

ANTIDIABETIC PROPERTIES OF THIRTEEN LOCAL MEDICINAL PLANTS IN NIGERIA, A REVIEW

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ABSTRACTS

Diabetes mellitus is a group of metabolic disorder associated with the endocrine system that resulted in hyperglycaemic condition. Themetabolic defects may leads to many complications such as neuropathy, retinopathy, microangiopathy, nephropathy, ischaemic heart disease and stroke. Over 800 plants are indicated by ethnobotanical information as traditional remedies for the treatment of diabetes all over the world. This review attempts to compile the antidiabetic properties of thirteen (13) local phytochemical plants in Nigeria for easy reference. The phytochemical plants evaluated in this review include; *Persea americana* (Avocado pear), *Sida acuta* (Broom-weed), *Tithonia diversifolia* (Wild Sunflower), *Aframomum melegueta* (Alligator Pepper), *Azadirachta indica* (Neem), *Carica*

Papaya (Paw-paw), *Ocimum gratissimum* (scent or mint leaf), *Parkia biglobosa* (African locust Bean), *Vernonia amygdalina* (Bitter Leaf), *Moringa oleifera* (drumstick or horseradish tree), *Momordica charantia* (Bitter melon), *Picralima nitida* (Akuama) and *Syzygium aromaticum* (Cloves). Various parts of these plants were evaluated and appreciated for hypoglycemic activity. Medicinal plants have been proved to be more effective, less side effects or zero side effect and relative low cost than the conventional pharmaceutical synthetic drugs. This review may be of help to researchers, diabetic patient and decision makers in field of ethanobotanical sciences.

KEYWORDS: Diabetes mellitus, medicinal Plants, antidiabetics, Nigeria.

INTRODUCTION

Diabetes Mellitus

Diabetes mellitus is an endocrine-metabolic disorder characterized by chronic hyperglycaemia (high blood sugar) giving rise to the risk of microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (ischaemic heart disease, stroke and peripheral vascular disease) damage, with associated reduced life expectancy and diminished quality of life.^[1] It is caused by the inherited and/or acquired deficiency in production of insulin by the pancreas or by the ineffectiveness of the insulin.^[2] World Health Organisation (WHO) estimated that about 30 million people suffered from diabetes in 1985 and the number increased to more than 171 million in 2000. It is estimated that the number will increase to over 366 million by 2030 and that large increase will occur in developing countries, especially in people aged between 45 and 64 years.^[3,4,5] Currently many countries face large increases in the number of people suffering from diabetes.^[4] Different types of reported diabetes mellitus can be classified under following two categories:

Type 1 Diabetes: This is known as Insulin-Dependent Diabetes Mellitus (IDDM). It is characterized by islets' langrahan in ability to produce insulin and it most often occurs in children and young adults. Type 1 diabetes accounts for 5–10% of diabetes. Though the cause of type 1 diabetes is not clear, it could speculate autoimmune attack, infectious agents, e.t.c. The condition seem to be unpreventable, with symptoms including; excessive excretion of urine (polyuria), thirst (polydipsia), constant hunger, weight loss, vision changes and fatigue, these symptoms may occur suddenly.^[6]

Type 2 Diabetes: This is also known as Noninsulin-Dependent Diabetes Mellitus (NIDDM), in which body produces inadequate amount of insulin to meet up with requirements, or improper use of secreted insulin due to fault at receptor levels. It is the most common form of diabetes, accounting for 90–95% of diabetes. Type 2 diabetes is nearing epidemic proportions, due to an increased number of elderly people, and a greater prevalence of obesity and sedentary lifestyles.^[7] Symptoms may be similar to those type 1 diabetes, but are often less marked. As a result, the disease may be diagnosed several years after onset, once complications have already arisen.^[6]

Phytochemical Plants

Ethno botanical information indicates that more than 800 plants are used as traditional remedies for the treatment of diabetes due to their effectiveness, less side effects and

relatively low cost.^[8] Although, pharmaceutical oral hypoglycaemic drugs and insulin-therapies the mainstay of treatment of diabetes, they have prominent side effects and fail to significantly alter or amend the course of diabetic complications.^[9] The common side effects associated with pharmaceutical oral hypoglycaemic agents are hypoglycaemia, weight gain, gastrointestinal disorders, peripheral oedema and impaired liver function, besides the cost of treatment.^[10] Since natural remedies are somehow safer and more efficient than pharmaceutically derived remedies, the practice or study of medicinal herbs has become mainstream worldwide.^[9,11]

The use of crude extracts of medicinal plants in the management/treatment of diabetes mellitus is widely practiced in Nigeria.^[12] Plant drugs and herbal formulations are frequently considered to be less toxic and free from side effects than synthetic ones. Anti-hyperglycaemic effects of some of these traditional plants are attributed to their ability to restore the function of pancreatic tissues by causing an increase in insulin production or restore the functions of insulin receptors.^[1] Some inhibit the intestinal absorption of glucose through the inhibition of digestive enzymes of carbohydrates, mainly α -amylases and α -glucosidases^[13] thereby affecting the glycaemic index of foods. The anti-diabetic properties of these plants could be attributed to their constituents which include; glycosides, alkaloids, terpenoids, flavonoids, carotenoids, etc., all of which are frequently implicated as having anti-diabetic effect^[1] Although many works have been done on the use of phytochemicals in treatment of diabetes through the increase in production of insulin or its receptors, few has been done on α -amylase and α -glucosidase phytochemical inhibition.

Avocado pear (Persea americana)

Avocado is one of the plants that have been extensively used in traditional folk-medicine.^[14] In Nigeria, the plant has various local names such as 'igba', 'apoka', or 'ewe pia' in Yoruba; 'ube-beke' or 'akwukwo ube' in Igbo and 'piya' in Hausa.^[15,16] The tree of *Persea americana* is cultivated in tropical and subtropical areas. The plant is usually 20m (60ft) tall, the leaves are 12 - 25cm long in alternate arrangement and the flowers are greenish yellow and bear a pear-shaped fruit.^[14] It has been reported that seed of *Persea americana* has various application in phytomedicine, going from treatment for diarrhoea, dysentery, toothache, intestinal parasites, skin treatment and beautification.^[17,18] The avocado seed oil has numerous health values e.g. it is used to reduce weight in obese patients. *Persea americana* leaves have been reported to possess anti-inflammatory and analgesic activities.

Antioxidant activity and phenolic content of seeds of avocado pear was found to be greater than 70%.^[17] Avocado seed has been shown to possess antidiabetic properties.^[17,18] Phytochemical compounds reported present are; terpenoids glycosides, aliphatic acetogenins (alkanol), flavonoids and coumarin.^[15]

Sida acuta

Sida acuta belongs to the family malvaceae and it serves as one of the medicinal plants used by traditional herbalist for the treatment of various diseases. *Sida acuta* is commonly called *seketu*, *osepotu*, *esoketu* or *akoko* in Yoruba, *Ogirishi* in igbo and wire-weed, broom-weedor spiny head among Nigerians in general.^[19] *Sida acuta* is a small shrub found widely in the tropics, these plants are used to treat infectious disease in children such as malaria, fever, pain, variola, and also have antibacterial, anti-inflammatory, analgesic and hepatoprotective properties^[20,21] screened the leaf extracts of *Sida acuta* for its hypoglycaemic activities in normoglycaemic and alloxan-induced diabetic rabbits and their results show a significant blood sugar reduction in normoglycaemic and alloxan-induced diabetic rabbits in dose dependent manner. This indicates that the plant has anti-hyperglycaemic properties. The phytochemical screening of the plants revealed that it contains alkaloids, steroids, flavones, anthracyanin, glycosides, amino acids, proteins, saponins, phenolic compounds, tannin, saponins, flavonoids and terpenoids.^[22,23,24,25]

***Tithonia diversifolia* (Wild Sun Flower)**

Tithonia diversifolia (Hemsl) A. Gray is an impressive member of the sunflower family, *Asteraceae*^[26] *Tithonia diversifolia* is a scientific name for a sunflower which belongs to the genus of annual and perennial herbs of composite flower. This genus is thought to be native to South America.^[27] *Tithonia diversifolia* is commonly referred to as Mexican sunflower, or tree marigold, Honduras sunflower, Japanese Sunflower and Shrub Sunflower, wild sunflower, *ogbo* or *agbale* (Yoruba) in Nigeria.^[28] It is a bushy perennial weed commonly found on the fields, wasteland and road sides of Nigeria. The plant is used for ornamental purposes or as manure for farming and for treatment of diabetes mellitus, malaria, sore throat, liver and menstrual pains.^[29,30] In addition, the plant is used for the treatment of stomach pains, indigestion, sore throat and liver pains. The plant serves as various native medicines in many countries.

Validations of some of these folkloric claims have shown that *Tithonia diversifolia* contains bioactive compounds that have anti-inflammatory activity, anti-diarrhoeal, anti-amoebic and

spasmolytic activities. Some of the bioactive compounds that have been isolated from the leaves include sesquiterpenes, saponins and alkaloids^[29] while the phytochemical screening carried out on the stem of *Tithonia diversifolia* revealed the presence of saponins, tannins, phlobatannins, flavonoids and cardiac glycoside.^[30,31] Aqueous leaf extract of the *Tithonia diversifolia* significantly increase glucose uptake without significant toxic effects.^[32,33] *Tithonia diversifolia* aqueous leaf extract treated alloxan-induced diabetic mice for 30 days significantly decreased blood glucose levels, total cholesterol, triacylglyceride and low density lipoprotein-cholesterol (LDL-cholesterol) while increased high density lipoprotein-cholesterol (HDL-cholesterol) significantly when compared with their respective control groups.^[34]

***Aframomum melegueta* (Alligator Pepper)**

Aframomum melegueta is a West African plant, with common or local names as Alligator pepper, Guinea pepper, Grain of paradise, 'Atare' (Yoruba), 'Ose orji' or 'Okwa' (Igbo), 'Cittaa Chilla' (Hausa).^[35] *Aframomum melegueta* is a spice plant and specie in the family, *Zingiberaceae*. It is about 1.0m tall with narrow lanceolate bamboo like leaves at base of leafy shoots on very short peduncles, with bracts, and pink or lilac labellum. The bracts enclose the developing flowers. The fruit is ovoid with reddish colour and numerous small brownish angular seeds with a cardamom flavour. *Aframomum melegueta* are valued spice and this earned the plant the name 'Grain of paradise'.^[36]

In West Africa, the fruit pulp is chewed as a refreshing stimulant and the seeds and the leaves are used for seasoning foods and in local medicine. *Aframomum melegueta* is used in the preparation of peper soup in the southern part of Nigeria and the fruits are used to prepare soup for the mothers from the first day of delivery to prevent postpartum contraction.^[37] It is also used as a remedy for variety of ailments such as snakebites, measles, malaria, toothache, cardiovascular diseases, diabetes and fertility control.^[19,38] Aqueous extracts of *Aframomum melegueta* leaf has reported to have reduced blood glucose level of alloxan-induced diabetic male rats in dose dependent manner and the extract was able to restore the organs of both diabetic and non-diabetic rats after treatment when compared with the control group.^[39] It has reported that 200mg/Kg and 400mg/Kg aqueous seed extract of *Aframomum melegueta* significantly decreased blood glucosein alloxan-induced diabetic rat when compared with the control group.^[40]

***Azadirachta indica* (Neem)**

Azadirachta indica known as Neem in many countries of the world is a large evergreen tree that belongs to the family Meliaceae. It is believed to have originated from Assam and Burma in South Asia and grows well in tropical and sub-tropical regions around the world with ability to withstand many adverse environmental conditions such as drought, infertile soil, stony, shallow or acidic soil.^[41] *Azadirachta indica* (Neem) commonly called 'Dongoyaro' (Yoruba), 'Og-wu' (Igbo) and 'Maina' (Hausa) in Nigeria is well known as one of the most versatile medicinal plants having a wide range of biological activities.^[42] The plant is useful in the treatment of many ailments such as malaria, neuromuscular pains, skin infections, diabetes, cancer and heart disease. Its antidiabetic potential has been validated scientifically in diabetic rats after its administration for two weeks.^[43]

Findings have shown that ethanolic leaf extracts of *Azadirachta indica* treatment improved hyperglycaemia in diabetes and produced normoglycaemic by week-2 of exposure of streptozotocin-induced diabetic rats.^[44] The aqueous leaf extracts of *Azadirachta indica* exhibited antidiabetic effect in alloxan-induced diabetic Wistar rats.^[41] The results of phytochemical screening conducted by Prashanth and Krishnaiah,^[45] showed that Neem contains Tannins, Phenolic compounds, Saponins, Alkaloids, Carbohydrates, Flavonoids and Glycosides.

***Carica papaya* Linn (Paw-paw)**

Paw-paw is the fruits of the plant *Carica papaya* belonging to the genus *Carica*.^[46] It contains chymopain and the enzyme papain, which is present in the fruits, stem, and leaves.^[16] Papain is a proteolytic enzyme which helps in protein digestion and Chymopain also aids digestion.^[18] *Carica papaya* is commonly called paw-paw and it belongs to the family Caricaceae and possesses excellent medicinal properties for treatment of different ailments.^[47] Paw-paw is locally called 'Ibepe' (Yoruba), 'Okworo beke', 'ojo' or 'Okworo' (Igbo) and 'Gwanda' (Hausa) in Nigeria.^[16,48] Unripe pulp of *Carica papaya* has been reported of its anti-hyperlipidaemia and anti-hyperglycaemic activities by reducing blood glucose level and lipid parameters significantly ($p < 0.05$), while the high density lipoprotein cholesterol (HDL-C) was increased significantly ($p < 0.05$) when compared with their respective control groups.^[49] These actions of *Carica papaya* may be due to the bioactive constituents of the plant.

Phytochemical analysis of *Carica papaya* leaf extract revealed the presence of alkaloids, glycosides, flavonoids, saponins, tannins, phenols and steroids.^[46,47] The different parts of the *Carica papaya* plant proved to have medicinal value including leaves, seeds, latex and fruit. *Carica papaya* has a wide variety of medicinal properties including anticancer, antiviral, anti-inflammatory, anti-microbial, anti-diabetic, anti-hypertensive, wound healing activity, free radical scavenging activity and increase in thrombocyte count.^[47] Papaya is a powerhouse of nutrients and is available throughout the year. It is a rich source of three powerful antioxidant (vitamin C, Vitamin A and Vitamin E), the minerals (Magnesium and Potassium), the B-Vitamin (pantothenic acid and folate) and fibre.^[50] In addition to all these, it contains a digestive enzyme, papain and also helps in the prevention of diabetic heart disease and lowers high-cholesterol levels.^[50]

Ocimum gratissimum

Ocimum gratissimum (Linn.), family Labiaceae, is herbaceous plant commonly found in the savannah, tropical rain forest and coastal areas of West Africa and tropical Asia.^[51] In Nigeria, it is commonly used as a condiment in cooking and reports showed that extracts from this plant parts are effective in the treatment of diabetes mellitus.^[12,52] It is called 'Nton' in Ibibio/Efik, 'Efinrin' in Yoruba 'Daidoya ta gida' in Hausa, 'Nchonwu' or 'Ahuji' in Igbo, 'Aramogbo' in Edo.^[51,52] Report has shown that aqueous extract of *Ocimum gratissimum* reduces blood sugar level in streptozotocin-induced diabetic rats and alleviates the cardinal symptoms of diabetes mellitus namely; polydipsia, polyphagia and weight loss.^[51]

Ocimum gratissimum is reputed for a number of therapeutic properties including hypoglycaemic, anti-helminthic effect, antifungal properties, antibacterial activities and anti-convulsant activity.^[53] Phytochemical analysis of *Ocimum gratissimum* revealed important constituents as tannins, alkaloids, saponins, flavonoids, steroids, phlobatannin, terpenoids, cardiac glycosides and phenolic compounds.^[54,55] It also contains anti-nutrient phytin phosphorus, oxalate, phytic acid and polyphenols.^[55,56]

Parkia biglobosa

Parkia biglobosa belongs to the plant family Fabaceae and sub family Mimosaceae of the order Leguminisae popularly known as the 'African locust bean tree' which in Yoruba is called 'Iru',^[57] 'Igba' or 'Irugba', in Hausa as 'Dorowa' or 'Daddawa' in Ibo as 'Origili', and in Tiv as 'Nune'.^[51,58,59,60] In West Africa, especially in Nigeria, the beans are usually fermented to yield a product popularly called 'Dawadawa', a black tasty seasoning rich in

protein. Dawadawa is commonly used as condiment in local soups and as a dietary protein source.^[60]

Phytochemical screening of the ethanolic extracts of *Parkia biglobosa* revealed the presence of alkaloids, saponins, tannins, terpenes, and phenols, reducing sugars, steroids, and flavones, glycosides and flavonoids.^[51,60,61,62,63] In Nigeria and other parts of West Africa where *Parkia biglobosa* is grown, there have been reports from herbal medical practitioners indicating that *Parkia biglobosa* stem bark was used in the treatment of diabetes mellitus,^[51] inflammatory diseases, pains and infections due to the presence of its active ingredients that has been reported to exhibit antioxidant properties.^[63] Report has shown that *Parkia biglobosa* significantly decrease glucose levels of normoglycaemic rats in dose dependent manner.^[57]

Parkia biglobosa is plants with an outstanding protein quality taking into account its protein and amino acid composition.^[64] The plant is commonly found both in the northern and western part of Nigeria.^[57]

***Vernonia amygdalina* (Bitter Leaf)**

Vernonia amygdalina is a member of the *Asteraceae* family, it is popularly called 'Bitter leaf' and it is known in Nigeria local languages as 'Etidot' in Efik, 'Uzi' in Ebirá, 'Onugbu' in Igbo, 'Chusarduki' in Hausa^[65] and 'Ewuro' in Yoruba. In another Africa countries, it is called 'Muop' or 'Ndole' in Cameroon, 'Tuntwano' in Tanzania and 'Mululuza' in Uganda.^[65] It is a shrub of 2 - 5m tall with abundant bitter principle in every part of the plant.^[66] It is a widely used local plant in Nigeria for both therapeutic and nutritional purpose, where it serves as the main ingredient in 'bitter leaf soap'.^[67]

It is cultivated in Nigeria mainly for its nutritional value.^[67] Fresh extract of the leaf has been reported to contain alkaloids, saponins, tannins, flavonoids, anthraquinones, glycosides, terpenoids and proteins as well as vitamins and minerals.^[65,68] Report has shown that aqueous leaf extract of *Vernonia amygdalina* caused significant ($p < 0.01$) and progressive time dependent reduction of blood glucose and serum triglyceride levels in both normoglycaemic and alloxan-induced diabetic rats.^[68]

Moringa oleifera

Moringa oleifera Lam, belongs to the mono-generic family *Moringaceae* and is one of the best known, most widely distributed and naturalized species. It is popularly known as

drumstick or horseradish tree in English^[69,70] and it is known with the following local names, 'Chigan wawa' in Nupe, 'Zogallagandi' or 'Zogali' in Fulani/Hausa, 'Ewe Igbale' or 'Idagbo monoye' in Yoruba, and 'Okwe oyibo' or 'Odudu oyibo' in Igbo.^[70,71,72] Many parts of this plant *i.e.*, leaves, immature pods, flowers and fruits are edible and are used as a highly nutritive vegetable in many countries.^[73] The leaves have been reported to be a rich source of β -carotene, protein, vitamin C, calcium and potassium and act as a good source of natural antioxidant due to the presence of ascorbic acid, flavonoids, phenolics and carotenoids.^[69] The leaves exhibit strong antioxidant property expressed in terms of free radical scavenging activity and reducing power.^[73] Phytochemical screening of *Moringa oleifera* seeds revealed that it contains alkaloids, glycosides, flavonoids, saponins, steroidal ring and little amount of Tannins and reducing sugars.^[71,72]

The aqueous extract of leaves of *Moringa oleifera* has shown to lower the blood sugar in diabetic people,^[69] streptozotocin-induced rats,^[73] alloxan-induced diabetic rabbits^[74] and streptozotocin-induced diabetic mice.^[75] Leaves of *Moringa oleifera* have been reported to elicit hypoglycaemic and hypocholesterolemic in type II diabetes mellitus in obese people.^[69] Dried leaf powder and ethanolic extract of *Moringa oleifera* caused significant reduction in blood glucose level of streptozotocin-induced diabetic and normoglycaemic rats.^[8] Aqueous extract of *Moringa oleifera* has been reported to have produced a high significant ($p < 0.001$) reduction in blood glucose levels at second-hour in fasted normal and alloxan-induced diabetic rabbits and the maximum percentage reduction was observed at 200mg/Kg dose when compared with control.^[74] The same result was observed by Edoga *et al.*^[76] in which the aqueous extract possess a significant dose-dependent hypoglycaemic activities in both normoglycaemic and alloxan-induced diabetic rats and almost as effective as the standard drug, tolbutamide.

***Momordica charantia* (Bitter melon)**

Momordica charantia, also known as bitter melon, bitter gourd or balsam pear, is a family of *Cucurbitaceae* and it is widely cultivated in many tropical and subtropical region of the world. It is known by different names among different ethnic groups in Nigeria, it is called 'Ejinrin' in Yoruba, 'Alo-ose' in Igbo and 'Kakayi' in Hausa.^[16] Extracts from various components of this plant have been reported to possess hypoglycaemic activities.^[2,9] The hypoglycaemic activity of *Momordica charantia* fruit juice is demonstrated in animals with experimental diabetes and also in humans in both type-1 and type-2 diabetes mellitus [11].

Three groups of constituents thought to be responsible for blood sugar lowering action of bitter melon; charantin (which is composed of sitosterol and stigmasterol glucosides), polypeptide P (plant insulin found in seeds and fruits) and alkaloids have been reported.^[9] Charantin can potentially substitute treatment by insulin, polypeptide P is similar to insulin in composition, then it can be of great benefit in therapy of type-1 diabetes and alkaloids have been noted for its hypoglycaemic activity.^[11] *Momordica charantia* contains a collection of unique and biologically active phytochemicals including triterpenes, proteins, steroids, glycosides, saponins, alkaloids.^[77] Oral administration of fresh fruit juice significantly lowered the blood sugar in normal and alloxan-induced diabetic rabbits when compared with control.^[10] The possible modes of the hypoglycaemic actions of *Momordica charantia* are its hypoglycaemic effect, stimulation of peripheral and skeletal muscle glucose utilisation, inhibition of intestinal glucose uptake, inhibition of adipocytes differentiation, suppression of key enzyme of pentose phosphate pathway and preservation of islet β -cells and their functions.^[10] Thus bitter melon (*Momordica charantia*) can be an alternative therapy used for lowering glucose level in diabetic patients.^[9]

Picralima nitida

Picralima nitida staphis a family of *Apocynaceae* and is a medicinal plant which is widely distributed in the tropical rain forest of Africa, when fully grown, it is about 20 metres high with white flower and large paired fruit.^[78,79] In Nigeria, *Picralima nitida* is popularly referred to 'Osi-igwe' by the Igbo speaking people and 'Akuama' or 'Aberé' by the Yoruba speaking people.^[79,80,81] This plant is used in traditional medicines in the treatment of inflammation, pulmonary bronchitis, venereal diseases, various fevers, hypertension, jaundice, gastrointestinal disorders and malaria. Studies have shown that the extracts from its seeds, fruit coat and stem bark possess antimicrobial, anti-inflammatory, antipyretic, anti-trypanosomal, anti-plasmodial, anti-leishmanial, larvicidal and hypoglycaemic potentials.^[81] Phytochemical analysis showed that ethanolic and aqueous stem bark extracts of *Picralima nitida* contained alkaloids, tannins, steroids, flavonoids, proteins, carbohydrates and ascorbic acid.^[80]

The blood glucose lowering effect of the seed extract of *Picralima nitida* has been suggested to be due to its rich glycosides and not its indole alkaloids.^[82] Coconut water extract of *Picralima nitida* seeds have a significant hypoglycaemic effects in alloxan-induced diabetic albino rats^[83] and significantly lower the blood glucose of alloxan-induced diabetic rabbits.^[84]

***Syzygium aromaticum* (Cloves)**

Syzygium aromaticum, popularly known as Clove, is a family of *Myrtaceae*.^[85] It is known by different languages in Nigeria such as ‘Kanafuru’ in Yoruba, ‘Osasagbogbo’ in Igbo and ‘Kanumfari’ in Hausa.^[86] *Syzygium aromaticum* is one of the most important herbs in traditional medicine, having a wide range of biological activities.^[87] Eugenol (70–85%) is the major phytochemicals found in clove followed by eugenyl acetate (15%), β -caryophyllene (5–12%) and other includes monoterpenes, sesquiterpenes, alkaloid, carbohydrate, protein, fat and oil, phenolic compounds and hydrocarbon compounds.^[88]

In Nigeria, most tradomedical practitioners administered decoction obtained by boiling the fruits and cloves in water to patients for the treatment of cough, chest congestion and catarrh.^[89] Report showed that oleanolic acid extracted from the plant exhibited anti-hyperglycaemic effect in streptozotocin-induced diabetic rats.^[90] Eugenol, a dominant ingredient of Clove oil, has been reported to have improved streptozotocin-induced diabetic rats.^[91]

CONCLUSION

Over time, diabetes can damage the heart, blood vessels, eyes, kidneys and nerves. According to the World Health Statistics,^[92] one in ten adult worldwide has diabetes and WHO,^[6] projects that diabetes will be the seventh leading cause of death by 2030. Oral hypoglycaemic agents or drugs may be effective for glycaemic control but they come with their consequent side effects such as liver disorders, abdominal fullness, flatulence, abdominal pain, renal tumours, hepatic injury, acute hepatitis and diarrhoea. However, there is an increasing need for the development of a natural and safe products with minimal or without side effects. These natural products or phytochemical plants elicit their anti-hyperglycaemic effects because of their ability to restore the function of pancreatic tissues by causing an increase in insulin output or a decrease in the intestinal absorption of glucose. More researches have to be conducted in order to classify the local antidiabetic phytochemical plants into the ones eliciting their anti-hyperglycaemic activities through the inhibition of gastrointestinal tract enzymes of carbohydrate (i.e. α -amylases and α -glucosidases) and the ones that restore the function of insulin.

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