sugars of Cucurbitane triterpenoids, Kuguacins, Charantosides, Trinorcucurbitacin, Penta-norcucurbitacins, Octa-norcucurbitacin (Lee et al., 2009); Momorcharins, Momordin, Momordolol, Charantins, Momordenol, Momordicilin, Charine, Momordicosides, Momordicines, Diosgenin, Cryptoxanthin, Vicine, Cucurbitins, Cucurbitacins, Cucurbitanes, Erythrodiol, Cycloartenols, Gentisic, Elaeostearic, Galacturonic and Pipecolic acids; MAP 30, Goyaglycosides, Goyasaponins, P-insulin polypeptide, Ascorbigen, Multiflorinols, Luteolin, Lauric, Myristic, Palmitic, Stearic, Palmitoleic, Oleic, Linoleic and Linolenic acids (Paul and Raychaudhuri, 2010)	Aqueous extract of the leaves inhibited GST enzyme in both rat and human liver cytosols and recombinant GSTs; as well as the activity of Cyp 2C9 supersomes but not Cyp 1A2, 2D6 and 3A4 (Appiah-Opong et al., 2008) A potentiated hypoglycaemic effect has been observed when extracts of the plant are co-administered with known anti-diabetic drugs (Nivitabishekam et al., 2009)
			Bitter melon	Ebe isiugwu (Bi)	SS		Malaria	Root	Juice extract			
74	*Momordica foetida* Schumach.	Cucurbitaceae		Ejinrin-wewe (Y)	SS	500 mg/kg aqueous leaf extract decreased blood glucose levels in normal, high glucose fed and alloxan-induced diabetic rats (Osinubi et al., 2008) Antioxidant effects (Acquaviva et al., 2013)	Malaria, Ulcer, GIT disorders, Anti-microbial, Anti-helminthic, Hypertension, Abortifacient	Fruit, Leaves, Stem, Flower, Whole plant	Maceration, Decoction	1 mg/kg foetidin isolated from the plant decreased blood glucose levels of normal fasted, but not alloxan-induced rats (Marquis et al., 1977)	5,25-stigmastadiene-ol-glucoside, Foetidin, β-sitosterol glucoside (Marquis et al., 1977); β-Hydroxyfriedel-6(7)-ene-3-one, Octadecanoic acid, Stigmasterol-β-D-glucoside, Choline chloride (Olaniyi, 1980); Cucurbitacins (Chen et al.,	

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											2005); 3β,7β-dihydroxyl-cucurbita-5,23,25-trien-19-al, Kaempferol-3-*O*-β-D-glucopyranoside (Odeleye et al., 2009)	
75	*Mondia whiteii* (Hook.f.) Skeels	Apocynaceae	White ginger, African ginger	Isirigun orAghuma orGbolo-gbolo (Y)	SW	Aqueous extract of the roots did not show any inhibition against pancreatic alpha amylase and lipase enzymes (Etoundi et al., 2010)§	Infertility, Erectile dysfunction, Malaria, Gonorrhea, Anti-parasitic, Anti-depressant, Anti-spasmodic, Hemorrhoids, Inflammation, Memory loss, Cancer	Stem, Root	Infusion, Decoction		Isovanillin, 2-hydroxy-4-methoxy benzaldehyde and its -2-*O*-β-D-glucopyranose-(1→6)-*O*-β-D-xylopyranoside (Koorbanally et al., 2000); Propacin, 5-methoxy propacin, 5-chloropropacin, Squalene, β-sitosterol, 3-methoxy-4-hydroxy benzaldehyde, 6-methoxy-7-hydroxycoumarin, 6-methoxy-7,8-dihydroxy coumarin (Patnam et al., 2005); Loliolide (Neergaard et al., 2010); Stigmasterol, 9-Hexacosene (Githinji et al., 2011); α and β-amyrin acetate (Watcho et al., 2012)	
76	*Morinda citrifolia* L.	Rubiaceae	Indian mulberry, Noni		SW	300 mg/kg of a mixture of the aqueous fruit extract alongside that of *Coccinia indica* decreased blood glucose levels in alloxan-induced diabetic rats (Kumar and Verma, 2011)§ Administration of 2 ml/kg of the fruit juice extract twice a day to STZ-induced diabetic rats for twenty days resulted in a significant decrease in fasting blood glucose levels by the 5th day post administration (Nayak et al., 2011)§ Antioxidant effects for the methanol extract of roots and ethyl acetate extract of plant (Zin et al., 2002)§ Administration of 1ml/ 150mg body weight of Tahitian noni juice® for 4 weeks resulted in a prophylactic action against alloxan-induced diabetes in rats (Horsfal et al., 2008).	Malaria, Wound healing, Anti-microbial, Anti-helminthic, Inflammation, Immune booster, Colds and Flu, Ulcers, Tumours, Analgesic, Arthritis, Hypertension, Tuberculosis	Fruits, Roots, Stems, Bark, Flower, Leaves	Decoction, Maceration	Hypoglycemic effects of the anthraquinones, damnacanthol-3-*O*-β-D-primeveroside and lucidin 3-*O*-β-D-primeveroside from the butanol fraction of the methanol extract at 100 mg/kg in STZ-induced diabetic mice. (Kamiya et al., 2008)	6-*O*-(β-D-glucopyranosyl)-1-*O*-octanoyl-β-D-gluco pyranose and 1-*O*-hexanoyl-β-D-glucopyranose, 3-methylbut-3-enyl 6-*O*-β-D-glucopyranosyl-β-D-glucopyranoside (Wang et al., 2000); Citrofolinin A and B, Kaempferol and Quercetin glycosides, Physcion, Ricinoleic, Octanoic, Hexanoic acids (Sang et al., 2001); Scopoletin, L-asperuloside, Alizarin, Asperulosidic, Caproic, Caprylic and Ursolic acids, Acubin, Rubiadin and its 1-methyl ether, Nordamnacanthal, Morindone, Rutin, 1-methoxy-2-formyl-3-hydroxy anthraquinone, Citrifolinoside, Proxeronine (Wang et al., 2002); Morenone-1 and 2, 6,8-dimethoxy-3-methyl anthraquinones 1-*O*-β-rhamnopyranosyl(1→4) β-D-glucopyranoside, 6α-hydroxyadoxoside, 6β,7β-epoxy-8-epi-splendoside,	Risk of liver injury/ hepatitis (Millonig et al., 2005; Yüce et al., 2006; Mrzljak et al., 2013) Noni juice extract increased the activity of amino-pyrine N-demethylase (APND) and glutathione-S-transferase (GST) enzymes and decreased the activity of uridine diphosphoglucuronosyl transferase (UGT) enzyme of rat liver hepatocytes both *In vitro* and *ex vivo* (Mahfoudh et al., 2009) Co-incubation of noni juice and digoxin in Caco-2 monolayers did not change the net digoxin flux indicating no modulation of P-gp by noni juice (Engdal and Nilsen, 2008)

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Borreriagenin, Deacetyl asperuloside, Dehydro methoxygaertneroside, 5,15-dimethyl morindol, Alizarin-1-methyl ether, Anthragallol-1,3-dimethyl ether, Anthragallol-2-methyl ether, 6-hydroxy-anthragallol-1,3-dimethyl ether, Morindone-5-methyl ether, Asuperlosidic acid, Deacetylasperulosidic acid, Morindacin (Kamiya et al., 2005);	
77	*Morinda lucida* Benth.	Rubiaceae	Brimstone tree	Oruwo (Y), Eze ogwu (I)	NC, SW	Administration of the methanol extract of the leaves produced a dose dependent (50-400mg/kg) decrease in plasma glucose levels in both normal and STZ-induced diabetic rats (Olajide et al., 1999)	Malaria, Anti-microbial, Anti-parasitic, Anti-helminthic, Analgesic, Laxative, Hypertension, Jaundice, Oligo-menorrhea, Insomnia, Wound ulcers, Diuretic	Leaves, Roots, Stem-bark	Decoction		Ursolic acid, Oleanolic acid (Cimanga et al., 2006) 1-Methylether alizarin, Soranjidiol, Damnacanthal, Nordamnacanthal, Lucidin, Rubiadin, Morindin, Munjistin, Purpuroxanthin, Digitolutein, Oruwalol, Oruwal (Lawal et al., 2012)	Aqueous extract dose dependently (1-20mg/ml) inhibited the P-gp mediated transport of digoxin across monolayers of Caco-2 cells (Oga et al., 2012) Aqueous extract and ethanol extract of the leaves moderately inhibited Cyp3A4 and 3A7 enzymes respectively (Agbonon et al., 2010) 0.5 mg/ml aqueous extract of the leaves inhibited the activity of the recombinant GST M1-1 enzyme by $>70\%$, but not those of rat and human liver cytosols (Appiah-Opong et al., 2008)
78	*Moringa oleifera* Lam.	Moringaceae	Drumstick orHorseradish tree, Moringa	Zogale (H), Okwe-oyibo or Okochi egbu (I), Gergedi (Igala), Ewe-igbale or Gbogbo-nise (Y), Konamarade (F)	SE, SW, NW, NC	Aqueous extract of the leaves decreased blood glucose levels in normal, high glucose fed and STZ-induced diabetic rats at doses between 100 and 300 mg/kg (Jaiswal et al., 2009)§ 200 mg/kg of the leaf powder improved glucose tolerance in both normal wistar and spontaneously type-2 diabetic GK rats (Ndong et al., 2007)§ Antioxidant effects (Siddhuraju and Becker, 2003)§	Antimicrobial, Anti-parasitic, Anti-cancer, Inflammation, Diuretic, Anemia, Hypertension, Aphrodisiac, Anti-pyretic, Purgative, GIT disorders, Immune stimulant, Anti-spasmodic	Leaves, Pods	Infusion, Dried leaves	Isolated benzyl derivatives from the methanol extract of the fruits stimulated insulin release from the pancreatic β-cell line INS-1 (Francis et al., 2004)	Quercetin and Kaempferol glycosides, Chlorogenic acid, Rutin (Ndong et al., 2007); Isoquercitrin, Rhamnetin, Vanillin, β-sitosterol, β-sitostenone, Zeatin, 4-hydroxymellin, Niazirin, Niazicin A, Methyl 2,4-(α-L-rhamnopyranosyl) phenyl acetate, *N*-[4-(β-D-glucopyranosyl)benzyl]-1-*O*-α-D-glucopyranosyl thiocarboxamide, 4-[(β-D-glucopyranosyl)-(1→3)-(α-L-rhamnopyranosyl) phenylacetonitrile, 1-*O*-phenyl-α-L-rhamno pyranoside, Methyl *N*-(4 [(4′-*O*-acetyl-α-L-	Aqueous and methanol extracts of the leaves inhibited Cyp3A4 hydroxylation of testosterone in human liver microsomes (Monera et al., 2008) Hydroalcoholic extract of the drumsticks increased the activities of hepatic Cyt P450 and Cyt b_5 enzymes as well as the antioxidant enzymes GST, GPx and GR (Bharali et al., 2003)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											rhamnopyranosyl)benzyl] carbamate, Methyl *N*-4-[(α-L-rhamnopyranosyl) benzy] carbamate, *O*-[2′-hydroxy-3′-2″-heptenyl oxy)]-propyl undecanoate, methyl *p*-hydroxybenzoate, Moringine, Moringinine (Anwar et al., 2007)	
79	*Morus alba* L.	Moraceae	White mulberry			Alpha glucosidase inhibitory effects of the aqueous extract of the leaves in Caco-2 cells (Hansawasdi and Kawabata, 2006)§ The leaf extract showed inhibitory effects against rat and human dissacharidase enzymes of the intestinal mucousa as well as decreased post-prandial glucose levels in sucrose fed rats (Oku et al., 2006)§ 400 and 600 mg/kg ethanol extract of the leaves decreased blood glucose levels in STZ-induced diabetic rats and increased the number of β-cells in the islets of the pancreas (Mohammadi and Naik, 2008)§ Ingestion of the leaf extract by KK-Ay mice as part of the diet decreased blood glucose levels, improved glucose tolerance and increased plasma insulin levels (Tanabe et al., 2011)§ Antioxidant effects (Yen et al., 1996)§	Anti-helminthic, Laxative, Emollient, Molluscicidal, Anti-microbial	Leaves, Fruit, Bark	Infusion, Decoction, Maceration		Morusin, Isomorusin, Compound A (Taro et al., 1978); Kuwanons K and L (Nomura et al., 1983); β-carotene, α-tocopherol (Yen et al., 1996); Isoquercitrin, Astragalin, Scopolin, Skimmin, Roseoside II, Benzyl D-glucopyranoside (Doi et al., 2001); 1-Deoxynojirimycin or Moranoline and its derivatives, Fagomine, Calystegin B1 and B2, (2R,3R,4R)-2-hydroxy methyl-3,4-dihydroxy pyrolidine-*N*-propionamide, 4-*O*-α-D-galactopyranosyl-calystegine B2, 3β,6β-dihydroxynortropane (Asano et al., 2001); Moralbanone, Kuwanon S, Mulberroside C, α-acetyl amyrin, Cyclomorusin, Eudraflavone-B hydroperoxide, Oxy dihydromorusin, Lechianone G (Du et al., 2003); Steppogenin-4′-*O*-β-D-glucosiade, Mulberroside A, Moracin M (Zhang et al., 2009b)	A sodium chloride extract of the leaves showed an insignificant dose dependent (2–6 mg/ml) inhibition of Cyp 3A4 enzyme activity in human liver microsomes (Pao et al., 2012)
80	*Murraya koenigii* (L.) Spreng.	Rutaceae	Curry tree, Sweet neem		NW, SW	Methanol extract of the stem and leaves did not significantly decrease blood glucose levels in normal and alloxan-induced diabetic rats; while chloroform extract of the stems and isolated constituents decreased glucose mediated insulin release from INS cells (Adebajo et al., 2005) Hypoglycaemic effect of defatted ethanol extract of the leaves in STZ-induced diabetic rats and Antioxidant	Dysentry, Diarrhoea, Stimulant, Anti-venom, Hypertension, Anti-microbial, Inflammation, Anti-parasitic	Leaves, Seed, Stem	Powdered leaves as spice, Decoction	Administration of mahanimbine isolated from the petroleum ether fraction of the leaves decreased blood glucose levels in STZ-induced diabetic rats and had a dose-dependent alpha amylase and alpha glucosidase inhibitory effect (Dineshkumar et	Indicolactone, 2″,3″-epoxy indicolactone, Anisolactone (Adebajo et al., 1997); Xanthotoxin, Phellopterin, Isogosferol, Byakangelicol, Gosferol, Isobyakangelicol, Neobyakangelicol, Byakangelicin (Adebajo and Reisch, 2000); Bismurrayafoline, Euchrestine B, Mahanine, Mahaninebicine, O-methyl mahanine, Isomahanine, Bismahane, 8,10-	Methanol extract of the leaves as well as isolated constituents of the plant inhibited Cyt P450 enzymes in rat liver microsomes. They also showed dose-dependent inhibitory effects against Cyp 1A2, 2C9, 2D6 and 3A4 enzymes (Pandit et al., 2012)

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						effects (Arulselvan and Subramanian, 2007)§				al., 2010) At a concentration of 1 mM, mangniferin showed 2-fold increase in glucose utilization in 3T3-L1 cells compared with untreated control (Dinesh Kumar et al., 2013)	tetrahydro dihydro tetramethyl bis(4-methyl-3-pentenyl)-bipyrano carbazole, Bispyrayafoline (Tachibana et al., 2003); Mahanimbilol, Grinimbine, Girinimbilol, Murrayanine, Isomahanimbine, Koenimbine, Murrayacine, Murrayaquinone-A, Murrayazolidine, Murrayazoline, Mahanimbine (Adebajo et al., 2005); Mahanimbilyl and Grinimbilyl acetate, Bicyclomahanimbiline (Adebajo et al., 2006); PI, PII, PIII (Ningappa and Srinivas, 2008)	
81	*Musa paradisiaca* L., Syn: *Musa sapientum* L.	Musaceae	Plantain Banana	Ogede (Y), Abrika (I), Ayaba (H)	SW	250 mg/kg aqueous and methanol extract of the root decreased blood glucose levels in alloxan (Adewoye et al., 2009) and STZ-induced diabetic rats singly and in combination with the leaves of *Coccinia indica* (Mallick et al., 2007)§; as well as *in vivo* antioxidant effects. Dose dependent hypoglycaemic effect of the methanol extract of the mature fruits in normal and STZ-induced diabetic mice (Ojewole and Adewunmi, 2003)	Anemia, Hypertension, Ulcers	Fruit	As a meal, Juice extract		14α-methyl cyclo-5α-ergost-24(28)-en-3β-ol (Knapp et al., 1972); α-glucan phosphorylase (Singh and Sanwal, 1975); Cycloeucalenol, 24-methyl cycloartanol, 31-nor cyclo laudenone, Trimethyl-5α-cholesta-dien-3β-ol (Dutta et al., 1983); Sitoindoside I, II, III and IV, Sitosterol gentiobioside, *Myo*-inosityl-β-D-glucoside, Sitosterol, Campesterol, Cycloartenol, Citrostadienol, Palmitic, Lauric, Myristic, Linoleic, Linolenic and Oleic acids; 24-ethyllophenol (Ghosal, 1985); Irenolone, Emenolone (Luis et al., 1993); Leucocyanidin, Leuco-anthocyanidin (Lewis et al., 1999); Polyphenol oxidase (Yang et al., 2000); *Rel*-(3S,4aR,10bR)-8-hydroxy-3-(4-hydroxy phenyl)-9-methoxy tetra hydro naphtopyran, 1,2-dihydro-trihydroxy-9-(4-methoxy phenyl) phenalene, Hydroxy anogorufone, 2-(4-hydroxyphenyl) naphthalic anhydride, 1,7-bis(4-hydroxy phenyl) hepta-4(*E*),6(*E*)-dien-3-one (Jang et al., 2002)	Polyvalent cations present in the plant has been shown to form non-absorbable complexes with quinolone antibiotics, thus affecting their pharmacokinetics if co-administered (Nwafor et al., 2003)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
82	*Ocimum gratissimum* L.	Lamiaceae	Scent leaf, African basil, Mint	Nchonwu (I), Efirin (Y), Daidoya (H)	SE, SS, SW[a], NW	200 mg/kg aqueous extract of the leaves improved glucose tolerance in normal and neonatal STZ-induced diabetic rats (Oguanobi et al., 2012) *In vitro* antioxidant effects (Akinmoladun et al., 2010) (Awah and Verla 2010) 400 mg/kg methanol extract of the leaves decreased blood glucose levels in normal and alloxan-induced diabetic rats (Aguiyi et al., 2000) 150 ml of a (1:1:1) decoction mix of the leaves of *Vernonia amygdalina*, *Ocimum gratissimum and Gongronema latifolium* decreased baseline blood glucose levels in normal subjects when preadministered to normal subjects 45 min before an OGTT (Ejike et al., 2013)	Diarrhoea, Malaria, Anti-microbial, Anti-parasitic, Anxiolytic, Analgesic, Inflammation, Wound healing, Cold symptoms, Hemorrhoids, Insect repellent, Anti-helminthic, Infant colic	Leaves	Infusion, Food vegetable		Oleanolic acid (Njoku et al., 1997); Xanthomicrol, Cirsimaritin, Rutin, Kaempferol 3-*O*-rutinoside, Luteolin 5-*O*- and 7-*O*-glucosides, Vicenin-2, Isothymusin, Apigenin 7-*O*-glucoside, Vitexin, Isovitexin, Quercetin 3-*O*-glucoside (Grayer et al., 2000); Thymol, Eugenol, Luteolin, Cirsiliol, α-Camphene, *p*-Cymene, 1,8-Cineole, Geraniol, γ-Caryophyllene, γ-terpinene, γ-terpineol, Terpinolene, α-Copaene, Methylchavicol, Anisole, γ-Selinene, γ-Murolene, Spathulenol (Vieira et al., 2001); Caffeic acid, Cichoric acid, Rosmarinic acid, Caffeoyl derivatives, Nevadensin (Ola et al., 2009)	Aqueous and ethanol extract of the leaves caused dose-dependent (400–3200 mg/kg) increase in AST and ALT enzyme levels, markers of hepatotoxicity (Ajibade et al., 2012; Onaolapo and Onaolapo, 2012)
83	*Parinari curatellifolia* Planch, ex Benth.	Chrysobalanaceae	Mobola plum	Ebere (Y)		Significant blood glucose lowering effects of 250 mg/kg of the aqueous ethanolic extract of the seeds in alloxan-induced diabetic rats (Ogbonnia et al., 2008b)	Malaria, Dysentry, Epilepsy, Toothache, STDs, Anti-cancer	Seeds, Root-bark			15-Oxozoapatlin and its 13-methoxy and 13-hydroxy derivatives (Lee et al., 1996); Quercetin-3-O-arabinoside, Quercetin-3-O-glucosyl galactoside, Quercetin-3-O-rhamnoside, Kaempferol-3,4-di-O-glucoside and glycoside, Kaempferol-3-O-glucoside, Quercetin-3-O-rutinoside, Kaempferol-3-O-rutinoside, Myricetin-3-O-rhamnoside, Myricetin-3-O-galactoside (Coradin et al., 1985)	
84	*Parkia biglobosa* (Jacq.) G.Don	Leguminosae	African locust beanSoumbala	Iru (Y), Ugba (I), Dawadawa (H)	SW	Diet supplementation with the aqueous and methanolic extract of the seeds (6 g/kg) resulted in $>60\%$ decrease in fasting blood glucose levels in alloxan-induced diabetic rats (Odetola et al., 2006)	Hypertension, Analgesic, Inflammation, Anti-microbial, Snake venom, Fevers, Diarrhoea, Anti-plasmodial, Anti-helminthic	Leaves, Root, Bark	Infusion		Epicatechin, Gallocatechin-*O*-glucuronide, Catechin-*O*-gallate-*O*-glucuronide and other catechin derivatives (Tala et al., 2013); Homogalacturonan, Arabinogalactan, Rhamnogalactans and Xylogalactans (El-Zoubair, 2010); Pyrazine derivatives, Dimethyl disulfide and trisulfide, Limonene, 2-Pentyl furan, Trimethyl oxazole, Indole, Methyl isothiazole, 4,4-Dihydro-2-methyl	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											thiazole, Trimethyl pyrazole, (Ouoba et al., 2005); Ferulic acid, Isoferuloyl alkanoyl glycerol, Feruloyl lignoceryl glycerol, Lupeol, Epicatechin-3-*O*-gallate, Epigallocatechin-3-*O*-gallate, 4-*O*-methyl-epi-gallocatechin, Epigallocatechin (Tringali et al., 2000)	
85	*Persea americana* Mill.	Lauraceae	Avocado pear, Alligator pear	Ube bekee or Ube oyibo (I), Igba or Apoka or Ipia (Y), Eben mbakara (Ef), Piya (H)	SE, SS	Administration of 10 mg/kg aqueous extract of the leaves for 8weeks decreased plasma glucose levels of rats fed a high-cholesterol diet (Brai et al., 2007) Hypoglycaemic effect of the aqueous extract of the seeds in normal and alloxan-induced diabetic rats and protective effect on pancreatic islet cells (Edem et al., 2009)	Anemia, Analgesic, Anti-microbial, Hypertension, High cholesterol, Inflammation, Convulsions, Wound healing, Gastric ulcer, Arthritis, Cough, Insecticidal	Seeds, Leaves, Root, Bark, Fruit			*Epi*-dihydrophaseic acid β-D-glucoside, Hydroxy abscisic acid β-D-glucoside, (del Refugio Ramos et al., 2004); 1,2,4-trihydroxy nonadecane derivatives, 1,2,4-trihydroxy heptadec-16-ene and heptadec-16-yne derivatives (Abe et al., 2005); Persin ((Z,Z)-1-(acetyloxy)-2-hydroxy-12,15-heneicosadien-4-one) (Oelrichs et al., 1995) α- and β-pinene, Sabinene, α- and β-cubebene, β-caryophyllene, Valencene, α-humulene, Germacrene D, *cis*-γ- and δ-cadinene, Caryophyllene oxide, Spathulenol (Ogunbinu et al., 2007)	Ethanol extract of the leaves inhibited the activity of Cyp3A4, 3A5 and 3A7 enzyme supersomes (Agbonon et al., 2010)
86	*Phyllanthus amarus*	Phyllanthaceae	Pick-a-back, Stone breaker, Carry me seed, Black catnip	Eyin olobe (Y)	SW	Antioxidant effects of constituents (Londhe et al., 2008) α-amylase inhibitory effects (Ali et al., 2006) Aqueous extract of the seeds and leaves showed a dose-dependent (150-600mg/kg) decrease in fasting blood glucose levels of normal rats (Adeneye et al., 2006) Dose dependent (200–1000 mg/kg) decrease in blood sugar levels by methanol extract in alloxan-indued diabetic rats (Raphael et al., 2002)§ No evidence of a hypoglycaemic effect was observed with NIDDM patients taking 25 g of the powdered extract daily for 1 week as a substitute to their oral hypoglycaemic drugs (Moshi et al., 2001)§	Fevers, Ringworm, Gonorrhoea, Cancer, Anti-viral, Diuretic, Hypertension, Anti-microbial, Diarrhoea, Inflammation, Analgesic, Dropsy, Jaundice, Hepato-protective, Gastric ulcers, Kidney disorders	Whole plant	Decoction		Geraniin, Amariin, Amarulone, Corilagin, 1,6-digalloylglucopyranose, Quercetin-3-*O*-glucopyranoside, Gallic acid, Rutin, Gallocatechin, (Foo, 1993); Amariinic acid, 1-O-galloyl-2,4-dehydro hexahydroxy diphenoyl glucopyranose elaeocarpusin, Geraniinic acid B, Repandusinic acid A, Phyllanthusiin D (Yeap Foo, 1995); Astragalin, Phyllanthin, Hypo-phyllanthin. Quercetin (Rajeshkumar et al., 2002); Ursolic acid, Oleanolic acid, Dotriacntanyl docosanoate, Triacontanol (Ali et al., 2006)	Aqueous and Ethanol extracts of the aerial parts of the plant inhibited the activity of Cyp3A4, 3A5 and 3A7 enzyme supersomes (Agbonon et al., 2010) Aqueous extract of the whole plant inhibited the activity of Cyp 1A2, 2C9, 2D6 and 3A4 plasmids as well as GST enzyme in rat and human liver cytosols (Appiah-Opong et al., 2008) The inhibitory effect on Cyt P450 enzymes was also observed with the methanol extract and confirmed *in vivo* (Hari Kumar and Kuttan, 2006)
87		Apocynaceae	Akuamma plant	Abere (Y), Osu-igwe,		Hypoglycaemic effect of the glycosidic fraction (250mg/	Hypertension, Anesthesia, Malaria,		Infusion	Akuammicine isolated from the	Pseudo-akuammidine, Akuammiline,	400 mg/kg of the stembark extract

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
	Picralima nitida (Stapf) T.Durand and H.Durand			Mkpokiri or Otosu (I)	SW, SE, NW, NC, SS	kg) of the methanol extract of the leaves in normal and alloxan-induced diabetic rats (Okonta and Aguwa, 2007) 300 mg/kg hydro-ethanol extract of the leaves decreased blood glucose levels in STZ-induced diabetic mice and *In vitro* antioxidant effects (Teugwa et al., 2013b)§	Jaundice, Pneumonia, AsthmaTrypanosomiasis	Stem-bark, Seeds, Root, Fruit rind		chloroform extract of the seeds stimulated glucose uptake in 3T3-L1 adipocytes (Shittu et al., 2010)	Melinosime, Akuammine, Picracine, Akuammidine, Picra-phylline, Akuammigine, Akuammicine (Oliver-Bever, 1986); Alstonine, Picranitidine, Picratidine, Picraline, ψ-akuammigine (Okunji et al., 2005); 10-deoxyakuammine, Burnamine (Shittu et al., 2010); Coumesan glycoside (Jacques et al., 2011)	produced hepato-toxic effects characterized by necrotic damage congestion of hepatic blood vessels (Fakeye et al., 2004) Methanol extract of the fruit rind administered daily for 6 weeks elevated AST, ALT and GSH levels in rats (Kouitcheu Mabeku et al., 2008)
88	*Rauvolfia vomitoria* Afzel.	Apocynaceae	African or Indian snakeroot	Asofeyeje (Y), Akanta (I), Wadda (H)	SW, SS	875 mg of a mix of extracts of the fruit and *Rauvolfia vomitoria* foliage (RC tea) decreased serum glucose levels in diabetes type 2 model db/db mice and also decreased tissue lipid accumulation (Campbell et al., 2006) In a pilot clinical study in type-2 diabetic patients, RC tea given daily for 4 months decreased post prandial and fasting plasma glucose levels with greater effects seen in patients with HbA1c levels $<7.3\%$ (Campbell-Tofte et al., 2011)	Mental disorders, Sedative, Hypertension, Snake bites, Skin infections, Anti-parasitic, Oral infections, Rheumatism, Aphrodisiac, Purgative	Root, Stem, Stem-bark, Leaves	Decoction, Maceration, Powdered root	*In silico* prediction of isosandwichine and ajmaline as potential DPP-IV inhibitors (Guasch et al., 2012)	Lupeol, Ursolic acid, β-stigmasterol, Betulinic acid, Sitosterol, Palmitic acid, 3β-hexadecanoyloxy-lupeol (Fannang et al., 2011); Reserpine, Yohimbine, Ajmaline, Ajmalicine, Alstonine, Serpentine Apigenin rhamnoside, Naringin (Campbell-Tofte et al., 2011)	
89	*Sarcocephalus latifolius* (Sm.) E. A.Bruce, Syn: *Nauclea latifolia*	Rubiaceae	African peach	Ubulu inu (I)	SE, NW	200 mg/kg aqueous extract of the leaves decreased blood glucose levels in alloxan-induced diabetic rats but not normal rats (Gidado et al., 2005) Anti-hyperglycaemic effect of 200 mg/kg ethanol extract of the leaves preadministered to rats prior to the oral or intraperitoneal administration of 2 g/kg glucose and alpha glucosidase inhibitory effects (Gidado et al., 2012) Hypoglycaemic effect in alloxan-induced diabetic rats and icreased activity of glucose metabolising enzymes (Iwueke and Nwodo, 2008) *In vitro* antioxidant effects (Awah et al., 2012)	Malaria, Anti-parasitic, Anti-infective, Hypertension, Jaundice, Infertility	Root, Bark, Leaves	Maceration		Strictosamide, 21-*O*-methyl strictosamide aglycone, 21-*O*-ethyl strictosamide aglycone, Angustine, Nauclefine, Angustidine, Angustoline, 19-*O*-ethyl angustoline, Naucleidinal, 19-*epi*-naucleidinal, Quinovic acid-3β-*O*-α-L-rhamno pyranoside, Quinovic acid-3β-*O*-β-D-fucopyranoside, Scopoletin, β-Sitosterol (Abreu and Pereira, 2001); Penta-*O*-benzoyl-α-D-fructo furanose, Penta-*O*-benzoyl-β-D-fructo furanose, Penta-*O*-benzoyl-β-D-fructo pyranose, Tetra-*O*-benzoyl-β-D-fructo pyranose, α- and β-D-pyranose forms of glucose, xylose and arabinose perbenzoates, Glycerol and D-Erythriol	Strictosamide binds to human serum albumin, which could in turn affect the bio-availability of highly protein bound drugs if co-administered (Pu et al., 2013)

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											perbenzoates, Tetra-*O*-benzoy-fructo furanoside (Abreu et al., 2001); Betulinic acid (Yinusa et al., 2012)	
90	*Scoparia dulcis* L.	Plantaginaceae	Sweet broomweed	Roma-fada (H), Aiya (I), Mesen-mesen gogoro (Y)Ndiyang (Ef) Bibimbelemo (Ij)	NC	Administration of the aqueous extract of the leaves for 45 days produced a dose dependent (150–450 mg/kg) decrease in glucose levels after an OGTT; as well as a hypoglycaemic effect in alloxan-induced diabetic rats. (Pari and Venkateswaran, 2002)§ 200 mg/kg aqueous extract of the whole plant also produced a hypoglycaemic effect in STZ-induced diabetic rats, increased plasma insulin levels and protected against diabetes induced oxidative stress (Latha and Pari, 2004; Latha et al., 2004)§ A flavonoid rich fraction of the aqueous extract of the aerial plant increased glucose uptake in cells possibly by increasing expression and translocation of the GLUT4 receptor (Beh et al., 2010)§	Anti-infective, HIV, Abortifacient, Sickle cell, InflammationAnalgesic, Anti-tumour, Bronchitis, Hypertension, Gastric disorders, Sedative	Leaves, Whole plant	Infusion, Decoction		Scoparol (3′-*O*-methyl luteolin), Scoparoside (glycosyl scopanol), Amellin (Oliver-Bever, 1986); Scoparic acid A, B and C, Scopadulcic acid A and B (Hayashi et al., 1988) Scopadulin (Hayashi et al., 1990); Scoparinol, Dulcinol, Benzoxazolinone, Betulinic acid, scutellarin, Sorbifolin (Ahmed and Jakupovic, 1990); Scopadulciol, Glutinol, Acacetin, 6-methoxy benzoxazoline (Hayashi et al., 1991); Adrenaline, Noradrenaline (Freire et al., 1996); Iso-dulcinol, Dulcidiol, 4-*epi*-scopadulcic acid B, Scopanolal, Scopadiol (Ahsan et al., 2003); β-sitosterol-β-D-gluc; side, Friedelan-3-one, Hispidulin (4,5,7-trihydroxy-6-methoxy flavone) (Osei-Safo et al., 2009); Luteolin, P-coumarin, Apigenin, Quercetin (Beh et al., 2010); Dulcinodal, Dulcinodiol, Scopadiol decanoate, (Ahsan et al., 2012)	
91	*Securidaca longipedunculata* Fresen	Polygalaceae	Violet tree, Rhodesian violet	Ipeta (Y), Sanya or Uwar magunguna (H), Ezeogwu (I)	SW, NE, SE	An extract of the root in buffer solution produced slight inhibition of α-amylase activity *in-vitro* (Funke and Melzig, 2006) Dose-dependent (50–800 mg/kg) hypoglycaemic effect of the aqueous root bark extract in normal and STZ-induced diabetic rats (Ojewole, 2008)	Erectile dysfunction, Arthritis, Tumours, Cough, Inflammation, Anti-pyretic, Analgesic, Pesticide, Anti-microbial, Convulsions	Root, Stem-bark Leaves, Seeds	Decoction, Tinctures, Infusions, Powders		Benzyl salicylate, Methyl paraben, Methyl vanillate, Methyl 2,6-dihydroxy benzoate, Lumiflavin (Costa et al., 1992); Methyl salicylate (Methyl-2-hydroxy benzoate), Methyl-2-hydroxy-6-methoxybenzoate, Benzyl-2-hydroxy-6-methoxy benzoate (Jayasekara et al., 2002); Securidaca xanthone (1,5-dihydroxy-2,3,6,7,8-penta	Nephrotoxic and hepatotoxic effects in rats administered 2 mg/kg aqueous extract intra-peritoneally for 14 days (Dapar et al., 2007) Elevated levels of serum alkaline and acid phosphatase levels as well as decreased levels of antioxidant enzymes such as GSH and SOD in the liver and kidney (Ajiboye et al., 2010)

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											methoxyxanthone), 2-hydroxy-1,7-dimethoxy xanthone, 1,6-dihydroxy xanthone, 6-methoxy salicylic acid and its methyl ester, β-D-(6-sinapoyl)-glucopyranoside, β-D-(3-sinapoyl)-fructofuranosyl-α-D-(6-sinapoyl)-gluco pyranoside (Meli Lannang et al., 2006); Methyl salicylate, α- and β-pinene, 1,8-cineole, α-cadinol, p-cymene, ethyl salicylate (Adebayo et al., 2007); 1,4-dihydroxy-7-methoxy xanthone, Senegenic acid, Senegenin, Elymoclavine, Dehydroelymoclavine, 4,5-di-*O*-caffeic acid, 3,4,5-tri-*O*-caffeoyl quinic acid, Sinapic acid (Meyer et al., 2008); Securidacaside A and B (Stevenson et al., 2009); Gallic acid, Chlorogenic acid, Caffeic acid, Epicatechin, P-coumaric acid, Rutin, Quercetin, Cinnamic acid, Apigenin (Muanda et al., 2010)	
92	*Secamone afzelii* (Roem. and Schult.) K.Schum.	Apocynaceae	Secamone, Ringworm plant	Ailu (Y)	SW	*In vitro* antioxidant effects (Mensah et al., 2004)	Hemorrhoids, Anti-microbial, Purgative, Dysentery, Colic, Wound healing, Aphrodisiac, Measles, STDs	Leaves, Pods, Stems, Whole plant	Maceration		Alpha tocopherol (Mensah et al., 2004); Caffeic, Gentysic, Ferulic, Chlorogenic, α-resorcylic, Syryngic, Protocatechuic, Homoprotocatechuic, p-hydroxyphenylacetic, p-hydroxybenzoic, Synapic, Vanillic, Coumaric, O-hydroxyphenylacetic and Salicylic acids (Nowak and Kawka, 1998)	
93	*Senna alata* (L.) Roxb., Syn. *Cassia alata* (L.)	Leguminosae	Ringworm plant, Candle bush	Asunwon oyibo (Y)	SW	De-fatted methanol extract of the leaves gave a slight dose-dependent (100–400 mg/kg) decrease in blood glucose levels in STZ-induced diabetic rats but not in normal rats (Palanichamy et al., 1988)§	Purgative, Ringworm, Eczema, Pruritus, Snake bites, Analgesic, Constipation, Hypertension, Anti-infective, Inflammation	Leaves, Flower, Root, Stem, Bark	Decoction, Juice extract	Alpha glucosidase inhibitory effects of the flavonoids kaempferol and its 3-*O*-gentiobioside isolated from the methanol extract of the leaves (Varghese et al., 2013)	Linalool, α-terpineol, Borneol, Pentadecanal, β-sitosterol, Stigmasterol, Daucosterol, Alarone, 2,6-dimethoxy bezoquinone, Dalbergin, 2,3,7 tri-*O*-methyl ellagic acid, Torachrysone, Alatonal, *p*-hydroxybenzoic acid, Adenine, Cassiaxanthone, Sennosides, Kaempferol, its 3-*O*-gentiobioside and	0.5 mg/ml aqueous extract of the leaves showed > 70% inhibition of GST enzymes in human and rat liver cytosols and recombinant GSTs; as well as inhibited Cyp 1A2, 2D6 and 3A4 supersomes but not 2C9 (Appiah-Opong et al., 2008).

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											3-*O*-β-D-glucopyranoside, Luteolin, Chrysoeriol-7-*O*- and Rhamnetin-3-*O*- (2″-*O*-β-D-manno pyranosyl)-β-D-allopyranoside, Aloe-emodin and its 8-*O*-*β*-glucoside, Chrysophanol, Rhein, Physcion and its 1-*O*-glucoside, Alquinone, Isochrysophanol, Adenine, 1,3,8-trihydroxy-2-methyl anthraquinones (Hennebelle et al., 2009); Naringin, Apigenin (Okpuzor et al., 2009)	
94	*Senna occidentalis* (L.) Synonym, *(Cassia occidentalis)*	Leguminosae	Coffee senna	Sanga-sanga or Rai dore (H), Rere (Y), Akede-agbara (I)	NW, SW	*In vitro* antioxidant effects (Akinmoladun et al., 2010) Incorporation of the dry leaves 6.25% by weight into the diet of STZ-induced diabetic mice did not produce any hypoglycaemic effect after 9 days of treatment (Swanston-Flatt et al., 1989)§ Hypoglycaemic effect of 200 mg/kg aqueous extract of the leaves was observed in both normal and alloxan-induced diabetic rats, as well as partial restoration of the islet cells of the diabetic rats (Verma et al., 2010)§	Inflammation, Anti-pyretic, Analgesic, Purgative, Malaria, Anti-tumour, Anti-microbial, Hepato-protective, Insecticidal, GIT ailments	Leaves, Pods, Seeds	Decoction		Achrosin, Aloe-emodin, Emodin, Apigenin, Chryso-obtusin, Aurantiobtusin, Campesterol, Cassiolin, Chrysarobin, Chrysophanic acid, Chrysophanol, Chrysoeriol, Funiculosin, Galactopyranosyl, Oleic, Linoleic, Linolenic and Lignoceric acids; Physcion, Islandicine, Helminthosporine, Rhein, Kaempferol, Matteucinol, Obtusifolin, Quercetin, Rhamnosides, Rubrofusarin, Xanthorine, 3,2-dihydroxy-7,8,4′-tri methoxyflavon-5-*O*-β-D-allopyranoside, 1,8-dihydroxy anthraquinones, Pinseline, Occidentalols, Questin, Germichrysone, Methylgermitorosone, Singueanol, Vitexin, 7-methyltorosachrysone, N-methyl morpholine, 1,1-bi-4,4′,5,5′-tetrahydroxy-2,2′-dimethyl anthraquinones, Metterucinol-7-*O*-*α*-L-rhamnoside, Occidentalins, β-sitosterol (Yadav et al., 2010)	Ingestion of the seeds (beans) has been shown to cause acute hepato-myoencephalopathy in children and is also known to be toxic to animals (Vashishtha et al., 2009) Possible risk of renal impairment with chronic administration of anthraquinones glycosides from senna (Vanderperren et al., 2005)
95	*Senna singueana* (Delile) Lock, *Syn: Cassia goratensis*	Leguminosae	Golden shower	Runfu (H)		200 mg/kg aqueous extract of the leaves decreased blood glucose levels by 53% in alloxan-induced diabetic rats (Etuk and Mohammed, 2009)	Inflammation, Analgesic, Malaria, Gonorrhea, Heartburn, Convulsions, Constipation, Wound	Root, Leaves	Decoction		Torosachrysone, 7-methyl physcion, Germichrysone, Cassiamin A, Singueanol-I and II, Chrysophanol, Cassiamin A, Lupeol,	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
							ulcers, Snake bites, Skin cancer				Campesterol, β-sitosterol, Stigmasterol, Leuco-pelargonidin (Gebrelibanos, 2012)	
96	*Solanum aethiopicum* L., misnamed *Solanum incanum* L.	Solanaceae	Garden egg	Osun (Y), Anara (I)	SE, SW	The root and fruit extracts (200 mg/kg) decreased blood glucose levels in both normal and STZ-induced diabetic rats. In addition, the fruit extract decreased weekly food consumption (Musabayane et al., 2006) Administration of 50 g of the leaves to normal volunteers prior to an oral glucose tolerance test produced a decrease in blood glucose levels (Okolie et al., 2009)	Convulsions, Colic, Flatulence, Syphillis, Hypertension, Anti-fungal, STDs, Hepatitis	Leaves, Fruit, Roots	Infusion, Juice extract		Diosgenin, Yamogenin (Gbile and Adesina, 1988) Solasodine, Solamargine, Solasonine, Ursolic acid, Carpesterol, β-sitosterol, Incanumine, Stigmasterol-β-D-glucoside, Khasianine (Lin et al., 1990) Chlorogenic acid, Trans-*p*-coumaric acid, Astragalin, Kaempferol, Quercetin, Isoquercitrin, Adenosine, Caffeic and Protocatechuic acids, Luteolin-7-*O*-β-D-glucopyranoside, Benzyl *O*-β-D-xylopyranosyl-β-D-glucopyranoside, Kaempferol glucosides, Isorhamnetin glucosides, Quercetin glucosides (Lin et al., 2000b) Solavetivone, Lubiminoic acid, Lubimin, Lubiminol, Aethione (Nagaoka et al., 2001) Aethiosides A–C (Tagawa et al., 2003)	
97	*Solanum melongena* L.	Solanaceae	African Eggplant, Aubergine	Igbagba or Igba ijesu (Y), Mafowo-bomonu (I)	SW, SS	*in vivo* antioxidant effects (Sudheesh et al., 1999) Low α-amylase but high α-glucosidase inhibitory effects and *In vitro* antioxidant effects (Nwanna et al., 2013)	Cholesterol, Anti-viral, Sedative, Analgesic, Fevers, Rheumatism, Skin diseases, Digestive tonic	Leaves, Fruit	Soup condiment, Juice extract		Polyphenol oxidase (Fujita and Tono, 1988); Solanidine (Keeler et al., 1990); Delphinidin (Nagase et al., 1998); α-solasoline, α-solamargine (Sánchez-Mata et al., 2010)	Possible inhibitory effect of steroidal alkaloids like solanidine on drug transport due to interaction with multi-drug resistant protein such as P-gp (Lavie et al., 2001)
98	*Sorghum bicolor* (L.) Moench, (*Sorghum caudatum*)	Poaceae	Sorghum	Okababa or Poroporo (Y), Sorgum (I), Jero (H)	SW	*In vitro* protein glycation inhibitory effects (Farrar et al., 2008)§ Alpha amylase and α-glucosidase inhibitors (Kim et al., 2011)§ 250 mg/kg sorghum extract decreased serum glucose and increased serum insulin levels in diabetic but not normal rats (Chung et al., 2011)§ *In vitro* antioxidant effects (Afify et al., 2012) Improved insulin sensitivity due to increased expression of $PPAR_{\gamma}$ receptors in rats fed a high fat diet followed by 0.5% and 1% sorghum meal (Park et al., 2012)§	Malaria, Fevers, Anemia, Anti-microbial	Leaves, Shaft	Maceration, Infusion		Procyanidin B1, Sinapic acid, Epicatechin gallate, Peonidin, Prodelphinidin, Luteolinidin, Fisetinidin, Pelagornidin, Cyanidin and Apigeninidin derivatives, Gallic, Caffeic, Gentisic, Chlorogenic, Syringic, *p*-hydroxy benzoic, Ferulic acids, Luteoforol, Apiforol, Luteolin, Naringenin, Eriodictoyl, Taxifolin, Sitosterol, Stigmasterol, Campesterol, Cholesterol (Awika and Rooney, 2004); Benzoic, *p*- *o*- and *m*-coumaric, β-resorcylic, Protocatechuic, Veratric, Vanillic, Homogentisic and	

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											t-cinnamic acids, Vanillin, Pyrogallol, Resveratrol, Hesperidin, Rutin, Myricetin, Hesperetin, Formononetin, Quercetin, Biochanin A, Naringin (Chung et al., 2011); β-carotene, α-tocopherol, Apigenin, Kaempferol, Hypersoid, Catechin, Christin (Afify et al., 2012)	
99	*Sphenocentrum jollyanum* Pierre	Menispermaceae		Akerejupon (Y)	SW, SE	*In vitro* (Nia et al., 2004) and *in vivo* antioxidant effects (Olorunnisola and Afolayan, 2013) Ethanol extract of the root decreased blood glucose levels in normal high glucose fed and alloxan-induced diabetic rabbits (Mbaka et al., 2009) Pre-administration of the aqueous extract of the roots for 7 days before induction of diabetes with alloxan had a protective effect against elevated sugar level and β-cell degeneration (Mbaka and Adeyemi, 2011)	Hypertension, Cough, Wounds, Fevers, Jaundice, Malaria, Emetic, Purgative, Aphrodisiac, Swollen breasts, Inflammation, Depression, Sickle cell, Anti-microbial, Analgesic, Anti-cancer, Anti-helminthic, Aphrodisiac, Constipation	Root, Seed, Stem-bark, Fruit, Leaves			Palmatine, Columbamine (Raji et al., 2006); Columbin, Isocolumbin, Fibleucine (Moody et al., 2006); Isocaryophyllene, α-Pinene, α-Eudesmol, 1,8-cineole (Aboaba and Ekundayo, 2010)	Extract of the leaves decreased the elevated levels of liver AST, ALT and ASP enzymes as well as increased GSH levels in rats infected with plasmodium (Olorunnisola and Afolayan, 2013)
100	*Spondias mombin* L.	Anacardiaceae	Hog plum	Iyeye or Olosan (Y), Tsada (H), Ngulungwu or Isikara (I)	SW	Hypoglycaemic effect of the methanol extract (1g/kg) of the leaves and its chloroform fraction was observed in glucose loaded (2 g/kg) and alloxan-induced diabetic rats (Fred-Jaiyesimi et al., 2009b) *In vitro* antioxidant effects (Akinmoladun et al., 2010)	Infertility, Child birth, Abortifacient, Inflammation, GIT disorders, Psychosis, Laxative, Anti-infective, Diuretic, Lactation, Anxiety	Leaves, Fruit	Decoction		Geraniin, Galloyl geranin, Chlorogenic acid, 2-*O*-caffeoylhydroxycitric acid (Corthout et al., 1992); Pelandjuaic acid, 6-(8′Z, 11′Z-heptadecadienyl)-salicylic acid, 6-(10′Z-heptadecenyl)-salicylic acid, 6-(12′Z-nona decenyl)-salicylic acid, 6-(15′Z-heneicosenyl)-salicylic acid (Corthout et al., 1994); Anacardic acid derivative (Coates et al., 1994); 3β-olean-12-en-3-yl (9Z)-hexadec-9-enoate, α-sitosterol (Fred-Jaiyesimi et al., 2009a)	
101	*Stachytarpheta angustifolia* (Mill.) Vahl	Verbenaceae		Ncha aji (I), Wutsiya bera (H), Iru alangba (Y)	SE, SW, NW	750 mg/kg aqueous extract decreased blood glucose levels in normal and alloxan-induced diabetic rats (Isah et al., 2007) 250 mg/kg of a herbal mixture (Okudiabet®) made up of bark of *Alstonia congensis*, aerial parts of *Stachytarpheta angustifolia* and fruits of *Xylopia aethiopica* administered for 30 days produced a hypoglycaemic effect in	Immune modulatory, Anti-microbial, Diarrhoea, Abortifacient, Skin ulcers, Rheumatism, Cataract, Ear sores, Gonorrhea	Leaves	Maceration		Ipolamide (Poser et al., 1997); Stachytarphine, β-(3′,4′)-dihydroxyphenyl)-ethyl-*O*-α-L-rhamnopyranosyl-(1,3)-β-D-(4-*O*-caffeoyl) glucopyranoside (Mohammed et al., 2012a, 2012b)	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						alloxan-induced diabetic rats (Ogbonnia et al., 2010) *In-vitro* antioxidant effects (Awah et al., 2010)						
102	*Strophanthus hispidus* DC.	Apocynaceae	Poison arrow vine, Brown/ hairy strophathus	Sagere (Y), Aguru-ala or Osisi nke aguru (I), Kwan-kwani (H)	SW, SE, NW, NC	Administration of 2 mg and 5 mg of various extracts of the plant produced a dose dependent decrease in blood glucose levels in normal rabbits (Ojiako and Igwe, 2009)	Cardio-stimulant, Snake bites, Insecticidal, STDs, Inflammation, Constipation	Stem, Root, Leaves	Decoction		Strophanthidin, Cymarin, Cymarol, Strophanthidol, Periplogenin, Emicymarin, (Heftmann et al., 1954); 9-hydroxyoctadec-12-enoic acid, Triglycerides, 2-mono glyceride (Gunstone and Qureshi, 1968)	
103	*Syzygium guineense* (Willd.) DC.	Myrtaceae	Snake bean treeWater berryWater pear	Malmo (H), Adere (Y), Ori (I), Mho (Ti), Asurahi (F)	SW, NW	The hypoglycaemic effect of the butanol fraction of the aqueous extract of the leaves decreased blood glucose levels in normal and alloxan-induced diabetic rats (Worku, 2009)§	Hypertension Cardio-protective, Anti-microbial, Diarrhoea, Inflammation, Immune-modulatory, venom, Anti-cancer	Seed, Stem, Leaves	Decoction		Arjunolic acid, Ursolic acid, Asciatic acid, Terminolic acid, Betulinic acid, Oleanolic acid, 2-hydroxy oleanolic acid, 2-hydroxy ursolic acid, 6-hydroxy asiatic acid, Arjunolic acid 28-β-gluco pyranosyl ester, Asiatic acid 28-β-glucopyranosyl ester (Djoukeng et al., 2005) Caryophyllene oxide, Benzyl benzoate, α-terpineol, Linalool, α and β caryophyllene, α-cadinol, (Noudogbessi et al., 2008) Arabinogalactan-type pectic polysaccharides (Ghildyal et al., 2010)	
104	*Tamarindus indica* L.	Leguminosae	Tamarind, Indian date	Tsamiya (H), Icheku oyibo (I), Ajagbon (Y), Tamsugu (Nu)	NW	*In vitro* (Siddhuraju, 2007) and *in vivo* antioxidant effects (Bhutkar and Bhise, 2011) 800 mg/kg of the aqueous extract of the seed administered for 14 days decreased blood glucose levels and increased serum insulin levels in STZ-induced diabetic rats, resulting in increased glucose metabolism (Maiti et al., 2005)§ An extract of the leaves in buffer solution produced 90% inhibition of α-amylase activity *in-vitro* (Funke and Melzig, 2006)	Nutritional, Inflammation, Anti-microbial, Anti-parasitic, Fevers, Laxative, Alcohol detox, Anti-cancer, Anti-obesity, Hepato-protective	Stem-bark, Fruits, Seed	Decoction, Maceration, Powder		Methyl 3,4-dihydroxy benzoate, Epicatechin, 3,4-dihydroxy phenylacetate, 2-hydroxy-3′,4′-dihydroxy acetophenone (Tsuda et al., 1994); Methyl salicylate, Eugenol, Vanillin; Lauric, Benzoic, Acetic, Myristic, Oleic, Linoleic, Linolenic and Palmitoleic acids (Wong et al., 1998); Apigenin, Eriodictyol, Narigenin, Procyanidin B_2, Taxifolin, Procyanidin trimer, tetramer, pentamer and hexamer; Luteolin (Sudjaroen et al., 2005); Apigenin, Vitexin, β-sitosterol, (+)-Pinitol, 21-oxobehenic and Eicosanoic acid, Octocasoanyl ferulate, *n*-hexacosane (Jain et al., 2007); Lupeol,	100 and 200 mg/kg ethanol extract of the bark administered for 45 days increased previously depleted GSH levels in alloxan-induced diabetic rats (Bhutkar and Bhise, 2011) Bioavailability of aspirin increased in healthy adults co-administered a porridge meal containing the fruit extract of tamarind (Mustapha et al., 1996)

Table 1 (*continued*)

S/ no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
105	*Tapinanthus bangwensis* (Engl. and K. Krause) Danser, Syn *Loranthus bangwensis* Engl. and K.Krause, often misnamed *Loranthus micranthus* Hook.f.	Loranthaceae	African mistletoe		SW, SE	An infusion of the leaves parasitic on *citrus limon* and *Psidium guajava* at a dose of 1.32mg//kg decreased blood glucose levels in normal and STZ-induced diabetic rats, but not that parasitic on *Jatropha curcas* (Obatomi et al., 1994) The blood glucose lowering effects of the methanol extract of the leaves was observed in alloxan-induced diabetic rats; an effect dependent on host plant and time of collection (Osadebe et al., 2004, 2010) *In vitro* antioxidant effects (Ogechukwu et al., 2012)	Anti-hypertensive, Anti-microbial, Immuno-modulatory, Anti-cancer	Leaves	Infusion, Decoction		Lupanone (Imam et al., 2007) Catechin-3-*O*-rhamnoside, Catechin-7-*O*-rhamnoside, 4-methoxy-catechin-7-*O*-rhamnoside (Ogechukwu et al., 2012); 7β, 15α-dihydroxyl-lup-20(29)-ene-3β-palmitate, 7β, 15α-dihydroxyl-lup-20(29)-ene-3β-stearate, 7β, 15α-dihydroxyl-lup-20(29)-ene-3β-deca decanoate (Ogechukwu et al., 2011); Stigmast-7,20(21)diene-3β-hdroxy-6-one, 3β-hdroxy-stigmast-23-ene, 7β, 15α-dihydroxyl-lup-20 (29)-ene-3β eicosanoate (Omeje et al., 2011); Linamarin gallate, Walsuraside, Catechin, Rutin, Epicatechin, Gallate derivatives of epicatechin, Quercetin-3-*O*-*β*-D-gluco pyranoside, Peltatoside (Agbo et al., 2013)	
106	*Telfairia occidentalis* Hook.f.	Cucurbitaceae	Fluted pumpkin	Ugwu/Ugu (I), Iroko or Apiroko (Y), Ubong (Ef), Umee (Urhobo), Umeke (Bi)		250 mg/kg ethanol extract of the leaves decreased blood glucose levels in normal and alloxan-induced diabetic rats; while 100 mg/kg ethanol extract of the seed decreased glucose levels in alloxan-induced but not in normal or glucose-loaded rats (Eseyin et al., 2005, 2007a) Alpha glucosidase and α-amylase inhibitory effects of the hydro-ethanolic extract of the leaves as well as Antioxidant effects (Oboh et al., 2012b) 50 mg/kg globulin proteins extracted from the seeds decreased blood glucose levels when pre-administered to normal high glucose fed rats (Teugwa et al., 2013a)§	Convulsion, GIT disorders, Anemia, Hypertension, Anti-tumour, Immune modulating, Anti-parasitic, Analgesia, Inflammation, High cholesterol, Anxiety	Leaves, Fruit, Seeds			Globulins, Carotenoids, γ-amino butyric acid, 13-hydroxy-9Z, 11E-octadecatrienoic acid, α- and β-moschins, Pectin, MAP 2, MAP 4, MAP 11, MAP 28 (Caili et al., 2006)	Co-administration of the leaves prior to or alongside chloroquine tablets altered its pharnacokinetics (Eseyin et al., 2007b)
107	*Terminalia catappa* L.	Combretaceae	Tropical almond, Umbrella tree	Belebo orIgifuruntu (Y), Ibulu (I)	SE, SS, SW	Methanol extract of the leaves decreased blood glucose levels in alloxan induced diabetic mice by 59% (Ezeigbo and Asuzu, 2010)	Aphrodisiac, Hepato-protective, Analgesic, Inflammation, Anti-microbial, Insomnia, Anti-cancer, Anti-viral	Leaves, Stem bark, Fruit, Seeds	Maceration		Terminolic acid, β-sitosterol, β-sitosteryl palmitate (Idemudia, 1970); Terflavin A and B, Tercatain, Tergallagin,	Potential hepatic toxicity with high doses due to Punicalagin and punicalin (Lin et al., 2001)

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
						Varying doses (40–78 mg/kg) of the aqueous, methanol and petroleum ether extracts of the fruits administered for 3 weeks also produced a hypoglycaemic effect in alloxan induced diabetic rats as well as regenerated the pancreas (Nagappa et al., 2003)§					Punicalagin, Punicalin, Chebulagic acid, Geranin, Granatin B, Corilagin, 1-desgalloyl eugenin (Tanaka et al., 1986); Isovitexin, Rutin, Vitexin, Isoorientin, Apigenin galloyl glucopyranosides (Lin et al., 2000a); Cyanidin-3-glucoside, Gallic acid, Ellagic acid, Brevifolin carboxylic acid, Euginic acid (Nagappa et al., 2003); Ursolic acid, Asiatic acid (Gao et al., 2004)	
108	*Tetrapleura tetraptera* (Schum. and Thonn.) Taub.	Leguminosae		Aridan (Y), Kpokrikpo or Mkpuruma oshosho (I)	SW, SE, SS, NC	800 mg/kg aqueous extract of the fruit produced a hypoglycaemic effect in normal and STZ-induced diabetic rats (Ojewole and Adewunmi, 2004) Aqueous extract of the fruit showed good antioxidant effects, moderate lipase inhibitory effects and little or no α-amylase inhibitory effects (Etoundi et al., 2010)§	Hemorrhoids, Insect repellent, Convulsions, Asthma, Cough, Insomnia, Poison antidote, Gonorrhoea, Rheumatism, Infertility, Bilharzia, Sickle cell, Lactation	Pod, Bark	Decoction, Infusion		Aridanin, Glycosides of Olean-12-ene-28-oic acid, Echinocystic acid-3-*O*-sodium sulphate (Ngassapa et al., 1993); Butanoic acid derivatives, Myrcene, *p*-Cymene, 1,8-Cineol, Limonene, 2,4-dihydro-3,4-dimethylfuran, γ-Terpinene, α-Terpinolene (Ngassoum et al., 2001)	Ethanol extract of the leaves given to rabbits for 10 days (50–150 mg/kg) increased serum ALT levels (Odesanmi et al., 2009)
109	*Treculia africana* Decne, ex Trécu	Moraceae	Breadfruit	Ukwa (I), Afon (Y)	SW	Fractions of the hydro aceton extract of the bark decreased blood glucose levels at a dose of 10 mg/kg in alloxan-induced diabetic rats but not normal rats (Oyelola et al., 2007) Hypoglycemic effect of 500 mg/kg aqueous extract of the leaves in normal fasted glucose-loaded and STZ-induced diabetic rats (Ogbonnia et al., 2008c)	Anti-microbial, Anti-helminth, Laxative, Skin diseases, Dental allergies, Depression				α- and β-Pinene, Camphene, Myrcene, Phellandrene, α- and γ-Terpinene, p-Cymene, Limonene, Linalool oxide, Thujanol, Geranylacetone, β-Caryophyllene, Terpineol (Aboaba et al., 2007) ; Phyllocoumarin, 6,9-dihydroxy megastigmane-3-one, Catechin (Kuete et al., 2008); 3-Prenyl-2′,4,4′-trihydroxy chalcone, 4-hydroxy benzoic acid, Bergapten, Morin, Epiphyllocoumarin, β-carotene, Riboflavin (Mueno et al., 2008)	
110	*Urena lobata* L.	Malvaceae	Caesar's weed	Ilasa-omode or Ilasa-agborin (Y), Odoazezo (I), Rama rama (H)	SW	Fasting blood glucose lowering effects of 200 mg/kg of the aqueous root extracts in normal rabbits (Omonkhua and Onoagbe, 2011) *in vivo* antioxidant effects (Omonkhua and Onoagbe, 2012)	Anti-microbial, Colic, Skin diseases, Dysentry, Expectorant, Emollient, Malaria, Rheumatism, Wound healing, Analgesic, Inflammation	Root, Flower			Tiliroside, Dihydro kaempferol 4′-*O*-β-gluco pyranoside, Kaempferol and Quercetin 3-*O*-β-glucoside and 3-*O*-β-rutinoside, Luteolin-4′-*O*-β-gluco pyranoside, Kaempferol-7-*O*-glucoside, Kaempferol, Quercetin (Matlawska and Sikorska, 1999); β-Sitosterol, stigmasterol,	

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Imperatorin, Mangiferin, Quercetin, Palmitic and Linoleic acid triglycerides (Morelli et al., 2006); Syringic acid, Glucosyringic acid, Salicylic acid, Protocatechuic acid and its methyl ester, Caffeic acid, Hexatriacontanoic acid, Pentadecanoic acid, Hexadecanoic acid, Maleic acid, Heptadecanoic acid, Diisobutyl phthalate (Lu et al., 2009); Ceplignan-4-*O*-β-D-glucoside, Urenoside A (Jia et al., 2010)	
111	*Vernonia amygdalina* Delile	Compositae	Bitter leaf	Ewuro (Y), Shuwaka (H), Olugbu (I), Etidot (Ib)	NW, NC, SE, SS, SW	80 mg/kg aqueous extract of the leaves produced a dose dependent decrease in blood glucose levels in normal and alloxan-induced diabetic rabbits (Akah and Okafor, 1992); Antioxidant effects (Igile et al., 1994; Fasakin et al., 2011); Chronic intake of 400 mg/kg ethanolic extract of the fresh leaves significantly decreased fasting blood glucose levels, increased serum and pancreatic insulin levels, increased the activity of liver antioxidant enzymes as well as increased the expression and distribution of Glut 4 receptors in STZ-induced diabetic rats (Ong et al., 2011)§; 150 ml of a (1:1:1) decoction mix of the leaves of *Vernonia amygdalina*, *Ocimum gratissimum* and *Gongronema latifolium* decreased baseline blood glucose levels in normal subjects when preadministered to normal subjects 45 min before an OGTT (Ejike et al., 2013)	Hemorrhoids, Measles, Ringworm, Analgesic, Malaria, Pneumonia, Anti-microbial, Anti-cancer, Anti-feedant	Leaves, Roots	Decoction, Juice extract		Vernodalin, Vernolide, Vernomygdin, Vernolepin (Kupchan et al., 1969); Vernodalol, 11,13-dihydrovernodalin (Ganjian et al., 1983); Vernonioside A1, A2, A3, A4 and its aglycone, B1, B2 and B3 (Jisaka et al., 1993); Luteolin, Luteolin 7-*O*-glucoside and 7-*O*-glucuronide (Igile et al., 1994); Vernonioside D and E (Igile et al., 1995); Luteolin 7-*O*- and 4′-*O*-rutinoside, Caffeoyl quinic acid, Chlorogenic acid, Rutin, 1,5-Dicaffeoyl quinic acid, Apigenin glucuronide, Luteolin (Ola et al., 2009)	Aqueous extract of the leaves inhibited P-gp efflux activity in Caco-2 cells (Oga et al., 2012)
112	*Ximenia americana* L.	Olacaceae	Sour plum, Hog plum, Yellow plum, Sea lemon, False sandal wood	Tsaada (H), Igo (Y)	NW	Graded doses (200, 400 and 600 mg/kg) of the extract produced significant blood glucose reduction to control levels 6 h after administration in alloxan-induced hyperglycaemic rats (Siddaiah et al., 2011)§	Anti-parasitic, Anti-microbial, Inflammation, Pesticidal, Analgesic, Anti-pyretic, Anti-cancer, Hepato-protective, Ulcers, Skin infections, Purgative	Fruits, Stem, Stem-bark, Leaves	Decoction		Mandelonitrile lyase (Kuroki and Conn, 1989); Xymenynic acid, Tariric acid (Fatope et al., 2000); Ximonicaine, Stigmastane (de Araújo et al., (2009)); Benzaldehyde, Hydroxy benzyl cyanide, Geraniol, Isophorone, Linalool, Caryophyllene oxide,	Aqueous extract of the stem bark and the root increased levels of hepatic enzymes ALT, AST and ALK-P significantly (James et al., 2008; Wurochekke et al., 2008); Inhibited P-gp mediated Rh-123

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)[*]	Region of use for diabetes[#]	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
											Methyl benzoate (Mevy et al., 2006); Hydrocyanic, Linolenic, Arachidonic, Erucic, Eicosatrienoic and Nervonic acids; Methyl-14,14-dimethyl-18-hydroxy hepta triacont-27,35-dienoate, Dimethyl-5-methyl-28,29-dihydroxy dotriacont-3,14,26-triendioate (Saeed and Bashier, 2010); Riproximin (Bayer et al., 2012); Sambunigrin, Gallic acid, Quercetin, β-glucogalline, 1,6-digalloyl-β-glucopyranose, Quercetin-3-*O*-(6-galloyl)-β-gluco pyranoside, Quercitrin, Avicularin, Quercetin-3-*O*-β-xylo pyranoside, Kaempferol-3-*O*-(6″-galloyl)-β-glucopyranoside (Le et al., 2012)	efflux in Caco-2 cells (Ezuruike et al., 2012)
113	*Xylopia aethiopica* (Dunal) A.Rich.	Annonaceae	Ethiopian or Negro pepper, Long nose pepper	Erunje or Eeru (Y), Uda (I), Kimba (H)		Administration of 1 g/kg of a 1:1 mixture of a hydroethanolic extract of *Alstonia congensis* bark and *Xylopia aethiopica* fruits decreased blood glucose levels in normal mice (Ogbonnia et al., 2008a); 250 mg/kg of a herbal mixture Okudiabet® made up of bark of *Alstonia congensis*, aerial parts of *Stachytarpheta angustifolia* and fruits of *Xylopia aethiopica* administered for 30 days had a marked hypoglycaemic effect in alloxan-induced diabetic rats (Ogbonnia et al., 2010); Potent inhibitory effects against pancreatic lipase, α-amylase and α-glucosidase enzymes; Antioxidant effects (Etoundi et al., 2010; Adefegha and Oboh, 2012)	Purgative, Neuralgia, Amenorrhea, Anti-convulsant, Bronchitis, Stomach ache, Cough, Hemorrhoids, Asthma, Insect antifeedant, Anti-microbial, Diuretic	Fruit, Seeds				Xylopic acid (15β-acetoxy kaur-16-en-19-oic acid) (Ekong and Ogan, 1968); Kauran-16α-ol, Kauran-16α, 19-diol, Kaur-16-en-19-oic acid (Leboeuf et al., 1980); α- and β-pinene, 1,8-cineole, Cuminic aldehyde, α-terpineol, β-caryophyllene, Limonene, Linalool, Ocimene, α- and β-Phellandrene, Sabinene, α-murolene (Lamaty et al., 1987); Kaur-15-en-17-al-19-oic acid, 15-oxo-trachyloban-19-oic acid, 15-hydroxy-(-)-trachyloban-19-oic acid, 15β-hydroxy-(-)-kaur-16-en-19-oic acid, 15-oxo-(-)-kaur-16-en-oic acid, Sitosterol glucoside (Harrigan et al., 1994a); Oxophoebine, Liriodenine, Oxoglaucine, *O*-methyl moschatoline, Lysicamine (Harrigan et al., 1994b); 7β-acetoxy (-)-kaur-16-en-19-oic acid, E-3-(4-hydroxy-3-

Table 1 (*continued*)

S/no.	Plant name	Family	Common name	Local Nigerian name(s)*	Region of use for diabetes#	Experimental evidence for its use in diabetes management	Other medicinal uses	Plant part (s) used	Traditional preparation method	Identified active constituent(s)	Other relevant phytoconstituents identified in the plant	Interaction/toxicity studies
												methoxy phenyl)-N-2-[4-hydroxy phenylethyl]-2-propenamide, E-3-(3,4-dihydroxyphenyl)-N-2-[4-hydroxyphenyl-ethyl]-2-propenamide, Grossamide, Demethylgrossamide, Cannabisin B and D (Lajide et al., 1995); 7α-hydroxy trachyloban-19β-oic acid (Ngouela et al., 1998)
114	*Zea mays* L.	Poaceae	Corn Maize	Agbado (Y), Oka (I), Masara (H)	SW	0.2 g/d aqueous extract of corn silk improved kidney parameters in STZ-induced diabetic rats but no significant hypoglycaemic effect (Suzuki et al., 2005); 100 mg/L ethanol extract of the corn silk showed PPARα and γ agonist activities (Rau et al., 2006)§; Inhibitory effects of the aqueous and ethanol extract of the maize kernels on α-glucosidase enzymes and antioxidant effects (Lee et al., 2010)§	Hypertension, Analgesic, Inflammation, Contraceptive, Nose bleeds	Seed silk	Decoction		Chrysoeriol 6-*C*-β-boivino pyranosyl-7-*O*-β-gluco pyranoside, Alternanthin (Suzuki et al., 2003)	Glucose yield and glycaemic index of maize starch has been shown to be high, which may pose a problem for diabetic patients (Izuagie et al., 2007; Omoregie and Osagie, 2008)
115	*Zingiber officinale* Roscoe	Zingiberaceae	Ginger	Atale (Y), Jinga (I), Chita (H)	SW	Ethanol extracts of the rhizome reduced blood glucose levels dose dependently (50–800 mg/kg) in normal and STZ-induced diabetic rats (Ojewole, 2006); Alpha amylase and Alpha glucosidase inhibitory effects and *In vitro* antioxidant effects (Oboh et al., 2010); *in vivo* antioxidant effects (Morakinyo et al., 2011)	Typhoid, Nausea, Cold symptoms, Asthma, Stimulant, Rheumatism, Hemorrhoids, Liver disorders, Obesity, Git disorders	Rhizome	Maceration	6-, 8- and 10-Gingerols increased glucose uptake in L6 muscle cells primarily by an increased GLUT4 expression (Li et al., 2012); Aldose reductase inhibitory effects of methoxy phenyl derivatives (Kato et al., 2006)	2-(4-Hydroxy-3-methoxy phenyl) ethanol, 2-(4-hydroxy-3-methoxy phenyl) ethanoic acid, 2-(3,4-dimethoxyphenyl) ethanooic acid, 4-(4-hydroxy-3-methoxy phenyl)-2-butanone, (4-hydroxy-3-methoxy phenyl) methanol (Kato et al., 2006); Zingerone, Geraniol (Chen et al., 2007); Gingerols and its derivatives, Gingesulfonic acids, Shogasulfonic acids, Gingerdiols, Zingerone, Shogaols, Paradols and its derivatives, Zingiberene, Curcumene, β-bisabolene, Citral, Camphene, Neral, β- and Sesqui-phellandrene, Diarylheptanoids, Cineole, Gingerdiones, Geranial, Terpineol (Ali et al., 2008; Kubra and Rao, 2011)	Insufficient evidence for a possible interaction with warfarin or CYPs (Vaes and Chyka, 2000); 6-gingerol increased the accumulation of daunorubicin and rhodamine and decreased efflux of daunorubicine indicating possible P-gp modulatory effect (Nabekura et al., 2005)

* Bi-Bini, Ef-Efik, Es-Esan, F-Fulani, H-Hausa, I-Ibo, Ib-Ibibio, Id-Idoma, Ig-Igala, Ige-Igede, Ij-Ijaw, Nu-Nupe, Ti-Tiv, and Y-Yoruba.

\# NC=North central, NE=North east, NW=North west, SE=South east, SS=South south, and SW=South west.

§ Experimental evidence involving plant samples not collected from within Nigeria.

other *in vivo* models used include spontaneous diabetic animal models obtained as a result of one or more genetic mutations such as obese zucker fatty rats, db/db mice and KK-A^y mice; as well as the use of high glucose or fructose-fed animals. This latter group simulate the development of diabetes from insulin resistance better as is more commonly found in patients with type-2 diabetes (Srinivasan and Ramarao, 2007).

Although most plants were only evaluated experimentally in a type-1 diabetes model, some of these have been shown to be effective hypoglycemic agents in type-2 diabetes patients, such as extracts of *Bridelia ferruginea* Benth. Daily administration of 15 mg of the leaves as an infusion to type-2 diabetic patients previously on insulin injections for eight weeks resulted in a significant decrease in their blood sugar levels (Iwu, 1983).

Only two out of the 96 plant species were ineffective in the *in vivo* experimental model of study, namely *Zea mays* L. (Suzuki et al., 2005) and *Cucumeropsis mannii* Naudin (Teugwa et al.). Despite its identified in *in vitro* PPARα and γ agonist activities and α-glucosidase inhibitory effects (Lee et al., 2010), extracts of *Zea mays* failed to produce a significant hypoglycemic effect *in vivo* (Rau et al., 2006). This could possibly be as a result of the absence of the bioactive constituent(s) responsible for the hypoglycemic effect in the sample used for the *in vivo* study. The absence of an *in-vivo* hypoglycemic effect would however not 'eliminate' its use in the clinical management of diabetes, which also takes into account co-morbid conditions. In this regard, *Zea mays* could also provide protection against diabetic nephropathy, as it has been shown to improve kidney parameters *in vivo* (Suzuki et al., 2005).

In the case of *Cucumeropsis mannii*, its traditional use involves the ingestion of its ashes or its juice (Gbolade, 2009). This may indicate that its use is based on its oligo-elements and/or vitamins. In fact the supplementation of elements such as chromium, magnesium and vanadium is actively explored in the treatment of diabetes (Anderson et al., 1997; Halberstam et al., 1996; Rodríguez-Morán and Guerrero-Romero, 2003); some of which have been identified in the seeds of *Cucumeropsis mannii* (Badifu and Ogunsua, 1991).

3.2. *In vitro pharmacological evidence*

It is recommended that *in vitro* experiments are carried out to ascertain the mechanism of action for the plant. Certain plants produce their hypoglycemic effects as a side effect of their *in vivo* toxicity (Marles and Farnsworth, 1995). There is also the risk that the hypoglycemic effect is being mediated – at least in part – through an unwanted physical mechanism, rather than a physiological one, such as was observed with *Gymnema sylvestre* (Retz.) R. Br. Ex Sm (Persaud et al., 1999). This immediately eliminates the potential use of such a plant as a therapeutic hypoglycemic agent. In addition, due to the ethical considerations surrounding animal use (Festing and Wilkinson, 2007), it is advised that validation experiments are 'replaced' with non-animal models where possible.

Over one-third of the plants in our review have been studied for *in vitro* in models that could possibly explain some or all of their mechanism of action. Twenty-nine plants have inhibitory effects against either α-amylase or α-glucosidase enzymes; five plants have agonist activity on the PPARγ receptor, whose activation enhances glucose metabolism; four plants increase insulin release from pancreatic cells; five plants increase glucose uptake in muscles or liver; while two plants increased the expression of the glucose transporter GLUT4, which in turn increases glucose uptake into muscles and adipose tissues. Two plants were identified as potential DPP-IV inhibitors, while six plants were identified as aldose reductase inhibitors (Fig. 1).

In vitro experiments are often designed to 'reflect' the mechanism of existing drugs used in diabetes management. Plants that possess alpha amylase or alpha glucosidase inhibitory effects reflect the action of acarbose, PPARγ agonist activity reflect the thiazolidinediones, while aldose reductase inhibitors are potential agents for preventing diabetic complications like the drug epalrestat. Thus with this identified mechanisms, researchers and healthcare professional alike can immediately identify the potential therapeutic benefit of the plant. This information could contribute to a more rational therapeutic regimen for diabetes patients, possibly benefitting from a synergistic effect with herbal remedies.

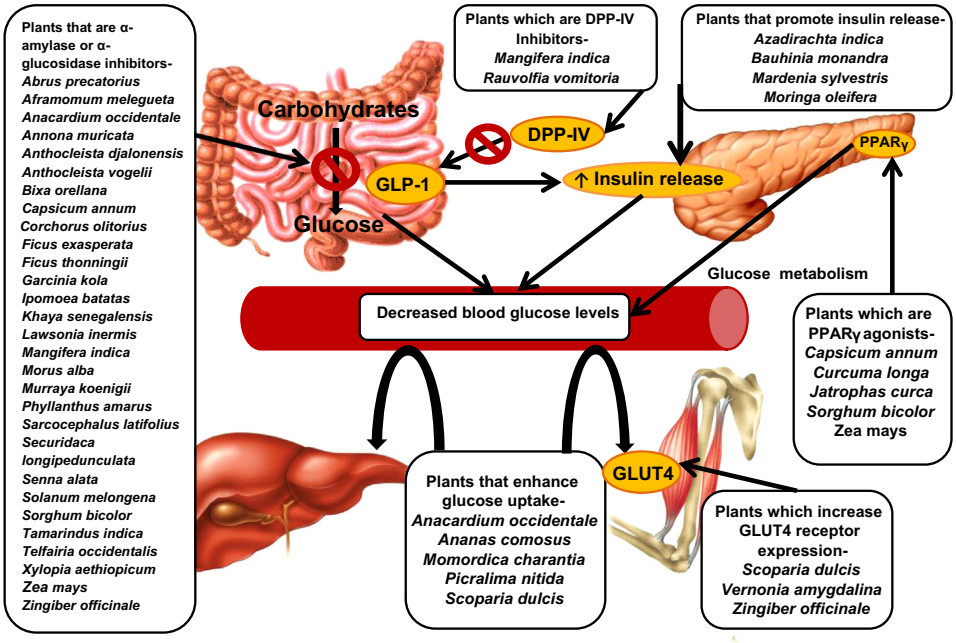

Fig. 1. Proposed molecular mechanisms of hypoglycemic effects for species studied so far.

The disadvantage of the molecular approach for experimental validation of plant activity is that the biological assays only explore known targets and do not take into account extracts that might be acting on unknown targets, possibly through innovative mechanisms. In addition, herbal medicines are often complex mixtures of various phytochemicals which work synergistically to achieve a desired therapeutic outcome (Campbell-Tofte et al., 2012). In such cases, a single end-point *in vitro* biological assay will not be sufficient in evaluating the clinical effect of the plant. For instance, the methanol extract of the root and stem of *Gongronema latifolium* Benth. produced a greater anti-hyperglycemic effect in glucose loaded rats than each of its fractions, indicating a synergistic effect of its constituents possibly acting through different molecular mechanisms (Adebajo et al., 2013).

There is also a holistic approach in the herbal management of diabetes such that plants which are not hypoglycemic themselves may be included in multi-component preparations because of their benefits in co-morbid conditions. Thus, *in vitro* studies might not immediately indicate the beneficial effect of the plant. A good example is the use of the aphrodisiac plant *Mondia whiteii* (Hook. f.) Skeels (Quasie et al., 2010). Despite not showing *in vitro* hypoglycemic effect (Etoundi et al., 2010), it is commonly included in multi-component preparations for diabetes management in men since erectile dysfunction is a common complication of the illness (personal communication during field work). This however does not preclude any *in vivo* activity which is yet to be evaluated.

3.3. Bioactive compounds

Over forty compounds from twenty three of the reviewed plants have been identified, either through an activity guided fractionation or *in silico* studies as the bioactive constituents responsible for some or all of the plants' beneficial effects in diabetes. Some of these constituents are species-specific such as the alkaloid mahanimbine from *Murraya koenigii* (L.) Spreng (Dineshkumar et al., 2010), while others are known to be present in many plants like the alkaloid trigonelline, which is responsible for the hypoglycemic effect of *Abrus precatorius* L. (Monago and Nwodo, 2010) and *Trigonella foenum-graecum* L. (fenugreek), a plant whose use in diabetes management is popular across India and Europe (Bailey and Day, 1989). We hereby classify these compounds according to similar chemical features (which may not necessarily refer to similar biosynthetic pathways) as follows: compounds containing nitrogen (**1–9**) (Fig. 2), terpenes (**10–16**) (Fig. 3), phenolic compounds (**17–33**) (Figs. 4 and 5), and compounds containing hydroxyl groups including sugars (**34–40**) (Fig. 6).

3.3.1. Nitrogen containing compounds

A number of alkaloidal and non-alkaloidal active principles from plants used in diabetes management have been reported. Some of these were isolated from samples not collected from Nigeria such as hypoglycin A (**1**) and B (**2**) – from the fruit of *Blighia sapida* K.D.Koenig. (Chen et al., 1957). *Murraya koenigii* leaves are also used traditionally in Indian Ayurvedic system to treat diabetes. Mahanimbine (**5**) isolated from the Indian plant samples decreased blood glucose levels in STZ-induced diabetic rats and also produced a dose-dependent α-amylase and α-glucosidase inhibitory effect (Dineshkumar et al., 2010). Its cellular mechanism of action is also thought to be mediated by an increase in glucose utilization (Dinesh Kumar et al., 2013). Paradoxically, this and other related carbazole alkaloids isolated

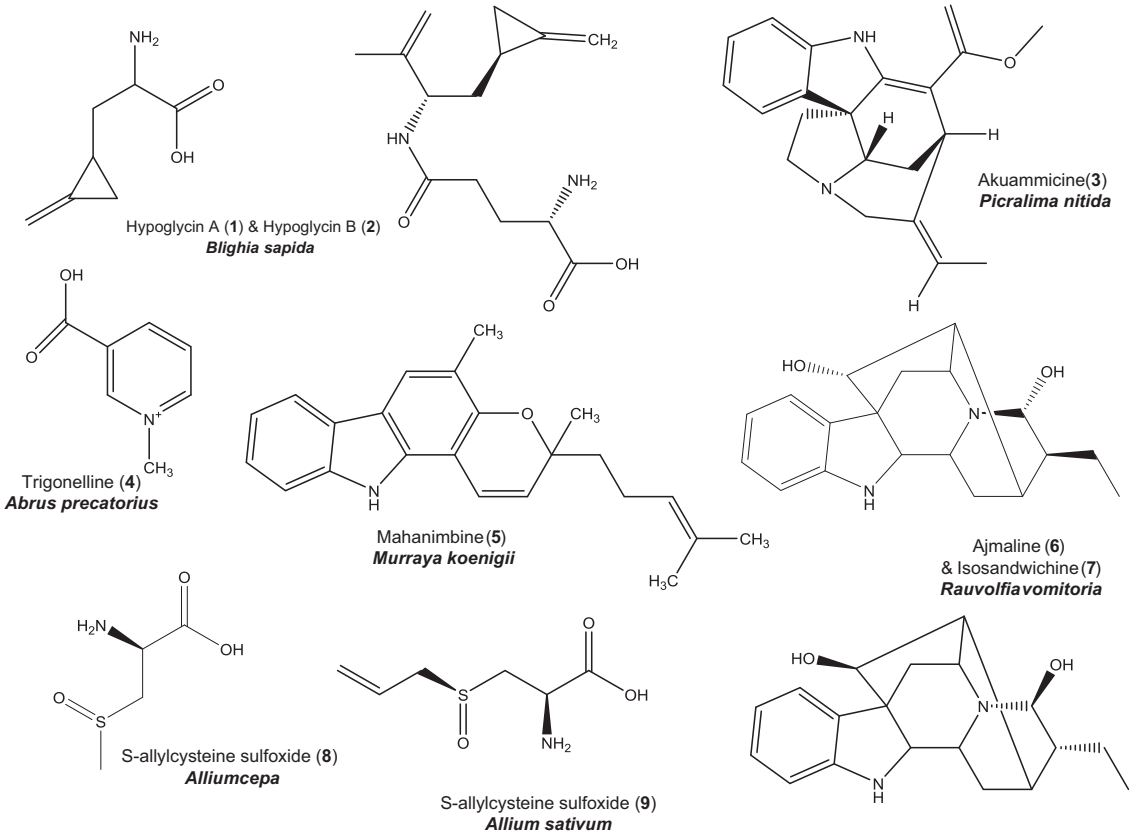

Fig. 2. Nitrogen containing compounds with beneficial effects in diabetes.

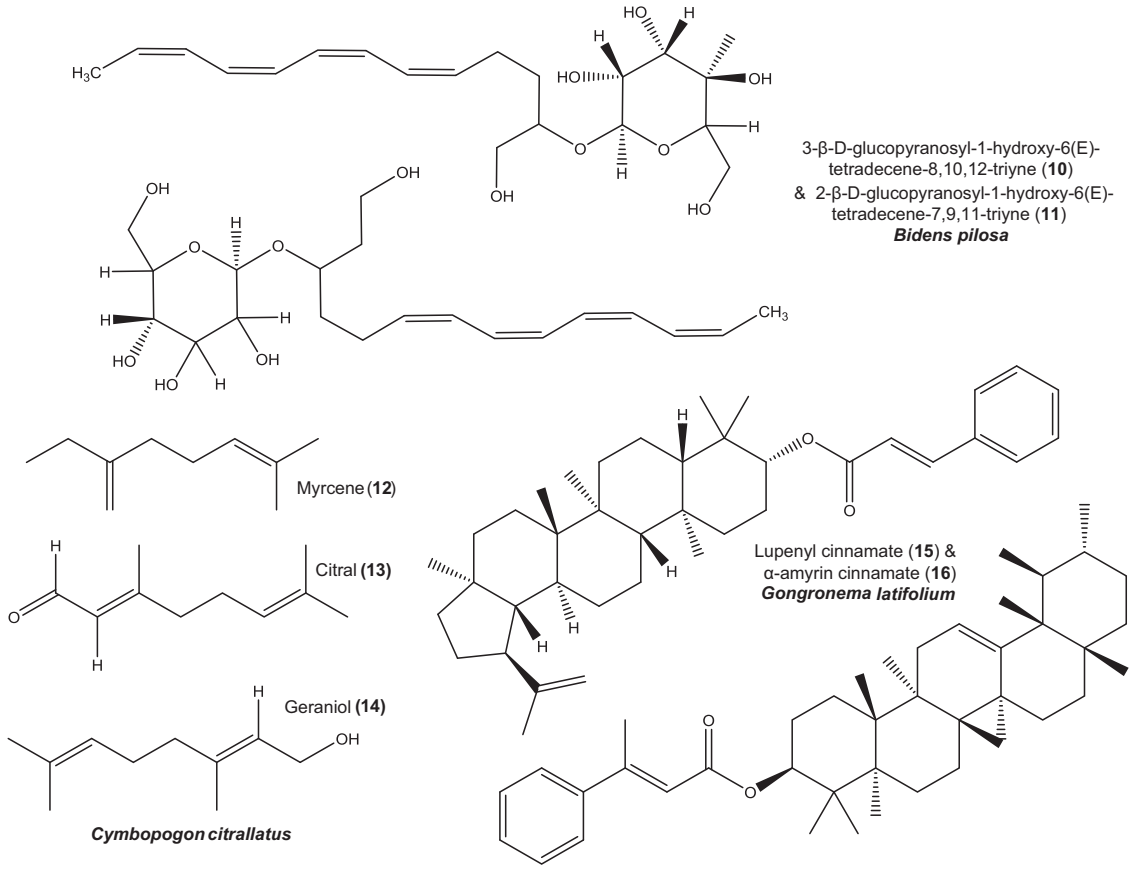

Fig. 3. Terpenes with beneficial effects in diabetes.

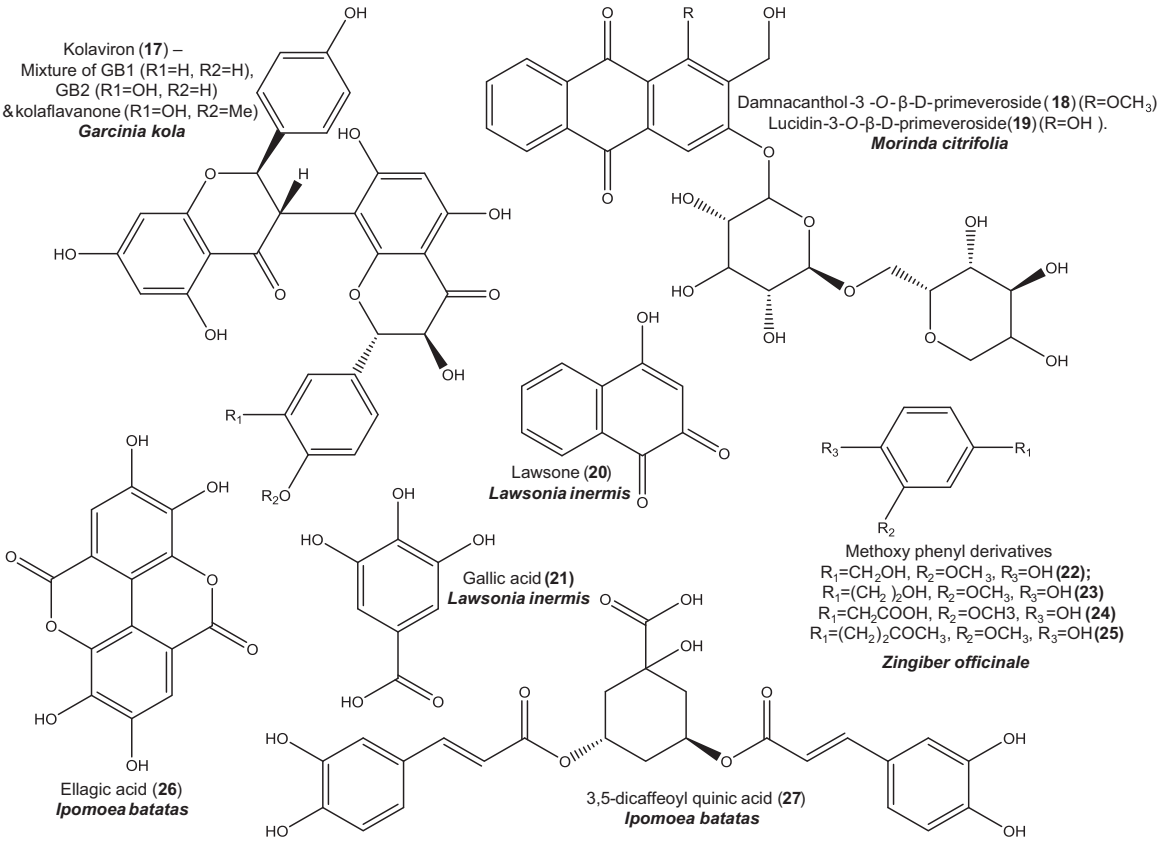

Fig. 4. Phenolic compounds with beneficial effects in diabetes.

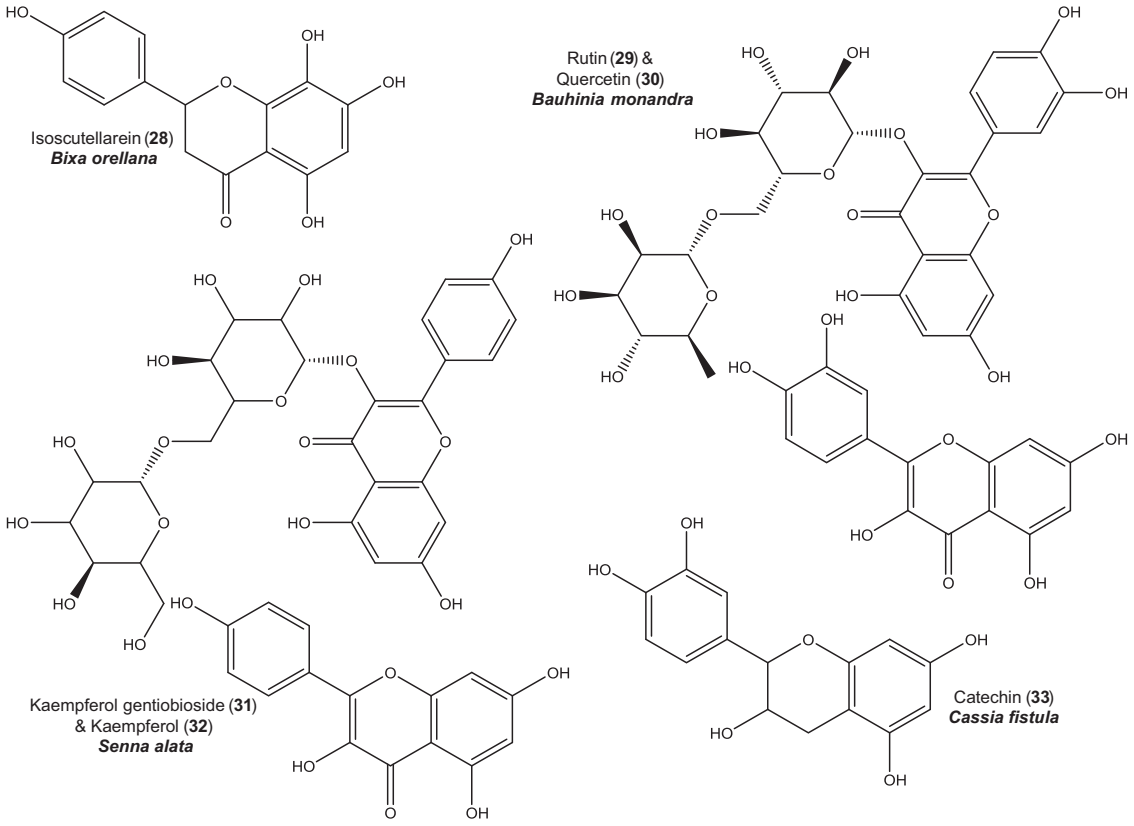

Fig. 5. Phenolic compounds (flavonoids) with beneficial effects in diabetes.

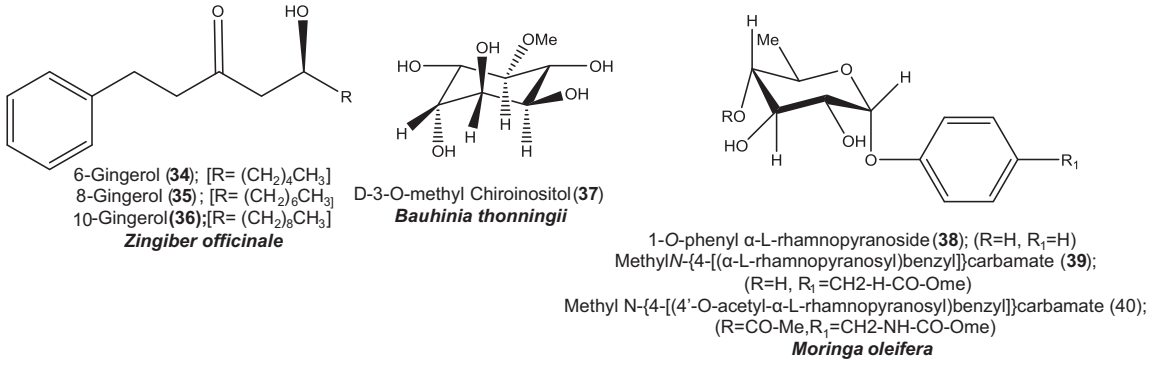

Fig. 6. Other hydroxylated compounds with beneficial effects in diabetes.

from plant samples from Nigeria decreased the glucose-mediated insulin release from INS-1 cells when compared to control, even though the amount of glucose released was dose dependent. This effect may however be explained by their known *in vitro* cytotoxicity (Adebajo et al., 2005).

The alkaloid trigonelline (**4**) isolated from the seeds of *Abrus precatorius* (L.) collected from the eastern part of Nigeria decreased blood glucose levels in alloxan-induced diabetic rats as well as reduced the activity of glucose-6-phosphatase and glycogen phosphorylase, two enzymes important for glucose production (Monago and Nwodo, 2010). Akuammicine (**3**) isolated from the chloroform extract of the seeds of *Picralima nitida* (Stapf) T.Durand and H.Durand stimulated glucose uptake in 3T3-L1 adipocytes (Shittu et al., 2010). It is also present in plants of the genus *Alstonia* such as *Alstonia boonei* De Wild. and *Alstonia Congensis* Engl. and would most likely be contributing to their blood glucose lowering activity. Ajmaline (**6**) and isosandwichine (**7**) from *Rauvolfia vomitoria* Afzel. were identified as DPP-IV inhibitors using an *in silico* approach (Guasch et al., 2012).

Garlic and onions are commonly used as part of the diet in many Nigerian households and the hypoglycemic effect of plant samples collected from Nigeria has also been studied (Eyo et al., 2011). This hypoglycemic effect is possibly due to the presence of S-methylcysteine sulfoxide (**8**) (SMCS) in onions and S-allylcysteine sulfoxide (**9**) (SACS) in garlic, which have been isolated from Indian plant samples and have been shown to improve glucose tolerance in alloxan-induced diabetic rats (Sheela et al., 1995). Clinical studies in humans have shown that the supplementation of garlic to diabetic patients in combination with hypoglycemic drugs improves glycemic control in addition to

the reduction of cardiovascular risk (Sobenin et al., 2008). Although they both contain nitrogen, SMCS and SACS are primarily classed as sulfur containing compounds.

3.3.2. Terpenes

A number of terpenes have been isolated as bioactive constituents in plants used for diabetes management (Fig. 3). The leaves of *Gongronema latifolium,* otherwise known as 'utazi' or 'madumaro' in Ibo and Yoruba respectively is commonly used as a food vegetable and is widely recognized for its traditional use in diabetes management. Lupenyl cinnamate (**15**), lupenyl acetate and α- and β-amyrin cinnamates (**16**) isolated from the combined root and stems of locally obtained samples have recently been identified as the bioactive compounds, possessing both anti-hyperglycemic effects in glucose-fasted rats as well as insulin stimulating effects in INS-1 cells (Adebajo et al., 2013).

Foetidin from the whole plant and the unripe fruits of *Momordica foetida* collected in Nigeria also decreased blood glucose levels of normal fasted, but not alloxan-induced rats at only 1 mg/kg (Marquis et al., 1977). Acetylenic glucosides (**10**) and (**11**) from *Bidens pilosa* decreased blood glucose in the murine type 2 diabetes model C57BL/Ks-*db*/*db* mice (Ubillas et al., 2000), and inhibited the spontaneous development of diabetes in non-obese diabetic (NOD) mice by modulating the differentiation of T-helper cells (Chang et al., 2004).

The monoterpenes myrcene (**12**), citral (**13**) and geraniol (**14**) found in *Cymbopogon citratus* were identified as aldose reductase inhibitors using *in-silico* docking methods (Vyshali et al., 2011). They are also components of the essential oil of many medicinal plants used in Nigeria as shown in Table 1. This preliminary information warrants further *in vitro* and *in vivo* studies involving plant samples from Nigeria previously shown to contain these compounds, given that the beneficial effect of the essential oil of *Cymbopogon citratus* containing high amounts of these monoterpenes has now been validated *in vivo* in experimentally induced type-2 diabetic rats (Bharti et al., 2013).

3.3.3. Phenolic compounds

A wide range of phenolic compounds have been identified as active principle(s) in some of the plants here reviewed. Anthraquinone glycosides from *Morinda citrifolia* L, namely damnacanthol-3-*O*-β-D-primeveroside (**18**) and lucidin 3-*O*-β-D-primeveroside (**19**), decreased blood glucose levels in STZ-induced diabetic mice at 100 mg/kg (Kamiya et al., 2008). Incidentally, this plant is not native to Nigeria and is not known to grow in Nigeria. However, the use of a registered herbal product of the juice extract, Tahitian noni juice® (TNJ) is quite popular in Nigeria for various ailments including diabetes. Administration of 1 ml/150 mg body weight of the rats twice daily for four weeks prior to and after the induction of diabetes with alloxan resulted in significant decrease in blood sugar levels, indicating a prophylactic effect of the extract against alloxan-induced diabetes (Horsfal et al., 2008). The presence of these phenolic compounds in the marketed product has however not been confirmed.

Kolaviron (**17**) is a mixture of flavanones isolated from the acetone extract of the edible nuts of *Garcinia kola* Heckel (bitter kola), which is valued in most parts of West Africa. It decreased blood sugar levels in normal and alloxan induced diabetic mice at a dose of 100 mg/kg, as well as inhibited rat lens aldose reductase (RLAR) activity (Iwu et al., 1990a).

Other phenolic compounds have been identified as bioactive constituents but not from plant samples collected in Nigeria. A diacylated anthocyanin peonidin 3-*O*-[2-*O*-(6-*O*-*E*-feruloyl-β-D-glucopyranosyl)-6-*O*-*E*-caffeoyl-β-D-glucopyranoside]-5-*O*-β-D-glucopyranoside isolated from the root of *Ipomoea batatas* (L.) Poir. showed potent maltase inhibitory effects *in vivo* (Matsui et al., 2002), while ellagic acid (**26**) and 3,5-dicaffeoylquinic acid (**27**) isolated from the hot water extract of the leaves showed potent aldose reductase inhibitory effects (Terashima et al., 1991). Lawsone (**20**) (a naphtoquinone) and gallic acid (**21**) isolated from the ethanol extract of the aerial parts of *Lawsonia inermis* L. inhibited the formation of advanced glycated end products *in vitro* (Sultana et al., 2009). Some methoxy phenyl derivatives (**22–25**) isolated from the rhizomes of *Zingiber officinale* Roscoe have been identified as aldose reductase inhibitors both *in vitro* and *in vivo*, suppressing sorbitol accumulation in human erythrocytes as well as lens galactitol accumulation in 30% galactose-fed rats (Kato et al., 2006).

Several isolated flavonoids have also been identified as bioactive constituents. Isoscutellarein (8-hydroxy apigenin) (**28**) is a flavonoid isolated from the hot water extract of the leaves of *Bixa orellana* L., which was identified as an aldose reductase inhibitor (Terashima et al., 1991). Rutin (**29**) and quercetin (**30**) were isolated from the leaves of *Bauhinia monandra* Kurz as the anti-hyperglycemic constituents in alloxan-induced diabetic rats (Alade et al., 2011, 2012). A bioassay guided fractionation of the stem bark of *Cassia fistula* L. led to the identification of catechin (**33**) as the bioactive agent. It decreased plasma glucose levels in STZ-induced diabetic rats, with direct effects on glucose metabolizing enzymes and expression of the glucose transporter GLUT4 (Daisy et al., 2010). Fractionation of the methanol extract of the leaves of *Senna alata* (L.) Roxb. (syn- *Cassia alata*), which showed potent α-glucosidase inhibitory effects, identified kaempferol gentiobioside (**31**) and kaempferol (**32**) as the bioactive compounds (Varghese et al., 2013). Increased translocation of GLUT4 receptors to the plasma membrane of L6 myotubes was also observed with a flavonoid-rich fraction of *Scoparia dulcis* L. (Beh et al., 2010), although the bioactive constituent(s) was not identified.

The presence of aromatic hydroxyl groups in the benzo-γ-pyran structure of flavonoids is associated with its antioxidant properties, particularly its free radical scavenging effects. These properties have been shown to protect pancreatic islet cells from oxidative stress as well as help in the regeneration of β-cells as shown with epicatechin found in green tea (Sabu et al., 2002) and quercetin (Coskun et al., 2005). More importantly, they can prevent the formation of advanced glycated end products (AGEs) and other diabetic complications associated with high oxidative stress conditions such as artherosclerosis, nephropathy, neuropathy, retinopathy and erectile dysfunction (Rahimi et al., 2005). Thus, the presence of quercetin and epicatechin as well as other potent antioxidant flavonoids in a wide range of plants such as *Irvingia gabonensis*, *Khaya senegalensis*, *Mangifera indica*, *Securidaca longipedunculata* and *Ocimum gratissimum,* will contribute to – and in some cases may be the basis for – their use in the holistic management of diabetes which includes the prevention of diabetic complications.

Other flavonoids have also been shown to directly affect specific therapeutic targets in diabetes. For instance, supplementation of mice diet with naringin or hesperidin modulated the activity of glucose metabolizing enzymes, with an increase in hepatic glucokinase activity and decrease in hepatic glucose-6-phosphatase activity in diabetic db/db mice (Jung et al., 2004) and GK type-2 diabetic rats (Akiyama et al., 2009). These two flavonoids are constituents of all citrus fruits and have also been identified in *Senna alata* (Hennebelle et al., 2009) and *Rauvolfia vomitoria* (Campbell-Tofte et al., 2011) and as such may account for some of their effects. Myricetin is another flavonoid that has shown direct beneficial effects in diabetes through enhanced glycogen metabolism (Ong and Khoo, 2000) and improved insulin sensitivity (Liu et al., 2007). It has been identified in some of the plants either in its aglycone form or as a glycoside. These are the

Allium species, *Aloe vera*, *Azadirachta indica*, *Citrus* species, *Carica papaya*, *Bryophyllum pinnatum*, *Cassia sieberiana*, *Chrysophyllum albidum*, *Ipomoea batatas* and *Bridelia ferruginea.*

3.3.4. Hydroxylated compounds including sugars

Some other non-phenolic hydroxylated cyclic compounds have been isolated and identified as bioactive agents. These include the gingerols (**34**–**36**) from *Zingiber officinale*, which were shown to enhance glucose uptake into muscles as a result of a direct increase in the expression of the GLUT4 receptor (Li et al., 2012). An inositol derivative, D-3-O-methyl chiroinositol (**37**) isolated from the methanol extract of the stem bark of *Bauhinia thonningii* Schum. produced a dose-dependent decrease in blood glucose levels in alloxan-induced diabetic rats (Asuzu and Nwaehujor, 2013).

Finally, a number of benzyl derivatives including carbamates and thiocarbamates have been isolated from fractions of the methanol extract of the fruits of *Moringa oleifera* Lam. These compounds have been shown to possess insulin secretory effects, stimulating $\geq$ 15 ng insulin/mg protein in pancreatic INS-1 cells at 100 ppm. Some of these compounds were identified as 1-*O*-phenyl α-L-rhamnopyranoside (**38**), methyl *N*-{4-[(α-L-rhamnopyranosyl) benzyl]}carbamate (**39**), and methyl *N*-{4-[(4′-*O*-acetyl-α-L-rhamnopyranosyl)benzyl]}carbamate (**40**).

Many plant secondary metabolites have been associated with specific beneficial effects in diabetes, which might account for the therapeutic effect of the herbal drug (Qi et al., 2010; Singh et al., 2013). Thus, apart from a bioguided fractionation, the biologically active agent of a plant can also be inferred by evaluating the phytochemical constituents that have previously been isolated. These can thereafter be confirmed in specific pharmacologic experiments.

3.4. Clinical studies

The validation of biologically active plants in randomized, placebo-controlled clinical trials involving human subjects is a necessary step towards the possible integration of traditional herbal products into health systems. For these purposes, isolation of the active constituent may not be necessary. The European Directive of Traditional Herbal Medicinal Products is an example of how reports of traditional use and a sound safety profile are enough to regulate herbal medicines (Cox and Roche, 2004). However, knowing the identity of the active principle would be ideal in order to ensure a better quality control and perhaps a more defined dosage.

Fourteen of the plants reviewed in this paper have been clinically evaluated in human subjects, either singly or in combination. These are *Bridelia ferruginea*, *Citrus aurantium*, *Gongronema latifolium*, *Ocimum gratissimum*, *Rauvolfia vomitoria*, *Vernonia amygdalina*, *Carica papaya*, *Curcuma longa*, *Ipomoea batatas*, *Irvingia gabonensis*, *Gymnema sylvestre*, *Phyllanthus amarus* and *Solanum aethiopicum* (Table 1), of which the first six involved plant samples collected from Nigeria. Only *Phyllanthus amarus* did not produce the desired clinical effect (Moshi et al., 2001).

Most of the clinical studies were not randomized, controlled trials but preliminary studies evaluating the therapeutic effect of the plant in human subjects. Exceptions to these were those carried out on *Rauvolfia vomitoria* and *Citrus aurantium* (Campbell-Tofte et al., 2011), *Irvingia gabonensis* (Ngondi et al., 2009) and *Ipomoea batatas* (Ludvik et al., 2004). Similarly, a meta-analysis by Leung et al. (2009) of all clinical studies carried out on *Momordica charantia* identified flaws in their study design, despite the extract consistently producing a hypoglycemic effect. As a result, appropriate conclusions that will act as guidelines for their clinical use cannot be drawn.

A good knowledge of the traditional use of these plants based on ethnobotanical studies is very important in the design of a good clinical study. This is especially important for plants which are used as mixtures, as the individual components may be working synergistically to produce the overall desired effect. An example is the synergistic effect produced by a decoction mix of the leaves of *Gongronema latifolium*, *Ocimum gratissimum* and *Vernonia amygdalina* in modulating baseline blood glucose levels, which was not observed with the individual plants (Ejike et al., 2013). Given that many of these herbal remedies are currently being taken by diabetic patients alongside their prescription medicines, a concerted effort between clinicians and researchers would be an ideal way to recruit patients to such studies.

To ensure the reliability of conclusions drawn from any clinical study, they should always involve proper planning with appropriate controls and ought to be conducted within a reasonable time frame, in line with the guidelines of the Declaration of Helsinki. In addition, the recommendations for reporting randomized clinical trials, as defined in the 'Consolidated Standards of Reporting Randomized Clinical Trials (CONSORT) statement' (Schulz et al., 2010) should also be followed. Nonetheless, this relatively high 'success' rate amongst the various studies conducted highlights the potential of harnessing ethnobotanical information in enhancing patient therapy.

4. Toxicological evidence and considerations

The administration of whole plant extracts or fractions consisting of a myriad of compounds, can elicit different biological effects in the body, some of which may be harmful toxic effects. Sometimes, these toxic effects are only associated with certain parts of the plant. For example, the leaves of *Senna occidentalis* have hepatoprotective effects and are used traditionally for the treatment of liver disorders (Jafri et al., 1999). However, ingestion of toxins found in the seeds (beans) is thought to be the probable cause of acute hepato-myoencephalopathy (HMP) in children (Vashishtha et al., 2009). This risk of toxicity associated with the use of herbal products is one of the main reasons for the hesitance amongst healthcare practitioners towards promoting their integration into healthcare systems.

Adequate knowledge about the traditional use of such plants is very necessary as this often helps to forestall the ingestion of such toxic plants or plant parts. Sometimes the toxic component may have been identified such as abrin, a toxic protein found in the seeds of *Abrus pecatorius*, with an estimated human fatal dose of 0.1–1 μg/kg (Kirsten et al., 2003). In rare cases, the hypoglycemic agent in the plant could also be the toxic agent, such as with hypoglycin from *Blighia sapida* (Sherratt, 1986). Thus, the therapeutic use of such a plants as whole extracts is therefore not recommended.

Various plants in Table 1 have been associated with specific organ toxicity. Examples include the nephrotoxic effects of *Alstonia congensis*, *Aristolochia spp.*, *Cassia sieberiana*, *Ficus exasperata*, *Securidaca longipedunculata* and the hepatotoxic effects of *Cassia sieberiana*, *Ficus exasperata*, *Morinda citrifolia*, *Picralima nitida* and *Senna occidentalis.* The hepatotoxic effects of some extracts such as *Ocimum gratissimum* and *Sphenocentrum jollyanum* are directly linked to their effect on the liver function enzymes. The cardiotoxic and neurotoxic effects of some other extracts have also been identified. Sometimes, these toxic effects are only seen at high doses, which would therefore not preclude their continued use as medicinal plants so long as there is appropriate information

about the safe dose ranges. The use of other more toxic plants would however need to be completely discontinued.

A thorough analysis of the plant's extracts as well as identified phytochemical constituents with respect to their safety/toxicity profile particularly in humans can ensure a critical assessment of its therapeutic potential. Previously, coumarins which are a component of a wide range of plants were identified as hepatotoxic based on various studies carried out in rodents. However, further studies have showed that certain animal species are resistant to coumarin-induced toxicity. The 7-hydroxylation metabolic pathway is the most favored in humans leading to the formation of non-toxic metabolites, whereas in rats the most favored pathway is a 3,4-epoxidation leading to the formation of toxic metabolites. Knowledge of this and a quantitative health risk assessment have now confirmed its safety in humans (Felter et al., 2006; Lake, 1999).

Evaluation of medicinal plants for potential herb–drug interactions is equally as important as its evaluation for efficacy and safety. Two types of herb–drug interactions exist: pharmacodynamic interactions and pharmacokinetic interactions. If a herbal plant alters the expected pharmacological effect of a drug as a result of its biochemical or physiological effect on the body, this is known as a 'pharmacodynamic interaction'. If the herb and the drug are both expected to produce the same pharmacological effect, there may be an increased therapeutic effect produced with their co-administration. This knowledge can be harnessed towards producing a synergistic effect between the two, which would possibly require a dose adjustment. Otherwise, the resulting effect could be detrimental if appropriate monitoring and evaluation is not done. A good example is the severe hypoglycemic that was observed in a female diabetic patient taking chlorpropamide and a meal containing *Momordica charantia* and *Allium sativum* (Izzo and Ernst, 2001).

A synergistic effect should however not be assumed. It is sometimes advisable for patients not to take drugs alongside their herbal products due to negative drug interactions that may occur. For instance, the water soluble fraction of okra fruits has been shown to decrease the absorption of metformin (Khatun et al., 2011). Although both would otherwise be beneficial in diabetes management, taken together would result in a decrease in the therapeutic concentration of metformin, which in turn may not bring about the desired hypoglycemic effect in the patient.

Constituents of medicinal plants also undergo the four main pharmacokinetic processes of absorption, distribution, metabolism and elimination (ADME). There is therefore the possibility of an interaction with one of the different ADME parameters by the herb, which could invariably affect the fate/bioavailability of a co-administered drug and possibly, the resulting therapeutic benefit (s). This is known as a 'pharmacokinetic interaction'.

Out of the one hundred and fifteen plants reviewed in this paper, over thirty of them have shown *in vitro* and/or *in vivo* modulation of the activity of one or more of these ADME parameters (Fig. 7). Some of these interactions were on absorption, either by modulating the effect of P-glycoprotein (P-gp), an intestinal efflux transporter, or by direct effects on the intestinal tight junctions. Other pharmacokinetic interactions were on metabolism, by interacting with one or more cytochrome P450 enzymes responsible for phase 1 metabolism or either of the phase 2 metabolic enzymes (Table 1).

The role of P-gp in the intestinal epithelium is the extrusion of certain xenobiotics from the blood to the intestinal lumen as well as to minimize the entry of drugs in the lumen into the bloodstream, ultimately resulting in decreased absorption and decreased oral bioavailability (Sharom, 2007). For drugs that are P-gp substrates such as glibenclamide, this effect of the efflux transporter is one of the determinant factors in the recommended

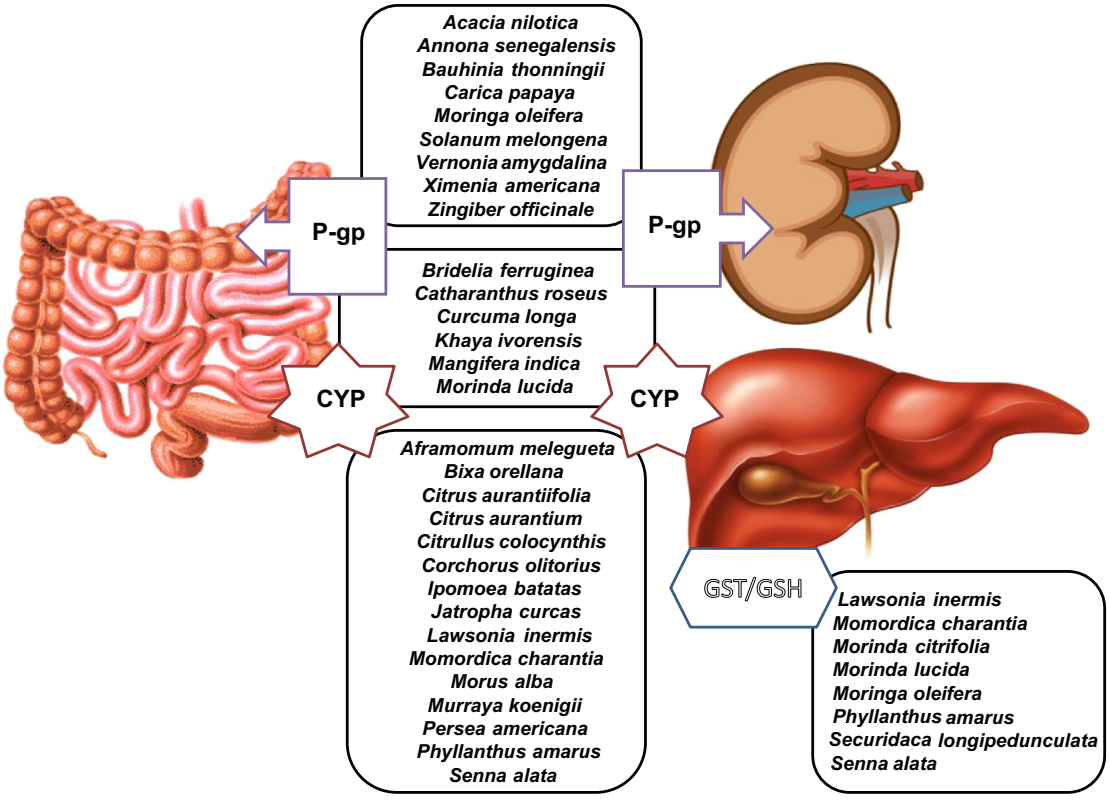

Fig. 7. *In vitro* pharmacokinetic herb–drug interactions identified based on the literature reviewed.

dose of the drug to ensure that an adequate therapeutic concentration is achieved in the bloodstream. Co-administration of the drug with a herb with inhibitory effects on P-gp such as *Acacia nilotica*, *Annona senegalensis*, *Bauhinia thonningii*, *Bridelia ferruginea*, *Carica papaya* and *Morinda lucida* might result in increased plasma concentration of the drug.

The cytochrome P450 (CYP) family of enzymes are responsible for phase 1 oxidative, peroxidative and reductive metabolic transformations of drugs, environmental chemicals and natural compounds into less toxic, more water-soluble products, in order to facilitate their excretion from the body. They are most abundant in the liver, which is the primary site for metabolism. The activity of CYP enzymes can be modified either by induction or inhibition as seen with the extracts of *Bixa orellana* and *Jatropha curcas* respectively. The biological activity of the xenobiotics metabolized by these enzymes can be greatly altered as a result (Rendic and Carlo, 1997). St John's wort (*Hypericum perforatum*) is a very good example of a herbal product that has produced clinically significant effects as a result of its interactions with P-gp and CYP enzymes (Henderson et al., 2002).

In vitro interactions have also been identified with the phase 2 metabolizing enzymes, particularly with the glutathione transferases (GSTs). As with P-gp and CYPs, such interactions can alter the plasma concentration and the resulting therapeutic effect of the co-administered substrate drug. In addition, GSTs directly control the levels of glutathione (GSH) within the cell. GSH also acts as an antioxidant within cells, and is particularly important in diabetic conditions characterized by oxidative stress. Unfortunately, plants such as *Securidaca longipedunculata* which decrease GSH levels might be counter-productive in diabetic patients.

For many of these plants in Fig. 7, the phytochemical constituents responsible for the pharmacokinetic interaction are still unknown. Polyphenols present in plants especially flavonoids have been the most implicated in herb–drug interactions, with direct effects seen with specific flavonoids on P-gp and drug metabolizing enzymes (Morris and Zhang, 2006) (Galati and O'Brien, 2004) (Hodek et al., 2002). It should however be taken into account that many of the *in vitro* pharmacokinetic interactions or alarming case studies published in primary literature fail to translate into significant clinical risks for the patients, as seen with many herbal remedies taken in Europe (Williamson et al., 2013). There is still an urgent need for effective pharmacovigilance of herbal medicines to ensure their safe and effective use in therapeutic management (Shaw et al., 2012).

5. Conclusions

Nigeria is endowed with a biodiversity of medicinal plants, many of which are currently used in the traditional management of diabetes. Our review shows that there is very good preclinical evidence for the efficacy of most of these plants, either as hypoglycemic agents or as useful agents in the management of diabetic complications. We have mapped their pharmacological mechanism of action as this can serve to promote a more rational use of these plants as herbal medicines based on the expected therapeutic outcome and their tabulated toxicological effects. Last but not least, we have also highlighted potential interactions with key parameters of the ADME process that can arise from the use of these plants in therapeutic management.

These available data can provide evidential support for the clinical development of a number of medicinal plants as adjuvant therapy. We believe that the criteria for selection should be based on social acceptance/frequency of use, efficacy and toxicity profile, and availability/sustainability of the supply chain, possibly tailored to each region. A set of quality parameters for the standardization of these plants as herbal preparations (such as pharmacopoeial monographs) would be required to ensure the reproducibility of their therapeutic effects. Finally, as a means of giving credence to the pre-clinical experimental evidence, intervention or clinical studies with the standardised materials should be carried out in order to validate their usefulness in diabetes management. We hope that in this manner the therapeutic potential of these medicinal plants can be best harnessed, towards a possible integration into the healthcare system.

Acknowledgments

U.F. Ezuruike is grateful to the Commonwealth Scholarship Commission in the UK for the award of a DFID (Department for International Development) sponsored Ph.D. scholarship.

Appendix A. Supplementary information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.jep.2014.05.055.

References

Abdelgadir, H.A., Van Staden, J., 2013. Ethnobotany, ethnopharmacology and toxicity of *Jatropha curcas* L. (Euphorbiaceae): a review. South African Journal of Botany 88, 204–218.

Abdelgaleil, S.A.M., Okamura, H., Iwagawa, T., Sato, A., Miyahara, I., Doe, M., Nakatani, M., 2001. Khayanolides, rearranged phragmalin limonoid antifeedants from *Khaya senegalensis*. Tetrahedron 57, 119–126.

Abdel-Hassan, I.A., Abdel-Barry, J.A., Tariq Mohammeda, S., 2000. The hypoglycaemic and antihyperglycaemic effect of *Citrullus colocynthis* fruit aqueous extract in normal and alloxan diabetic rabbits. Journal of Ethnopharmacology 71, 325–330.

Abdelwahab, S.I., Hassan, L.E.A., Sirat, H.M., Yagi, S.M.A., Koko, W.S., Mohan, S., Taha, M.M.E., Ahmad, S., Chuen, C.S., Narrima, P., Rais, M.M., Hadi, A.H.A., 2011. Anti-inflammatory activities of cucurbitacin E isolated from *Citrullus lanatus* var. *citroides*: role of reactive nitrogen species and cyclooxygenase enzyme inhibition. Fitoterapia 82, 1190–1197.

Abdu-Aguye, I., Sannusi, A., Alafiya-Tayo, R.A., Bhusnurmath, S.R., 1986. Acute toxicity studies with *Jatropha curcas* L. Human Toxicology 5, 269–274.

Abe, F., Nagafuji, S., Okawa, M., Kinjo, J., Akahane, H., Ogura, T., Martinez-Alfaro, M. A., Reyes-Chilpa, R., 2005. Trypanocidal constituents in plants 5. Evaluation of some mexican plants for their trypanocidal activity and active constituents in the seeds of *Persea americana*. Biological and Pharmaceutical Bulletin 28, 1314–1317.

Abo, K.A., Fred-Jaiyesimi, A.A., Jaiyesimi, A.E.A., 2008. Ethnobotanical studies of medicinal plants used in the management of diabetes mellitus in South Western Nigeria. Journal of Ethnopharmacology 115, 67–71.

Abo, K., Jimoh, T., 2004. Anti-hyperglycaemic potential of stem bark of *Bauhinia monandra* Kurz in rats. Nigerian Journal of Natural Products and Medicine 8, 48–51.

Aboaba, S., Ekundayo, O., 2010. Constituents, antibacterial activities and toxicological assay of essential oils of *Artocarpus communis* Forst (Moraceae) and *Sphenocentrum jollyanum* (Menispermaceae). International Journal of Biological and Chemical Sciences 4, 1455–1461.

Aboaba, S.A., Ekundayo, O., Omikorede, O., 2007. Constituents of Breadfruit tree (*Treculia africana*) leaves, stem and root barks. Journal of Essential Oil Bearing Plants 10, 189–193.

Abotsi, W.M.K., Woode, E., Ainooson, G.K., Amo-Barimah, A.K., Boakye-Gyasi, E., 2010. Antiarthritic and antioxidant effects of the leaf extract of *Ficus exasperata* P. Beauv. (Moraceae). Pharmacognosy Research 2, 89–97.

Abreu, P., Pereira, A., 2001. New indole alkaloids from *Sarcocephalus latifolius*. Natural Product Letters 15, 43–48.

Abreu, P., Pereira, A., Relva, A., 2001. Characterisation of a sugar fraction from *Sarcocephalus latifolius* stem bark extract. Carbohydrate Polymers 45, 155–160.

Abuh, F.Y., Wambebe, C., Rai, P.P., Sokomba, E.N., 1990. Hypoglycaemic activity of *Anthocleista vogelii* (Planch) aqueous extract in rodents. Phytotherapy Research 4, 20–24.

Abu-Reidah, I.M., Arráez-Román, D., Segura-Carretero, A., Fernández-Gutiérrez, A., 2013. Profiling of phenolic and other polar constituents from hydro-methanolic extract of watermelon (*Citrullus lanatus*) by means of accurate-mass spectrometry (HPLC–ESI–QTOF–MS). Food Research International 51, 354–362.

Acquaviva, R., Giacomo, C.D., Vanella, L., Santangelo, R., Sorrenti, V., Barbagallo, I., Genovese, C., Mastrojeni, S., Ragusa, S., Iauk, L., 2013. Antioxidant activity of extracts of *Momordica Foetida* Schumach. et Thonn. Molecules 18, 3241–3249.

Adamson, I., Okafor, C., Abu-Bakare, A., 1990. A supplement of Dikanut (*Irvingia gabonesis*) improves treatment of type II diabetics. West African Journal of Medicine 9, 108–115.

Adaramoye, O.A., Adeyemi, E.O., 2006. Hypoglycaemic and hypolipidaemic effects of fractions from kolaviron, a biflavonoid complex from *Garcinia kola* in streptozotocin-induced diabetes mellitus rats. Journal of Pharmacy and Pharmacology 58, 121–128.

Addae-Mensah, I., Munenge, R.W., 1989. Quercetin-3-neohesperidoside (rutin) and other flavonoids as the active hypoglycaemic agents of *Bridelia ferruginea*. Fitoterapia 60, 359–362.

Addae-Mensah, I., Achenbach, H., 1985. Terpenoid and flavonoids of *Bridelia ferruginea*. Phytochemistry 24, 1817–1819.

Adebajo, A.C., Ayoola, M.D., Odediran, S.A., Aladesanmi, A.J., Schmidt, T.J., Verspohl, E.J., 2013. Evaluation of ethnomedical claim III: anti-hyperglycemic activities of *Gongronema latifolium* root and stem. Journal of Diabetes 5, 336–343.

Adebajo, A.C., Ayoola, O.F., Iwalewa, E.O., Akindahunsi, A.A., Omisore, N.O.A., Adewunmi, C.O., Adenowo, T.K., 2006. Anti-trichomonal, biochemical and toxicological activities of methanolic extract and some carbazole alkaloids isolated from the leaves of *Murraya koenigii* growing in Nigeria. Phytomedicine 13, 246–254.

Adebajo, A.C., Olayiwola, G., Verspohl, J.E., Iwalewa, E.O., Omisore, N.O.A., Bergenthal, D., Kumar, V., Adesina, S.K., 2005. Evaluation of the ethnomedical claims of *Murraya koenigii*. Pharmaceutical Biology 42, 610–620.

Adebajo, A.C., Olugbade, T.A., Elujoba, A.A., Aladesanmi, A.J., Reisch, J., 1997. 2″, 3″-Epoxyindicolactone from *Murraya koenigii*. Nigerian Journal of Natural Products and Medicine 1, 21–24.

Adebajo, A.C., Reisch, J., 2000. Minor furocoumarins of *Murraya koenigii*. Fitoterapia 71, 334–337.

Adebayo, A.H., Abolaji, A.O., Kela, R., Ayepola, F.O., Olorunfemi, T.B., Taiwo, O.S., 2011. Antioxidant activities of the leaves of *Chrysophyllum albidum* G. Pakistan Journal of Pharmaceutical Sciences 24, 545–551.

Adebayo, M.A., Karioti, A., Skaltsa, H., Ogunwande, I.A., 2007. Essential oils of Nigeria II: analysis of the leaf oil of *Securidaca longependuculata* Fers. Journal of Essential Oil Research 19, 452–454.

Adediwura, F.-J., Bernard, N., Omotola, A., 2011. Biochemical effects of chronic administration of *Cola acuminata* (P. Beauv.) Schott & Endl extracts in alloxan induced diabetic rats. Asian Journal of Pharmaceutical and Biological Research 1, 355–359.

Adefegha, S.A., Oboh, G., 2012. Inhibition of key enzymes linked to type 2 diabetes and sodium nitroprusside-induced lipid peroxidation in rat pancreas by water extractable phytochemicals from some tropical spices. Pharmaceutical Biology 50, 857–865.

Adejuwon, A.A., Oluwatoyin, S.M., Sunday, A.O., 2011. Anti-inflammatory and antioxidant activities of *Hunteria umbellata* seed fractions. Pharmacologia 2, 165–171.

Adejuwon, A.A., Peter, C.A., Anne-Frances, M., Jack, G., Olufunmilayo, A.O., Esther, A. O., 2012. Isolation and structure elucidation of a new indole alkaloid, erinidine, from *Hunteria umbellata* seed. Pharmacologia 3, 204–214.

Adeneye, A.A., Adeyemi, O.O., 2009. Further evaluation of antihyperglycaemic activity of *Hunteria umbellata* (K. Schum) Hallier f. seed extract in experimental diabetes. Journal of Ethnopharmacology 126, 238–243.

Adeneye, A., Olagunju, J., 2009. Preliminary hypoglycemic and hypolipidemic activities of the aqueous seed extract of *Carica papaya* Linn. in Wistar rats. Biology and Medicine 1, 1–10.

Adeneye, A.A., Adeyemi, O.O., Agbaje, E.O., Sofidiya, M.O., 2012. The novel anti-hyperglycaemic action of *Hunteria umbellata* seed fractions mediated via intestinal glucose uptake inhibition. African Journal of Traditional Complementary and Alternative Medicines 9, 17–24.

Adeneye, A.A., Agbaje, E.O., 2007. Hypoglycemic and hypolipidemic effects of fresh leaf aqueous extract of *Cymbopogon citratus* Stapf. in rats. Journal of Ethnopharmacology 112, 440–444.

Adeneye, A.A., Amole, O.O., Adeneye, A.K., 2006. Hypoglycemic and hypocholesterolemic activities of the aqueous leaf and seed extract of *Phyllanthus amarus* in mice. Fitoterapia 77, 511–514.

Aderibigbe, A.O., Emudianughe, T.S., Lawal, B.A.S., 2001. Evaluation of the antidiabetic action of *Mangifera indica* in mice. Phytotherapy Research 15, 456–458.

Aderogba, M., McGaw, L., Ogundaini, A., Eloff, J., 2008. Cytotoxicity study of antioxidant flavonoids from *Bauhinia tomentosa* leaf extract. Nigerian Journal of Natural Products and Medicine 12, 50–54.

Aderogba, M.A., Ogundaini, A.O., Eloff, J.N., 2006. Isolation of two flavonoids from *Bauhinia monandra* (Kurz) leaves and their antioxidative effects. African Journal of Traditional, Complementary and Alternative Medicines 3, 59–65.

Adesogan, E.K., Taylor, D.A.H., 1970. Limonoid extractives from *Khaya ivorensis*. Journal of the Chemical Society C: Organic 0, 1710–1714.

Adesokan, A., Akanji, M.A., Adewara, G.S., 2010. Evaluation of hypoglycaemic efficacy of aqueous seed extract of *Aframomum melegueta* in alloxan-induced diabetic rats. Sierra Leone Journal of Biomedical Research 2, 91–94.

Adewole, S.O., Ojo, S.K., Adenowo, T.K., Salako, A.A., Naicker, T., Ojewole, J.A., 2012. Effects of *Ficus exasperata* vahl. (moraceae) leaf aqueous extract on the renal function of streptozotocin-treated rats. Folia Morphologica 71, 1–9.

Adewole, S.O., Adenowo, T., Naicker, T., Ojewole, J.A.O., 2011. Hypoglycaemic and hypotensive effects of *Ficus exasperata* Vahl. (Moraceae) leaf aqueous extract in rats. African Journal of Traditional, Complementary and Alternative Medicine 8, 275–283.

Adewole, S.O., Caxton-Martins, E.A., 2006. Morphological changes and hypoglycemic effects of *Annona muricata* Linn. (Annonaceae) leaf aqueous extract on pancreatic B-cells of streptozotocin-treated diabetic rats. African Journal of Biomedical Research 9, 173–187.

Adewoye, E.O., Taiwo, V.O., Olayioye, F.A., 2009. Anti-oxidant and anti-hyperglycemic activities of *Musa sapientum* root extracts in alloxan-induced diabetic rats. African Journal of Medicine and Medical Sciences 38, 109–117.

Adika, O.A., Madubunyi, I.I., Asuzu, I.U., 2011. Antidiabetic and antioxidant effects of the methanol extract of *Bridelia micrantha* (Hochst) Baill. (Euphorbiaceae) leaves on alloxan-induced diabetic albino mice. Comparative Clinical Pathology 10, 1205–1208.

Adikwu, M.U., Yoshikawa, Y., Takada, K., 2004. Pharmacodynamic–pharmacokinetic profiles of metformin hydrochloride from a mucoadhesive formulation of a polysaccharide with antidiabetic property in streptozotocin-induced diabetic rat models. Biomaterials 25, 3041–3048.

Adotey, J.P.K., Adukpo, G.E., Opoku Boahen, Y., Armah, F.A., 2012. A review of the ethnobotany and pharmacological importance of *Alstonia boonei* De Wild (Apocynaceae). ISRN Pharmacology 2012, 9.

Afify, A.E.-M.M.R., El-Beltagi, H.S., El-Salam, S.M.A., Omran, A.A., 2012. Biochemical changes in phenols, flavonoids, tannins, vitamin E, β-carotene and antioxidant activity during soaking of three white sorghum varieties. Asian Pacific Journal of Tropical Biomedicine 2, 203–209.

Afzal, M., Kazmi, I., Khan, R., Singh, R., Chauhan, M., Bisht, T., Anwar, F., 2012. *Bryophyllum pinnatum*: a review. International Journal of Research in Biological Sciences 2, 143–149.

Agaie, B.M., Onyeyili, P.A., Muhammad, B.Y., Ladan, M.J., 2007. Acute toxicity effects of the aqueous leaf extract of *Anogeissus leiocarpus* in rats. African Journal of Biotechnology 6, 886–889.

Agbo, M.O., Lai, D., Okoye, F.B.C., Osadebe, P.O., Proksch, P., 2013. Antioxidative polyphenols from Nigerian mistletoe *Loranthus micranthus* (Linn.) parasitizing on *Hevea brasiliensis*. Fitoterapia 86, 78–83.

Agbonon, A., Eklu-Gadegbeku, K., Aklikokou, K., Gbeassor, M., Akpagana, K., Tam, T. W., Arnason, J.T., Foster, B.C., 2010. in vitro inhibitory effect of West African medicinal and food plants on human cytochrome P450 3A subfamily. Journal of Ethnopharmacology 128, 390–394.

Agbor, G.A., Oben, J.E., Ngogang, J.Y., Xinxing, C., Vinson, J.A., 2005. Antioxidant capacity of some herbs/spices from Cameroon: a comparative study of two methods. Journal of Agricultural and Food Chemistry 53, 6819–6824.

Aguh, B., Nock, I., Ndams, I., Agunu, A., Ukwubile, C., 2013. Hypoglycaemic activity and nephro-protectective effect of *Bauhinia rufescens* in alloxan-induced diabetic rats. International Journal of Advances in Pharmacy, Biology and Chemistry 2, 249–255.

Aguiyi, J.C., Obi, C.I., Gang, S.S., Igweh, A.C., 2000. Hypoglycaemic activity of *Ocimum gratissimum* in rats. Fitoterapia 71, 444–446.

Ahmadu, A., Abdulkarim, A., Grougnet, R., Myrianthopoulos, V., Tillequin, F., Magiatis, P., Skaltsounis, A.-L., 2010. Two new peltogynoids from *Acacia nilotica* Delile with kinase inhibitory activity. Planta Medica 76, 458–460.

Ahmadu, A., Haruna, A.K., Garba, M., Ehinmidu, J.O., Sarker, S.D., 2004. Phytochemical and antimicrobial activities of the *Daniellia oliveri* leaves. Fitoterapia 75, 729–732.

Ahmed, F., Ahmed, K.M., Abedin, M.Z., Karim, A.A., 2012. Traditional uses and pharmacological potential of *Ficus exasperata* vahl. Systematic Reviews in Pharmacy 3, 15–23.

Ahmed, I., Adeghate, E., Cummings, E., Sharma, A.K., Singh, J., 2004. Beneficial effects and mechanism of action of *Momordica charantia* juice in the treatment of streptozotocin-induced diabetes mellitus in rats. Molecular and Cellular Biochemistry 261, 63–70.

Ahmed, M., Jakupovic, J., 1990. Diterpenoids from *Scoparia dulcis*. Phytochemistry 29, 3035–3037.

Ahsan, M., Haque, M.R., Islam, S.K.N., Gray, A.I., Hasan, C.M., 2012. New labdane diterpenes from the aerial parts of *Scoparia dulcis* L. Phytochemistry Letters 5, 609–612.

Ahsan, M., Islam, S.N., Gray, A.I., Stimson, W.H., 2003. Cytotoxic diterpenes from *Scoparia dulcis*. Journal of Natural Products 66, 958–961.

Aiyeloja, A.A., Bello, O.A., 2006. Ethnobotanical potentials of common herbs in Nigeria: a case study of Enugu State. Educational Research and Review 1, 16–22.

Ajala, O.S., Coker, H.A., 2012. Segunoside: a new iridolactone-β-glucoside from the stem bark of *Hunteria umbellata* (K. Schum). International Journal of Pharmaceutical Chemistry 2, 134–137.

Ajala, O.S., Piggott, A.M., Plisson, F., Khalil, Z., Huang, X.-c., Adesegun, S.A., Coker, H. A.B., Capon, R.J., 2011. Ikirydinium A: a new indole alkaloid from the seeds of *Hunteria umbellata* (K. Schum). Tetrahedron Letters 52, 7125–7127.

Ajibade, A.J., Fakunle, P.B., Ehigie, L.O., Akinrinmade, A.O., 2012. Sub-chronic hepatotoxicity in adult Wistar rats following administration of *Ocimum gratissimum* aqueous extract. European Journal of Medicinal Plants 2, 19–30.

Ajibesin, K.K., Ekpo, B.A., Bala, D.N., Essien, E.E., Adesanya, S.A., 2008. Ethnobotanical survey of Akwa Ibom State of Nigeria. Journal of Ethnopharmacology 115, 387–408.

Ajiboye, T., Salau, A., Yakubu, M., Oladiji, A., Akanji, M., Okogun, J., 2010. Aqueous extract of *Securidaca longepedunculata* root induce redox imbalance in male rat liver and kidney. Human and Experimental Toxicology 29, 679–688.

Akah, P.A., Nworu, C.S., Mbaoji, F.N., Nwabunike, I.A., Onyeto, C.A., 2012. Genus Detarium: ethnomedicinal, phytochemical and pharmacological profile. Phytopharmacology 3, 367–375.

Akah, P.A., Okafor, C.L., 1992. Blood sugar lowering effect of *Vernonia amygdalina* Del, in an experimental rabbit model. Phytotherapy Research 6, 171–173.

Akinmoladun, A.C., Obuotor, E.M., Farombi, E.O., 2010. Evaluation of antioxidant and free radical scavenging capacities of some Nigerian indigenous medicinal plants. Journal of Medicinal Food 13, 444–451.

Akinmoladun, A.C., Akinloye, O., 2007. Prevention of the onset of hyperglycaemia by extracts of *Aloe barbadensis* in rabbits treated with alloxan. African Journal of Biotechnology 6, 1028–1030.

Akinola, O.B., Caxton-Martins, E.A., Dini, L., 2010. Chronic treatment with ethanolic extract of the leaves of *Azadirachta indica* Ameliorates lesions of pancreatic islets in streptozotocin diabetes. International Journal of Morphology 28, 291–302.

Akiyama, S., Katsumata, S.-i., Suzuki, K., Nakaya, Y., Ishimi, Y., Uehara, M., 2009. Hypoglycemic and hypolipidemic effects of hesperidin and cyclodextrin-clathrated hesperetin in Goto-Kakizaki rats with Type 2 diabetes. Bioscience, Biotechnology, and Biochemistry 73, 2779–2782.

Alade, G.O., Adebajo, A.C., Omobuwajo, O.R., Proksch, P., Verspohl, E.J., 2012. Quercetin, a minor constituent of the antihyperglycemic fraction of *Bauhinia monandra* leaf. Journal of Diabetes 4, 439–441.

Alade, G.O., Omobuwajo, O.R., Adebajo, C.A., Verspohl, E.J., 2011. Evaluation of the hypoglycaemic activity of *Bauhinia monandra* leaf in alloxan-diabetic rats and INS-1 insulin cells. Journal of Chemical and Pharmaceutical Research 3, 506–521.

Aladodo, R.A., Muhammad, N.O., Balogun, E.A., 2013. Effects of aqueous root extract of *Jatropha curcas* on hyperglycaemic and haematological indices in alloxan-induced diabetic rats. Fountain Journal of Natural and Applied Sciences 2, 52–58.

Alexander-Lindo, R.L., Morrison, E.Y.S.A., Nair, M.G., 2004. Hypoglycaemic effect of stigmast-4-en-3-one and its corresponding alcohol from the bark of *Anacardium occidentale* (cashew). Phytotherapy Research 18, 403–407.

Ali, B.H., Blunden, G., Tanira, M.O., Nemmar, A., 2008. Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale* Roscoe): a review of recent research. Food and Chemical Toxicology 46, 409–420.

Ali, H., Houghton, P.J., Soumyanath, A., 2006. α-Amylase inhibitory activity of some Malaysian plants used to treat diabetes; with particular reference to *Phyllanthus amarus*. Journal of Ethnopharmacology 107, 449–455.

Aliyu, A., Ibrahim, H., Musa, A., Ibrahim, M., Oyewale, A., Amupitan, J., 2010. in vitro evaluation of antioxidant activity of *Anisopus mannii* N.E. Br. African Journal of Biotechnology 9, 2437–2441.

Aliyu, A.B., Ibrahim, M.A., Musa, A.M., Ibrahim, H., Abdulkadir, I.E., Oyewale, A.O., 2009. Evaluation of antioxidant activity of leave extract of *Bauhinia rufescens* Lam. (Caesalpiniaceae). Journal of Medicinal Plants Research 3, 563–567.

Al-Romaiyan, A., Liu, B., Asare-Anane, H., Maity, C.R., Chatterjee, S.K., Koley, N., Biswas, T., Chatterji, A.K., Huang, G.C., Amiel, S.A., Persaud, S.J., Jones, P.M., 2010. A novel *Gymnema sylvestre* extract stimulates insulin secretion from human islets in vivo and in vitro. Phytotherapy Research 24, 1370–1376.

Alvarez-Diez, T.M., Zheng, J., 2004. Mechanism-based inactivation of cytochrome P450 3A4 by 4-ipomeanol. Chemical Research in Toxicology 17, 150–157.

Al-Wandawi, H., 1983. Chemical composition of seeds of two okra cultivars. Journal of Agricultural and Food Chemistry 31, 1355–1358.

Anderson, R.A., Cheng, N., Bryden, N.A., Polansky, M.M., Cheng, N., Chi, J., Feng, J., 1997. Elevated intakes of supplemental chromium improve glucose and insulin variables in individuals with type 2 diabetes. Diabetes 46, 1786–1791.

Andrade-Cetto, A., Heinrich, M., 2005. Mexican plants with hypoglycaemic effect used in the treatment of diabetes. Journal of Ethnopharmacology 99, 325–348.

Aniagu, S.O., Nwinyi, F.C., Akumka, D.D., Agbani, E.O., Dzarma, S., Ajoku, G.A., Izebe, K.S., Agala, P., Adelusola, K.A., Ibe, J., Inyang, U.S., Gamaniel, K.S., 2008. Short-term toxicity studies of *Ficus thonningii* Blume (Moraceae) leaf extract in rats. International Journal of Food Science and Technology 43, 456–463.

Anju, J., Manodeep, C., Kamath Jagdish, V., 2011. *Bauhinia tomentosa*: a phytopharmacological review. International Research Journal of Pharmacy 2, 128–131.

Antia, B.S., Pansanit, A., Ekpa, O.D., Ekpe, U.J., Mahidol, C., Kittakoop, P., 2010. Alpha glucosidase inhibitory, aromatase inhibitory, and antiplasmodial activities of a biflavonoid GB1 from *Garcinia kola* stem bark. Planta Medica 76, 276–277.

Anwar, F., Latif, S., Ashraf, M., Gilani, A.H., 2007. *Moringa oleifera*: a food plant with multiple medicinal uses. Phytotherapy Research 21, 17–25.

Appiah-Opong, R., Commandeur, J.N.M., Axson, C., Vermeulen, N.P.E., 2008. Interactions between cytochromes P450, glutathione S-transferases and Ghanaian medicinal plants. Food and Chemical Toxicology 46, 3598–3603.

Appiah-Opong, R., Commandeur, J.N.M., van Vugt-Lussenburg, B., Vermeulen, N.P.E., 2007. Inhibition of human recombinant cytochrome P450s by curcumin and curcumin decomposition products. Toxicology 235, 83–91.

Aquino, R., Ciavatta, M.L., De Tommasi, N., Gàcs-Baitz, E., 1992. Tetranorditerpenes from *Detarium microcarpum*. Phytochemistry 31, 1823–1825.

Arapitsas, P., 2008. Identification and quantification of polyphenolic compounds from okra seeds and skins. Food Chemistry 110, 1041–1045.

Argolo, A.C.C., Sant'Ana, A.E.G., Pletsch, M., Coelho, L.C.B.B., 2004. Antioxidant activity of leaf extracts from *Bauhinia monandra*. Bioresource Technology 95, 229–233.

Arias, B.Á., Ramón-Laca, L., 2005. Pharmacological properties of citrus and their ancient and medieval uses in the Mediterranean region. Journal of Ethnopharmacology 97, 89–95.

Arogba, S.S., 2000. Mango (*Mangifera indica*) kernel: chromatographic analysis of the tannin, and stability study of the associated polyphenol oxidase activity. Journal of Food Composition and Analysis 13, 149–156.

Arulselvan, P., Subramanian, S.P., 2007. Beneficial effects of *Murraya koenigii* leaves on antioxidant defense system and ultra structural changes of pancreatic β-cells in experimental diabetes in rats. Chemico-Biological Interactions 165, 155–164.

Asano, N., Yamashita, T., Yasuda, K., Ikeda, K., Kizu, H., Kameda, Y., Kato, A., Nash, R. J., Lee, H.S., Ryu, K.S., 2001. Polyhydroxylated alkaloids isolated from mulberry trees (*Morus alba* L.) and silkworms (*Bombyx mori* L.). Journal of Agricultural and Food Chemistry 49, 4208–4213.

Asase, A., Kokubun, T., Grayer, R.J., Geoffrey, Kite, Simmonds, M.S.J., Oteng-Yeboah, A.A., Odamtten, G.T., 2008. Chemical constituents and antimicrobial activity of medicinal plants from Ghana: *Cassia sieberiana, Haematostaphis barteri, Mitragyna inermis* and *Pseudocedrela kotschyi*. Phytotherapy Research 22, 1013–1016.

Asnaashari, S., Delazar, A., Habibi, B., Vasfi, R., Nahar, L., Hamedeyazdan, S., Sarker, S.D., 2010. Essential oil from *Citrus aurantifolia* prevents ketotifen-induced weight-gain in mice. Phytotherapy Research 24, 1893–1897.

Aspinall, G.O., Carlyle, J.J., McNab, J.M., Rudowski, A., 1969. *Anogeissus leiocarpus* gum. Part II. Fractionation of the gum and partial hydrolysis of leiocarpan A. Journal of the Chemical Society C: Organic 0, 840–845.

Asuzu, I.U., Nwaehujor, C.O., 2013. The anti-diabetic, hypolipidemic and anti-oxidant activities of D-3-O-methylchiroinositol in alloxan-induced diabetic rats. Hygeia Journal for Drugs and Medicines 5, 27–33.

Atawodi, S.E., Adekunle, O.O., Bala, I., 2011. Antioxidant, organ protective and ameliorative properties of methanol extract of *Anogeissus leiocarpus* stem bark against carbon tetrachloride-induced liver injury. International Journal of Pharmaceutical Sciences and Research 2, 748–753.

Atawodi, S.E., Atawodi, J.C., Pala, Y., Idakwo, P., 2009. Assessment of the polyphenol profile and antioxidant properties of leaves, stem and root barks of *Khaya senegalensis* (Desv.) A.Juss. Electronic Journal of Biology 5, 80–84.

Atawodi, S.E.-o., Pfundstein, B., Haubner, R., Spiegelhalder, B., Bartsch, H., Owen, R. W., 2007. Content of polyphenolic compounds in the Nigerian stimulants *Cola nitida* ssp. alba, *Cola nitida* ssp. rubra A. Chev, and *Cola acuminata* Schott and Endl and their antioxidant capacity. Journal of Agricultural and Food Chemistry 55, 9824–9828.

Awah, F.M., Uzoegwu, P.N., Ifeonu, P., Oyugi, J.O., Rutherford, J., Yao, X., Fehrmann, F., Fowke, K.R., Eze, M.O., 2012. Free radical scavenging activity, phenolic contents and cytotoxicity of selected Nigerian medicinal plants. Food Chemistry 131, 1279–1286.

Awah, F.M., Uzoegwu, P.N., Oyugi, J.O., Rutherford, J., Ifeonu, P., Yao, X.-J., Fowke, K. R., Eze, M.O., 2010. Free radical scavenging activity and immunomodulatory effect of *Stachytarpheta angustifolia* leaf extract. Food Chemistry 119, 1409–1416.

Awah, F.M., Verla, A.W., 2010. Antioxidant activity, nitric oxide scavenging activity and phenolic contents of *Ocimum gratissimum* leaf extract. Journal of Medicinal Plants Research 4, 2479–2487.

Awika, J.M., Rooney, L.W., 2004. Sorghum phytochemicals and their potential impact on human health. Phytochemistry 65, 1199–1221.

Azuma, K., Nakayama, M., Koshioka, M., Ippoushi, K., Yamaguchi, Y., Kohata, K., Yamauchi, Y., Ito, H., Higashio, H., 1999. Phenolic antioxidants from the leaves of *Corchorus olitorius* L. Journal of Agricultural and Food Chemistry 47, 3963–3966.

Babayi, H., Udeme, J.J.I., Abalaka, J., Okogun, J., Salawu, O.A., Akumka, D., Adamu, H. N.D., Zarma, S., Adzu, B., Abdulmumuni, S., Ibrahime, K., Elisha, B., Zakariys, S., Inyang, U., 2007. Effect of oral administration of aqueous whole extract of *Cassytha filiformis* on haematograms and plasma biochemical parameters in rats. Journal of Medical Toxicology 3, 146–151.

Badifu, G.I.O., Ogunsua, A.O., 1991. Chemical composition of kernels from some species of Cucurbitaceae grown in Nigeria. Plant Foods for Human Nutrition 41, 35–44.

Badmus, J.A., Adedosu, T.O., Fatoki, J.O., Adegbite, V.A., Adaramoye, O.A., Odunola, O.A., 2011. Lipid peroxidation inhibition and antiradical activities of some leaf fractions of *Mangifera indica*. Acta Poloniae Pharmaceutica-Drug Research 68, 23–29.

Bafor, E.E., Lim, C.V., Rowan, E.G., Edrada-Ebel, R., 2013. The leaves of *Ficus exasperata* Vahl (Moraceae) generates uterine active chemical constituents. Journal of Ethnopharmacology 145, 803–812.

Bahorun, T., Neergheen, V.S., Aruoma, O.I., 2005. Phytochemical constituents of *Cassia fistula*. African Journal of Biotechnology 4, 1530–1540.

Bailey, C.J., Day, C., 1989. Traditional plant medicines as treatments for diabetes. Diabetes Care 12, 553–564.

Bakoma, B., Eklu-Gadegkeku, K., Agbonon, A., Aklikokou, K., Bassene, E., Gbeassor, M., 2011. Preventive effect of *Bridelia ferruginea* against high-fructose diet induced glucose intolerance, oxidative stress and hyperlipidemia in male Wistar rats. Journal of Pharmacology and Toxicology 6, 249–257.

Banzouzi, J.T., Prado, R., Menan, H., Valentin, A., Roumestan, C., Mallie, M., Pelissier, Y., Blache, Y., 2002. in vitro antiplasmodial activity of extracts of *Alchornea cordifolia* and identification of an active constituent: ellagic acid. Journal of Ethnopharmacology 81, 399–401.

Barakati, S.E.M., Wasfi, A., Adam, S.E.I., 1983. The toxicity of *Aristolochia bracteata* in goats. Veterinary Pathology 20, 611–616.

Baratta, M.T., Ruberto, G., Tringali, C., 1999. Constituents of the pods of *Piliostigma thonningii*. Fitoterapia 70, 205–208.

Barth, A., Müller, D., Dürrling, K., 2002. in vitro investigation of a standardized dried extract of *Citrullus colocynthis* on liver toxicity in adult rats. Experimental and Toxicologic Pathology 54, 223–230.

Baskaran, K., Ahamath, B.K., Shanmugasundaram, K.R., Shanmugasundaram, E.R.B., 1990. Antidiabetic effect of a leaf extract from *Gymnema sylvestre* in non-

insulin-dependent diabetes mellitus patients. Journal of Ethnopharmacology 30, 295–305.
Baumgart, A., Schmidt, M., Schmitz, H.-J., Schrenk, D., 2005. Natural furocoumarins as inducers and inhibitors of cytochrome P450 1A1 in rat hepatocytes. Biochemical Pharmacology 69, 657–667.
Bayer, H., Ey, N., Wattenberg, A., Voss, C., Berger, M.R., 2012. Purification and characterization of riproximin from *Ximenia americana* fruit kernels. Protein Expression and Purification 82, 97–105.
Bayoumi, S.A.L., Rowan, M.G., Beeching, J.R., Blagbrough, I.S., 2010. Constituents and secondary metabolite natural products in fresh and deteriorated cassava roots. Phytochemistry 71, 598–604.
Beh, J.E., Latip, J., Abdullah, M.P., Ismail, A., Hamid, M., 2010. *Scoparia dulcis* (SDF7) endowed with glucose uptake properties on L6 myotubes compared insulin. Journal of Ethnopharmacology 129, 23–33.
Berardini, N., Fezer, R., Conrad, J., Beifuss, U., Carle, R., Schieber, A., 2005. Screening of mango (*Mangifera indica* L.) cultivars for their contents of flavonol O- and xanthone C-glycosides, anthocyanins, and pectin. Journal of Agricultural and Food Chemistry 53, 1563–1570.
Bever, B.O., 1980. Oral hypoglycaemic plants in West Africa. Journal of Ethnopharmacology 2, 119–127.
Bharali, R., Tabassum, J., Azad, M.R.H., 2003. Chemomodulatory effect of *Moringa Oleifera*, Lam, on hepatic carcinogen metabolising enzymes, antioxidant parameters and skin papillomagenesis in mice. Asian Pacific Journal of Cancer Prevention 4, 131–139.
Bharti, S.K., Kumar, A., Prakash, O., Krishnan, S., Gupta, A.K., 2013. Essential oil of *Cymbopogon Citratus* against diabetes: validation by in vivo experiments and computational studies. Bioanalysis & Biomedicine 5, 194–203.
Bhaskar, V.H., Ajay, S.S., 2009. Evaluation of antihperglycemic activity of extracts of *Calotropis procera* (Ait.) R.Br on streptozotocin induced diabetic rats. Global Journal of Pharmacology 3, 95–98.
Bhutkar, M.A., Bhise, S.B., 2011. Anti-oxidative effect of *Tamarindus indica* in alloxan induced diabetic rats. International Journal of Research in Pharmaceutical and Biomedical Sciences 2, 1006–1009.
Biswas, K., Chattopadhyay, I., Banerjee, R.K., Bandyopadhyay, U., 2002. Biological activities and medicinal properties of neem (*Azadirachta indica*). Current Science 82, 1336–1345.
Brai, B.I.C., Odetola, A.A., Agomo, P.U., 2007. Hypoglycemic and hypocholesterolemic potential of *Persea americana* leaf extracts. Journal of Medicinal Food 10, 356–360.
Byamukama, R., Namukobe, J., Kiremire, B., 2009. Anthocyanins from leaf stalks of cassava (*Manihot esculenta* Crantz). African Journal of Pure and Applied Chemistry 3, 020–025.
Caili, F.U., Huan, S.H.I., Quanhong, L.I., 2006. A review on pharmacological activities and utilization technologies of pumpkin. Plant Foods for Human Nutrition 61, 70–77.
Calapai, G., Firenzuoli, F., Saitta, A., Squadrito, F., Arlotta, R., Costantino, M., Inferrera, G., G., 1999. Antiobesity and cardiovascular toxic effects of *Citrus aurantium* extracts in the rat: a preliminary report. Fitoterapia 70, 586–592.
Campbell, J.I.A., Mortensen, A., Mølgaard, P., 2006. Tissue lipid lowering-effect of a traditional Nigerian anti-diabetic infusion of *Rauwolfia vomitoria* foilage and *Citrus aurantium* fruit. Journal of Ethnopharmacology 104, 379–386.
Campbell-Tofte, J.I.A., Mølgaard, P., Josefsen, K., Abdallah, Z., Hansen, S.H., Cornett, C., Mu, H., Richter, E.A., Petersen, H.W., Nørregaard, J.C., Winther, K., 2011. Randomized and double-blinded pilot clinical study of the safety and anti-diabetic efficacy of the Rauvolfia-Citrus tea, as used in Nigerian traditional medicine. Journal of Ethnopharmacology 133, 402–411.
Campbell-Tofte, J.I.A., Mølgaard, P., Winther, K., 2012. Harnessing the potential clinical use of medicinal plants as anti-diabetic agents. Botanics: Targets and Therapy 2, 7–19.
Canini, A., Alesiani, D., D'Arcangelo, G., Tagliatesta, P., 2007. Gas chromatography–mass spectrometry analysis of phenolic compounds from *Carica papaya* L. leaf. Journal of Food Composition and Analysis 20, 584–590.
Carmen Zafra-Polo, M., Figadère, B., Gallardo, T., Tormo, J., Cortes, D., 1998. Natural acetogenins from annonaceae, synthesis and mechanisms of action. Phytochemistry 48, 1087–1117.
Caron, C., Graftieaux, A., Massiot, G., Le Men-Olivier, L., Delaude, C., 1989. Alkaloids from *Alstonia congensis*. Phytochemistry 28, 1241–1244.
Carvalho, I.S., Cavaco, T., Carvalho, L.M., Duque, P., 2010. Effect of photoperiod on flavonoid pathway activity in sweet potato (*Ipomoea batatas* (L.) Lam.) leaves. Food Chemistry. 118, 384–390.
Cava, M.P., Rao, K.V., Douglas, B., Weisbach, J.A., 1968. Alkaloids of *Cassytha americana*. Journal of Organic Chemistry 33, 2443–2446.
Cavin, A.-L., Hay, A.-E., Marston, A., Stoeckli-Evans, H., Scopelliti, R., Diallo, D., Hostettmann, K., 2006. Bioactive diterpenes from the fruits of *Detarium microcarpum*. Journal of Natural Products 69, 768–773.
Chabert, P., Attioua, B., Brouillard, R., 2006. *Croton lobatus*, an African medicinal plant: spectroscopic and chemical elucidation of its many constituents. BioFactors 27, 69–78.
Chakravarty, M., Chaudhuri, C., Achari, B., Chandra, S., 1988. N-acetylnornuciferine and other constituents of *Aristolochia bracteata*. Planta Medica 54, 467–468.
Champy, P., Melot, A., Guérineau Eng, V., Gleye, C., Fall, D., Höglinger, G.U., Ruberg, M., Lannuzel, A., Laprévote, O., Laurens, A., Hocquemiller, R., 2005. Quantification of acetogenins in *Annona muricata* linked to atypical parkinsonism in guadeloupe. Movement Disorders 20, 1629–1633.
Chan, B.G., Waiss Jr, A.C., Lukefahr, M., 1978. Condensed tannin, an antibiotic chemical from *Gossypium hirsutum*. Journal of Insect Physiology 24, 113–118.
Chang, F.-R., Chao, Y.-C., Teng, C.-M., Wu, Y.-C., 1998. Chemical constituents from *Cassytha filiformis* II. Journal of Natural Products 61, 863–866.
Chang, S.-L., Chang, C.L.-T., Chiang, Y.-M., Hsieh, R.-H., Tzeng, C.-R., Wu, T.-K., Sytwu, H.-K., Shyur, L.-F., Yang, W.-C., 2004. Polyacetylenic compounds and butanol fraction from *Bidens pilosa* can modulate the differentiation of helper T cells and prevent autoimmune diabetes in non-obese diabetic mice. Planta Medica 70, 1045–1051.
Chapelle, J.P., 1974. Chemical constituents of the leaves of *Anthocleista vogelii*. Planta Medica 26, 301–304.
Chattopadhyay, R.R., 1999. Possible mechanism of antihyperglycemic effect of *Azadirachta indica* leaf extract: Part V. Journal of Ethnopharmacology 67, 373–376.
Chaubal, R., Mujumdar, A.M., Puranik, V.G., Deshpande, V.H., Deshpande, N.R., 2003. Isolation and X-ray study of an anti-inflammatory active androstene steroid from *Acacia nilotica*. Planta Medica 69 (287), 288.
Chaubal, R., Pawar, P.V., Hebbalkar, G.D., Tungikar, V.B., Puranik, V.G., Deshpande, V. H., Deshpande, N.R., 2005. Larvicidal activity of *Acacia nilotica* extracts and isolation of D-pinitol – a bioactive carbohydrate. Chemistry and Biodiversity 2, 684–688.
Chaudhary, G., Goyal, S., Poonia, P., 2010. *Lawsonia inermis* Linnaeus: a phytopharmacological review. International Journal of Pharmaceutical Sciences and Drug Research 2, 91–98.
Cheel, J., Theoduloz, C., Rodriguez, J., Schmeda-Hirschmann, G., 2005. Free radical scavengers and antioxidants from Lemongrass (*Cymbopogon citratus* (DC.) Stapf. Journal of Agricultural and Food Chemistry 53, 2511–2517.
Chehade, J., Mooradian, A., 2000. A rational approach to drug therapy of type 2 diabetes mellitus. Drugs 60, 95–113.
Chen, J.C., Chiu, M.H., Nie, R.L., Cordell, G.A., Qiu, S.X., 2005. Cucurbitacins and cucurbitane glycosides: structures and biological activities. Natural Product Reports 22, 386–399.
Chen, J.-C., Huang, L.-J., Wu, S.-L., Kuo, S.-C., Ho, T.-Y., Hsiang, C.-Y., 2007. Ginger and its bioactive component inhibit enterotoxigenic *Escherichia coli* heat-labile enterotoxin-induced diarrhea in mice. Journal of Agricultural and. Food. Chemistry. 55, 8390–8397.
Chen, K.K., Anderson, R.C., McCowen, M.C., Harris, P.N., 1957. Pharmacologic action of hypoglycin A and B. Journal of Pharmacology and Experimental Therapeutics 121, 272–285.
Chieli, E., Romiti, N., Rodeiro, I., Garrido, G., 2009. in vitro effects of *Mangifera indica* and polyphenols derived on ABCB1/P-glycoprotein activity. Food and Chemical Toxicology 47, 2703–2710.
Ching, L.S., Mohamed, S., 2001. Alpha-tocopherol content in 62 edible tropical plants. Journal of Agricultural and Food Chemistry 49, 3101–3105.
Choi, S., Chung, M.-H., 2003. A review on the relationship between aloe vera components and their biologic effects. Seminars in Integrative Medicine 1, 53–62.
Choi, Y.-H., Hussain, R.A., Pezzuto, J.M., Kingborn, A.D., Morton, J.F., 1989. Abrusosides A–D, four novel sweet-tasting triterpene glycosides from the leaves of *Abrus precatorius*. Journal of Natural Products 52, 1118–1127.
Choudhury, M., Haruna, A., 1994. Phytochemical investigation of *Aristolochia albida* duch. Indian Journal of Pharmaceutical Sciences 56, 230–231.
Chung, I.-M., Kim, E.-H., Yeo, M.-A., Kim, S.-J., Seo, M.C., Moon, H.-I., 2011. Antidiabetic effects of three Korean sorghum phenolic extracts in normal and streptozotocin-induced diabetic rats. Food Research International 44, 127–132.
Chung, I.-M., Park, H.-Y., Ali, M., San, K.Y., Peebles, C.A.M., Hong, S.-B., Ahmad, A., 2007. A New Chemical Constituent from the Hairy Root Cultures of *Catharanthus roseus*. Bulletin of the Korean Chemical Society 28, 229–234.
Cimanga, K., Ying, L., De Bruyne, T., Apers, S., Cos, P., Hermans, N., Bakana, P., Tona, L., Kambu, K., Kalenda, D.T., Pieters, L., Berghe, D.V., Vlietinck, A.J., 2001. Radical scavenging and xanthine oxidase inhibitory activity of phenolic compounds from *Bridelia ferruginea* stem bark. Journal of Pharmacy and Pharmacology 53, 757–761.
Cimanga, R.K., Tona, G.L., Mesia, G.K., Kambu, O.K., Bakana, D.P., Kalenda, P.D.T., Penge, A.O., Muyembe, J.-J.T., Totté, J., Pieters, L., Vlietinck, A.J., 2006. Bioassay-guided isolation of antimalarial triterpenoid acids from the leaves of *Morinda lucida*. Pharmaceutical Biology 44, 677–681.
Coates, N.J., Gilpin, M.L., Gwynn, M.N., Lewis, D.E., Milner, P.H., Spear, S.R., Tyler, J. W., 1994. SB-202742, a novel β-lactamase inhibitor isolated from *Spondias mombin*. Journal of Natural Products 57, 654–657.
Cometa, M.F., Palazzino, G., Galeffi, C., Palmery, M., 2001. Studies on vasoconstrictor activity of *Curculigo pilosa* extracts and of its isolated compounds. Il Farmaco 56, 353–356.
Compaoré, M., Lamien, C.E., Lamien-Meda, A., Vlase, L., Kiendrebeogo, M., Ionescu, C., Nacoulma, O.G., 2011. Antioxidant, xanthine oxidase and lipoxygenase inhibitory activities and phenolics of *Bauhinia rufescens* Lam. (Caesalpiniaceae). Natural Product Research 26, 1069–1074.
Coradin, L., Giannasi, D.E., Prance, G.T., 1985. Chemosystematic studies in the Chrysobalanaceae. I. Flavonoids in Parinari. Brittonia 37, 169–178.
Corthout, J., Pieters, L., Claeys, M., Berghe, D.V., Vlietinck, A., 1992. Antiviral caffeoyl esters from *Spondias mombin*. Phytochemistry 31, 1979–1981.
Corthout, J., Pieters, L., Claeys, M., Geerts, S., Berghe, D.V., Vlietinck, A., 1994. Antibacterial and molluscicidal phenolic acids from *Spondias mombin*. Planta Medica 60, 460–463.
Corzo-Martínez, M., Corzo, N., Villamiel, M., 2007. Biological properties of onions and garlic. Trends in Food Science and Technology 18, 609–625.

Coskun, O., Kanter, M., Korkmaz, A., Oter, S., 2005. Quercetin, a flavonoid antioxidant, prevents and protects streptozotocin-induced oxidative stress and β-cell damage in rat pancreas. Pharmacological Research 51, 117–123.
Costa, C., Bertazzo, A., Biasiolo, M., Allegri, G., Curcuruto, O., Traldi, P., 1992. Gas chromatographic/mass spectrometric investigation of the volatile main components from roots of *Securidaca longipedunculata*. Organic Mass Spectrometry 27, 255–257.
Cotterill, P.J., Scheinmann, F., Stenhouse, I.A., 1978. Extractives from guttiferae. Part 34. Kolaflavanone, a new biflavanone from the nuts of *Garcinia kola* Heckel. Applications of 13C nuclear magnetic resonance in elucidation of the structures of flavonoids. Journal of the Chemical Society, Perkin Transactions 1 (0), 532–539.
Cox, P., Roche, D., 2004. Directive 2004/24/EC of the European parliament and of the council amending, as regards traditional herbal medicinal products, Directive 2001/83/EC on the community code relating to medicinal products for human use. Official Journal of the European Union L136, 85.
Daisy, P., Balasubramanian, K., Rajalakshmi, M., Eliza, J., Selvaraj, J., 2010. Insulin mimetic impact of Catechin isolated from *Cassia fistula* on the glucose oxidation and molecular mechanisms of glucose uptake on Streptozotocin-induced diabetic Wistar rats. Phytomedicine 17, 28–36.
Danish, M., Singh, P., Mishra, G., Srivastava, S., Jha, K.K., Khosa, R.L., 2011. *Cassia fistula* Linn. (Amulthus) – an important medicinal plant: a review of its traditional uses, phytochemistry and pharmacological properties. Journal of Natural Products & Plant Resources 1, 101–118.
Dapar, L.P.M., Aguiyi, C.J., Wannang, N.N., Gyang, S.S., Tanko, M.N., 2007. The histopathologic effects of *Securidaca longipedunculata* on heart, liver, kidney and lungs of rats. African Journal of Biotechnology 6, 591–595.
Dasgupta, T., Rao, A.R., Yadava, P.K., 2003. Modulatory effect of Henna leaf (*Lawsonia inermis*) on drug metabolising phase I and phase II enzymes, antioxidant enzymes, lipid peroxidation and chemically induced skin and forestomach papillomagenesis in mice. Molecular and Cellular Biochemistry 245, 11–22.
Dastagir, M.G., Husaain, M.M., Billah, A.H.M.M., Ismail, M., Quader, A., 2012. Phytochemical studies on *Capsicum frutescens*. International Journal of Pharmaceutical Sciences and Research 3, 1507–1510.
de Araújo, M.R.S., Monte, F.J.Q., Braz-Filho, R., 2009. A new sesquiterpene from *Ximenia americana* Linn. Helvetica Chimica Acta 92, 127–132.
De Marino, S., Borbone, N., Gala, F., Zollo, F., Fico, G., Pagiotti, R., Iorizzi, M., 2006. New constituents of sweet *Capsicum annuum* L. fruits and evaluation of their biological activity. Journal of Agricultural and Food Chemistry 54, 7508–7516.
De-Oliveira, A.C.A.X., Silva, I.B., Manhães-Rocha, D.A., Paumgartten, F.J.R., 2003. Induction of liver monooxygenases by annatto and bixin in female rats. Brazilian Journal of Medical and Biological Research 36, 113–118.
Deferme, S., Kamuhabwa, A., Nshimo, C., de Witte, P., Augustijns, P., 2003. Screening of Tanzanian plant extracts for their potential inhibitory effect on P-glycoprotein mediated efflux. Phytotherapy Research 17, 459–464.
del Refugio Ramos, M.A., Jerz, G., Villanueva, S., López-Dellamary, F., Waibel, R., Winterhalter, P., 2004. Two glucosylated abscisic acid derivates from avocado seeds (*Persea americana* Mill. Lauraceae cv. Hass). Phytochemistry 65, 955–962.
Deters, A.M., Lengsfeld, C., Hensel, A., 2005. Oligo- and polysaccharides exhibit a structure-dependent bioactivity on human keratinocytes in vitro. Journal of Ethnopharmacology 102, 391–399.
Dicko, M.H., Searle-van Leeuwen, M.J.F., Beldman, G., Ouedraogo, O.G., Hilhorst, R., Traoré, A.S., 1999. Purification and characterization of β-amylase from *Curculigo pilosa*. Applied Microbiology and Biotechnology 52, 802–805.
Dinesh Kumar, B., Krishnakumar, K., Kumar, J.S., Mandal, M., 2013. Effect of Mangiferin and Mahanimbine on glucose utilization in 3T3-L1 cells. Pharmacognosy Magazine 9, 72–75.
Dineshkumar, B., Mitra, A., Mahadevappa, M., 2010. Antidiabetic and hypolipidemic effects of mahanimbine (carbazole alkaloid) from *Murraya koenigii* (rutaceae) leaves. International Journal of Phytomedicine 2, 22–30.
Djoukeng, J.D., Abou-Mansour, E., Tabacchi, R., Tapondjou, A.L., Bouda, H., Lontsi, D., 2005. Antibacterial triterpenes from *Syzygium guineense* (Myrtaceae). Journal of Ethnopharmacology 101, 283–286.
Doi, K., Kojima, T., Makino, M., Kimura, Y., Fujimoto, Y., 2001. Studies on the constituents of the leaves of *Morus alba* L. Chemical and Pharmaceutical Bulletin 49, 151–153.
Donfack, J.H., Fotso, G.W., Ngameni, B., Tsofack, F.N., Tchoukoua, A., Ambassa, P., Abia, W., Tchana, A.N., Giardina, S., Buonocore, D., Finz, P.V., Vidari, G., Marzatico, F., Ngadjui, B.T., Moundipa, P.F., 2010. in vitro hepatoprotective and antioxidant activities of the crude extract and isolated compounds from *Irvingia gabonensis*. Asian Journal of Traditional Medicines 5, 79–88.
Du, J., He, Z.-D., Jiang, R.-W., Ye, W.-C., Xu, H.-X., But, P.P.-H., 2003. Antiviral flavonoids from the root bark of *Morus alba* L. Phytochemistry 62, 1235–1238.
Dutta, P.K., Das, A.K., Banerji, N., 1983. A tetracyclic triterpenoid from *Musa paradisiaca*. Phytochemistry 22, 2563–2564.
Ebong, P.E., Atangwho, I.J., Eyong, E.U., Egbung, G.E., 2008. The antidiabetic efficacy of combined extracts from two continental plants: *Azadirachta indica* (A. Juss) (Neem) and Vernonia amygdalina (Del.) (African Bitter leaf). American Journal of Biochemistry and Biotechnology 4, 239–244.
Edem, D.O., Ekanem, I.S., Ebong, P.E., 2009. Effect of aqueous extracts of alligator pear seed (*Persea americana* Mill) on blood glucose and histopathology of pancreas in alloxan-induced diabetic rats. Pakistan Journal of Pharmaceutical Science 22, 272–276.
Edet, U.U., Ehiabhi, O.S., Ogunwande, I.A., Walker, T.M., Schmidt, J.M., Setzer, W.N., Ogunbinu, A.O., Ekundayo, O., 2005. Analyses of the volatile constituents and antimicrobial activities of *Gongronema latifolium* (Benth.) and *Gnetum africanum* L. Journal of Essential Oil Bearing Plants 8, 324–329.
Egunyomi, A., Gbadamosi, I.T., Animashahun, M.O., 2011. Hypoglycaemic activity of the ethanol extract of *Ageratum conyzoides* linn. shoots on alloxan-induced diabetic rats. Journal of Medicinal Plants Research 5, 5347–5350.
Eidi, A., Eidi, M., Esmaeili, E., 2006. Antidiabetic effect of garlic (*Allium sativum* L.) in normal and streptozotocin-induced diabetic rats. Phytomedicine 13, 624–629.
Ejike, C.E.C.C., Awazie, S.O., Nwangozi, P.A., Godwin, C.D., 2013. Synergistic postprandial blood glucose modulatory properties of *Vernonia amygdalina* (Del.), *Gongronema latifolium* (Benth.) and *Occimum gratissimum* (Linn.) aqueous decoctions. Journal of Ethnopharmacology 149, 111–116.
Ekong, D.E.U., Ogan, A.U., 1968. Chemistry of the constituents of *Xylopia aethiopica*. The structure of xylopic acid, a new diterpene acid. Journal of the Chemical Society C: Organic 0, 311–312.
Ekundayo, O., 1980. Constituents of *Gongronema latifolium* Benth. in Hook. (Asclepiadaceae). Quarterly Journal of Crude Drug Research 18, 127–129.
El Tahir, K.E.H., 1991. Pharmacological actions of Magnoflorine and Aristolochic acid-1 isolated from the seeds of *Aristolochia bracteata*. Pharmaceutical Biology 29, 101–110.
Elzen, G.W., Williams, H.J., Bell, A.A., Stipanovic, R.D., Vinson, S.B., 1985. Quantification of volatile terpenes of glanded and glandless *Gossypium hirsutum* L. cultivars and lines by gas chromatography. Journal of Agricultural and Food Chemistry 33, 1079–1082.
El-Zoubair, E.E., 2010. New Immune Modulating Compounds Isolated from a Wound-healing Plant from Mali – *Parkia biglobosa* Bark (M.Sc. thesis). Department of Pharmaceutical Chemistry, University of Oslo, Oslo, Norway, pp. 87.
Engdal, S., Nilsen, O.G., 2008. Inhibition of P-glycoprotein in Caco-2 cells: effects of herbal remedies frequently used by cancer patients. Xenobiotica 38, 559–573.
Enwere, O.O., Salako, B.L., Falade, C.O., 2006. Prescription and Cost Consideration at a Diabetic Clinic in Ibadan, Nigeria: A Report. Annals of Ibadan Postgraduate Medicine, vol. 4, pp. 35–39.
Eseyin, O.A., Ebong, P., Ekpo, A., Igboasoiyi, A., Oforah, E., 2007a. Hypoglycemic effect of the seed extract of *Telfairia occidentalis* in rat. Pakistan Journal of Biological Sciences 10, 498–501.
Eseyin, O.A., Edoho, E.J., Godwin, N.E., Igboasoiyi, A., Ekpo, A., 2007b. Effects of the leaf extract of Telfairia occidentalis on the pharmacokinetics of Chloroquine in rats. International Journal of Biological Chemistry 1, 256–260.
Eseyin, O.A., Igboasoiyi, A.C., Oforah, E., Nkop, N., Agboke, A., 2005. Hypoglycaemic activity of *Telfairia occidentalis* in rats. Journal of Pharmacy and Bioresources 2, 36–42.
Esimone, C.O., Nwafor, S.V., Okoli, C.O., Chah, K.F., Uzuegbu, D.B., Chibundu, C., Eche, M.A., Adikwu, M.U., 2002. in vivo evaluation of interaction between aqueous seed extract of *Garcinia kola* Heckel and ciprofloxacin hydrochloride. American Journal of Therapeutics 9, 275–280.
Esimone, C.O., Nworu, C.S., Adikwu, M.U., Odimegwu, D.C., Ezugwu, C.O., 2007. The effect of a new adaptogen, *Garcinia kola* seed, on the bioavailability of ofloxacin in humans. Scientific Research and Essay 2, 482–485.
Eteshola, E., Oraedu, A.C.I., 1996. Fatty acid compositions of tigernut tubers (*Cyperus esculentus* L.), baobab seeds (*Adansonia digitata* L.), and their mixture. Journal of the American Oil Chemists' Society 73, 255–257.
Etoundi, C.B., Kuaté, D., Ngondi, J.L., Oben, J., 2010. Anti-amylase, anti-lipase and antioxidant effects of aqueous extracts of some Cameroonian spices. Journal of Natural Products 3, 165–171.
Etuk, E.U., Mohammed, B.J., 2009. Informant consensus selection method: a reliability assessment on medicinal plants used in north western Nigeria for the treatment of diabetes mellitus. African Journal of Pharmacy and Pharmacology 3, 496–500.
Eyo, J.E., Ozougwu, J.C., Echi, P.C., 2011. Hypoglycaemic effects of *Allium cepa*, *Allium sativum* and *Zingiber officinale* aqueous extracts on alloxan-induced diabetic *Rattus novergicus*. Medical Journal of Islamic World Academy of Sciences 19, 121–126.
Ezeigbo, I.I., Asuzu, I.U., 2010. Preliminary evaluation of the antihyperglycaemic properties of medicinal plants in Nsukka Area, Enugu State, Nigeria. International Journal of Current Research 5, 006–008.
Ezuruike, U., Mazzari, A., Seiberth, J., Seiberth, S., Chieli, E., Prieto, J., 2012. The risk of herb-drug interactions with anti-diabetic plants used in Nigeria – modulation of P-glycoprotein activity and glutathione levels. In: Proceedings of the British Pharmacological Society: From the BPS Winter Meeting 2012. pA2 Online-E-Journal of the British Pharmacological Society. Queen Elizabeth II Conference Centre London, 176pp.
Fakeye, T.O., Awe, S.O., Odelola, H.A., Ola-Davies, O.E., Itiola, O.A., Obajuluwa, T., 2004. Evaluation of valuation of toxicity profile of an alkaloidal fraction of the stem bark of *Picralima nitida* (Fam. Apocynaceae). Journal of Herbal Pharmacotherapy 4, 37–45.
Fakeye, T.O., Oladipupo, T., Showande, O., Ogunremi, Y., 2007. Effects of coadministration of extract of *Carica papaya* Linn (family Cariaceae) on activity of two oral hypoglycemic agents. Tropical Journal of Pharmaceutical Research 6, 671–678.
Fannang, S., Kuete, V., Mbazoa, C., Momo, J., Van-Dufat, H., Tillequin, F., Seguin, E., Chosson, E., Wandji, J., 2011. A new acylated triterpene with antimicrobial activity from the leaves of *Rauvolfia vomitoria*. Chemistry of Natural Compounds 47, 404–407.

Faparusi, S., Bassir, O., 1972. Triterpenes from *Alstonia boonei*. Phytochemistry 11, 3083–3084.
Farrar, J.L., Hartle, D.K., Hargrove, J.L., Greenspan, P., 2008. A novel nutraceutical property of select sorghum (*Sorghum bicolor*) brans: inhibition of protein glycation. Phytotherapy Research 22, 1052–1056.
Fasakin, C.F., Udenigwe, C.C., Aluko, R.E., 2011. Antioxidant properties of chlorophyll-enriched and chlorophyll-depleted polyphenolic fractions from leaves of *Vernonia amygdalina* and *Gongronema latifolium*. Food Research International 44, 2435–2441.
Fatema, K., Ali, L., Rahman, M.H., Parvin, S., Hassan, Z., 2003. Serum glucose and insulin response to mango and papaya in type 2 diabetic subjects. Nutrition Research 23, 9–14.
Fatope, M.O., Adoum, O.A., Takeda, Y., 2000. C18 acetylenic fatty acids of *Ximenia americana* with potential pesticidal activity. Journal of Agricultural and. Food Chemistry 48, 1872–1874.
Felter, S.P., Vassallo, J.D., Carlton, B.D., Daston, G.P., 2006. A safety assessment of coumarin taking into account species-specificity of toxicokinetics. Food and Chemical Toxicology 44, 462–475.
Fernandes, A.C.S., Almeida, C.A., Albano, F., Laranja, G.A.T., Felzenszwalb, I., Lage, C.L. S., de Sa, C.C.N.F., Moura, A.S., Kovary, K., 2002. Norbixin ingestion did not induce any detectable DNA breakage in liver and kidney but caused a considerable impairment in plasma glucose levels of rats and mice. Journal of Nutritional Biochemistry 13, 411–420.
Festing, S., Wilkinson, R., 2007. The ethics of animal research. EMBO Reports 8, 526–530.
Foo, L.Y., 1993. Amariin, a di-dehydrohexahydroxydiphenoyl hydrolysable tannin from *Phyllanthus amarus*. Phytochemistry 33, 487–491.
Fournier, G., Leboeuf, M., Cavé, A., 1999. Annonaceae essential oils: a review. Journal of Essential Oil Research 11, 131–142.
Fowden, L., Smith, A., 1969. Peptides from *Blighia sapida* seed. Phytochemistry 8, 1043–1045.
Francis, J.A., Jayaprakasam, B., Olson, L.K., Nair, M.G., 2004. Insulin secretagogues from *Moringa oleifera* with cyclooxygenase enzyme and lipid peroxidation inhibitory activities. Helvetica Chimica Acta 87, 317–326.
Fred-Jaiyesimi, A., Kio, A., Richard, W., 2009a. α-Amylase inhibitory effect of 3β-olean-12-en-3-yl (9Z)-hexadec-9-enoate isolated from *Spondias mombin* leaf. Food Chemistry 116, 285–288.
Fred-Jaiyesimi, A.A., Wilkins, M.R., Abo, K.A., 2009b. Hypoglycaemic and amylase inhibitory activities of leaves of *Spondias mombin* Linn. African Journal of Medicine and Medical Sciences 38, 343–349.
Freire, S.M.D.F., Torres, L.M.B., Souccar, C., Lapa, A.J., 1996. Sympathomimetic effects of *Scoparia dulcis* L. and catecholamines isolated from plant extracts. Journal of Pharmacy and Pharmacology 48, 624–628.
Fröde, T.S., Medeiros, Y.S., 2008. Animal models to test drugs with potential antidiabetic activity. Journal of Ethnopharmacology 115, 173–183.
Fugh-Berman, A., Myers, A., 2004. *Citrus aurantium*, an ingredient of dietary supplements marketed for weight loss: current status of clinical and basic research. Experimental Biology and Medicine 229, 698–704.
Fujita, S., Tono, T., 1988. Purification and some properties of polyphenoloxidase in eggplant (*Solanum melongena*). Journal of the Science of Food and Agriculture 46, 115–123.
Funke, I., Melzig, M.F., 2006. Traditionally used plants in diabetes therapy: phytotherapeutics as inhibitors of a-amylase activity. Revista Brasileira de Farmacognosia 16, 1–5.
Galati, G., O'Brien, P.J., 2004. Potential toxicity of flavonoids and other dietary phenolics: significance for their chemopreventive and anticancer properties. Free Radical Biology and Medicine 37, 287–303.
Gandhi, M., Lal, R., Sankaranarayanan, A., Banerjee, C.K., Sharma, P.L., 1988. Acute toxicity study of the oil from *Azadirachta indica* seed (neem oil). Journal of Ethnopharmacology 23, 39–51.
Ganjian, I., Kubo, I., Fludzinski, P., 1983. Insect antifeedant elemanolide lactones from *Vernonia amygdalina*. Phytochemistry 22, 2525–2526.
Gao, J., Tang, X., Dou, H., Fan, Y., Zhao, X., Xu, Q., 2004. Hepatoprotective activity of *Terminalia catappa* L. leaves and its two triterpenoids. Journal of Pharmacy and Pharmacology 56, 1449–1455.
Garg, H.S., Mitra, C.R., 1967. *Blighia sapida* I. Constituents of the fresh fruit. Planta Medica 15, 74–80.
Gbile, Z.O., Adesina, S.K., 1988. Nigerian Solanum species of economic importance. Annals of the Missouri Botanical Garden 75, 862–865.
Gbolade, A.A., 2009. Inventory of antidiabetic plants in selected districts of Lagos State, Nigeria. Journal of Ethnopharmacology 121, 135–139.
Gebrelibanos, M., 2012. in vitro erythrocyte haemolysis inhibition properties of *Senna singueana* extracts. Momona Ethiopian Journal of Science 4, 16–28.
Ghildyal, P., Grønhaug, T.E., Rusten, A., Skogsrud, M., Rolstad, B., Diallo, D., Michaelsen, T. E., Inngjerdingen, M., Paulsen, B.S., 2010. Chemical composition and immunological activities of polysaccharides isolated from the Malian medicinal plant *Syzygium guineense*. Journal of Pharmacognosy and Phytotherapy 2, 76–85.
Ghosal, S., 1985. Steryl glycosides and acyl steryl glycosides from *Musa paradisiaca*. Phytochemistry 24, 1807–1810.
Ghosal, S., Dutta, S.K., 1971. Alkaloids of *Abrus precatorius*. Phytochemistry 10, 195–198.
Gidado, A., Ameh, D.A., Atawodi, S.E., Ibrahim, S., 2012. A preliminary study of the mechanism of hypoglycaemic activity of *Nauclea latifolia* leaf ethanolic extract. Journal of Complementary and Integrative Medicine 9, 1–11.
Gidado, A., Ameh, D.A., Atawodi, S.E., 2005. Effect of *Nauclea latifolia* leaves aqueous extracts on blood glucose levels of normal and alloxan-induced diabetic rats. African Journal of Biotechnology 4, 91–93.
Gill, G.V., Mbanya, J.C., Ramaiya, K.L., Tesfaye, S., 2009. A sub-Saharan African perspective of diabetes. Diabetologia 52, 8–16.
Githinji, C.G., Mbugua, P.M., Kanui, T.I., Kariuki, D.K., 2011. Antinociceptive effects of stigmasterol and 9-hexacosene isolated from *Mondia whytei* (Hook.F.) root. International Journal of Phytopharmacology 2, 70–75.
Govindachari, T.R., Kumari, G.N.K., 1998. Tetranortriterpenoids from *Khaya senegalensis*. Phytochemistry 47, 1423–1425.
Grayer, R.J., Kite, G.C., Abou-Zaid, M., Archer, L.J., 2000. The application of atmospheric pressure chemical ionisation liquid chromatography–mass spectrometry in the chemotaxonomic study of flavonoids: characterisation of flavonoids from *Ocimum gratissimum* var. *gratissimum*. Phytochemical Analysis 11, 257–267.
Green, E., Obi, L.C., Samie, A., Bessong, P.O., Ndip, R.N., 2011. Characterization of n-Hexane sub-fraction of *Bridelia micrantha* (Berth) and its antimycobacterium activity. BMC Complementary and Alternative Medicine, 11.
Greenblatt, D.J., Leigh-Pemberton, R.A., von Moltke, L.L., 2006. In vitro interactions of water-soluble garlic components with human cytochromes P450. Journal of Nutrition 136, 806S–809S.
Grover, J.K., Yadav, S., Vats, V., 2002. Medicinal plants of India with anti-diabetic potential. Journal of Ethnopharmacology 81, 81–100.
Guasch, L., Sala, E., Ojeda, M.J., Valls, C., Bladé, C., Mulero, M., Blay, M., Ardévol, A., Garcia-Vallvé, S., Pujadas, G., 2012. Identification of novel human dipeptidyl peptidase-IV inhibitors of natural origin (Part II): *in silico* prediction in antidiabetic extracts. PLoS One 7, e44972.
Guimarães, R., Barros, L., Barreira, J.C.M., Sousa, M.J., Carvalho, A.M., Ferreira, I.C.F.R., 2010. Targeting excessive free radicals with peels and juices of citrus fruits: grapefruit, lemon, lime and orange. Food and Chemical Toxicology 48, 99–106.
Gunstone, F.D., Qureshi, M.I., 1968. Glyceride studies. VIII. The component glycerides of four Strophanthus oils containing an unsaturated hydroxy acid. Journal of the Science of Food and Agriculture 19, 386–388.
Gupta, S., Banerjee, R., 2011. Radical scavenging potential of phenolics from *Bryophyllum pinnatum* (Lam.) Oken. Preparative Biochemistry and Biotechnology 41, 305–319.
Gutierrez, R.M.P., Baez, E.G., Cortez, M.d.S.L., Cárdenas, S.A., 2011. Extracts of bixa inhibit glycation and AGEs formation in vitro. Journal of Medicinal Plants Research 5, 942–948.
Haeuser, J., Hall, S.F., Oehlschlager, A.C., Ourisson, G., 1970. The structure and stereochemistry of oliveric acid. Tetrahedron 26, 3461–3465.
Halberstam, M., Cohen, N., Shlimovich, P., Rossetti, L., Shamoon, H., 1996. Oral vanadyl sulfate improves insulin sensitivity in NIDDM but not in obese nondiabetic subjects. Diabetes 45, 659–666.
Hamman, J., 2008. Composition and applications of aloe vera leaf gel. Molecules 13, 1599–1616.
Hanny, B.W., 1980. Gossypol, flavonoid, and condensed tannin content of cream and yellow anthers of five cotton (*Gossypium hirsutum* L.) cultivars. Journal of Agricultural and Food Chemistry 28, 504–506.
Hansawasdi, C., Kawabata, J., 2006. Alpha-glucosidase inhibitory effect of mulberry (*Morus alba*) leaves on Caco-2. Fitoterapia 77, 568–573.
Hari Kumar, K.B., Kuttan, R., 2006. Inhibition of drug metabolizing enzymes (cytochrome P450) in vitro as well as in vivo by *Phyllanthus amarus* Schum & Thonn. Biological and Pharmaceutical Bulletin 29, 1310–1313.
Harrigan, G.G., da, S, Bolzani, V., Leslie Gunatilaka, A.A., Kingston, D.G.I., 1994a. Kaurane and trachylobane diterpenes from *Xylopia aethiopica*. Phytochemistry 36, 109–113.
Harrigan, G.G., Gunatilaka, A.A.L., Kingston, D.G.I., Chan, G.W., Johnson, R.K., 1994b. Isolation of bioactive and other oxoaporphine alkaloids from two annonaceous plants, *Xylopia aethiopica* and Miliusa cf. banacea. Journal of Natural Products 57, 68–73.
Hasrat, J.A., De Bruyne, T., De Backer, J.P., Vauquelin, G., Vlietinck, A.J., 1997. Isoquinoline derivatives isolated from the fruit of *Annona muricata* as 5-HTergic 5-HT1A receptor agonists in rats: unexploited antidepressive (lead) products. Journal of Pharmacy and Pharmacology 49, 1145–1149.
Hassall, C.H., Reyle, K., Feng, P., 1954. Hypoglycin A and B: biologically active polypeptides from *Blighia sapida*. Nature 173, 356–357.
Hayashi, K., Niwayama, S., Hayashi, T., Nago, R., Ochiai, H., Morita, N., 1988. in vitro and in vivo antiviral activity of scopadulcic acid B from *Scoparia dulcis*, Scrophulariaceae, against herpes simplex virus type 1. Antiviral Research 9, 345–354.
Hayashi, T., Asano, S., Mizutani, M., Takeguchi, N., Kojima, T., Okamura, K., Morita, N., 1991. Scopadulciol, an inhibitor of gastric H^+,K^+-ATPhase from *Scoparia dulcis*, and its structure-activity relation-ships. Journal of Natural Products 54, 802–809.
Hayashi, T., Kawasaki, M., Miwa, Y., Taga, T., Morita, N., 1990. Antiviral agents of plant origin. III. Scopadulin, a novel tetracyclic diterpene from *Scoparia dulcis* L. Chemical and Pharmaceutical Bulletin 38, 945–947.
Heftmann, E., Berner, P., Hayden, A.L., Miller, H.K., Mosettig, E., 1954. Identification of cardiac glycosides and aglycones in Strophanthus seeds by paper chromatography. Archives of Biochemistry and Biophysics 51, 329–339.
Heinrich, M., Chan, J., Wanke, S., Neinhuis, C., Simmonds, M.S.J., 2009. Local uses of Aristolochia species and content of nephrotoxic aristolochic acid 1 and 2 – a global assessment based on bibliographic sources. Journal of Ethnopharmacology 125, 108–144.
Henderson, L., Yue, Q.Y., Bergquist, C., Gerden, B., Arlett, P., 2002. St John's wort (*Hypericum perforatum*): drug interactions and clinical outcomes. British Journal of Clinical Pharmacology 54, 349–356.

Hennebelle, T., Weniger, B., Joseph, H., Sahpaz, S., Bailleul, F., 2009. Senna alata. Fitoterapia 80, 385–393.
Hodek, P., Trefil, P., Stiborová, M., 2002. Flavonoids-potent and versatile biologically active compounds interacting with cytochromes P450. Chemico-Biological Interactions 139, 1–21.
Horsfal, A., Olabiyi, O., Osinubi, A., Noronha, C., Okanlawon, A., 2008. Anti diabetic effect of fruit juice of *Morinda Citrifolia* (Tahitian Noni Juice®) on experimentally induced diabetic rats. Nigerian Journal of Health and Biomedical Sciences 7, 34–37.
Hou, X.-L., Takahashi, K., Kinoshita, N., Qiu, F., Tanaka, K., Komatsu, K., Takahashi, K., Azuma, J., 2007. Possible inhibitory mechanism of Curcuma drugs on CYP3A4 in 1α,25 dihydroxyvitamin D3 treated Caco-2 cells. International Journal of Pharmaceutics 337, 169–177.
Hou, X.-L., Takahashi, K., Tanaka, K., Tougou, K., Qiu, F., Komatsu, K., Takahashi, K., Azuma, J., 2008. Curcuma drugs and curcumin regulate the expression and function of P-gp in Caco-2 cells in completely opposite ways. International Journal of Pharmaceutics 358, 224–229.
Hsouna, A.B., Trigui, M., Culioli, G., Blache, Y., Jaoua, S., 2011. Antioxidant constituents from *Lawsonia inermis* leaves: isolation, structure elucidation and antioxidative capacity. Food Chemistry 125, 193–200.
Ibewuike, J.C., Ogungbamila, F.O., Ogundaini, A.O., Okeke, I.N., Bohlin, L., 1997. Antiinflammatory and antibacterial activities of C-methylflavonols from *Piliostigma thonningii*. Phytotherapy Research 11, 281–284.
Ibrahim, S.R.M., Mohamed, G.A., Shaala, L.A., Banuls, L.M.Y., Van Goietsenoven, G., Kiss, R., Youssef, D.T.A., 2012. New ursane-type triterpenes from the root bark of *Calotropis procera*. Phytochemistry Letters 5, 490–495.
Idemudia, O.G., 1970. Terpenoids of Nigerian Terminalia species. Phytochemistry 9, 2401–2402.
Idowu, T.O., Iwalewa, E.O., Aderogba, M.A., Akinpelu, B.A., Ogundaini, A.O., 2006. Antinociceptive, anti-inflammatory and antioxidant activities of eleagnine: an alkaloid isolated from *Chrysophyllum albidum* seed cotyledons. Journal of Biological Sciences 6, 1029–1034.
Igbinosa, O.O., Igbinosa, I.H., Chigor, V.N., Uzunuigbe, O.E., Oyedemi, S.O., Odjadjare, E.E., Okoh, A.I., Igbinosa, E.O., 2011. Polyphenolic contents and antioxidant potential of stem bark extracts from *Jatropha curcas* (Linn). International Journal of Molecular Sciences 12, 2958–2971.
Igile, G., Olenszek, W., Jurzysta, M., Aquino, R., de Tommasi, N., Pizza, C., 1995. Vemoniosides D and E, two novel saponins from *Vernonia amygdalina*. Journal of Natural Products 58, 1438–1443.
Igile, G.O., Oleszek, W., Jurzysta, M., Burda, S., Fafunso, M., Fasanmade, A.A., 1994. Flavonoids from *Vernonia amygdalina* and their antioxidant activities. Journal of Agricultural and. Food. Chemistry 42, 2445–2448.
Igoli, O.J., Alexander, G.I., 2008. Friedelanone and other triterpenoids from *Hymenocardia acida*. International Journal of Physical Sciences 3, 156–158.
Igoli, J.O., Ogaji, O.G., Tor-Anyiin, T.A., Igoli, N.P., 2005. Traditional medicine practice amongst the Igede people of Nigeria Part II. African Journal of Traditional, Complementary and Alternative Medicines 2, 134–152.
Igwenyi, I.O., Akubugwo, E.I., 2010. Analysis of four seeds used as soup thickeners in the South Eastern part of Nigeria. In: Proceedings of the 2010 International Conference on Chemistry and Chemical Engineering (ICCCE), pp. 426–430.
Ilic, N., Schmidt, B.M., Poulev, A., Raskin, I., 2010. Toxicological evaluation of grains of paradise (*Aframomum melegueta*) [Roscoe] K. Schum. Journal of Ethnopharmacology 127, 352–356.
Imam, S., Azhar, I., Hasan, M.M., Ali, M.S., Ahmed, S.W., 2007. Two triterpenes lupanone and lupeol isolated and identified from *Tamarindus indica* linn. Pakistan Journal of Pharmaceutical Sciences 20, 125–127.
Inawati, S., Winarno, H., 2008. The effect of Inai (*Lawsonia inermis* Linn) leaves extract on blood sugar level: an experimental study. Research Journal of Pharmacology 2, 20–23.
Isah, A.B., Ibrahim, Y.K.E., Abdulrahman, E.M., Ibrahim, M.A., 2007. The hypoglycaemic activity of the aqueous extract of *Stachytarpheta angustifolia* (Verbanaceae) in normoglycaemic and alloxan-induced diabetic rats. Pakistan Journal of Biological Sciences 10, 137–141.
Islam, M.S., Choi, H., 2008. Dietary red chilli (*Capsicum frutescens* L.) is insulinotropic rather than hypoglycemic in type 2 diabetes model of rats. Phytotherapy Research 22, 1025–1029.
Islam, M.S., Yoshimoto, M., Yahara, S., Okuno, S., Ishiguro, K., Yamakawa, O., 2002. Identification and characterization of foliar polyphenolic composition in sweetpotato (*Ipomoea batatas* L.) genotypes. Journal of Agricultural and Food Chemistry 50, 3718–3722.
Iwu, M., Igboko, O., 1982. Flavonoids of *Garcinia kola* seeds. Journal of Natural Products 45, 650–651.
Iwu, M.M., 1983. The hypoglycaemic properties of *Bridelia ferruginea*. Fitoterapia 54, 243–248.
Iwu, M.M., Igboko, O.A., Okunji, C.O., Tempesta, M.S., 1990a. Antidiabetic and aldose reductase activities of biflavanones of *Garcinia kola*. Journal of Pharmacy and Pharmacology 42, 290–292.
Iwu, M.M., Igboko, O.A., Tempesta, M.S., 1990b. Biflavonoid constituents of *Garcinia kola* roots. Fitoterapia 61, 178–181.
Iwueke, A.V., Nwodo, O.F.C., 2008. Antihyperglycaemic effect of aqueous extract of *Daniella oliveri* and *Sarcocephalus latifolius* roots on key carbohydrate metabolic enzymes and glycogen in experimental diabetes. Biokemistri 20, 63–70.
Iwueke, A.V., Nwodo, O.F.C., Ojiako, O.A., Okwu, G.N., Nwogu, L.A., Igwe, C.U., 2010. Modification of lipid peroxidation and oxidative stress in hepatocytes of diabetic rats treated with root extract of *Sarcocephalus latifolius* and *Daniella oliveri*. Australian Journal of Basic and Applied Sciences 4, 3578–3584.
Izuagie, A.A., Babajide, J.O., Oguntimehin, P.O., 2007. The relative glucose yields of some carbohydrate foods: need for caution. Journal of Applied Sciences Research 3, 961–963.
Izzo, A.A., Ernst, E., 2001. Interactions between herbal medicines and prescribed drugs. Drugs 61, 2163–2175.
Jacques, K., Mabeku, L.B.K., Kuiate, J.R., Tiabou, A.T., Fomum, Z.T., 2011. Antimicrobial glycosides and derivatives from roots of *Picralima nitida*. International Journal of Chemistry 3.
Jafri, M.A., Subhani, M.J., Javed, K., Singh, S., 1999. Hepatoprotective activity of leaves of *Cassia occidentalis* against paracetamol and ethyl alcohol intoxication in rats. Journal of Ethnopharmacology 66, 355–361.
Jain, R., Jain, S., Sharma, A., Ito, H., Hatano, T., 2007. Isolation of (+)-pinitol and other constituents from the root bark of *Tamarindus indica* Linn. Journal of Natural Medicines 61, 355–356.
Jaiswal, D., Kumar Rai, P., Kumar, A., Mehta, S., Watal, G., 2009. Effect of *Moringa oleifera* Lam. leaves aqueous extract therapy on hyperglycemic rats. Journal of Ethnopharmacology 123, 392–396.
James, D.B., Owolabi, A.O., Ibiyeye, H., Magaji, J., Ikugiyi, Y.A., 2008. Assessment of the hepatic effects, heamatological effect and some phytochemical constituents of *Ximenia americana* (leaves, stem and root) extracts. African Journal of Biotechnology 7, 4274–4278.
Jang, D.S., Park, E.J., Hawthorne, M.E., Vigo, J.S., Graham, J.G., Cabieses, F., Santarsiero, B.D., Mesecar, A.D., Fong, H.H.S., Mehta, R.G., Pezzuto, J.M., Kinghorn, A.D., 2002. Constituents of *Musa x paradisiaca* cultivar with the potential to induce the phase II enzyme, quinone reductase. Journal of Agricultural and Food Chemistry 50, 6330–6334.
Jayasekara, T.K., Stevenson, P.C., Belmain, S.R., Farman, D.I., Hall, D.R., 2002. Identification of methyl salicylate as the principal volatile component in the methanol extract of root bark of *Securidaca longepedunculata* Fers. Journal of Mass Spectrometry 37, 577–580.
Jewell, C., O'Brien, N.M., 1999. Effect of dietary supplementation with carotenoids on xenobiotic metabolizing enzymes in the liver, lung, kidney and small intestine of the rat. British Journal of Nutrition 81, 235–242.
Jia, L., Bi, Y.-F., Jing, L.-L., Zhou, S.-A., Kong, D.-Y., 2010. Two new compounds from *Urena lobata* L. Journal of Asian Natural Products Research 12, 962–967.
Jigam, A.A., Akanya, H.O., Dauda, B.E.N., Okogun, J.O., 2010. Polygalloyltannin isolated from the roots of *Acacia nilotica* Del. (Leguminoseae) is effective against *Plasmodium berghei* in mice. Journal of Medicinal Plants Research 4, 1169–1175.
Jisaka, M., Ohigashi, H., Takegawa, K., Hirota, M., Irie, R., Huffman, M.A., Koshimizu, K., 1993. Steroid glucosides from *Vernonia amygdalina*, a possible chimpanzee medicinal plant. Phytochemistry 34, 409–413.
Juncker, T., Schumacher, M., Dicato, M., Diederich, M., 2009. UNBS1450 from *Calotropis procera* as a regulator of signaling pathways involved in proliferation and cell death. Biochemical Pharmacology 78, 1–10.
Jung, U.J., Lee, M.-K., Jeong, K.-S., Choi, M.-S., 2004. The hypoglycemic effects of hesperidin and naringin are partly mediated by hepatic glucose-regulating enzymes in C57BL/KsJ-db/db Mice. Journal of Nutrition 134, 2499–2503.
Kamalu, B.P., 1991. The effect of a nutritionally-balanced cassava (*Manihot esculenta* Crantz) diet on endocrine function using the dog as a model 1. Pancreas. British Journal of Nutrition 65, 365–372.
Kamiya, K., Hamabe, W., Harada, S., Murakami, R., Tokuyama, S., Satake, T., 2008. Chemical constituents of *Morinda citrifolia* roots exhibit hypoglycemic effects in streptozotocin-induced diabetic mice. Biological and Pharmaceutical Bulletin 31, 935–938.
Kamiya, K., Tanaka, Y., Endang, H., Umar, M., Satake, T., 2005. New Anthraquinone and Iridoid from the fruits of *Morinda citrifolia*. Chemical and Pharmaceutical Bulletin 53, 1597–1599.
Kang, M.-H., Lee, M.S., Choi, M.-K., Min, K.-S., Shibamoto, T., 2012. Hypoglycemic activity of *Gymnema sylvestre* extracts on oxidative stress and antioxidant status in diabetic rats. Journal of Agricultural and Food Chemistry 60, 2517–2524.
Kanth, J.S., Reddy, P.R.C., Rao, P.P., Reddy, A.V.B., 2012. A preliminary pharmacognostical report on the stem bark of *Cassia fistula* Linn. Hygeia Journal for Drugs and Medicines 4, 29–33.
Kapseu, C., Kamga, R., Tchatchueng, J.B., 1993. Triacylglycerols and fatty acids composition of egusi seed oil (*Cucumeropsis Mannii* Naudin). Grasas y Aceites 44, 354–356.
Kato, A., Higuchi, Y., Goto, H., Kizu, H., Okamoto, T., Asano, N., Hollinshead, J., Nash, R.J., Adachi, I., 2006. Inhibitory effects of *Zingiber officinale* Roscoe derived components on aldose reductase activity in vitro and in vivo. Journal of Agricultural and Food Chemistry 54, 6640–6644.
Kaur, A.K., Jain, S.K., Gupta, A., Gupta, S.K., Bansal, M., Sharma, P.K., 2011. Antidiabetic activity of *Bauhinia tomentosa* Linn. roots extract in alloxan induced diabetic rats. Der Pharmacia Lettre 3, 456–459.
Kazeem, M.I., Oyedapo, B.F., Raimi, O.G., Adu, O.B., 2013. Evaluation of *Ficus exasperata* Vahl. Leaf extracts in the management of diabetes mellitus in vitro. Journal of Medical Sciences 13, 269–275.
Keeler, R.F., Baker, D.C., Gaffield, W., 1990. Spirosolane-containing Solanum species and induction of congenital craniofacial malformations. Toxicon 28, 873–884.
Khalid, S.A., Friedrichsen, G.M., Kharazmi, A., Theander, T.G., Olsen, C.E., Brøgger Christensen, S., 1998. Limonoids from *Khaya senegalensis*. Phytochemistry 49, 1769–1772.

Khatun, H., Rahman, A., Biswas, M., Islam, A.U., 2011. Water-soluble fraction of *Abelmoschus esculentus* L Interacts with glucose and metformin hydrochloride and alters their absorption kinetics after coadministration in rats. International Scholarly Research Network: Pharmaceutics 2011 (Article ID 260537).

Khoshvaghti, A., Hamidi, A., 2012. Comparative effects of oral administration of *Citrullus colocynthis* and insulin injection on serum biochemical parameters of alloxan-induced diabetic dogs. Comparative Clinical Pathology 21, 1337–1341.

Kim, J.-S., Hyun, T.K., Kim, M.-J., 2011. The inhibitory effects of ethanol extracts from sorghum, foxtail millet and proso millet on α-glucosidase and α-amylase activities. Food Chemistry 124, 1647–1651.

Kirsten, J.D., Sally, M.B., Paul, R., Gareth, D.G., Vale, J.A., 2003. Abrin poisoning. Toxicological Reviews 22, 137–142.

Kleiman, R., Plattner, R.D., Spencer, G.F., 1977. *Alchornea cordifolia* seed oil: a rich source of a new C20 epoxide, (+)cis-14,15-epoxy-cis-11-eicosenoic acid. Lipids 12, 610–612.

Knapp, F.F., Phillips, D.O., Goad, L.J., Goodwin, T.W., 1972. Isolation of 14α-methyl-9β,19-cyclo-5α-ergost-24(28)-en-3β-ol from *Musa sapientum*. Phytochemistry 11, 3497–3500.

Kök, A.N., Ertekin, M.V., Ertekin, V., Avci, B., 2004. Henna (*Lawsonia inermis* Linn.) induced haemolytic anaemia in siblings. International Journal of Clinical Practice 58, 530–532.

Kondo, T., Yoshikawa, T., 2007. Purification and characterization of abelesculin, a novel ribosome-inactivating protein from the mature seeds of *Abelmoschus esculentus*. Journal of Natural Medicines 61, 170–174.

Kone, D., Diop, B., Diallo, D., Djilani, A., Dicko1, A., 2012. Identification, quantitative determination, and antioxidant properties of polyphenols of some malian medicinal plant parts used in folk medicine. In: Uddin, J. (Ed.), Macro to Nano Spectroscopy. InTech Europe, Croatia, pp. 131–142.

Koorbanally, N.A., Mulholland, D.A., Crouch, N.R., 2000. Isolation of isovanillin from aromatic roots of the medicinal african Liane, *Mondia whitei*. Journal of Herbs, Spices and Medicinal Plants 7, 37–43.

Kouitcheu Mabeku, L.B., Kouam, J., Paul, A., Etoa, F.X., 2008. Phytochemical screening and toxicological profile of methanolic extract of *Picralima nitida* fruit-rind (Apocynaceae). Toxicological and Environmental Chemistry 90, 815–828.

Kpegba, K., Agbonon, A., Petrovic, A.G., Amouzou, E., Gbeassor, M., Proni, G., Nesnas, N., 2011. Epiafzelechin from the root bark of *Cassia sieberiana*: detection by DART mass spectrometry, spectroscopic characterization and antioxidant properties. Journal of Natural Products 74, 455–459.

Krishna, K.L., Paridhavi, M., Patel, J.A., 2008. Review on nutritional, medicinal and pharmacological properties of Papaya (*Carica papaya* Linn). Natural Product Radiance 7, 364–373.

Kubra, I.R., Rao, L.J.M., 2011. An impression on current developments in the technology, chemistry, and biological activities of ginger (*Zingiber officinale* Roscoe). Critical Reviews in Food Science and Nutrition 52, 651–688.

Kucera, M., Marquis, V., Kucerova, H., 1972. Contribution to the knowledge of Nigerian medicinal plants. I. TLC separation and quantitative evaluation of *Alstonia boonei* alkaloids. Planta Medica 21, 343–346.

Kuete, V., Metuno, R., Ngameni, B., Mbaveng, A.T., Ngandeu, F., Bezabih, M., Etoa, F. X., Ngadjui, B.T., Abegaz, B.M., Beng, V.P., 2008. Antimicrobial activity of the methanolic extracts and compounds from *Treculia africana* and *Treculia acuminata* (Moraceae). South African Journal of Botany 74, 111–115.

Kumar, A.S., Venkatarathanamma, V, Suneeta, K, Kumari, B.S., 2011. Comparative in vitro screening of a-amylase and a-glucosidase enzyme Inhibitory studies in leaves of annona species. Journal of Pharmacy Research 4, 4431–4434.

Kumar, M., Verma, D., 2011. Antidiabetic and antihyperlipidemic effect of *Morinda citrofolia* and *Coccinia indica* in alloxan induced diabetic rats. Pharmacologyonline 2, 307–311.

Kumar, S., Kumar, D., Jusha, M., Saroha, K., Singh, N., Vashishta, B., 2008. Antioxidant and free radical scavenging potential of *Citrullus colocynthis* (L.) Schrad. methanolic fruit extract. Acta Pharmaceutica 58, 215–220.

Kumar, V. Poonam, Prasad, A.K., Parmar, V.S., 2003. Naturally occurring aristolactams, aristolochic acids and dioxoaporphines and their biological activities. Natural Product Reports 20, 565–583.

Kuo, S.-C., Chen, S.-C., Chen, L.-H., Wu, J.-B., Wang, J.-P., Teng, C.-M., 1995. Potent antiplatelet, anti-inflammatory and antiallergic isoflavanquinones from the roots of *Abrus precatorius*. Planta Medica 61, 307–312.

Kupchan, S.M., Hemingway, R.J., Karim, A., Werner, D., 1969. Tumor inhibitors. XLVII. Vernodalin and vernomygdin, two new cytotoxic sesquiterpene lactones from *Vernonia amygdalina* del. Journal of Organic Chemistry 34, 3908–3911.

Kuroda, M., Mimaki, Y., Nishiyama, T., Mae, T., Kishida, H., Tsukagawa, M., Takahashi, K., Kawada, T., Nakagawa, K., Kitahara, M., 2005. Hypoglycemic effects of turmeric (*Curcuma longa* L. Rhizomes) on genetically diabetic KK-Ay mice. Biological and Pharmaceutical Bulletin 28, 937–939.

Kuroki, G.W., Conn, E.E., 1989. Mandelonitrile lyase from *Ximenia americana* L.: stereospecificity and lack of flavin prosthetic group. Proceedings of the National Academy of Sciences 86, 6978–6981.

Kwon, Y.-I., Apostolidis, E., Shetty, K., 2007. Evaluation of pepper (*Capsicum annuum)* for management of diabetes and hypertension. Journal of Food Biochemistry 31, 370–385.

Lagnika, L., Weniger, B., Vonthron-Senecheau, C., Sannia, A., 2009. Antiprotozoal activities of compounds isolated from *Croton lobatus* L. African Journal of Infectious Diseases 3, 1–5.

Lajide, L., Escoubas, P., Mizutani, J., 1993. Antifeedant activity of metabolites of *Aristolochia albida* against the tobacco cutworm, *Spodoptera litura*. Journal of Agricultural and Food Chemistry 41, 669–673.

Lajide, L., Escoubas, P., Mizutani, J., 1995. Termite antifeedant activity in *Xylopia aethiopica*. Phytochemistry 40, 1105–1112.

Lake, B.G., 1999. Coumarin metabolism, toxicity and carcinogenicity: relevance for human risk assessment. Food and Chemical Toxicology 37, 423–453.

Lamaty, G., Menut, C., Bessiere, J.M., Zoilo, P.H.A., Fekam, 1987. Aromatic plants of tropical central Africa. I. Volatile components of two annonaceae from Cameroon: *Xylopia aethiopica* (dunal) A. Richard and *Monodora myristica* (Gaertn.) Dunal. Flavour and Fragrance Journal 2, 91–94.

Lamikanra, A., Ogundaini, A.O., Ogungbamila, F.O., 1990. Antibacterial constituents of *Alchornea cordifolia* leaves. Phytotherapy Research 4, 198–200.

Lannuzel, A., Michel, P.P., Caparros-Lefebvre, D., Abaul, J., Hocquemiller, R., Ruberg, M., 2002. Toxicity of Annonaceae for dopaminergic neurons: Potential role in atypical parkinsonism in Guadeloupe. Movement Disorders 17, 84–90.

Lanzotti, V., 2006. The analysis of onion and garlic. Journal of Chromatography A 1112, 3–22.

Latha, M., Pari, L., 2004. Effect of an aqueous extract of *Scoparia dulcis* on blood glucose, plasma insulin and some polyol pathway enzymes in experimental rat diabetes. Brazilian Journal of Medical and Biological Research 37, 577–586.

Latha, M., Pari, L., Sitasawad, S., Bhonde, R., 2004. Insulin-secretagogue activity and cytoprotective role of the traditional antidiabetic plant *Scoparia dulcis* (Sweet Broomweed). Life Sciences 75, 2003–2014.

Lavie, Y., Harel-Orbital, T., Gaffield, W., Liscovitch, M., 2001. Inhibitory effects of steroidal alkaloids on drug transport and multi drug resistance in human cancer cells. Anticancer Research 21, 1189–1194.

Lawal, H.O., Etatuvie, S.O., Fawehinmi, A.B., 2012. Ethnomedicinal and pharmacological properties of *Morinda lucida*. Journal of Natural Products 5, 93–99.

Lawal, I.O., Uzokwe, N.E., Igboanugo, A.B.I., Adio, A.F., Awosan, E.A., Nwogwugwu, J.O., Faloye, B., Olatunji, B.P., Adesoga, A.A., 2010. Ethno medicinal information on collation and identification of some medicinal plants in Research Institutes of South-west Nigeria. African Journal of Pharmacy and Pharmacology 4, 001–007.

Le, N.H.T., Malterud, K.E., Diallo, D., Paulsen, B.S., Nergård, C.S., Wangensteen, H., 2012. Bioactive polyphenols in *Ximenia americana* and the traditional use among Malian healers. Journal of Ethnopharmacology 139, 858–862.

Leboeuf, M., Cavé, A., Bhaumik, P.K., Mukherjee, B., Mukherjee, R., 1980. The phytochemistry of the annonaceae. Phytochemistry 21, 2783–2813.

Lee, C.-H., Garcia, H.S., Parkin, K.L., 2010. Bioactivities of kernel extracts of 18 strains of maize (*Zea mays*). Journal of Food Science 75, C667–C672.

Lee, k.-S., Shamon, L.A., Chai, H.-B., Chagwedera, T.E., Besterman, J.M., Farnsworth, N.R., Cordell, G.A., Pezzuto, J.M., Kinghorn, A.D, 1996. Cell-cycle specific cytotoxicity mediated by rearranged ent-kaurene diterpenoids isolated from *Parinari curatellifolia*. Chemico-Biological Interactions 99, 193–204.

Lee, S.Y., Eom, S.H., Kim, Y.K., Park, N.I., Sang Un III, Park, 2009. Cucurbitane-type triterpenoids in *Momordica charantia* Linn. Journal of Medicinal Plants Research 3, 1264–1269.

Leela, N.K., Aldo, T., Mahamad Shafi, P., Sinu, P.J., Chempakam, B., 2002. Chemical composition of essential oils of turmeric (*Curcuma longa*.). Acta Pharmaceutica 52, 137–141.

Leung, L., Birtwhistle, R., Kotecha, J., Hannah, S., Cuthbertson, S., 2009. Anti-diabetic and hypoglycaemic effects of *Momordica charantia* (bitter melon): a mini review. British Journal of Nutrition 102, 1703–1708.

Levêque, D., Jehl, F., 2007. Molecular pharmacokinetics of Catharanthus (Vinca) alkaloids. Journal of Clinical Pharmacology 47, 579–588.

Lewis, D.A., Fields, W.N., Shaw, G.P., 1999. A natural flavonoid present in unripe plantain banana pulp (*Musa sapientum* L. var. *paradisiaca*) protects the gastric mucosa from aspirin-induced erosions. Journal of Ethnopharmacology 65, 283–288.

Li, Y., Tran, V.H., Duke, C.C., Roufogalis, B.D., 2012. Gingerols of *Zingiber officinale* enhance glucose uptake by increasing cell surface GLUT4 in cultured L6 myotubes. Planta Medica 78, 1549–1555.

Lima Silva, F., Fischer, D.C.H., Fechine Tavares, J., Sobral Silva, M., Filgueiras de Athayde-Filho, P., Barbosa-Filho, J.M., 2011. Compilation of secondary metabolites from *Bidens pilosa* L. Molecules 16, 1070–1102.

Lin, C.-C., Hsu, Y.-F., Lin, T.-C., Hsu, H.-Y., 2001. Antioxidant and hepatoprotective effects of punicalagin and punicalin on acetaminophen-induced liver damage in rats. Phytotherapy Research 15, 206–212.

Lin, C.-N., Lu, C.-M., Cheng, M.-K., Gan, K.-H., Won, S.-J., 1990. The cytotoxic principles of *Solanum incanum*. Journal of Natural Products 53, 513–516.

Lin, Y.-L., Kuo, Y.-H., Shiao, M.-S., Chen, C.-C., Ou, J.-C., 2000a. Flavonoid glycosoides from *Terminalia catappa* L. Journal of the Chinese Chemical Society 47, 253–256.

Lin, Y.-L., Wang, W.-Y., Kuo, Y.-H., Chen, C.-F., 2000b. Nonsteroidal constituents from *Solanum incanum* L. Journal of the Chinese Chemical Society 47, 247–251.

Liu, B., Yao, L., Wang, W., Gao, J., Chen, F., Wang, S., Xu, Y., Tang, L., Jia, Y., 2010. Molecular cloning and characterization of phospholipase D from *Jatropha curcas*. Molecular Biology Reports 37, 939–946.

Liu, I.M., Tzeng, T.-F., Liou, S.-S., Lan, T.-W., 2007. Myricetin, a naturally occurring flavonol, ameliorates insulin resistance induced by a high-fructose diet in rats. Life Sciences 81, 1479–1488.

Londhe, J.S., Devasagayam, T.P.A., Foo, L.Y., Ghaskadbi, S.S., 2008. Antioxidant activity of some polyphenol constituents of the medicinal plant *Phyllanthus amarus* Linn. Redox Report 13, 199–207.

Lu, J., Haibo, G., Lin-lin, J., Sheng-an, Z., De-yun, K., 2009. Study on chemical constituents of *Urena lobata* L. II. Phenolic acid constituents. Chinese Journal of Pharmaceuticals 40, 746.

Ludvik, B., Neuffer, B., Pacini, G., 2004. Efficacy of *Ipomoea batatas* (Caiapo) on diabetes control in type 2 diabetic subjects treated with diet. Diabetes Care 27, 436–440.

Luis, J.G., Echeverri, F., Quinones, W., Brito, I., Lopez, M., Torres, F., Cardona, G., Aguiar, Z., Pelaez, C., Rojas, M., 1993. Irenolone and emenolone: two new types of phytoalexin from *Musa paradisiaca*. Journal of Organic Chemistry 58, 4306–4308.

Luximon-Ramma, A., Bahorun, T., Soobrattee, M.A., Aruoma, O.I., 2002. Antioxidant activities of phenolic, proanthocyanidin, and flavonoid components in extracts of *Cassia fistula*. Journal of Agricultural and Food Chemistry 50, 5042–5047.

Ma, C., Xiao, S.-y., Li, Z.-g., Wang, W., Du, L.-j., 2007. Characterization of active phenolic components in the ethanolic extract of *Ananas comosus* L. leaves using high-performance liquid chromatography with diode array detection and tandem mass spectrometry. Journal of Chromatography A 1165, 39–44.

Maatooq, G.T., El-Sharkawy, S.H., Afifi, M.S., Rosazza, J.P.N., 1997. C-p-hydroxybenzoylglycoflavones from *Citrullus colocynthis*. Phytochemistry 44, 187–190.

Mahfoudh, A.M., Ismail, N., Ismail, S., Hussin, A.H., 2009. in vitro ex vivo assessment of *Morinda citrifolia* on drug metabolizing enzymes in spontaneously hypertensive rats. Pharmaceutical Biology (Formerly International Journal of Pharmacognosy) 47, 1108–1116.

Maiga, A., Diallo, D., Fane, S., Sanogo, R., Paulsen, B.S., Cisse, B., 2005. A survey of toxic plants on the market in the district of Bamako, Mali: traditional knowledge compared with a literature search of modern pharmacology and toxicology. Journal of Ethnopharmacology 96, 183–193.

Maillard, M.P., Recio-Iglesias, M.-C., Saadou, M., Stoeckli-Evans, H., Hostettmann, K., 1991. Novel antifungal tetracyclic compounds from *Bauhinia rufescens* LAM. Helvetica Chimica Acta 74, 791–799.

Maiti, R., Das, U.K., Ghosh, D., 2005. Attenuation of hyperglycemia and hyperlipidemia in streptozotocin-induced diabetic rats by aqueous extract of seed of *Tamarindus indica*. Biological and Pharmaceutical Bulletin 28, 1172–1176.

Malan, E., 1991. Derivatives of (+)-catechin-5-gallate from the bark of *Acacia nilotica*. Phytochemistry 30, 2737–2739.

Malhotra, S., Bailey, D.G., Paine, M.F., Watkins, P.B., 2001. Seville orange juice-felodipine interaction: comparison with dilute grapefruit juice and involvement of furocoumarins. Clinical Pharmacology and Therapeutics 69, 14–23.

Mallick, C., Chatterjee, K., Mandal, U., Ghosh, D., 2007. Antihyperglycaemic, antilipidperoxidative and antioxidative effects of extracts of *Musa paradisiaca* and *Coccinia indica* in streptozotocin-induced diabetic rat. Ethiopian Pharmaceutical Journal 25, 9–22.

Malpani, S.N., Manjunath, K.P., 2012. Antidiabetic activity and phytochemical investigations of *Cassia fistula* Linn. bark. International Journal of Pharmaceutical Sciences and Research 3, 1822–1825.

Maniyar, Y., Bhixavatimath, P., 2012. Antihyperglycemic and hypolipidemic activities of aqueous extract of *Carica papaya* Linn. leaves in alloxan-induced diabetic rats. Journal of Ayurveda and Integrative Medicine 3, 70–74.

Manni, P.E., Sinsheimer, J.E., 1965. Constituents from *Gymnema sylvestre* leaves. Journal of Pharmaceutical Sciences 54, 1541–1544.

Manonmani, G., Bhavapriya, V., Kalpana, S., Govindasamy, S., Apparanantham, T., 2005. Antioxidant activity of *Cassia fistula* (Linn.) flowers in alloxan induced diabetic rats. Journal of Ethnopharmacology 97, 39–42.

Manosroi, J., Zaruwa, M.Z., Manosroi, A., 2011. Potent hypoglycemic effect of nigerian antidiabetic medicinal plants. Journal of Complementary and Integrative Medicine 8.

Manwa, B., Kashongwe, Z., Bahindwa, B., Kolanowski, J., Hermans, M.P., 2010. Dietary cassava, β-cell function and hyperbolic product loss rate in type 2 diabetes patients from South Kivu. Diabetes and Metabolism 36, 108–113.

Markowitz, J.S., DeVane, C.L., Chavin, K.D., Taylor, R.M., Ruan, Y., Donovan, J.L., 2003. Effects of garlic (*Allium sativum* L.) supplementation on cytochrome P450 2D6 and 3A4 activity in healthy volunteers. Clinical Pharmacology and Therapeutics 74, 170–177.

Marles, R.J., Farnsworth, N.R., 1995. Antidiabetic plants and their active constituents. Phytomedicine 2, 137–189.

Marquis, V.O., Adanlawo, T.A., Olaniyi, A.A., 1977. The effect of foetidin from *Momordica foetida* on blood glucose level of albino rats. Planta Medica 31, 367–374.

Martey, O.N.K., Ocloo, A., Koomson, E., Okine, L.K.N., 2009. Assessment of Tonica, an aqueous herbal haematinic, in the modulation of rat hepatic microsomal CYP-mediated drug metabolizing enzymes: implications for drug interactions. Journal of Pharmacology and Toxicology 4, 70–78.

Martin, M.T., Païs, M., Ogundaini, A.O., Ibewuilke, J.C., Ogungbamila, F.O., 1997. Complete 1H and 13C NMR assignment of a kaurane diterpene from *Piliostigma thonningii*. Magnetic Resonance in Chemistry 35, 896–898.

Matlawska, I., Sikorska, M., 1999. Flavonoid compunds in the flowers of *Urena lobata* L. (Malvaceae). Acta Poloniae Pharmaceutica Drug Research 56, 69–71.

Matsui, T., Ebuchi, S., Kobayashi, M., Fukui, K., Sugita, K., Terahara, N., Matsumoto, K., 2002. Anti-hyperglycemic effect of diacylated anthocyanin derived from *Ipomoea batatas* cultivar ayamurasaki can be achieved through the α-glucosidase inhibitory action. Journal of Agricultural and Food Chemistry 50, 7244–7248.

Mavar-Manga, H., Haddad, M., Pieters, L., Baccelli, C., Penge, A., Quetin-Leclercq, J., 2008. Anti-inflammatory compounds from leaves and root bark of *Alchornea cordifolia* (Schumach. & Thonn.) Müll. Arg. Journal of Ethnopharmacology 115, 25–29.

Mazzini, F., Betti, M., Netscher, T., Galli, F., Salvadori, P., 2009. Configuration of the vitamin E analogue garcinoic acid extracted from *Garcinia kola* seeds. Chirality 21, 519–524.

Mbaka, G.O., Adeyemi, O.O., 2011. The protective role of *Sphenocentrum Jollyanum* leaf extract on beta cells morphology of alloxan treated rabbits. Asian Journal of Medical Sciences 2, 195–201.

Mbaka, G., Adeyemi, O., Noronha, C., Anunobi, C., Okanlawon, A., 2009. Anti-hyperglycaemic and hypoglycaemic effects of ethanol root extract of *Sphenocentrum jollyanum* in normal and alloxan-induced diabetic rabbits. Brazilian Journal of Morphological Science 26, 123–127.

McKenzie, R.A., Franke, F.P., Dunster, P.J., 1987. The toxicity to cattle and bufadienolide content of six Bryophyllum species. Australian Veterinary Journal 64, 298–301.

Meli Lannang, A., Lontsi, D., Ngounou, F.N., Sondengam, B.L., Nkengfack, A.E., van Heerden, F.R., Assob, J.C.N., 2006. Securidacaxanthone A, a heptaoxygenated xanthone from *Securidaca longepedunculata*. Fitoterapia 77, 199–202.

Menezes, F.d.S., Mintol I, A.B.M., Ruela III, H.S., Kuster III, R.M., SheridanII II, H., Frankish, N., 2007. Hypoglycemic activity of two Brazilian Bauhinia species: *Bauhinia forficata* L. and *Bauhinia monandra* Kurz. Revista Brasileira de Farmacognosia 17, 8–13.

Mensah, A.Y., Houghton, P.J., Akyirem, G.N.A., Fleischer, T.C., Mensah, M.L.K., Sarpong, K., Adosraku, R., 2004. Evaluation of the antioxidant and free radical scavenging properties of *Secamone afzelii* Rhoem. Phytotherapy Research 18, 1031–1032.

Mevy, J.-P., Bessiere, J.-M., Greff, S., Zombre, G., Viano, J., 2006. Composition of the volatile oil from the leaves of *Ximenia americana* L. Biochemical Systematics and Ecology 34, 549–553.

Meyer, J.J.M., Rakuambo, N.C., Hussein, A.A., 2008. Novel xanthones from *Securidaca longepedunculata* with activity against erectile dysfunction. Journal of Ethnopharmacology 119, 599–603.

Michl, J., Simmonds, M., Ingrouille, M., Heinrich, M., 2011. Toxicological risk assessment of Aristolochia species. In: Proceedings of the 59th International Congress and Annual Meeting of the Society for Medicinal Plant and Natural Product Research – Planta Medica (Planta Med.; 77 – WSII4). Society for Medicinal Plant and Natural Product Research, Antalya, Turkey, pp. 1236.

Miean, K.H., Mohamed, S., 2001. Flavonoid (myricetin, quercetin, kaempferol, luteolin, and apigenin) content of edible tropical plants. Journal of Agricultural and Food Chemistry 49, 3106–3112.

Millonig, G., Stadlmann, S., Vogel, W., 2005. Herbal hepatotoxicity: acute hepatitis caused by a Noni preparation (*Morinda citrifolia*). European Journal of Gastroenterology and Hepatology 17, 445–447.

Mishra, S.B., Vijayakumar, M., Ojha, S.K., Verma, A., 2010. Antidiabetic effect of *Jatropha curcas* L. leaves extract in normal and alloxan-induced diabetic rats. International Journal of Pharmaceutical Sciences 2, 482–487.

Mohammadi, J., Naik, P.R., 2008. Evaluation of hypoglycemic effect of *Morus alba* in an animal model. Indian Journal of Pharmacology 40, 15–18.

Mohammed, M., Haruna, A.K., Ilyas, M., Pateh, U.U., 2012a. Iridoid and caffeic glycoside ester from the leaf and stem of *Stachytarpheta angustifolia* (Mill) Vahl Verbenacea. International Journal of Science and Technology 2, 259–264.

Mohammed, R.K., Ibrahim, S., Atawodi, S.E., Eze, E.D., Suleiman, J.B., 2012b. Antidiabetic and haematological effects of n-butanol fraction of *Alchornea cordifolia* leaf extract in streptozotocin-induced diabetic Wistar rats. Global Journal of Medicinal Plant Research 1, 14–21.

Moller, D.E., 2001. New drug targets for type 2 diabetes and the metabolic syndrome. Nature 414, 821–827.

Momoh, M.A., Muhammed, U., 2011. Toxicological and hypoglycemic studies on the oil extracted from seeds of *Khaya senegalensisis* on blood glucose levels of alloxan-induced diabetic albino rats. Journal of Medicinal Plants Research 5, 4021–4024.

Monago, C.C., Nwodo, O.F.C., 2010. Antidiabetic effect of crude trigonelline of *Abrus precatorius* Linn seed in alloxan diabetic rabbits. Journal of Pharmacy Research 3, 1916–1919.

Monera, T.G., Wolfe, A.R., Maponga, C.C., Benet, L.Z., Guglielm, J., 2008. *Moringa oleifera* leaf extracts inhibit 6β-hydroxylation of testosterone by CYP3A4. Journal of Infection in Developing Countries 2, 379–383.

Montilla, E.C., Hillebrand, S., Winterhalter, P., 2011. Anthocyanins in purple sweet potato (*Ipomoea batatas* L.) varieties. Fruit, Vegetable and Cereal Science and Biotechnology 5, 19–24.

Moody, J.O., Robert, V.A., Connolly, J.D., Houghton, P.J., 2006. Anti-inflammatory activities of the methanol extracts and an isolated furanoditerpene constituent of *Sphenocentrum jollyanum* Pierre (Menispermaceae). Journal of Ethnopharmacology 104, 87–91.

Morakinyo, O.A., James, A., Akindele, J., Ahmned, Z., 2011. Modulation of antioxidant enzymes and inflammatory cytokines: possible mechanism of antidiabetic effect of ginger extracts. African Journal of Biomedical Research 14.

Morelli, C.F., Cairoli, P., Speranza, G., Alamgir, M., Rajia, S., 2006. Triglycerides from *Urena lobata*. Fitoterapia 77, 296–299.

Morris, M.E., Zhang, S., 2006. Flavonoid–drug interactions: effects of flavonoids on ABC transporters. Life Sciences 78, 2116–2130.

Moshi, M.J., Lutale, J.J.K., Rimoy, G.H., Abbas, Z.G., Josiah, R.M., Swai, A.B.M., 2001. The effect of *Phyllanthus amarus* aqueous extract on blood glucose in non-insulin dependent diabetic patients. Phytotherapy Research 15, 577–580.

Mrzljak, A., Kosuta, I., Skrtic, A., Filipec Kanizaj, T., Vrhovac, R., 2013. Drug-induced liver injury associated with Noni (*Morinda citrifolia*) Juice and phenobarbital. Case Reports in Gastroenterology 7, 19–24.

Muanda, F., Koné, D., Dicko, A., Soulimani, R., Younos, C., 2011. Phytochemical composition and antioxidant capacity of three malian medicinal plant parts. Evidence-Based Complementary and Alternative Medicine 2011.

Muanda, F.N., Dicko, A., Soulimani, R., 2010. Assessment of polyphenolic compounds, in vitro antioxidant and anti-inflammation properties of *Securidaca longepedunculata* root barks. Comptes Rendus Biologies 333, 663–669.
Mueno, R., Ngandeu, F., Tchinda, A., Ngameni, B., Kapche, G.D.W.F., Djemgou, P.C., Ngadjui, B.T., Bezabih, M., Abegaz, B.M., 2008. Chemical constituents of *Treculia acuminata* and *Treculia africana*. Biochemical Systematics and Ecology 36, 148–152.
Musabayane, C.T., Bwititi, P.T., Ojewole, J.A.O., 2006. Effects of oral administration of some herbal extracts on food consumption and blood glucose levels in normal and streptozotocin-treated diabetic rats. Methods and Findings in Experimental and Clinical Pharmacology 28, 223.
Musabayane, C.T., Gondwe, M., Kamadyaapa, D.R., Chuturgoon, A.A., Ojewole, J.A.O., 2007. Effects of *Ficus thonningii* (Blume) [Moraceae] stem-bark ethanolic extract on blood glucose, cardiovascular and kidney functions of rats, and on kidney cell lines of the proximal (LLC-PK1) and distal tubules (MDBK). Renal Failure 29, 389–397.
Mustafa, N., Verpoorte, R., 2007. Phenolic compounds in *Catharanthus roseus*. Phytochemistry Reviews 6, 243–258.
Mustapha, A., Yakasai, I.A., Abdu Aguye, I., 1996. Effect of *Tamarindus indica* L. on the bioavailability of aspirin in healthy human volunteers. European Journal of Drug Metabolism and Pharmacokinetics 21, 223–226.
Mvitu Muaka, M., Longo-Mbenza, B., Tulomba Mona, D., Nge Okwe, A., 2010. Reduced risk of metabolic syndrome due to regular intake of vegetables rich in antioxidants among African type 2 diabetics. Diabetes and Metabolic Syndrome: Clinical Research and Reviews 4, 132–136.
Mythili, S., Sathiavelu, A., Sridharan, T.B., 2011. Evaluation of antioxidant activity of *Cassytha filiformis*. International Journal of Applied Biology and Pharmaceutical Technology 2, 380–385.
Nabekura, T., Kamiyama, S., Kitagawa, S., 2005. Effects of dietary chemopreventive phytochemicals on P-glycoprotein function. Biochemical and Biophysical Research Communications 327, 866–870.
Nagaoka, T., Goto, K., Watanabe, A., Sakata, Y., Yoshihara, T., 2001. Sesquiterpenoids in root exudates of *Solanum aethiopicum*. Zeitschrift fur Naturforschung (Journal for Nature Research) 56C, 707–713.
Nagappa, A.N., Thakurdesai, P.A., Venkat Rao, N., Singh, J., 2003. Antidiabetic activity of *Terminalia catappa* Linn fruits. Journal of Ethnopharmacology 88, 45–50.
Nagase, H., Sasaki, K., Kito, H., Haga, A., Sato, T., 1998. Inhibitory effect of Delphinidin from *Solanum melongena* on Human Fibrosarcoma HT-1080 invasiveness in vitro. Planta Medica 64, 216–219.
Nakatani, M., Abdelgaleil, S.A.M., Kassem, S.M.I., Takezaki, K., Okamura, H., Iwagawa, T., Doe, M., 2002. Three new modified limonoids from *Khaya senegalensis*. Journal of Natural Products 65, 1219–1221.
Nammi, S., Boini, M.K., Lodagala, S.D., Behara, R.B.S., 2003. The juice of fresh leaves of *Catharanthus roseus* Linn. reduces blood glucose in normal and alloxan diabetic rabbits. BMC Complementary and Alternative Medicine 3.
Nawwar, M., Ayoub, N., Hussein, S., Hashim, A., El-Sharawy, R., Wende, K., Harms, M., Lindequist, U., 2012. Flavonol triglycoside and investigation of the antioxidant and cell stimulating activities of *Annona muricata* Linn. Archives of Pharmacal Research 35, 761–767.
Nayak, B.S., Marshall, J.R., Isitor, G., Adogwa, A., 2011. Hypoglycemic and hepatoprotective activity of fermented fruit juice of *Morinda citrifolia* (Noni) in diabetic rats. Evidence-Based Complementary and Alternative Medicine 2011, 5.
Ndong, M., Uehara, M., Katsumata, S.-i., Suzuki, K., 2007. Effects of oral administration of *Moringa oleifera* Lam on glucose tolerance in Goto-Kakizaki and Wistar rats. Journal of Clinical and Biochemical Nutrition 40, 229–233.
Neergaard, J.S., Rasmussen, H.B., Stafford, G.I., Van Staden, J., Jäger, A.K., 2010. Serotonin transporter affinity of (−)-loliolide, a monoterpene lactone from *Mondia whitei*. South African Journal of Botany 76, 593–596.
Negrelle, R.R.B., Gomes, E.C., 2007. *Cymbopogon citratus* (DC.) Stapf: chemical composition and biological activities. Revista Brasileira de Plantas Medicinais 9, 80–92.
Ngassapa, O., Beecher, C.W.W., Pezzuto, J.M., Farnsworth, N.R., Henderson, T.O., Boye, G.L., 1993. Isolation of echinocystic acid-3-O-sulfate, a new triterpene, from *Tetrapleura tetraptera*, and evaluation of the mutagenic potential of molluscicidal extracts and isolates. Journal of Natural Products 56, 1872–1877.
Ngassoum, M., Jirovetz, L., Buchbauer, G., 2001. SPME/GC/MS analysis of headspace aroma compounds of the Cameroonian fruit *Tetrapleura tetraptera* (Thonn.) Taub. European Food Research and Technology 213, 18–21.
Ngondi, J.L., Etoundi, B.C., Nyangono, C.B., Mbofung, C.M., Oben, J.E., 2009. IGOB131, a novel seed extract of the West African plant *Irvingia gabonensis*, significantly reduces body weight and improves metabolic parameters in overweight humans in a randomized double-blind placebo controlled investigation. Lipids in Health and Disease 8.
Ngouela, S., Nyassé, B., Tsamo, E., Brochier, M.-C., Morin, C., 1998. A trachylobane diterpenoid from *Xylopia aethiopica*. Journal of Natural Products 61, 264–266.
Nia, R., Paper, D.H., Essien, E.E., Iyadi, K.C., Bassey, A.I.L., Aatai, A.B., Franz, G., 2004. Evaluation of the anti-oxidant and anti-angiogenic effects of *Sphenocentrum jollyanum* Pierre. African Journal of Biomedical Research 7, 129–132.
Niemenak, N., Onomo, P.E., Fotso, Lieberei, R., Ndoumou, D.O., 2008. Purine alkaloids and phenolic compounds in three Cola species and *Garcinia kola* grown in Cameroon. South African Journal of Botany 74, 629–638.
Ningappa, M.B., Srinivas, L., 2008. Purification and characterization of approximately 35 kDa antioxidant protein from curry leaves (*Murraya koenigii* L.). Toxicology in vitro 22, 699–709.
Nirmala, A., Eliza, J., Rajalakshmi, E.P., Daisy, P., 2008. Effect of hexane extract of *Cassia fistula* barks on blood glucose and lipid profile in streptozotocin diabetic rats. International Journal of Pharmacology 4.
Nivitabishekam, S.N., Asad, M., Prasad, V.S., 2009. Pharmacodynamic interaction of *Momordica charantia* with rosiglitazone in rats. Chemico-Biological Interactions 177, 247–253.
Njoku, C.J., Zeng, L., Asuzu, I.U., Oberlies, N.H., McLaughlin, J.L., 1997. Oleanolic acid, a bioactive component of the leaves of *Ocimum Gratissimum* (Lamiaceae). Pharmaceutical Biology 35, 134–137.
Nok, A.J., Sallau, B.A., Onyike, E., Useh, N.M., 2005. Columbin inhibits cholesterol uptake in bloodstream forms of *Trypanosoma brucei* – a possible trypanocidal mechanism. Journal of Enzyme Inhibition and Medicinal Chemistry 20, 365–368.
Nomura, T., Fukai, T., Hano, Y., Nemoto, K., Terada, S., Kuramochi, T., 1983. Constituents of cultivated mulberry tree XII.[1],[2] isolation of two new natural diels-alder adducts from root bark of *Morus alba*. Planta Medica 47, 151–156.
Noudogbessi, J.-P., Yédomonhan, P., Sohounhloué, D.C.K., Chalchat, J.-C., Figuérédo, G., 2008. Chemical composition of essential oil of *Syzygium guineense* (Willd.) DC. var. guineense (Myrtaceae) from Benin. Records of Natural Products 2, 33–38.
Nowak, R., Kawka, S., 1998. Phenolic acids in leaves of *Secamone afzelii* (Rhoem.) Schult. (Asclepiadaceae). Acta Societas Botanicorum Poloniae 67, 243–245.
Núñez Sellés, A.J., Vélez Castro, H.T., Agüero-Agüero, J., González-González, J., Naddeo, F., De Simone, F., Rastrelli, L., 2002. Isolation and quantitative analysis of phenolic antioxidants, free sugars, and polyols from mango (*Mangifera indica* L.) stem bark aqueous decoction used in Cuba as a nutritional supplement. Journal of Agricultural and. Food. Chemistry 50, 762–766.
Nwafor, S., Esimone, C., Amadi, C., Nworu, C., 2003. in vivo interaction between ciprofloxacin hydrochloride and the pulp of unripe plantain (*Musa paradisiaca*). European Journal of Drug Metabolism and Pharmacokinetics 28, 253–258.
Nwanjo, H.U., 2008. Hypoglycemic and Hypolipidemic effects of aqueous extracts of *Abrus precatorius* Linn seeds in streptozotocin-induced diabetic Wistar rats. Journal of Herbs, Spices & Medicinal Plants 14, 68–76.
Nwanjo, H.U., 2006. Antioxidant activity of the exudate from *Aloe barbadensis* leaves in diabetic rats. Biokemistri 18, 77–81.
Nwanna, E.E., Ibukun, E.O., Oboh, G., 2013. Inhibitory effects of methanolic extracts of two eggplant species from South-western Nigeria on starch hydrolysing enzymes linked to type-2 diabetes. African Journal of Pharmacy and Pharmacology 7, 1575–1584.
Nyarko, A.K., Okine, L.K.N., Wedzi, R.K., Addo, P.A., Ofosuhene, M., 2005. Subchronic toxicity studies of the antidiabetic herbal preparation ADD-199 in the rat: absence of organ toxicity and modulation of cytochrome P450. Journal of Ethnopharmacology 97, 319–325.
Nyunai, N., Njikam, N., H., Abdennebi, Mbafor, J.T., Lamnaouer, D., 2009. Hypoglycaemic and antihyperglycaemic activity of *Ageratum conyzoides* L. in rats. African Journal of Traditional, Complementary, and Alternative Medicines 6, 123–130.
Obatomi, D.K., Bikomo, E.O., Temple, V.J., 1994. Anti-diabetic properties of the African mistletoe in streptozotocin-induced diabetic rats. Journal of Ethnopharmacology 43, 13–17.
Obidah, W., Sa'ad, U.A., Wurochekke, A.U., 2009. Toxic effects of aqueous stem bark extract of *Cassia sieberiana* on some biochemical parameters in rats. African Journal of Biochemistry Research 3, 229–231.
Oboh, G., Olabiyi, A.A., Akinyemi, A.J., 2013. Inhibitory effect of aqueous extract of different parts of unripe pawpaw (*Carica papaya*) fruit on Fe^{2+}-induced oxidative stress in rat pancreas in vitro. Pharmaceutical Biology 51, 1165–1174.
Oboh, G., Ademiluyi, A.O., Akinyemi, A.J., Henle, T., Saliu, J.A., Schwarzenbolz, U., 2012a. Inhibitory effect of polyphenol-rich extracts of jute leaf (*Corchorus olitorius*) on key enzyme linked to type 2 diabetes (α-amylase and α-glucosidase) and hypertension (angiotensin I converting) in vitro. Journal of Functional Foods 4, 450–458.
Oboh, G., Akinyemi, A.J., Ademiluyi, A.O., 2012b. Inhibition of α-amylase and α-glucosidase activities by ethanolic extract of *Telfairia occidentalis* (fluted pumpkin) leaf. Asian Pacific Journal of Tropical Biomedicine 2, 733–738.
Oboh, G., Ademiluyi, A.O., Faloye, Y.M., 2011. Effect of combination on the antioxidant and inhibitory properties of tropical pepper varieties against α-amylase and α-glucosidase activities in vitro. Journal of Medicinal Food 14, 1152–1158.
Oboh, G., Ademosun, A.O., 2011. Phenolic-rich extracts from orange peels (*Citrus sinensis*) inhibit key enzymes linked to non-insulin dependent diabetes mellitus (NIDDM) and hypertension. La Rivista Italiana Delle Sostanze Grasse 88, 16–23.
Oboh, G., Akinyemi, A.J., Ademiluyi, A.O., Adefegha, S.A., 2010. Inhibitory effects of aqueous extract of two varieties of ginger on some key enzymes linked to type-2 diabetes in vitro. Journal of Food and Nutrition Research 49, 14–20.
Odebode, A.C., 1996. Phenolic compounds in the kola nut (*Cola nitida* and *Cola acuminata*) (Sterculiaceae) in Africa. Revista de Biologia Tropical 44, 513–515.
Odeleye, O., Oyedeji, O., Shode, F., 2009. Constituents of *Momordica foetida* and evaluation of their antimicrobial activity. Planta Medica 75.
Odesanmi, S.O., Lawal, R.A., Ojokuku, S.A., 2009. Effects of ethanolic extract of *Tetrapleura tetraptera* on liver function profile and histopathology in male Dutch white rabbits. International Journal of Tropical Medicine 4, 136–139.
Odetola, A.A., Akinloye, O., Egunjobi, C., Adekunle, W.A., Ayoola, A.O., 2006. Possible antidiabetic and antihyperlipidaemic effect of fermented *Parkia biglobosa* (jacq) extract in alloxan-induced diabetic rats. Clinical and Experimental Pharmacology and Physiology 33, 808–812.
Oelrichs, P.B., Ng, J.C., Seawright, A.A., Ward, A., Schäffeler, L., Macleod, J.K., 1995. Isolation and identification of a compound from avocado (*Persea americana*)

leaves which causes necrosis of the acinar epithelium of the lactating mammary gland and the myocardium. Natural Toxins 3, 344–349.
Oga, E.F., Sekine, S., Shitara, Y., Horie, T., 2012. P-glycoprotein mediated efflux in Caco-2 cell monolayers: the influence of herbals on digoxin transport. Journal of Ethnopharmacology 144, 612–617.
Ogbera, A.O., Chinenye, S., Onyekwere, A., Fasanmade, O., 2007. Prognostic indices of diabetes mortality. Ethnicity & Disease 17, 721–725.
Ogbera, A.O., Awobusuyi, J., Unachukwu, C., Fasanmade, O., 2009. Clinical features, predictive factors and outcome of hyperglycaemic emergencies in a developing country. BMC Endocrine Disorders 9.
Ogbonnia, S.O., Mbaka, G.O., Adekunle, A., Anyika, E.N., Gbolade, O.E., Nwakakwa, N., 2010. Effect of a poly-herbal formulation, Okudiabet, on alloxan- induced diabetic rats. Agriculture and Biology Journal of North America 1, 139–145.
Ogbonnia, S., Anyakora, C., 2009. Chemistry and Biological Evaluation of Nigerian Plants with Anti-Diabetic Properties, African Natural Plant Products; in New Discoveries and Challenges in Chemistry and Quality. American Chemical Society, pp. 185–207.
Ogbonnia, S., Adekunle, A.A., Bosa, M.K., Enwuru, V.N., 2008a. Evaluation of acute and subacute toxicity of *Alstonia congensis* Engler (Apocynaceae) bark and *Xylopia aethiopica* (Dunal) A. Rich (Annonaceae) fruits mixtures used in the treatment of diabetes. African Journal of Biotechnology 7, 701–705.
Ogbonnia, S.O., Adekunle, A., Olagbende-Dada, S.O., Anyika, E.N., Enwuru, V.N., Orolepe, M., 2008b. Assessing plasma glucose and lipid levels, body weight and acute toxicity following oral administration of an aqueous ethanolic extract of *Parinari curatellifolia* Planch, (Chrysobalanaceae) seeds in alloxan-induced diabetes in rats. African Journal of Biotechnology 7, 2998–3003.
Ogbonnia, S.O., Odimegwu, J.I., Enwuru, V.N., 2008c. Evaluation of hypoglycaemic and hypolipidaemic effects of aqueous ethanolic extracts of *Treculia africana* Decne and *Bryophyllum pinnatum* Lam. and their mixture on streptozotocin (STZ)-induced diabetic rats. African Journal of Biotechnology 7, 2535–2539.
Ogechukwu, O.E., Ogoamaka, O.P., Kawamura, A., Hassan, A., Debbab, A., Okechukwu, E.C., Sylvester, N.C., Ngozi, N., Peter, P., 2012. Three (-) catechin-O-rhamnosides from the Eastern Nigeria mistletoe with potent immunostimulatory and antioxidant activities. Biomolecules 1.
Ogechukwu, O.E., Ogoamaka, O.P., Sylvester, N.C., Hassan, A., Debbab, A., Okechukwu, E.C., Kawamura, A., Peter, P., 2011. Steroids and triterpenoids from Eastern Nigeria mistletoe, *Loranthus micranthus* Linn. (Loranthaceae) parasitic on *Kola acuminata* with immunomodulatory potentials. Phytochemistry Letters 4, 357–362.
Oguakwa, J.U., 1984. Na-formylechitamidine, an alkaloid from *Alstonia boonei*. Phytochemistry 23, 2708–2709.
Oguanobi, N.I., Chijioke, C.P., Ghasi, S.I., 2012. Effects of aqueous leaf extract of *Ocimum gratissimum* on oral glucose tolerance test in type-2 model diabetic rats. African Journal of Pharmacy and Pharmacology 6, 630–635.
Ogunbinu, A.O., Ogunwandeb, I.A., Flaminid, G., Cionid, P.L., 2007. Volatile compounds of *Persea americana* Mill from Nigeria. Journal of Essential Oil Bearing Plants 10, 133–138.
Ogundipe, O.O., Moody, J.O., Akinyemi, T.O., Raman, A., 2003. Hypoglycemic potentials of methanolic extracts of selected plant foods in alloxanized mice. Plant Foods for Human Nutrition 58, 1–7.
Ogunmodede, O.S., Saalu, L.C., Ogunlade, B., Akunna, G.G., Oyewopo, A.O., 2012. An Evaluation of the hypoglycaemic, antioxidant and hepatoprotective potential of Onion (*Allium cepa* L.) on alloxan-induced diabetic rabbits. International Journal of Pharmacology 8, 21–29.
Ogunsua, A.O., 1980. Changes in some chemical constituents during the fermentation of cassava tubers (*Manihot esculenta*, Crantz). Food Chemistry 5, 249–255.
Ogunwande, I.A., Sonibare, M.A., Thang, T.D., Dung, N.X., Soladoye, M.O., Morohunfolu, O.O., 2008. Comparative analysis of the oils of three Ficus species from Nigeria. Journal of Essential Oil Research 20, 386–389.
Ohadoma, S.C., Michael, H.U., 2011. Effects of co-administration of methanol leaf extract of *Catharanthus roseus* on the hypoglycemic activity of metformin and glibenclamide in rats. Asian Pacific Journal of Tropical Medicine 4, 475–477.
Ojewole, J., 2008. Analgesic, anti-inflammatory and hypoglycaemic effects of *Securidaca longepedunculata* (Fresen.) [Polygalaceae] root-bark aqueous extract. Inflammopharmacology 16, 174–181.
Ojewole, J.A.O., 2005. Antinociceptive, anti-inflammatory and antidiabetic effects of *Bryophyllum pinnatum* (Crassulaceae) leaf aqueous extract. Journal of Ethnopharmacology 99, 13–19.
Ojewole, J.A.O., 2006. Analgesic, antiinflammatory and hypoglycaemic effects of ethanol extract of *Zingiber officinale* (roscoe) rhizomes (zingiberaceae) in mice and rats. Phytotherapy Research 20, 764–772.
Ojewole, J.A.O., Adewunmi, C.O., 2004. Anti-inflammatory and hypoglycaemic effects of *Tetrapleura tetraptera* (Taub) [fabaceae] fruit aqueous extract in rats. Journal of Ethnopharmacology 95, 177–182.
Ojewole, J.A.O., Adewunmi, C.O., 2003. Hypoglycemic effect of methanolic extract of *Musa paradisiaca* (Musaceae) green fruits in normal and diabetic mice. Methods and Findings in Experimental and Clinical Pharmacology 25, 453–456.
Ojewole, J.A., 2003. Laboratory evaluation of the hypoglycemic effect of *Anacardium occidentale* Linn (Anacardiaceae) stem-bark extracts in rats. Methods and Findings in Experimental & Clinical Pharmacology 25, 199.
Ojezele, M.O., Abatan, O.M., 2011. Hypoglycaemic and coronary risk index lowering effects of *Bauhinia thoningii* in alloxan induced diabetic rats. African Health Sciences 11.
Ojiako, O.A., Igwe, C.U., 2009. A time-trend hypoglycemic study of ethanol and chloroform extracts of *Strophanthus hispidus*. Journal of Herbs, Spices and Medicinal Plants 15, 1–8.
Okine, L.K.N., Nyarko, A.K., Osei-Kwabena, N., Oppong, I.V., Barnes, F., Ofosuhene, M., 2005. The antidiabetic activity of the herbal preparation ADD-199 in mice: a comparative study with two oral hypoglycaemic drugs. Journal of Ethnopharmacology 97, 31–38.
Okokon, J.E., Antia, B.S., Udobang, J.A., 2012. Antidiabetic activities of ethanolic extract and fraction of *Anthocleista djalonensis*. Asian Pacific Journal of Tropical Biomedicine 2, 461–464.
Okoli, R.I., Aigbe, O., Ohaju-Obodo, J.O., Mensah, J.K., 2007. Medicinal herbs used for managing some common ailments among Esan people of Edo State, Nigeria. Pakistan Journal of Nutrition 6, 490–496.
Okolie, V.U., Okeke, E.C., Ehiemere, O.I., Ezenduka, O.P., 2009. Investigation of the effect of *Solanum incanum* on postprandial blood glucose concentration of normoglycemic Nigerians. Pakistan Journal of Nutrition 8, 1631–1635.
Okonta, J.M., Aguwa, C.N., 2007. Evaluation of hypoglycemic activity of glycosides and alkaloids extracts of *Picralima nitida* Stapf (Apocynaceae) seed. International Journal of Pharmacology 3, 505–509.
Okoye, F.B.C., Osadebe, P.O., Nworu, C.S., Okoye, N.N., Omeje, E.O., Esimone, C.O., 2011. Topical anti-inflammatory constituents of lipophilic leaf fractions of *Alchornea floribunda* and *Alchornea cordifolia*. Natural Product Research 25, 1941–1949.
Okpuzor, J., Ogbunugafor, H., Kareem, G.K., Igwo-Ezikpe, M.N., 2009. in vitro investigation of antioxidant phenolic compounds in extracts of *Senna alata*. Research Journal of Phytochemistry 3, 68–76.
Oku, T., Yamada, M., Nakamura, M., Sadamori, N., Nakamura, S., 2006. Inhibitory effects of extractives from leaves of *Morus alba* on human and rat small intestinal disaccharidase activity. British Journal of Nutrition 95, 933–938.
Okunade, A.L., 2002. *Ageratum conyzoides* L. (Asteraceae). Fitoterapia 73, 1–16.
Okunji, C.O., Iwu, M.M., Ito, Y., Smith, P.L., 2005. Preparative separation of indole alkaloids from the Rind of *Picralima nitida* (Stapf) T. Durand & H. Durand by pH-zone-refining countercurrent chromatography. Journal of Liquid Chromatography and Related Technologies 28, 775–783.
Okwute, S.K., Ndukwe, G.I., Watanabe, K., Ohno, N., 1986. Isolation of Griffonilide from the stem bark of *Bauhinia thonningii*. Journal of Natural Products 49, 716–717.
Ola, S.S., Catia, G., Marzia, I., Francesco, V.F., Afolabi, A.A., Nadia, M., 2009. HPLC/DAD/MS characterisation and analysis of flavonoids and cynnamoil derivatives in four Nigerian green-leafy vegetables. Food Chemistry 115, 1568–1574.
Oladosu, I.A., Zubair, M.F., Ali, M.S., Olawore, N.O., 2009. Anticandidal activity of volatile compounds from the root bark of *Ficus exasperata* Vahl-Holl (Moraceae). Journal of Essential Oil Bearing Plants 12, 562–568.
Olajide, O.A., Awe, S.O., Makinde, J.M., Morebise, O., 1999. Evaluation of the antidiabetic property of *Morinda lucida* Leaves in streptozotocin-diabetic rats. Journal of Pharmacy and Pharmacology 51, 1321–1324.
Olaleye, M.T., Rocha, B.T.J., 2008. Acetaminophen-induced liver damage in mice: effects of some medicinal plants on the oxidative defense system. Experimental and Toxicologic Pathology 59, 319–327.
Olaleye, M.T., Rocha, J.B.T., 2007. Commonly used tropical medicinal plants exhibit distinct in vitro antioxidant activities against hepatotoxins in rat liver. Experimental and Toxicologic Pathology 58, 433–438.
Olaniyi, A.A., 1980. 1β-Hydroxyfriedel-6(7)-ene-3-one from *Momordica foetida*. Planta Medica 40, 303–305.
Olaokun, O., McGaw, L., Eloff, J., Naidoo, V., 2013. Evaluation of the inhibition of carbohydrate hydrolysing enzymes, antioxidant activity and polyphenolic content of extracts of ten African Ficus species (Moraceae) used traditionally to treat diabetes. BMC Complementary and Alternative Medicine 13, 1–10.
Olatunji, L.A., Okwusidi, J.I., Soladoye, A.O., 2005. Antidiabetic effect of *Anacardium occidentale* stem-bark in fructose-diabetic rats. Pharmaceutical Biology 43, 589–593.
Oliver-Bever, B., 1986. Medicinal Plants in Tropical West Africa. Cambridge University Press, Cambridge, New York, Australia.
Olmo, L.R.V., da Silva, M.F.d.G.F., Rodrigues Fo, E., Vieira, P.C., Fernandes, J.B., Pinheiro, A.L., Vilela, E.F., 1997. Limonoids from leaves of *Khaya senegalensis*. Phytochemistry 44, 1157–1161.
Olorunnisola, O.S., Afolayan, A.J., 2013. in vivo antioxidant and biochemical evaluation of *Sphenocentrum jollyanum* leaf extract in *P. berghei* infected mice. Pakistan Journal of Pharmaceutical Sciences 26, 445–450.
Olorunnisola, O.S., Amao, S., Ehigie, L.O., Ajayi, A.F., 2008. Anti-hyperglycemic and hypolipidemic effect of ethanolic extract of *Chrysophyllum albidum* seed cotyledon in alloxan-induced diabetic rats. Research Journal of Applied Sciences 3, 123–127.
Olowokudejo, J.D., Kadiri, A.B., Travih, V.A., 2008. An ethnobotanical survey of herbal markets and medicinal plants in Lagos State of Nigeria. Ethnobotanical Leaflets 12, 851–865.
Olowu, A.O., Adeneye, A.A., Adeyemi, O.O., 2011. Hypoglycaemic effect of *Ipomoea batatas* aqueous leaf and stem extract in normal and streptozotocin-induced hyperglycaemic rats. Journal of Natural Pharmaceuticals 2, 56–61.
Olubomehin, O.O., Abo, K.A., Ajaiyeoba, E.O., 2013. Alpha-amylase inhibitory activity of two Anthocleista species and in vivo rat model anti-diabetic activities of *Anthocleista djalonensis* extracts and fractions. Journal of Ethnopharmacology 146, 811–814.
Oluwole, F.S., Bolarinwa, A.F., 1997. *Jatropha curcas* extract causes anaemia in rat. Phytotherapy Research 11, 538–539.

Omeje, E.O., Osadebe, P.O., Nworu, C.S., Nwodo, J.N., Obonga, W.O., Kawamura, A., Esimone, C.O., Proksch, P., 2011. A novel sesquiterpene acid and an alkaloid from leaves of the Eastern Nigeria mistletoe, *Loranthus micranthus* with potent immunostimulatory activity on C57BL6 mice splenocytes and CD69 molecule. Pharmaceutical Biology 49, 1271–1276.

Omonkhua, A.A., Onoagbe, I.O., 2011. Evaluation of the long-term effects of *Urena lobata* root extracts on blood glucose and hepatic function of normal rabbits. Journal of Toxicology and Environmental Health Sciences 3, 204–213.

Omonkhua, A.A., Onoagbe, O.I., 2012. Long-term effects of three hypoglycaemic plants (*Irvingia gabonensis, Urena lobata* and *Carica papaya*) on the oxidative status of normal rabbits. Biokemistri 24, 82–89.

Omoregie, E.S., Osagie, A.U., 2008. Glycemic indices and glycemic load of some Nigerian foods. Pakistan Journal of Nutrition 7, 710–716.

Onaolapo, A.Y., Onaolapo, O.J., 2012. *Ocimum Gratissimum* Linn causes dose dependent hepatotoxicity in streptozotocin-induced diabetic Wistar rats. Macedonian Journal of Medical Sciences 5, 17–25.

Onayade, O.A., Looman, A.M.G., Scheffer, J.J.C., Gbile, Z.O., 1998. Lavender lactone and other volatile constituents of the oleoresin from seeds of *Garcinia kola* Heckel. Flavour and Fragrance Journal 13, 409–412.

Ong, K.C., Khoo, H.-E., 2000. Effects of myricetin on glycemia and glycogen metabolism in diabetic rats. Life Sciences 67, 1695–1705.

Ong, K.W., Hsu, A., Song, L., Huang, D., Tan, B.K.H., 2011. Polyphenols-rich *Vernonia amygdalina* shows anti-diabetic effects in streptozotocin-induced diabetic rats. Journal of Ethnopharmacology 133, 598–607.

Onocha, P.A., Okorie, D.A., Connolly, J.D., Roycroft, D.S., 1995. Monoterpene diol, iridoid glucoside and dibenzo-α-pyrone from *Anthocleista djalonensis*. Phytochemistry 40, 1183–1189.

Osadebe, P.O., Okide, G.B., Akabogu, I.C., 2004. Study on anti-diabetic activities of crude methanolic extracts of *Loranthus micranthus* (Linn.) sourced from five different host trees. Journal of Ethnopharmacology 95, 133–138.

Osadebe, P.O., Omeje, E.O., Uzor, P.F., David, E.K., Obiorah, D.C., 2010. Seasonal variation for the antidiabetic activity of *Loranthus micranthus* methanol extract. Asian Pacific Journal of Tropical Medicine 3, 196–199.

Osei-Safo, D., Chama, M.A., Addae-Mensah, I., Waibel, R., 2009. Hispidulin and other constituents of *Scoparia dulcis* Linn. Journal of Science and Technology 29, 7–15.

Osinubi, A.A., Enye, L.A., Adesiyun, A.E., Ajayi, G.O., 2008. Comparative effects of three herbs and standard hypoglycaemic agents on blood glucose in normoglycaemic, hyperglycaemic and alloxan-induced diabetic male rats. African Journal of Endocrinology and Metabolism 7.

Osoniyi, O., Onajobi, F., 2003. Coagulant and anticoagulant activities in *Jatropha curcas* latex. Journal of Ethnopharmacology 89, 101–105.

Ouoba, L.I.I., Diawara, B., Annan, N.T., Poll, L., Jakobsen, M., 2005. Volatile compounds of Soumbala, a fermented African locust bean (*Parkia biglobosa*) food condiment. Journal of Applied Microbiology 99, 1413–1421.

Owiredu, W.K.B.A., Takyi, N.K., Okine, L.K.N., Sittie, A.A., Amidu, N., Boateng, K.A., Antwi, S., Donkor, K., Addai-Mensah, O., 2011. Safety evaluation of BF001, an anti-diabetic herbal preparation in Sprague–Dawley rats. West African Journal of Pharmacy 22, 49–57.

Oyedeji, A.O., Ekundayo, O., Koenig, W.A., 2005. Essential oil composition of *Lawsonia inermis* L. leaves from Nigeria. Journal of Essential Oil Research 17, 403–404.

Oyelola, O.O., Moody, J.O., Odeniyi, M.A., Fakeye, T.O., 2007. Hypoglycemic effect of *Treculia africana* Decne root bark in normal and alloxan-induced diabetic rats. African Journal of Traditional, Complementary and Alternative Medicines 4, 387–391.

Ozolua, R.I., Idogun, S.E., Tafamel, G.E., 2010. Acute and sub-acute toxicological assessment of aqueous leaf extract of *Bryophyllum Pinnatum* (Lam.) in Sprague–Dawley rats. American Journal of Pharmacology and Toxicology 5, 145–151.

Ozolua, R.I., Eriyamremu, G.E., Okene, E.O., Ochei, U., 2006. Hypoglycaemic effects of viscous preparation of *Irvingia gabonensis* (Dikanut) seeds in streptozotocin-induced diabetic Wistar rats. Journal of Herbs, Spices and Medicinal Plants 12, 1–9.

Pais, M., Marchand, J., Ratle, G., Jarreau, F., 1968. Peptidic alkaloids. VI. Hymenocardine, alkaloid from *Hymenocardia acida* Tul. Bulletin de la Société Chimique de France 7, 2979–2984.

Palanichamy, S., Nagarajan, S., Devasagayam, M., 1988. Effect of *Cassia alata* leaf extract on hyperglycemic rats. Journal of Ethnopharmacology 22, 81–90.

Palazzino, G., Galeffi, C., Federici, E., Delle Monache, F., Francesca Cometa, M., Palmery, M., 2000. Benzylbenzoate and norlignan glucosides from *Curculigo pilosa*: structural analysis and in vitro vascular activity. Phytochemistry 55, 411–417.

Pandit, S., Mukherjee, P.K., Mukherjee, K., Gajbhiye, R., Venkatesh, M., Ponnusankar, S., Bhadra, S., 2012. Cytochrome P450 inhibitory potential of selected Indian spices – possible food drug interaction. Food Research International 45, 69–74.

Pao, L.-H., Hu, O.Y.-P., Fan, H.-Y., Lin, C.-C., Liu, L.-C., Huang, P.-W., 2012. Herb–drug interaction of 50 Chinese herbal medicines on CYP3A4 activity in vitro and in vivo. American Journal of Chinese Medicine 40, 57–73.

Pari, L., Murugan, P., 2007. Changes in glycoprotein components in streptozotocin–nicotinamide induced type 2 diabetes: influence of tetrahydrocurcumin from *Curcuma longa*. Plant Foods for Human Nutrition 62, 25–29.

Pari, L., Venkateswaran, S., 2002. Hypoglycaemic activity of *Scoparia dulcis* L. extract in alloxan induced hyperglycaemic rats. Phytotherapy Research 16, 662–664.

Park, J.H., Lee, S.H., Chung, I.-M., Park, Y., 2012. Sorghum extract exerts an anti-diabetic effect by improving insulin sensitivity via PPAR-γ in mice fed a high-fat diet. Nutritional Research and Practice 6, 322–327.

Patnam, R., Kadali, S.S., Koumaglo, K.H., Roy, R., 2005. A chlorinated coumarino-lignan from the African medicinal plant, *Mondia whitei*. Phytochemistry 66, 683–686.

Paul, A., Raychaudhuri, S.S., 2010. Medicinal uses and molecular identification of two *Momordica charantia* varieties – a review. Electronic Journal of Biology 6, 43–51.

Pegel, K.H., Rogers, C.B., 1968. Constituents of *Bridelia micrantha*. Phytochemistry 7, 655–656.

Pérez, Y.Y., Jiménez-Ferrer, E., Zamilpa, A., Hernández-Valencia, M., Alarcón-Aguilar, F.J., Tortoriello, J., Román-Ramos, R., 2007. Effect of a polyphenol-rich extract from *Aloe vera* gel on experimentally induced insulin resistance in mice. American Journal of Chinese Medicine 35, 1037–1046.

Perkins-Veazie, P., Collins, J.K., Davis, A.R., Roberts, W., 2006. Carotenoid content of 50 watermelon cultivars. Journal of Agricultural and Food Chemistry 54, 2593–2597.

Persaud, S., Al-Majed, H., Raman, A., Jones, P., 1999. *Gymnema sylvestre* stimulates insulin release in vitro by increased membrane permeability. Journal of Endocrinology 163, 207–212.

Peterson, J.J., Dwyer, J.T., Beecher, G.R., Bhagwat, S.A., Gebhardt, S.E., Haytowitz, D. B., Holden, J.M., 2006. Flavanones in oranges, tangerines (mandarins), tangors, and tangelos: a compilation and review of the data from the analytical literature. Journal of Food Composition and Analysis 19 (Suppl.), S66–S73.

Phuwapraisirisan, P., Puksasook, T., Kokpol, U., Suwanborirux, K., 2009. Corchorusides A and B, new flavonol glycosides as α-glucosidase inhibitors from the leaves of *Corchorus olitorius*. Tetrahedron Letters 50, 5864–5867.

Piovan, A., Filippini, R., 2007. Anthocyanins in *Catharanthus roseus* in vivo and in vitro: a review. Phytochemistry Reviews 6, 235–242.

Ponnusamy, S., Ravindran, R., Zinjarde, S., Bhargava, S., Ravi Kumar, A., 2011. Evaluation of traditional indian antidiabetic medicinal plants for human pancreatic amylase inhibitory effect in vitro. Evidence-Based Complementary and Alternative Medicine 2011 (Article ID 515647).

Popoola, J.O., Obembe, O.O., 2013. Local knowledge, use pattern and geographical distribution of *Moringa oleifera* Lam. (Moringaceae) in Nigeria. Journal of Ethnopharmacology 150, 682–691.

Porchezhian, E., Dobriyal, R.M., 2003. An overview on the advances of *Gymnema sylvestre*: chemistry, pharmacology and patents. Die Pharmazie – International Journal of Pharmaceutical Sciences 58, 5–12.

Poser, G., Toffoli, M., Sobral, M., Henriques, A., 1997. Iridoid glucosides substitution patterns inVerbenaceae and their taxonomic implication. Plant Systematics and Evolution 205, 265–287.

Potchoo, Y., Guissou, I.P., Lompo, M., Sakie, E., Yaro, B., 2008. Antioxidant activty of aqueous methanol and ethyl acetate extract of leaves of *Annona senegalensis* Pers from Togo versus the one that originates from Burkina Faso. International Journal of Pharmacology 4, 120–124.

Pott, I., Breithaupt, D.E., Carle, R., 2003. Detection of unusual carotenoid esters in fresh mango (*Mangifera indica* L. cv. 'Kent'). Phytochemistry 64, 825–829.

Prashanth, D., Amit, A., Samiulla, D.S., Asha, M.K., Padmaja, R., 2001. Alpha-glucosidase inhibitory activity of *Mangifera indica* bark. Fitoterapia 72, 686–688.

Pu, H., Jiang, H., Chen, R., 2013. Combined multispectroscopic and molecular docking investigation on the interaction between strictosamide and human serum albumin. Luminescence 28, 482–489.

Qi, L.-W., Liu, E.H., Chu, C., Peng, Y.-B., Cai, H.-X., Li, P., 2010. Anti-diabetic agents from natural products. An update from 2004 to 2009. Current Topics in Medicinal Chemistry 10, 434–457.

Quasie, O., Martey, O.N.K., Nyarko, A.K., Gbewonyo, W.S.K., Okine, L.K.N., 2010. Modulation of penile erection in rabbits by *Mondia whitei*: possible mechanism of action. African Journal of Traditional, Complementary and Alternative Medicines 7, 241–252.

Raga, D., Espiritu, R., Shen, C.-C., Ragasa, C., 2011. A bioactive sesquiterpene from *Bixa orellana*. Journal of Natural Medicines 65, 206–211.

Rahimi, R., Nikfar, S., Larijani, B., Abdollahi, M., 2005. A review on the role of antioxidants in the management of diabetes and its complications. Biomedicine and Pharmacotherapy 59, 365–373.

Raja, K.C.M., Ramakrishna, S.V., 1990. Compositional and pasting characteristics of plain-dried and parboiled cassava (*Manihot esculenta* Crantz). Food Chemistry 38, 79–88.

Rajeshkumar, N.V., Joy, K.L., Kuttan, G., Ramsewak, R.S., Nair, M.G., Kuttan, R., 2002. Antitumour and anticarcinogenic activity of *Phyllanthus amarus* extract. Journal of Ethnopharmacology 81, 17–22.

Raji, Y., Fadare, O.O., Adisa, R.A., Salami, S.A., 2006. Comprehensive assessment of the effect of *Sphenocentrum jollyanum* root extract on male reproductive activity in albino rats. Reproductive Medicine and Biology 5, 283–292.

Rajic, A., Kweifio-Okai, G., Macrides, T., Sandeman, R.M., Chandler, D.S., Polya, G.M., 2000. Inhibition of serine proteases by anti-inflammatory triterpenoids. Planta Medica 66, 206–210.

Raphael, K.R., Sabu, M.C., Kuttan, R., 2002. Hypoglycemic effect of methanol extract of *Phyllanthus amarus* Schum & Thonn on alloxan induced diabetes mellitus in rats and its relation with antioxidant potential. Indian Journal of Experimental Biology 40, 905–909.

Rashid, M.A., Gustafson, K.R., Cardellina, J.H., Boyd, M.R., 2000. A new podophyllotoxin derivative from *Bridelia ferruginea*. Natural Product Letters 14, 285–292.

Rau, O., Wurglics, M., Dingermann, T., Abdel-Tawab, M., Schubert-Zsilavecz, M., 2006. Screening of herbal extracts for activation of the human peroxisome proliferator-activated receptor. Die Pharmazie 61, 952–956.

Ravindranath, N., Ravinder Reddy, M., Ramesh, C., Ramu, R., Prabhakar, A., Jagadeesh, B., Das, B., 2004. New lathyrane and podocarpane diterpenoids from *Jatropha curcas*. Chemical and Pharmaceutical Bulletin 52, 608–611.

Refaat, J., Desoky, S.Y., Ramadan, M.A., Kamel, M.S., 2013. Bombacaceae: a phytochemical review. Pharmaceutical Biology 51, 100–130.
Rendic, S., Carlo, F.J.D., 1997. Human cytochrome P450 enzymes: a status report summarizing their reactions, substrates, inducers, and inhibitors. Drug Metabolism Reviews 29, 413–580.
Rivera-Pastrana, D.M., Yahia, E.M., González-Aguilar, G.A., 2010. Phenolic and carotenoid profiles of papaya fruit (*Carica papaya* L.) and their contents under low temperature storage. Journal of the Science of Food and Agriculture 90, 2358–2365.
Rodeiro, I., Donato, M.T., Jimenez, N., Garrido, G., Molina-Torres, J., Menendez, R., Castell, J.V., Gómez-Lechón, M.J., 2009. Inhibition of human P450 enzymes by natural extracts used in traditional medicine. Phytotherapy Research 23, 279–282.
Rodríguez-Morán, M., Guerrero-Romero, F., 2003. Oral magnesium supplementation improves insulin sensitivity and metabolic control in type 2 diabetic subjects: a randomized double-blind controlled trial. Diabetes Care 26, 1147–1152.
Rotenstein, L.S., Kozak, B.M., Shivers, J.P., Yarchoan, M., Close, J., Close, K.L., 2012. The ideal diabetes therapy: what will it look like? How close are we?. Clinical Diabetes 30, 44–53.
Roth, G.N., Chandra, A., Nair, M.G., 1998. Novel bioactivities of *Curcuma longa* constituents. Journal of Natural Products 61, 542–545.
Roy, S., Sehgal, R., Padhy, B.M., Kumar, V.L., 2005. Antioxidant and protective effect of latex of *Calotropis procera* against alloxan-induced diabetes in rats. Journal of Ethnopharmacology 102, 470–473.
Russell, K.R.M., Morrison, E.Y.S.A., Ragoobirsingh, D., 2005. The effect of annatto on insulin binding properties in the dog. Phytotherapy Research 19, 433–436.
Sabitha, V., Ramachandran, S., Naveen, K.R., Panneerselvam, K., 2011. Antidiabetic and antihyperlipidemic potential of *Abelmoschus esculentus* (L.) Moench. in streptozotocin-induced diabetic rats. Journal of Pharmacy and Bioallied Sciences 3, 397–402.
Sabu, M.C., Smitha, K., Ramadasan, K., 2002. Anti-diabetic activity of green tea polyphenols and their role in reducing oxidative stress in experimental diabetes. Journal of Ethnopharmacology 83, 109–116.
Saeed, A.E.M., Bashier, R.S.M., 2010. Physico-chemical analysis of *Ximenia americana*.L seed oil and structure elucidation of some chemical constituents of its seed oil and fruit pulp. Journal of Pharmacognosy and Phytotherapy 2, 49–55.
Saidu, A.N., Mann, A., Onuegbu, C.D., 2012. Phytochemical screening and hypoglycemic effect of aqueous *Blighia sapida* root bark extract on normoglycemic albino rats. British Journal of Pharmaceutical Research 2, 89–97.
Sakakibara, H., Honda, Y., Nakagawa, S., Ashida, H., Kanazawa, K., 2003. Simultaneous determination of all polyphenols in vegetables, fruits, and teas. Journal of Agricultural and. Food. Chemistry 51, 571–581.
Salama, H.M.H., 2012. Alkaloids and flavonoids from the air dried aerial parts of *Citrullus colocynthis*. Journal of Medicinal Plants Research 6, 5150–5155.
Samy, R.P., Rajendran, P., Li, F., Anandi, N.M., Stiles, B.G., Ignacimuthu, S., Sethi, G., Chow, V.T.K., 2012. Identification of a Novel *Calotropis procera* protein that can suppress tumor growth in breast cancer through the suppression of NF-κB pathway. PLoS One 7, e48514.
Sánchez-Mata, M.a.-C., Yokoyama, W.E., Hong, Y.-J., Prohens, J., 2010. α-Solasonine and α-solamargine contents of Gboma (*Solanum macrocarpon* L.) and Scarlet (*Solanum aethiopicum* L.) eggplants. Journal of Agricultural and Food Chemistry 58, 5502–5508.
Sandoval-Montemayor, N.E., García, A., Elizondo-Treviño, E., Garza-González, E., Alvarez, L., Camacho-Corona, M.d.R., 2012. Chemical composition of hexane extract of *Citrus aurantifolia* and anti-mycobacterium tuberculosis activity of some of its constituents. Molecules 17, 11173–11184.
Sang, S., Cheng, X., Zhu, N., Stark, R.E., Badmaev, V., Ghai, G., Rosen, R.T., Ho, C.-T., 2001. Flavonol glycosides and novel iridoid glycoside from the leaves of *Morinda citrifolia*. Journal of Agricultural and. Food. Chemistry 49, 4478–4481.
Sani, D., Sanni, S., Ngulde, S.I., 2009. Hypoglycaemic effect of aqueous stem extract of *Anisopus mannii* in normal rats. African Journal of Pharmacy and Pharmacology 3, 481–484.
Schieber, A., Berardini, N., Carle, R., 2003. Identification of flavonol and xanthone glycosides from mango (*Mangifera indica* L. Cv. "Tommy Atkins") peels by high-performance liquid chromatography–electrospray ionization mass spectrometry. Journal of Agricultural and. Food. Chemistry 51, 5006–5011.
Schneider, C., Rotscheidt, K., Breitmaier, E., 1993. Vier neue pregnanglycoside aus *Gongronema latifolium* (Asclepiadaceae). Liebigs Annalen der Chemie 1993, 1057–1062.
Schulz, K.F., Altman, D.G., Moher, D., 2010. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. British Medical Journal 340, 698–702.
Schweiggert, U., Carle, R., Schieber, A., 2006. Characterization of major and minor capsaicinoids and related compounds in chili pods (*Capsicum frutescens* L.) by high-performance liquid chromatography/atmospheric pressure chemical ionization mass spectrometry. Analytica Chimica Acta 557, 236–244.
Schwob, I., Viano, J., Bessière, J.-M., Haddad, C., 2008. Comparison of essential oil composition of *Daniellia oliveri* (Rolfe) Hutch et Dalz. (Caesalpiniaceae) leaves from Senegal and Ivory Coast. Journal of Essential Oil Research 20, 155–157.
Sebbagh, N., Cruciani-Guglielmacci, C., Ouali, F., Berthault, M.F., Rouch, C., Sari, D.C., Magnan, C., 2009. Comparative effects of *Citrullus colocynthis*, sunflower and olive oil-enriched diet in streptozotocin-induced diabetes in rats. Diabetes and Metabolism 35, 178–184.
Selvam, R., Subramanian, L., Gayathri, R., Angayarkanni, N., 1995. The anti-oxidant activity of turmeric (*Curcuma longa*). Journal of Ethnopharmacology 47, 59–67.
Shafaei, H., Esmaeili, A., Rad, J.S., Delazar, A., Behjat, M., 2012. *Citrullus colocynthis* as a medicinal or poisonous plant: a revised fact. Journal of Medicinal Plants Research 6, 4922–4927.
Shaker, K.H., Morsy, N., Zinecker, H., Imhoff, J.F., Schneider, B., 2010. Secondary metabolites from *Calotropis procera* (Aiton). Phytochemistry Letters 3, 212–216.
Shalaby, N.M.M., Abd-Alla, H.I., Ahmed, H.H., Basoudan, N., 2011. Protective effect of *Citrus sinensis* and *Citrus aurantifolia* against osteoporosis and their phytochemical constituents. Journal of Medicinal Plants Research 5, 579–588.
Shanmugasundaram, E.R.B., Gopinath, K.L., Shanmugasundaram, K.R., Rajendran, V. M., 1990a. Possible regeneration of the islets of langerhans in streptozotocin-diabetic rats given *Gymnema sylvestre* leaf extracts. Journal of Ethnopharmacology 30, 265–279.
Shanmugasundaram, E.R.B., Rajeswari, G., Baskaran, K., Kumar, B.R.R., Shanmugasundaram, K.R., Ahmath, B.K., 1990b. Use of *Gymnema sylvestre* leaf extract in the control of blood glucose in insulin-dependent diabetes mellitus. Journal of Ethnopharmacology 30, 281–294.
Sharom, F.J., 2007. Drug Transporters, Multidrug Resistance Protein (P-Glycoprotein; MDR1), Guelph, Canada. ⟨http://www.fluorosome.com/pdf/p-glycoprotein-multidrug-resistance-protein.pdf⟩ (accessed 05.12.11).
Shaw, D., Graeme, L., Pierre, D., Elizabeth, W., Kelvin, C., 2012. Pharmacovigilance of herbal medicine. Journal of Ethnopharmacology 140, 513–518.
Shaw, D., Leon, C., Kolev, S., Murray, V., 1997. Traditional remedies and food supplements. Drug-Safety 17, 342–356.
Shaw, J.E., Sicree, R.A., Zimmet, P.Z., 2010. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Research and Clinical Practice 87, 4–14.
Sheehan, M.T., 2003. Current therapeutic options in type 2 diabetes mellitus: a practical approach. Clinical Medicine and Research 1, 189–200.
Sheela, C.G., Kumud, K., Augusti, K.T., 1995. Anti-diabetic effects of onion and garlic sulfoxide amino acids in rats. Planta Medica 61, 356–357.
Sherratt, H.S.A., 1986. Hypoglycin, the famous toxin of the unripe Jamaican ackee fruit. Trends in Pharmacological Sciences 7, 186–191.
Sheu, S.-C., Lai, M.-H., 2012. Composition analysis and immuno-modulatory effect of okra (*Abelmoschus esculentus* L.) extract. Food Chemistry 134, 1906–1911.
Shittu, H., Gray, A., Furman, B., Young, L., 2010. Glucose uptake stimulatory effect of akuammicine from *Picralima nitida* (Apocynaceae). Phytochemistry Letters 3, 53–55.
Shuaibu, M., Wuyep, P., Yanagi, T., Hirayama, K., Tanaka, T., Kouno, I., 2008. The use of microfluorometric method for activity-guided isolation of antiplasmodial compound from plant extracts. Parasitology Research 102, 1119–1127.
Shuichi, K., Abe, H., 2000. Antidiabetic activity of white skinned sweet potato (*Ipomoea batatas* L.) in obese zucker fatty rats. Biological and Pharmaceutical Bulletin 23, 23–26.
Siddaiah, M., Jayaveera, K.N., Souris, K., Krishna, J.P.Y., Kumar, P.V., 2011. Phytochemical screening and anti diabetic activity of methanolic extract of leaves of *Ximenia americana* in rats. International Journal of Innovative Pharmaceutical Research 2, 78–83.
Siddhuraju, P., 2007. Antioxidant activity of polyphenolic compounds extracted from defatted raw and dry heated *Tamarindus indica* seed coat. LWT – Food Science and Technology 40, 982–990.
Siddhuraju, P., Becker, K., 2003. Antioxidant properties of various solvent extracts of total phenolic constituents from three different agroclimatic origins of drumstick tree (*Moringa oleifera* Lam.) Leaves. Journal of Agricultural and. Food. Chemistry 51, 2144–2155.
Siddiqui, B.S., Kardar, M.N., Ali, S.T., Khan, S., 2003. Two new and a known compound from *Lawsonia inermis*. Helvetica Chimica Acta 86, 2164–2169.
Silva, G.F., Gamarra, F.M.C., Oliveira, A.L., Cabral, F.A., 2008. Extraction of bixin from annatto seeds using supercritical carbon dioxide. Brazilian Journal of Chemical Engineering 25, 419–426.
Singh, R., Kaur, N., Kishore, L., Kumar Gupta, G., 2013. Management of diabetic complications: a chemical constituents based approach. Journal of Ethnopharmacology 150, 51–70.
Singh, R., Singh, B., Singh, S., Kumar, N., Kumar, S., Arora, S., 2008. Anti-free radical activities of kaempferol isolated from *Acacia nilotica* (L.) Willd. Ex. Del. Toxicology in vitro 22, 1965–1970.
Singh, S., Sanwal, G.G., 1975. Characterization of multiple forms of α-glucan phosphorylase from *Musa paradisiaca* fruits. Phytochemistry 14, 113–118.
Singh, S.N., Vats, P., Suri, S., Shyam, R., Kumria, M.M.L., Ranganathan, S., Sridharan, K., 2001. Effect of an antidiabetic extract of *Catharanthus roseus* on enzymic activities in streptozotocin induced diabetic rats. Journal of Ethnopharmacology 76, 269–277.
Sinsheimer, J.E., McIlhenny, H.M., 1967. Constituents from *Gymnema sylvestre* leaves. II. Nitrogenous compounds. Journal of Pharmaceutical Sciences 56, 732–736.
Sinsheimer, J.E., Rao, G.S., McIlhenny, H.M., 1970. Constituents from *Gymnema sylvestre* leaves V: isolation and preliminary characterization of the gymnemic acids. Journal of Pharmaceutical Sciences 59, 622–628.
Sobenin, I., Nedosugova, L., Filatova, L., Balabolkin, M., Gorchakova, T., Orekhov, A., 2008. Metabolic effects of time-released garlic powder tablets in type 2 diabetes mellitus: the results of double-blinded placebo-controlled study. Acta Diabetologica 45, 1–6.
Sofidiya, M., Lange, C., Sattler, I., Beukes, D., Afolayan, A., Odukoya, O., Familoni, O., 2010. Bioactivity profile of compounds isolated from *Hymenocardia acida* Tul. leaves. Planta Medica 76, P141.
Sofidiya, M.O., Odukoya, O.A., Afolayan, A.J., Familoni, O.B., 2009. Phenolic contents, antioxidant and antibacterial activities of *Hymenocardia acida*. Natural Product Research 23, 168–177.

Sofidiya, M.O., Oduwole, B., Bamgbade, E., Odukoya, O., Adenekan, S., 2011. Nutritional composition and antioxidant activities of *Curculigo pilosa* (Hypoxidaceae) rhizome. African Journal of Biotechnology 10, 17275–17281.
Soladoye, M.O., Chukwuma, E.C., Owa, F.P., 2012. An 'Avalanche' of plant species for the traditional cure of diabetes mellitus in South-Western Nigeria. Journal of Natural Products and Plant Resources 2, 60–72.
Soto-Blanco, B., Górniak, S.L., 2010. Toxic effects of prolonged administration of leaves of cassava (*Manihot esculenta* Crantz) to goats. Experimental and Toxicologic Pathology 62, 361–366.
Souza, J.D., Silva, M.B.R., Argolo, A.C.C., Napoleão, T.H., Sá, R.A., Correia, M.T.S., Paiva, P.M.G., Silva, M.D.C., Coelho, L.C.B.B., 2011. A new *Bauhinia monandra* galactose-specific lectin purified in milligram quantities from secondary roots with antifungal and termiticidal activities. International Biodeterioration and Biodegradation 65, 696–702.
Srinivasan, K., Ramarao, P., 2007. Animal models in type 2 diabetes research: an overview. Indian Journal of Medical Research 125, 451–472.
Staubmann, R., Ncube, I., Gübitz, G.M., Steiner, W., Read, J.S., 1999. Esterase and lipase activity in *Jatropha curcas* L. seeds. Journal of Biotechnology 75, 117–126.
Stergiopoulou, T., De Lucca, A.J., Meletiadis, J., Sein, T., Boue, S.M., Schaufele, R., Roilides, E., Ghannoum, M., Walsh, T.J., 2008. in vitro activity of CAY-1, a saponin from *Capsicum frutescens*, against Microsporum and Trichophyton species. Medical Mycology 46, 805–810.
Stevenson, P.C., Dayarathna, T.K., Belmain, S.R., Veitch, N.C., 2009. Bisdesmosidic saponins from *Securidaca longepedunculata* roots: evaluation of deterrency and toxicity to Coleopteran storage pests. Journal of Agricultural and Food Chemistry 57, 8860–8867.
Stévigny, C., Block I, S., Pauw-Gillet, M.C.D., Hoffmann, E.d., Llabrès, G., Adjakidjé, V., Quetin-Leclercq, J., 2002. Cytotoxic aporphine alkaloids from *Cassytha filiformis*. Planta Medica 68, 1042–1044.
Sudheesh, S., Sandhya, C., Sarah Koshy, A., Vijayalakshmi, N.R., 1999. Antioxidant activity of flavonoids from *Solanum melongena*. Phytotherapy Research 13, 393–396.
Sudjaroen, Y., Haubner, R., Würtele, G., Hull, W.E., Erben, G., Spiegelhalder, B., Changbumrung, S., Bartsch, H., Owen, R.W., 2005. Isolation and structure elucidation of phenolic antioxidants from Tamarind (*Tamarindus indica* L.) seeds and pericarp. Food and Chemical Toxicology 43, 1673–1682.
Sultana, B., Anwar, F., 2008. Flavonols (kaempeferol, quercetin, myricetin) contents of selected fruits, vegetables and medicinal plants. Food Chemistry 108, 879–884.
Sultana, N., Choudhary, M.I., Khan, A., 2009. Protein glycation inhibitory activities of *Lawsonia inermis* and its active principles. Journal of Enzyme Inhibition and Medicinal Chemistry 24, 257–261.
Sun, J., Chen, P., 2012. Ultra high-performance liquid chromatography with high-resolution mass spectrometry analysis of african mango (*Irvingia gabonensis*) seeds, extract, and related dietary supplements. Journal of Agricultural and. Food. Chemistry 60, 8703–8709.
Suzuki, R., Okada, Y., Okuyama, T., 2003. Two flavone C-glycosides from the style of *Zea mays* with glycation inhibitory activity. Journal of Natural Products 66, 564–565.
Suzuki, R., Okada, Y., Okuyama, T., 2005. The favorable effect of style of *Zea mays* L. on streptozotocin induced diabetic nephropathy. Biological and Pharmaceutical Bulletin 28, 919–920.
Svoboda, G.H., Johnson, I.S., Gorman, M., Neuss, N., 1962. Current status of research on the alkaloids of *Vinca rosea* Linn. (*Catharanthus roseus* G. Don). Journal of Pharmaceutical Sciences 51, 707–720.
Swanston-Flatt, S., Day, C., Bailey, C., Flatt, P., 1989. Evaluation of traditional plant treatments for diabetes: Studies in streptozotocin diabetic mice. Acta Diabetologia Latina 26, 51–55.
Szkudelski, T., 2001. The mechanism of alloxan and streptozotocin action in B cells of the rat pancreas. Physiological Research 50, 536–546.
Tachibana, Y., Kikuzaki, H., Lajis, N.H., Nakatani, N., 2003. Comparison of antioxidative properties of carbazole alkaloids from *Murraya koenigii* leaves. Journal of Agricultural and Food Chemistry 51, 6461–6467.
Tagawa, C., Okawa, M., Ikeda, T., Yoshida, T., Nohara, T., 2003. Homo-cholestane glycosides from *Solanum aethiopicum*. Tetrahedron Letters 44, 4839–4841.
Taiwo, I.A., Adebesin, O.A., Shittu, A.F., Lawal, R.I., Odeigah, P.G.C., 2010. Glycaemic activity of *Ficus exasperata* in fructose-induced glucose intolerance in rats. Researcher 2, 80–83.
Takeda, Y., Fatope, M.O., 1988. New phenolic glucosides from *Lawsonia inermis*. Journal of Natural Products 51, 725–729.
Tala, V.R.S., Silva, V.C.d., Rodrigues, C.M., Nkengfack, A.E., Santos, L.C.d., Vilegas, W., 2013. Characterization of Proanthocyanidins from *Parkia biglobosa* (Jacq.) G. Don. (Fabaceae) by flow injection analysis – electrospray ionization ion trap tandem mass spectrometry and liquid chromatography/electrospray ionization mass spectrometry. Molecules 18, 2803–2820.
Tamboura, H.H., Bayala, B., Lompo, M., Guissou, I.P., Sawadogo, L., 2005. Ecological distribution, morphological characteristics and acute toxicity of aqueous extracts of *Holarrhena floribunda* (G. Don) Durand & Schinz, *Leptadenia hastata* (Pers.) decne and *Cassia sieberiana* (dc) used by veterinary healers in Burkina Faso. African Journal of Traditional, Complementary and Alternative Medicines 2, 13–24.
Tanabe, K., Nakamura, S., Omagari, K., Oku, T., 2011. Repeated ingestion of the leaf extract from *Morus alba* reduces insulin resistance in KK-Ay mice. Nutrition Research 31, 848–854.
Tanaka, T., Nonaka, G.-I., Nishioka, I., 1986. Tannins and related compounds. XLII. Isolation and characterization of four new hydrolyzable tannins Terflavin A and B, Tergallagin and Tercatain from the leaves of *Terminalia catappa* L. Chemical and Pharmaceutical Bulletin 34, 1039–1049.
Tanko, Y., Muhammad, A., Elaigwu, J., Mohammed, K.A., Jimoh, A., Sada, N.M., Dallatu, M.K., Yerima, M., Mohammed, A., 2013. Anti-diabetic effects of ethyl acetate and n-butanol fractions of *Acacia nilotica* leaves methanolic extract on alloxan-induced diabetic wistar rats. Journal of Applied Pharmaceutical Science 3, 89–93.
Tanko, Y., Yerima, M., Mahdi, M.A., Yaro, A.H., Musa, K.Y., Mohammed, A., 2008. Hypoglycemic activity of methanolic stem bark of *Adansonia digitata* extract on blood glucose levels of streptozocin-induced diabetic wistar rats. International Journal of Applied Research in Natural Products 1, 32–36.
Taofeek, O.A., 2011. in vivo antioxidant potentials of *Piliostigma thonningii* (Schum) leaves: studies on hepatic marker enzyme, antioxidant system, drug detoxifying enzyme and lipid peroxidation. Human and Experimental Toxicology 30, 55–62.
Taro, N., Toshio, F., Sachiko, Y., Masa, K., 1978. Studies on the constituents of the cultivated mulberry tree. I. Three new Prenylflavones from the root bark of *Morus alba* L. Chemical and Pharmaceutical Bulletin 26, 1394–1402.
Tchacondo, T., Karou, S.D., Batawila, K., Agban, A., Ouro-Bang'na, K., Anani, K.T., Gbeassor, M., Souza1, C.d., 2011. Herbal remedies and their adverse effects in Tem tribe traditional medicine in Togo. African Journal of Traditional, Complementary and Alternative Medicine 8, 45–60.
Tedong, L., Madiraju, P., Martineau, L.C., Vallerand, D., Arnason, J.T., Desire, D.D.P., Lavoie, L., Kamtchouing, P., Haddad, P.S., 2010. Hydro-ethanolic extract of cashew tree (*Anacardium occidentale*) nut and its principal compound, anacardic acid, stimulate glucose uptake in C2C12 muscle cells. Molecular Nutrition and Food Research 54, 1753–1762.
Terashima, S., Shimizu, M., Horie, S., Morita, N., 1991. Studies on aldose reductase inhibitors from natural products. IV. Constituents and aldose reductase inhibitory effect of *Chrysanthemum morifolium*, *Bixa orellana* and *Ipomoea batatas*. Chemical and Pharmaceutical Bulletin 39, 3346–3347.
Teugwa, C.M., Boudjeko, T., Tchinda, B.T., Mejiato, P.C., Zofou, D., 2013a. Anti-hyperglycaemic globulins from selected Cucurbitaceae seeds used as antidiabetic medicinal plants in Africa. BMC Complementary and Alternative Medicine, 13.
Teugwa, C.M., Mejiato, P.C., Zofou, D., Tchinda, B.T., Boyom, F.F., 2013b. Antioxidant and antidiabetic profiles of two African medicinal plants: *Picralima nitida* (Apocynaceae) and *Sonchus oleraceus* (Asteraceae). BMC Complementary and Alternative Medicine 13, 175.
Tirimanna, A.S.L., 1981. Study of the carotenoid pigments of *Bixa orellana* L. seeds by thin layer chromatography. Mikrochimica Acta 76, 11–16.
Tlili, I., Hdider, C., Lenucci, M.S., Riadh, I., Jebari, H., Dalessandro, G., 2011. Bioactive compounds and antioxidant activities of different watermelon (*Citrullus lanatus* (Thunb.) Mansfeld) cultivars as affected by fruit sampling area. Journal of Food Composition and Analysis 24, 307–314.
Toma, I., Karumi, Y., Geidam, M.A., 2009. Phytochemical screening and toxicity studies of the aqueous extract of the pods pulp of *Cassia sieberiana* DC. (*Cassia kotchiyana* Oliv.). African Journal of Pure and Applied Chemistry 3, 026–030.
Toyomizu, M., Sugiyama, S., Jin, R.L., Nakatsu, T., 1993. α-Glucosidase and aldose reductase inhibitors: Constituents of cashew, *Anacardium occidentale*, nut shell liquids. Phytotherapy Research 7, 252–254.
Tringali, C., Spatafora, C., Longo, O.D., 2000. Bioactive constituents of the bark of *Parkia biglobosa*. Fitoterapia 71, 118–125.
Trox, J., Vadivel, V., Vetter, W., Stuetz, W., Scherbaum, V., Gola, U., Nohr, D., Biesalski, H.K., 2010. Bioactive compounds in cashew nut (*Anacardium occidentale* L.) kernels: effect of different shelling methods. Journal of Agricultural and Food Chemistry 58, 5341–5346.
Tsai, T.-H., Wang, G.-J., Lin, L.-C., 2008. Vasorelaxing alkaloids and flavonoids from *Cassytha filiformis*. Journal of Natural Products 71, 289–291.
Tsopmo, A., Kamnaing, P., Watchueng, J., Gao, J.-M., Konishi, Y., Sterner, O., 2009. Chemical constituents from the bark of *Anisopus mannii*. Canadian Journal of Chemistry 87, 397–400.
Tsuda, T., Watanabe, M., Ohshima, K., Yamamoto, A., Kawakishi, S., Osawa, T., 1994. Antioxidative Components isolated from the seed of tamarind (*Tamarindus indica* L.). Journal of Agricultural and. Food. Chemistry 42, 2671–2674.
Tsumbu, C.N., Deby-Dupont, G., Tits, M., Angenot, L., Franck, T., Serteyn, D., Mouithys-Mickalad, A., 2011. Antioxidant and antiradical activities of *Manihot esculenta* Crantz (Euphorbiaceae) leaves and other selected tropical green vegetables investigated on lipoperoxidation and phorbol-12-myristate-13-acetate (PMA) activated monocytes. Nutrients 3, 818–838.
Ubillas, R.P., Mendez, C.D., Jolad, S.D., Luo, J., King, S.R., Carlson, T.J., Fort, D.M., 2000. Antihyperglycemic acetylenic glucosides from *Bidens pilosa*. Planta Medica 66, 82–83.
Ugochukwu, N.H., Babady, N.E., 2002. Antioxidant effects of *Gongronema latifolium* in hepatocytes of rat models of non-insulin dependent diabetes mellitus. Fitoterapia 73, 612–618.
Ugochukwu, N.H., Babady, N.E., 2003. Antihyperglycemic effect of aqueous and ethanolic extracts of *Gongronema latifolium* leaves on glucose and glycogen metabolism in livers of normal and streptozotocin-induced diabetic rats. Life Sciences 73, 1925–1938.
Ukeh, D.A., Umoetok, S.B.A., 2011. Repellent effects of five monoterpenoid odours against *Tribolium castaneum* (Herbst) and *Rhyzopertha dominica* (F.) in Calabar, Nigeria. Crop Protection 30, 1351–1355.
Usia, T., Watabe, T., Kadota, S., Tezuka, Y., 2005. Cytochrome P450 2D6 (CYP2D6) inhibitory constituents of *Catharanthus roseus*. Biological and Pharmaceutical Bulletin 28, 1021–1024.
Vadivel, V., Nandety, A., Biesalski, H.K., 2011. Antioxidant, free radical scavenging and type II diabetes-related enzyme inhibition properties of traditionally

processed Jequirity bean (*Abrus precatorius* L.). International Journal of Food Science and Technology 46, 2505–2512.
Vaes, L.P., Chyka, P.A., 2000. Interactions of warfarin with garlic, ginger, ginkgo, or ginseng: nature of the evidence. Annals of Pharmacotherapy 34, 1478–1482.
van den Berg, A.J.J., Horsten, S.F.A.J., Kettenes-van den Bosch, J.J., Kroes, B.H., Beukelman, C.J., Leeflang, B.R., Labadie, R.P., 1995. Curcacycline A – a novel cyclic octapeptide isolated from the latex of *Jatropha curcas* L. FEBS Letters 358, 215–218.
Vanderperren, B., Rizzo, M., Angenot, L., Haufroid, V., Jadoul, M., Hantson, P., 2005. Acute liver failure with renal impairment related to the abuse of senna anthraquinone glycosides. Annals of Pharmacotherapy 39, 1353–1357.
Vanucci, C., Lange, C., Lhommet, G., Dupont, B., Davoust, D., Vauchot, B., Clement, J. L., Brunck, F., 1992. An insect antifeedant limonoid from seed of *Khaya ivorensis*. Phytochemistry 31, 3003–3004.
Varghese, G.K., Bose, L.V., Habtemariam, S., 2013. Antidiabetic components of *Cassia alata* leaves: Identification through α-glucosidase inhibition studies. Pharmaceutical Biology 51, 345–349.
Vashishtha, V.M., John, T.J., Kumar, A., 2009. Clinical and pathological features of acute toxicity due to *Cassia occidentalis* in vertebrates. Indian Journal of Medical Research 130, 23–30.
Veitch, N.C., Grayer, R.J., 2011. Flavonoids and their glycosides, including anthocyanins. Natural Product Reports 28, 1626–1695.
Verma, L., Khatri, A., Kaushik, B., Patil, U.K., Pawar, R.S., 2010. Antidiabetic activity of *Cassia occidentalis* (Linn) in normal and alloxan-induced diabetic rats. Indian Journal of Pharmacology 42, 224–228.
Vieira, R.F., Grayer, R.J., Paton, A., Simon, J.E., 2001. Genetic diversity of *Ocimum gratissimum* L. based on volatile oil constituents, flavonoids and RAPD markers. Biochemical Systematics and Ecology 29, 287–304.
Vyshali, P., Saraswathi, K.J.T., Sanakal, R.D., Kaliwal, B.B., 2011. Inhibition of aldose activity by essential phytochemicals of *Cymbopogon Citratus* (DC.) Stapf. International Journal of Biometrics and Bioinformatics 5, 257–267.
Wallace, T.M., Matthews, D.R., 2000. Poor glycaemic control in type 2 diabetes: a conspiracy of disease, suboptimal therapy and attitude. Quarterly Journal of Medicine 93, 369–374.
Wang, M., Kikuzaki, H., Jin, Y., Nakatani, N., Zhu, N., Csiszar, K., Boyd, C., Rosen, R.T., Ghai, G., Ho, C.-T., 2000. Novel glycosides from Noni (*Morinda citrifolia*). Journal of Natural Products 63, 1182–1183.
Wang, M.-Y., West, B.J., Jensen, C.J., Nowicki, D., Chen, S.U., Palu, A.K., Anderson, G., 2002. *Morinda citrifolia* (Noni): a literature review and recent advances in Noni research. Acta Pharmacologica Sinica 23, 1127–1141.
Watcho, P., Zelefack, F., Ngouela, S., Nguelefack, T.B., Kamtchouing, P., Tsamo, E., Kamanyi, A., 2012. Enhancement of erectile function of sexually naïve rats by β-sitosterol and α-β-amyrin acetate isolated from the hexane extract of *Mondia whitei*. Asian Pacific Journal of Tropical Biomedicine 2, S1266–S1269.
WHO, 2013. In: World Health Organization (Ed.), WHO Traditional Medicine Strategy 2014–2023. WHO Press, Geneva, Switzerland.
WHO, 2008. Traditional Medicine. ⟨http://www.who.int/mediacentre/factsheets/fs134/en/⟩ (accessed 08.08.13).
Wickenberg, J., Ingemansson, S.L., Hlebowicz, J., 2010. Effects of *Curcuma longa* (turmeric) on postprandial plasma glucose and insulin in healthy subjects. Nutrition Journal, 9.
Williamson, E., Driver, S., Baxter, K., 2013. Stockley's Herbal Medicines Interactions – A Guide to the Interactions of Herbal Medicines, Second ed. Pharmaceutical Press, London, United Kingdom.
Wong, K.C., Tan, C.P., Chow, C.H., Chee, S.G., 1998. Volatile constituents of the fruit of *Tamarindus indica* L. Journal of Essential Oil Research 10, 219–221.
Worku, T., 2009. Investigation of Antihyperglycemic and Hypoglycemic Activity of *Ajuga remota* and *Syzygium guineense* on Mice. School of Graduate Studies of Addis Ababa, Addis Ababa University, Addis Ababa.
Wurochekke, A.U., Anthony, A.E., Obidah, W., 2008. Biochemical effects on the liver and kidney of rats administered aqueous stem bark extract of *Ximenia americana*. African Journal of Biotechnology 7, 2777–2780.
Xie, W., Wang, W., Su, H., Xing, D., Pan, Y., Du, L., 2006. Effect of ethanolic extracts of *Ananas comosus* L. leaves on insulin sensitivity in rats and HepG2. Comparative Biochemistry and Physiology Part C: Toxicology and Pharmacology 143, 429–435.
Yadav, J.P., Arya, V., Yadav, S., Panghal, M., Kumar, S., Dhankhar, S., 2010. *Cassia occidentalis* L.: a review on its ethnobotany, phytochemical and pharmacological profile. Fitoterapia 81, 223–230.
Yang, C.-P., Fujita, S., Ashrafuzzaman, M.D., Nakamura, N., Hayashi, N., 2000. Purification and characterization of polyphenol oxidase from banana (*Musa sapientum* L.) pulp. Journal of Agricultural and Food Chemistry 48, 2732–2735.
Yeap Foo, L., 1995. Amariinic acid and related ellagitannins from *Phyllanthus amarus*. Phytochemistry 39, 217–224.
Yeh, G.Y., Eisenberg, D.M., Kaptchuk, T.J., Phillips, R.S., 2003. Systematic review of herbs and dietary supplements for glycemic control in diabetes. Diabetes Care 26, 1277–1294.
Yen, G.-C., Wu, S.-C., Duh, P.-D., 1996. Extraction and identification of antioxidant components from the leaves of mulberry (*Morus alba* L.). Journal of Agricultural and Food Chemistry 44, 1687–1690.
Yessoufou, A., Ategbo, J.-M., Girard, A., Prost, J., Dramane, K.L., Moutairou, K., Hichami, A., Khan, N.A., 2006. Cassava-enriched diet is not diabetogenic rather it aggravates diabetes in rats. Fundamental and Clinical Pharmacology 20, 579–586.
Yinusa, I., George, N.I., Amupitan, J.O., 2012. Isolation and bioactivity of pentacyclic triterpenoid (Betunilic acid) from the bark of *Sarcocephalus latifolius* (Smith Bruce). Journal of Natural Sciences Research 2.
Yogisha, S., Raveesha, K.A., 2010. Dipeptidyl peptidase IV inhibitory activity of *Mangifera indica*. Journal of Natural Products 3, 76–79.
Yoshikawa, M., Morikawa, T., Kobayashi, H., Nakamura, A., Matsuhira, K., Nakamura, S., Matsuda, H., 2007. Bioactive saponins and glycosides. XXVII. Structures of new cucurbitane-type triterpene glycosides and antiallergic constituents from *Citrullus colocynthis*. Chemical and Pharmaceutical Bulletin 55, 428–434.
You, M., Wickramaratne, D.B.M., Silva, G.L., Chai, H., Chagwedera, T.E., Farnsworth, N.R., Cordell, G.A., Kinghorn, A.D., Pezzuto, J.M., 1995. (-)-Roemerine, an aporphine alkaloid from *Annona senegalensis* that reverses the multidrug-resistance phenotype with cultured cells. Journal of Natural Products 58, 598–604.
Yüce, B., Gülberg, V., Diebold, J., Gerbes, A.L., 2006. Hepatitis Induced by Noni Juice from *Morinda citrifolia*: a rare cause of hepatotoxicity or the tip of the iceberg? Digestion 73, 167–170.
Yusuff, K., Obe, O., Joseph, B., 2008. Adherence to anti-diabetic drug therapy and self management practices among type-2 diabetics in Nigeria. Pharmacy World & Science 30, 876–883.
Zhang, B., Yang, S.-P., Yin, S., Zhang, C.-R., Wu, Y., Yue, J.-M., 2009a. Limonoids from *Khaya ivorensis*. Phytochemistry 70, 1305–1308.
Zhang, H., Wang, X., Chen, F., Androulakis, X.M., Wargovich, M.J., 2007. Anticancer activity of limonoid from *Khaya senegalensis*. Phytotherapy Research 21, 731–734.
Zhang, M., Chen, M., Zhang, H.-Q., Sun, S., Xia, B., Wu, F.-H., 2009b. in vivo hypoglycemic effects of phenolics from the root bark of *Morus alba*. Fitoterapia 80, 475–477.
Zimmet, P., Alberti, K.G.M.M., Shaw, J., 2001. Global and societal implications of the diabetes epidemic. Nature 414, 782–787.
Zin, Z.M., Abdul-Hamid, A., Osman, A., 2002. Antioxidative activity of extracts from Mengkudu (*Morinda citrifolia* L.) root, fruit and leaf. Food Chemistry 78, 227–231.