WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 11, Issue 12, 23-59. Review Article ISSN 2277– 7105

ETHNOMEDICINAL USES AND PHYTOCHEMISTRY OF MEDICINAL PLANTS USED IN THE TREATMENT OF DIABETES BY THE PEOPLE OF NSUKKA LOCAL GOVERNMENT AREA, SOUTH EASTERN-NIGERIA: A REVIEW

Uchenna E. Odoh[1]*, Chukwuma Michael Onyegbulam[1], Constance O. Ezema[1], Patience O. Osadebe[2], Philip F. Uzor[2], Longinus C. Odoh[3] and Chuka W. Agubata[4]

[1]Department of Pharmacognosy & Environmental Medicines, University of Nigeria, Nsukka. 410001. Enugu State, Nigeria.

[2]Department of Pharmaceutical & Medicinal Chemistry, University of Nigeria, Nsukka. 410001. Enugu State, Nigeria.

[3]Department of Accountancy, University of Nigeria, Nsukka.

[4]Department of Pharmacognosy, Enugu State University of Science and Technology, Enugu State, Nigeria.

Article Received on
03 July 2022,

Revised on 23 July 2022,
Accepted on 13 August 2022

DOI: 10.20959/wjpr202212-24241

***Corresponding Author**
Prof. Uchenna E. Odoh
Department of Pharmacognosy & Environmental Medicines, University of Nigeria, Nsukka. 410001. Enugu State, Nigeria.

ABSTRACT

Background: The older generation who are the reservoir of traditional medicine information and practice are fast passing away. Deforestation, strong preference for synthetic drugs and rural-urban migration has made it "unnecessary" to seek/acquire traditional medicine knowledge. Therefore, it is necessary to document ethnomedicinal uses of plants. This study aims to identify the plants used by the people of Nsukka Local Government Area of Enugu State, Nigeria in the management of diabetes, and document all relevant information on them. **Materials and Methods:** Available literature was searched for information on diabetes and plants used for treatment of diabetes by the people of Nsukka Local Government Area using Elsevier-Science direct, SpringerLink (Springer/Kluwer), Wiley Interscience (Wiley), Researchgate, Pubmed, Google Scholar, Virtual Health Library and Science Direct. The search included the following keywords: "Diabetes", "antidiabetic activity", "medicinal plants", "ethnomedicine","Nsukka Local Government Area", "phytomedicine", "traditional medicine", "phytochemistry". The ethnomedicinal uses and

phytochemistry were reviewed. **Conclusions:** The plants used by the people of Nsukka LGA of Enugu state for the treatment of diabetes mellitus have other medicinal uses in other places. They also contain many pharmacologically active compounds.

KEYWORDS: Diabetes, Antidiabetic activity, Medicinal plants, Ethnomedicine, Phytomedicine, Traditional medicine.

INTRODUCTION

Diabetes mellitus (DM) is an important endocrine and metabolic disease causing considerable mortality and morbidity in human population. With improved healthcare the diagnosis of diabetes is increasing in most African countries. Yet it is difficult to estimate the numbers of people with the disease as the majority of cases are untreated. Because of the chronic nature of the disease and the complexity of its management, diabetes requires comprehensive patient care and an interdisciplinary approach to treatment.Diabetes mellitus is a hereditary, metabolic disease characterized by hyperglycemia and eventual glycosuria. It is caused by the inability of tissues to carry out normal metabolism of carbohydrates, fats and proteins, due to an absolute or relative lack of insulin.[1] It is a group of metabolic disorders characterized by hyperglycemia;is associated with abnormalities in carbohydrate, fat and protein metabolism, and results in chronic complications including microvascular and macrovascular disorders. These complications contribute to diabetes being the leading cause of new cases of blindness among adults, end stage renal disease, and non-traumatic lower limb amputations.[2]

Based on cost estimates from a recent systematic review, it has been estimated that the direct annual cost of diabetes to the world is more than US$ 827 billion.[3] Bloom *et al*.,[4] estimated that losses in GDP worldwide from 2011 to 2030, including both the direct and indirect costs of diabetes, will total US$ 1.7 trillion, comprising US$ 900 billion for high-income countries and US$ 800 billion for low- and middle-income countries.

Insulin and oral hypoglycemic drugs are used in the management of diabetes. Insulin is indicated in all patients with type 1 diabetes mellitus and in about one-third of patients with type 2 DM. Oral hypoglycaemic drugs are useful in type 2 diabetes as adjuncts to continued dietary restraint (Biguanides, Sulphonylureas, thiazolidinediones and α-glucosidase inhibitors. A number of plants have been identified in ethnomedicinal surveys as potent agents in management of diabetes. Examples include *Combretum micranthum,*[5] *Stachytarpheta jamaicensis,*[5] *Acalypha wilkesiana,*[6] *Loranthus micranthus*,[7] *Moringa*

oleifera, *Momordica charantia*, *Garcinia kola*, *Citrus aurantiifolia*, *Caesalpinia bonduc*,[8] *Scoparia dulcis*,[9] *Alafia barteri*, *Alstonia boonei*, *Thaumatococcus danielli*,[10] *Glycyrrhiza glabra*,[11] *Allium cepa* (Onion), *Allium sativum* (Garlic), *Aloe vera* and *Cinnamomum cassie*.[12] The medicinal uses of plants are attributed to the secondary metabolites content such as alkaloids, flavonoids, saponins, tannins, terpenoids, steroids etc.

The search focused on other ethnomedicinal uses and phytochemistry of the plants used for the treatment of diabetes in Nsukka LGA of Enugu state of Nigeria.

METHODOLOGY

A literature search using Elsevier-Science direct, SpringerLink (Springer/Kluwer), Wiley Interscience (Wiley), Researchgate, Pubmed, Google Scholar, Virtual Health Library, Science Direct, Science alert was conducted. The search included the following keywords: "Diabetes", "antidiabetic activity", "medicinal plants", "ethnomedicine", "phytomedicine", "traditional medicine", "phytochemistry".. The search focused on other ethnomedicinal and pharmacological uses of the plants used for the treatment of diabetes in Nsukka LGA of Enugu state of Nigeria.

RESULTS

Ethnomedicinal use of the plants used for the treatment of diabetes in Nsukka LGA

Abelmoschus esculentus (L.) Moench (*Malvaceae*)

The oils of the seeds are useful in treating leucorrhoea, spermatorrhoea thinness of semen, premature ejaculation, jaundice. It can be also used as non-caffeinated substitute for coffee. Okra seeds may be roasted and ground to form a caffeine-free substitute for coffee. It promotes healthy skin and blood. In Nepal juice of the roots is used externally to treat cuts, wounds and boils; the infusion of the roots is used in the treatment of syphilis. The pods, flowers, leaves and fruits are used as therapeutic diets. In Turkey and Cyprus they serve as remedies for swelling and inflammation.[13]

Acanthus montanus (Nees) T. Anderson (*Acanthaceae*)

The Igede people of Nigeria use the ground leaves to treat boils, skin infections and hypertension and as an antitussive. In the Democratic Republic of Congo, the leaves are pounded in water with those of Ananas comosus and Costusspp and used to treat urogenital infections, urethral pain, endometritis, urinary disease, cystitis, leucorrhoea. In Cameroon it is used to treat cough, carious teeth, pharyngitis, dysmenorrhoea, gastritis, false labour,

epilepsy, and intestinal helminthiasis while in other African countries, it is used alleviate uretheral discharge, chest pain, emesis, constipation, rheumatic pains, and syphilis.[9] The roots are used for bathing to relieve aches and pains.[14]

***Allium cepa*, Linnaues (*Liliaceae*)**

In Cameroun, the rhizome is used as a decoction for the treatment of Sexual weakness, rheumatism. The bulb is used locally in the treatment of diabetes in the southern zones of Eritrea; often used as an antipyretic, antiseptic, anthelminthic and in treatment of gastro-intestinal disoders. Fresh Onion juice is often recommended infolk medicine of various countries for pain and swelling afterbee or wasp stings, which are followed by an allergy-inducedreaction of the skin. Onions have also beenused as adjuvant therapy for diabetes.[15]

***Allium sativum*, Linnaues (*Liliaceae*)**

To treat diarrhea. To treat intestinal and extraintestinal diseases. Ancient Japanese and Chinese used it to treat headache, flu, sore throat and fever. In Africa, particularly in Nigeria, it is used to treat abdominal discomfort, diarrhea, otitis media and respiratory tract infections. In Europe and India, it was used to treatcommon colds, hay fever and asthma.[16]

***Aloe barbadensis*, (Linnaues) Burm (*Liliaceae*)**

Diabetes salopecia, bacterial and fungal skin infections, chronic leg wounds, parasitic infections, systemic lupus erythematosus, arthritis and tic douloureux.[17]

***Alstonia boonei* De Wild (Apocynaceae)**

Is used to combat rheumatic and arthritic pains, Painful menstruation (dysmenorrhoea), when associated with uterine fibroid or ovarian cysts in women; lower abdominal and pelvic congestion associated with gynaecological problems such as pelvic inflammatory diseases; to relieve the painful urethritis. A cold infusion made from the fresh or dried bark of Alstonia taken orally two to three times daily exerts a mild hypoglycaemic effect on diabetic patients. The bark decoction of Alstoniaboonei is used with other preparations in the treatment of fractures or dislocation. Therapeutically, the bark has been found to possess antirheumatic, anti-inflammatory. The cold infusion is also administered orally for the purpose of expelling round worms, threadworms Indigenous treatment of malaria in Southwestern part of Nigeria jaundice, and for inducing breast milk. Its latex is taken as a purgative. The hardened latex is used for the treatment of yaws. The hardened latex is used for the treatment of yaws. *Alstonia boonei* is regarded as one of few herbs with potential anti-HIV indicators, Analgesic/pain-

killing, antimalaria / antipyretic, antidiabetic (mild hypoglycaemic), antihelminthic, antimicrobial andantibiotic. It has been reported to be used for treatment of malaria, intestinal helminthes, rheumatism, muscular pain, insomnia, and hypertension.[18]

***Anacardium occidentale* Linnaues (*Anarcardiaceae*)**

In India, the plant is extensively used locally the treatment of diabetes mellitus, dyspepsia, impotence, diarrhoea, urinary disorders, veneral diseases, leishmaniasis and syphilis – related skin disorders, diarrhea, dysentery and colonic pain. In West Africa and South America, the leaf infusion is used in the treatment of gastrointestinal disorders, mouth ulcers and throat problems.[19]

***Annona muricata* Linnaues (Annonaceae)**

In Nigeria the leaf decoction is used to treat Gastric disorders, prostate cancer, diabetes, neuralgia In Togo the leaf decoction is used to treat Hypertension/ diabetes. In Brazil it is used topically to treat snake bite while the leaf decoction is used orally to treat Arthritis pain, rheumatism, neuralgia, weight loss. In South America and tropical Africa, including Nigeria, leaves of A. muricata are deployed as an ethnomedicine against tumors and cancer.[20] The fruit is used as natural medicine for arthritic pain, neuralgia, arthritis, diarrhea, dysentery, fever, malaria, parasites, rheumatism, skin rushes and worms, and it is also eaten to elevate a mother's milk after childbirth. The leaves are employed to treat cystitis, diabetes, headaches and insomnia. Moreover, internal administration of the leaf's decoction is believed to exhibit anti-rheumatic and neuralgic effects, whereas the cooked leaves are topically used to treat abscesses and rheumatism. The leaves have also beenused to treat cystitis, diabetes, headaches, and insomnia.[21] Treatment of abscess bronchitis, asthma, diarrhoea, dysentery. The roots of have been shown to have anti-parasitic and pesticidal properties in traditional medicine. The leaves are used in the bath to cure skin diseases in the Caribbean islands, Indonesia as well as in the South Pacific countries. In Ecuador, Mauritius, and New Guinea, the application of the A. muricata leaves is local on the pain site. Decoctions of A. muricata leaves are used as analgesics in Brazil, Martinique, Mexico and Nicaragua, while in Benin, the Caribbean, Cuba, and Mexico, it is used to reduce colds, flu, and asthma. The importance of A. muricata leaves to treatmalaria is very crucial in tropical countries such as Cameroon, Togo, and Vietnam. In Ghana, A. muricata and some other plants are decocted into a mixture and used in bath for feminine hygiene. The bark, leaves and roots have sedative,

antispasmodic, hypoglycemic, hypotensive, smooth muscle relaxant and nervine properties.[22]

***Anthocleista vogelii* Planch (Gentianaceae)**

In Sierra lone, decoction of the root is taken to alleviate chest pain and for the treatment of hepatitis when taken with lemon.The decoction of A. vogeliiroot is reported to be commonly taken to treat constipation and to regulate menstruation. The combination of the stem bark and the leaves is used as anti-inflammatory, antidiabetic agents and in treatment of wounds. The root decoction of A. vogeliiand Combretum mucronatumwith pepper and ashes is taken to treat chest pain in Ghana.[23] The bark is noted for its anti-pyretic, tonic and purgative properties and a decoction of the leaves is known to prevent malaria and also used to treat jaundice and as haemostatic.

***Azadirachta indica* A. Jus (Meliaceae)**

Azadirachta indica is indigenously used as a bitter tonic, antimalarial, antipyretic, anti-inflammatory, antihelmintic, and for antimicrobial and antiviral effects. The traditional Ayurvedic uses of neem include the treatment of fever, leprosy, malaria, ophthalmia and tuberculosis. Other folkloric uses include use as an anthelmintic, anti-feedant, antiseptic, diuretic, emmenagogue, contraceptive, febrifuge, parasiticide, pediculocide and insecticide.[24]

***Buchholzia coriaceae* Engler (Capparaceae)**

The seed of the plant is used in folk medicine for the treatment of diabetes, ulcer, malaria, antihelmintic disorders, hypercholesterolemia. In Ghana, the fresh bark of the plant helps for ear ache.[25] In Cameroun, it is used as a remedy to relieve chest pain. The ground seeds are mixed with palm oil and taken orally as treatment for malaria. In Ivory Coast, the bark can be made into a pulp for inhalation or into a snuff to relieve headache, sinusitis, and nasal congestion while the crushed up seeds, are pasted over the stomach for difficult childbirth. It is used as cough medicine, treatment of ulcer and also used in the treatment of hypertension by drinking the fluid squeezed out of the leaves with pea leaves and small salt. In Gabon pounded bark of is used as a lotion against scabies, smallpox or skin itching while the fruit serves as an anthelmintic.[26]

***Carica papaya* Linnaues (*Caricaceae*)**

The leaves of Carica papaya are used traditionally to treat numerous ailments such as malaria, dengue, jaundice, immune-modulatory, and antiviral activity. The latex is used in antihelmintic, relives dyspepsia, cures diarrhea, pain of burns and topical use, bleeding haemorrhoids, stomachic and whooping cough. In Mexican folk medicine the different parts are used to treat diseases such as diarrhea, inflammation and diabetes.[27]

Chrysophyllum albidum* G. Don (*Sapotaceae)

The bark is used for the treatment of yellow fever and malaria. The seeds androots extracts help to stop bleeding from fresh wounds and to inhibit microbial growth of known wounds, decoction of the leaves is employed in diarrhoea and stomach ache while the leaves are exhausted as emollient and for medication of skin eruptions. The cotyledons from the seeds are used in the management of vaginal and dermatological infections, while pregnant women consume the fruit pulp to thwart nausea in Western Nigeria.[28] The stem-bark is engaged in African trypanosomiasis, yellow fever and malaria alleviation.

***Cinnamonium verum* J.Presi (*Lauraceae*)**

Cinnamonium has been known to improve the health of the colon, thereby reducing the risk of colon cancer, acts as a coagulant. Its flavouring principles helps in removing bad breath when produced as chewing gums and as tooth powder in treatment of tooth aches and dental problems.[29]

***Citrus aurantifolia* (Chrism) Swingle (*Rutaceae*)**

It is used as antidiabetic, antihypertensive, anti-inflammatory, antiparasitic, and antilipidemic, treatment of cardiovascular, hepatic, ostheoporosis, urolithiasis diseases, and as fertility promoter.[30] Used as an antitoxic, appetizer and stomachic.

***Citrus limon* (Linnaues) Burman (*Rutaceae*)**

In traditional Asian medicines the citrus fruit has been used to treat indigestion and improve asthmatic and bronchial conditions. Ancient and medieval uses of *C. limon* in the Mediterranean region includes; antitoxic, antihelmintic, antipyretic, anti-inflammatory amongst other uses.Fruit is used as tooth powder to maintain orodental health.[31]

***Cucumis sativus* Linnaeus *(*Cucurbitaceae)**

The fruit is used as demulcent, depurative, emollient, purgative and resolvent. It is also internally used for the treatment of blemished skin, heat rash and externally for burns, sores, wounds, and also used as cosmetic for softening, moisturizing and whitening skin. Raw cucumber fruit is also used in treatment of coeliac disease. In IndoChina raw fruit is used for treatment of dysentery in children. The seeds are used as diuretic, tonic, anthelmintic and also as taeniacide. The leaf juice is emetic and is used to treat dyspepsia in children. A decoction of root is used as diuretic. The boiled leaves when mixed with cumin seeds are used for throat infections.[32]

***Cymbopogon citratus* (de Candolle) Stapf (Poaceae)**

In serves several purposes in different ethno medicinal systems such as Cuba, Brazil, Egypt, India etc. Hot water extract of the dried leaves and stem is taken orally as a hypotensive for catarrh and rheumatism, renal anti-plasmodic and diuretic. Infusions of *C. citrates* are useful in the treatment of infections such as laryngitis, sore-throats, bronchitis etc. Likewise, its leaves decoction is used as diaphoretic in fever and lemon grass tea is commonly used to combat flu, fever, pneumonia.[33]

***Dioscorea alata* Linnaeus (Dioscoreaceae)**

Tubers of different *Dioscorea* species are used as a cure for different diseases and ailments (cough, cold, stomach ache, leprosy, burns, fungal infections, dysentery, skin diseases, rheumatism, arthritis, etc.) in several formulations, and even for birth control.[34]

Garcinia kola* Heckel *(Clusiaceae)

It has Purgative, antiparasitic, and antimicrobial properties.[35] It is used to treat cough in South-Eastern Nigeria.

***Glycyrrhizia glabra* Linnaeus (Fabaceae)**

It is used to treat many diseases, such as asthma, tonsillitis, sore throat, hyperdipsia, flatulence, epilepsy, fever, sexual debility, paralysis, coughs, stomach ulcers, heartburn, colic, swellings, rheumatism, skin diseases, acidity, leucorrhoea, bleeding, hemorrhagic diseases, and jaundice. Moreover, it was traditionally used as an insecticide, laxative, anti-inflammatory, anti-ulcer, antibiotic, anti-arthritic, antiviral, memory stimulant due to its actionas a monoamine oxidase (MAO) inhibitor, anti-cholinergic, antitussive, anti-caries, hypolipidemic, anti-mycotic, estrogenic, antioxidant, anticancer, and anti-diuretic agent[36]

Modern folk medicine employs licorice roots both independently and in dozens of multicomponent preparations (teas) possessing cholagogic, diaphoretic, expectorant, analgesic, wound-healing, antiseptic, antidotal, antiallergic and tonic properties. Liquorice is also used for the treatment of disorders in lungs, respiratory tracts, stomach, kidneys, and other organs. The licorice powder and extract are useful for the treatment of sore throat, cough, and bronchial catarrh. It has antitussive, demulcent, and expectorant loosening activities. Fresh leaf (external) Used for wounds. Root (decoction, oral) used for kidney stones, lung ailment, ulcers.Root (decoction, oral) used for cough, stomachache. Aqueous extract of stem (oral) used for tuberculosis.[37]

***Gongronema latifolium* Bentham (Apocynacaeae)**

Infused leaves can be used as a home remedy for dysentery and intestinal worms. The leaves can be chewed raw or infused water can act as fast relief for catarrh, congested chest, running nose and cough.[38]

***Irvingia gabonensis* (Aubry-Lecomte) exO'Rorke) Bill (Irvingiaceae)**

The powdered kernels of Irvingiagabonensis can be used as an astringent applied to soothe burns.[25]

***Magnifera indica* Linnaeus (*Anarcadiaceae*)**

Traditionally aqueous extract of Mangifera indica L. used in Cuba for its analgesic, anti-inflammatory, antioxidant and immune-modulatory properties. In several medicinal systems such as India, Brazil, Haiti, Ghana, Benin, Bangladesh, the fruit, seed, leaves, root and bark of M. indica have seen used in the treatment of different ailments. Some of which include; Hypertension, diabetes, Hepatic disorders, gastric disorders, asthma, mouth sores, leucorrhea, bleeding hemorrhoids, lung hemorrhage, nerve disorders, syphilis, cough, liver diseases, urinary tract infections, rheumatism.[39]

***Moring oleifera* Lam (Moringaceae)**

Roots and fruits are antiparalytic. The roots are also laxative, expectorant, diuretic and good for inflammations, throat, bronchitis, piles and cures stomatitis, urinary discharges and obstimate asthma. The root juice of Moringa oleifera when mixed with milk helps to cure lower back pain as it contains analgesics called moringine and moringinine.[40] Its roots are also prescribed for the treatment of snakebites and scorpion stings. Its leaves are antihelmentic, aphrodisiac and cure hallucinations, dry tumors, hiccough and asthma.

Moringa flowers are a rich source of potassium and calcium. They are also used in the folk remedies for tumors. They also act as hypocholesterolemic and antiarthritic agents and helps to cure urinary problems and cold.[41] Immature pods can be used in the diet of an obese person In India it is used traditionally as antifungal, stimulant, diuretic, tonic, fried pods for diabetes, decoction is used as a gargle in hoarseness and sore throat.

***Musa acuminate* Colla (Musaceae)**

In Northern Nigeria, its fruit peels are used in the treatment of hypertension and related cardiovascular diseases while in Akwa Ibom State of Nigeria *M. acuminata* is used traditionally for the treatment of anaemia. In Brazil its infloresences are used as therapeutic nutritional complements. In Ayurveda traditional system its peel is used for the management of diabetics.[42]

***Musa paradisiaca* Linnaeus (Musaceae) PCG/UNN/0353**

In Ayurveda traditional system of medicine it is utilized in the treatment of bronchitis and cough, antidote for snake bite, Asthma, burns, diabetes, dysentery, excessive menstrual flow, fever, gangrene, gout, head ache, stomach aches and lack of appetite.[43]

***Nauclea diderichii* (de Wild &T.Durand) Merr (Rubiaceae)**

The roots are credited with diuretic properties and used for the treatment of anaemia. Bark decoctions are taken in Sierra Leone and Ghana against stomach-ache and malaria. In Côte d'Ivoire the bark is sometimes used to treat fever and jaundice. In Nigeria bark preparations are used against fever and malaria, and as antiperiodic, appetizer and diuretic. In Gabon a bark infusion is drunk against fever. In Congo bark decoctions are taken or the leaf pulp is rubbed in for the treatment of fever, stomach problems, gonorrhoea and menstruation problems, while a bark infusion is taken as a vermifuge. In DR Congo bark decoctions are drunk for the treatment of hepatitis, and drunk or used as a wash as a vermifuge. Hausa/Fulani tribes in Keffi, Nasarawa State Nigeria, *N. diderrichii* is used for the treatment of skin infections.[44]

***Nauclea latifolia* Smith (Rubiaceae)**

Traditionally, infusions and decoctions of the bark and leaves of N. latifolia are used in West and South Africa in the treatment of stomach ache, fever, tuberculosis, diarrhoea, malaria.[45] In Niger State, Nigeria roots and major ingredients of N. latifolia are used in treatment of respiratory illnesses such as tuberculosis, asthma, bronchitis, cough and cold.

***Ocimum gratissimum* Linnaues (Lamiaceae)**

In the coastal areas of Nigeria, the plant is used in the treatment of epilepsy, high fever and diarrhoea. In the Savannah areas decoctions of the leaves are used to treat mental illness. Also used in the management of the baby's cord, to keep the wound surfaces sterile. It is also used in the treatment of fungal infections, fever, cold and catarrh. Brazilian tropical forest inhabitants use the root decoction as a sedative for children. In Kenya and sub Saharan African communities, the leaves when rubbed between the palms and sniffed serves as a treatment for blocked nostrils, they are also used for abdominal pains, sore eyes, ear infections, coughs, barrenness, fever, convulsions, and tooth gargle, regulation of menstruation and as a cure for prolapse of the rectum.[46] In India, the whole plant has been used for the treatment of sunstroke, headache, influenza, as a diaphoretic, antipyretic and for its anti-inflammatory activity.

***Persea Americana* Miller (Lauraceae)**

In ethno-medicine the seed of *P. americana* (avocado seed) has diverse applications, ranging from the treatment of dysentery, intestinal parasites, toothache, diarrhea, skin treatment and beautification. The leaves decoction is used in Cameroon for the treatment of diabetes, toothache, malaria, high blood pressure, and to relief painful menstruations. In Mexico, the crude or toasted seed is used in the cure of fungal and bacterial infections, alongside the treatment of asthma, high blood pressure, and rheumatism.[47] Also, its seeds are used for the prevention of cardio-vascular diseases .Various parts are used to treat diarrhea, dysentery caused by helminths and amoebas, toothache, intestinal worms, diabetes, skin rashes, infectious processes caused by fungi and bacteria, asthma, high blood pressure and rheumatism, malaria and typhoid fever.

***Petersianthus macrocarpus* (P.Beauv.) Liben (Rubiaceae)**

The stem is used in the treatment of pulmonary trouble, the bark is abortificient, anodyne, ecbolic, emetic, treatment of arthritis, rheumatism, heart diseases and as a laxative. In Nigeria it is used in the treatment of pains, headache, recurrent fever and malaria. The aqueous extract of the bark is used traditionally in the treatment of constipation, haemorrhoids, veneral diseases and as abortificient. Traditionally, it is used in South Eastern Nigeria, Ghana and Cameroun in the treatment of gastrointestinal disorders, cancer, malaria also for relief from pain and fever associated with malaria.[48] The aqueous extract of the stem bark is used in the treatment of constipation, haemorrhoids, and veneral diseases and as an abortifacient.

Also, in Ghana poultice and decoction of its leaves is used in the treatment of boils. It has been reported as being used ethnomedicinally in Cameroun for the treatment of prostrate diseases. It is used in the folkloric medicine of the South Eastern part of Nigeria (where it is called owewe) for the relief of many ailments including pains, and re-current fever associated with malaria and as an anti-cancer agent. The plant is also used as traditional folk medicine in Cameroon for the treatment of different infections and disorders like gastrointestinal disorders (e.g. dysentry).[49]

***Psidium guajava* Linnaues (Myrtaceae)**

The guava leaves can be used in the form of an infusion or decoction for the treatment of diarrhea (especially in Lao People's Democratic Republic (PDR), pain, fever, cough, diabetes, hypertension, wounds, spasms, and rheumatism. Decoction and poultice of the roots of guava are used as astringents, for ulcers, wounds and diarrhea. Barks of Psidium guajava has been reported for their astringent, febrifuge, antiseptic properties.[50]

***Securida calongepeduncula* Fresen (Polygalaceae)**

In African traditional medicine, the whole plant, leaves, roots and stembark of S. longepedunculata is used for the treatment of several ailments, such as; Venereal diseases, syphilis, dysentery, malaria, typhoid, pains, fever, epilepsy, pneumonia, tuberculosis, headaches, abortion, constipation, coughs, sexual boost, toothache, rheumatism, skin cancer, skin infections, contraceptive purposes amongst others.[51] Various preparations from the plant's roots have been applied to wounds, sores and also used as a contraceptive.

***Strophanthus hispidus* De Candolle (Apocynaceae)**

Traditionally it is used in the treatment of rheumatism, arthritis, stroke and heart failure. Decoctions of leaf, stembark or root are externally utilized in the Savannah Zone of West Africa for the treatment of skin diseases and leprosy. Also various parts of the plant are used as analgesic and in the treatment ofdiabetes, snake bites, sexual diseases, dysentery, malaria, inflammatory, heart failure, gonorrhea, constipation, and ulcers.[52]

***Tapinanthus globiferas* (Richard) van Tieghem (Loranthaceae)**

In Nigeria the whole plant T. globiferus is used locally by the traditional herbalist for the treatment of various diseases including stroke and diabetes. It is used as an herbal cure for hypertension, ulcer, heart disease and diabetics in Akwa Ibom State. Aqueous leaves extract

of Tapinanthusglobiferus have been used in traditional medicine in the management of epilepsy, hypertension, relief pain, tinnitus and Trypanosomiasis.[53]

***Uvaria chamae* P. Beauv. (Annonaceae)**

Infusions of Uvaria chamae are used for gonorrhea and jaundice and treating many ailments; including diarrhea, gastroenteritis, inflamed gums, wounds, dysentery, sore throats, sickle cell disease, stroke, and cancer.[54]

***Vernonia amygdalina* Delile (Compositae)**

In Nigeria, it has been used widely in folk medicine as anti-malaria, purgative, antiparasitic, treatment of eczema and for maintaining healthy blood glucose levels. Also, in Africa it is used traditionally for the treatment of infertility, diabetes, sexually transmitted diseases and gastrointestinal problems,[55] antihelminth, antimalarial, laxative, digestive tonic, appetizer, and febrifuge.[56] In some African countries including Ethiopia, V. amygdalina is among medicinally significant plants used against malaria, helminth infections, gastrointestinal disorders, and fever. It is also used to promote wound healing. And to treat microbial infections. The leaves can be taken as an appetizer and the water extract as a digestive tonic. These are largely consumed by the female Hausas in their belief that it makes them more sexually attractive. In Northern Nigeria, it has been added to horse feed to provide a strengthening or fattening tonic called *Chusar Doki*‘in Hausa . The leaves have also been used in Ethiopia as hops in preparing tela beer.[57] The leaves are widely used for fevers and are known as a quinine– substitute in Nigeria and some other African countries. The young leaves are used in folk medicine as antihelmintic, antimalarial, laxative/purgative, enema, expectorant, worm expeller and fertility inducer in sub-fertile women. Many herbalists and naturopathic doctors have recommended the aqueous extracts for their patients as treatment for emesis, nausea, diabetes, loss of appetiteinducedabrosia, dysentery and other gastrointestinal tract problems.[55]

***Xylopia aethiopica* (Dunal) A. Rich. (Annonaceae)**

Xylopia aethiopica is used traditionally in the treatment of several ailments such as; dysentery, cough, malaria, cancer, aches and pains, biliousness, uterine fibroid, bronchitis etc. A fruit extract, a decoction of the bark orthat from the fruit is useful in the treatment of bronchitis anddysenteric conditions. In Congo, it is used against the attacks ofasthma, stomach aches and rheumatism.[58] Among theconditions treated with *X. aethiopica* in traditional medicine arecough (fruits and roots of the plant) bronchitis, dysentery and

biliousness (fruits and stem bark) and boils and sores (leaves and bark).[59] In Ivory Coast, it is utilized as a postpartum tonic, promotes fertility and eases childbirth. Also, its leaves and bark are used to manage wounds, boils, cuts and sores.

***Zingiber officinale* Roscoe (Zingiberaceae)**

Z.officinale has anti-nausea and antiemetic activities. It is used for its protective effects against respiratory disorders, treatment of catarrh, rheumatism, nervous diseases, gingivitis, toothache, asthma, stroke, constipation and diabetes in the traditional medicines of many countries. *Z. officinale* has been used traditionally in African, Caribbean, Ayurveda, Chinese medicinal systems to cure diseases such as; cough, asthma, nausea, loss of appetite, constipation, indigestion, pain amongst several other uses. For the treatment of arthritis, hypertension, muscular aches, rheumatism, cramps, dementia, and sore throats.[60]

Table 1: Medicinal Plants used in treating diabetes in Nsukka LGA, Enugu State, Nigeria, their common Name and Local names.

S/No	**Plant Botanical Name (Family)**	**Common Name**	**Igbo name**	**Plant part**	**Habitat**
1	*Abelmoschus esculentus* (L.) Moench Malvaceae	Okro	Okwuru	Fruit	Shrub
2	*Acanthus montanus* (Nees) T. Anderson, Acanthaceae	Mountain thistle	Agamusoso	Leaf	Tree
3	*Allium cepa,* Linnaues, Liliaceae	Onion	Yabas	Bulb	Herb
4	*Allium sativum*, Linnaues, Liliaceae	Garlic	Galik	Bulb	Herb
5	*Aloe barbadensis*, (Linnaues) Burm, Liliaceae	Aloe vera	Alo vera	Leaf	Shrub
6	*Alstonia boonei* De Wild, Apocynaceae	Cheese wood	Egbu	Bark	Tree
7	*Anacardium occidentale* Linnaues Anarcardiaceae	Cashew	Kashu	Leaf / bark	Tree
8	*Annona muricata*, Linnaues Annonaceae	Soursop	Sawashop	Leaf/ fruit	Tree
9	*Anthocleista vogelii* Planch Gentianaceae	English cabbage tree	Odogwu	Leaf/ root	Tree
10	*Azadirachta indica A. Jus* Meliaceae	Neem	Dongoyaro	Leaf	Tree
11	*Buchholzia coriacea* Engler Capparaceae	Wonderful kola	Wondafu Kola	Nut	Shrub
12	*Carica papaya* Linnaues Caricaceae	Pawpaw	Okwuru Bekee	Unriped fruit/ root	Tree
13	*Chrysophyllum albidum* G. Don Sapotaceae	African cherry	Udara	All parts	Tree

14	*Cinnamonium verum* J. Presi.(Lauraceae)	Cinnamon	Cinnamon	Bark	Tree
15	*Citrus aurantifolia (Chrism)* Swingle Rutaceae	Lime	Oroma nkirisi	Leaf / fuit	Tree
16	*Citrus limon*(Linnaues) Burman Rutaceae	Lemon	Lemon	Fruit	Tree
17	*Cucumis sativus* Linnaeus Cucurbitaceae	Cucumber	Kukumba	Fruit	Herb
18	*Cymbopogon citratus (*de Candolle) Stapf Poaceae	Lemon grass	Lemon grass	Leaf	Grass
19	*Dioscorea alata.* Linnaeus (Dioscoreaceae)	Wateryam	Abala	Fruit	Root
20	*Garcinia kola* Heckel Clusiaceae	Bitter kola	Akiilu	Nut	Tree
21	*Glycyrrhizia glabra* Linnaeus Fabaceae	Liquorice	Likworice	Leaf	Herb
22	*Gongronema latifolium* Bentham Apocynacaeae	Amaranth globe	Utazi	Leaf	Herb
23	*Irvingia gabonensis* (Aubry-Lecomte) exO'Rorke) Bill Irvingiaceae	African mango	Ogbonno	Bark	Tree
24	*Magnifera indica* Linnaeus Anarcadiaceae	Mango	Mangoro	Leaf /bark	Tree
25	*Moringa oleifera* Lam Moringaceae	Moringa Drumstick tree Horseradish tree	Agbadi	Leaf/seed/ root	Tree
26	*Musa acuminate* Colla Musaceae	Red banana	Ogede	Un-ripped fruit	Tree
27	*Musa paradisiaca* Linnaeus Musaceae	Plantain	Ojioko	Un-ripped fruit	Tree
28	*Nauclea diderichii* (de Wild &T.Durand) Merr Rubiaceae	Pin cushion tree Brimstone tree, African peach (En). Acajou jaune d'Afrique, acajou jaune du Gabon,	Uvuruuso	Root	Tree
29	*Nauclea latifolia* Smith Rubiaceae	African peach	UvuruIli	Root	Tree
30	*Ocimum gratissimum* Linnaues Lamiaceae	Scent leaf, Basil	Nchanwu	Leaf	Herb
31	*Persea americana* Miller Lauraceae	Avocado Pear, alligator pea	Ube oyibo	Dried seeed / leaf	Tree

32	*Petersianthus macrocarpus* (P.Beauv.) Liben Rubiaceae	stinkwood tree (English), Esia (Ghana), Abalć (France), Owewe (Nigeria), soap tree	Anwushi	Leaf	Tree
33	*Psidium guajava* Linnaues Myrtaceae	Guava	Gova	Leaf	Tree
34	*Securidacalonge pedunculata* Fresen. Polygalaceae	African violet tree	Aga egu	Leaf	Tree
35	*Strophanthus hispidus* De Candolle Apocynaceae	Kombe seed	Kagoro	Root	Shrub
36	*Tapinanthus globiferas* (Richard) Van Tieghem (Loranthaceae).	African mistletoe	Owube	Leaf	Shrub
37	*Uvaria chamae* P.Beauv. Annonaceae	Black pepper	Uda-egu	Seed	Tree
38	*Vernonia amygdalina* Delile Compositae)	Bitterleaf	Olugbu	Leaf	Herb
39	*Xylopia aethiopica* (Dunal) A. Rich. Annonaceae	Ethiopian pepper	Uda	Seed	Tree
40	*Zingiber officinale* Roscoe Zingiberaceae	Ginger	Jinja	Rhizome	Herb

Table 2: Some compounds isolated from the plants used for the treatment of diabetes in Nsukka LGA.

S/ No	Plant Botanical Name (Family)	Plant part	Isolated compound(s)
1	*Abelmoschus esculentus* (L.) Moench (Malvaceae)	Fruits	5,7,3′,4′-tetrahydroxy-4″-O-methyl flavonol -3-O-β-D- glucopyranoside, 5,7,3′,4′-tetrahydroxy flavonol -3-O-[β-D-glucopyranosyl-(1→6)]-β-Dglucopyranoside[61] scopoletin 7-hydroxy-6-methoxychromen-2-one has been isolated[62]
2	*Acanthus montanus*(Nees) T. Anderson (Acanthaceae)	aerial parts leaves	β-sitosterol-3-O- –D-glucoside, palmitic acid linaroside ,homoplantagenin , 5, 7, 3'-trihydroxy6,4'-dimethoxy flavone-7-O-glucoside, shikimic acid,protochatecuicacid, blepharin and acetoside [63] 2,6-bis(1,1-dimethylethyl)-4-methyl phenol,allyl(2tetrahydrofuryl methoxy)dimethylsilane, sulfurous acid cyclohexylmethyl hexyl ester, alpha-methyl 4methylmannoside, hexadecanoic acid methyl ester,

			11-octadecenoic acid methyl ester, docosane, N,Ndimethylvaleramide and 2,6,10,15-tetramethyl heptadecane.[64]
3	*Allium cepa*, Linnaues (Liliaceae)	bulb	kaempferol, quercetin ,isorhamnetin, and isorhamentin-4`-O-β- D-glucopyranoside.[65] Quercetin 3,40-diglucoside, quercetin 40monoglucoside, peonidin glucoside, petunidin glucoside, andmalvidin glucoside, myricetin, quercetinaglycone.[66] Polyphenols-Kaempferol, Quercetin, Ferulic acid, Chlorogenic acid, Gallic acid Organic acids-Pyruvic acid, Succinic acid, Ascorbic acid, Oxalic acid, Tartaric acid, Citric acid, Malic acid, di- and trisulfides. Alliuocide G, (Z,Z)-d,l-2,3-dimethyl-1,4-butanthiol-S,S'-dioxide.[67]
4	*Allium sativum*, Linnaues (Liliaceae)		S-allylcysteinesulphoxide, Allicin, allicin, alliin, diallyl sulfide, diallyl disulfide, diallyl trisulfide, ajoene, and S-allyl-cysteine. diallyl thiosulfonate (allicin), diallyl sulfide (DAS), diallyl disulfide (DADS), diallyl trisulfide (DATS), E/Z-ajoene, S-allyl-cysteine (SAC), and S-allyl-cysteine sulfoxide (alliin).[68]
5	*Aloe barbadensis*, (Linnaues) Burm (Liliaceae)		lophenol, 24-methyl-lophenol,24-ethyl-lophenol, cycloartanol, and 24-methylene-cycloartanol.[69]
6	*Alstonia boonei* De Wild (Apocynaceae)	Fresh leaves stem	2,10-Dodecadien-1-ol,3,7,11- trimethyl-, (E)-, 9-Octadecenoic acid(Z) -, 2, 3-dihydroxypropyl ester, Oleic Acid, l-(+)-Ascorbic acid2,6-dihexadecanoate, 3-O-Methyl-d-glucose, 2-Undecenoic acid, Hydroquinone, 8-Methylenecyclooctene-3,4-diol, Beta.,.beta.-Galactonicphenylhydrazide.[70] 3β-hydroxylolean-12-ene (β-amyrin) and 3βacetoxyurs-12-ene (α-amyrin acetate) [71] ursolic acid, β-amyrin, Lupeol is also known as (3β)-Lup-20(29)-en-3-ol
7	*Anarcardium occidentale* Linnaues (Anarcardiaceae 0	cashew nut powder	cardoltriene [5-(8Z,11Z)-8,11,14-Pentadecatrien-1yl-1,3-benzenediol], cardol diene [5-(8Z,11Z)-8,11-Pentadecadien-1-yl-1,3-benzenediol]. Cardanoltriene[3-(8Z,11Z)-8,11,14-Pentadecatrien1-ylphenol].[72] cardanolmonoene [3-(8Z)-8-Pentadecen-1-ylphenol], anacardic acid diene [2-Hydroxy-6-(8Z,11Z)-8,11pentadecadien-1-ylbenzoic acid], and anacardic acid monoene [2-Hydroxy-6-(8Z)-8-pentadecenylbenzoic acid].androstane steroid 3-[(trimethylsilyl) oxy]-17-[o(phenylmethyl) oxime]-(3α,5α)-androstane-11,17dione.2-trifluoroacetoxydodecane Oleic acid 1-cyclohexylnonene Octadecanoic acid, 2,3-dihydroxypropyl ester Benzoic acid 17-(5-ethyl-6-

			methylheptan-2-yl)10,13dimethyl,3,4,7,8,9,11,12,14,15,16,17dodecahydro-1Hcyclopenta[a]phenanthren-3-yl ester. Anacardic acid.[73]
8	*Annona muricata* Linnaues (Annonaceae)	Leaf Seed	Annoionol A, annoionol B, annoionol C, annoionoside, vomifoliol, roseoside, turpinionoside A, citroside A, blumenol C, (+)-epiloliolide, loliolide, (1S,2S,4R)-trans-2-hydroxy-1,8-cineoleb-Dglucopyranoside, (Z)-3-hexenyl b-D-glucopyranoside andrutin[74]. β-caryophyllene, δ-cadinene, epi-α-cadinol, α-cadinol.annonamine, (R)-O,O-dimethylcoclaurine, (S)-norcorydine and (R)-4′-O-methylcoclaurine. argentinine, catechine, chlorogenic acid, epicatechine, kaempferol, kaempferol 3-O-rutinoside, quercetin3-O-glucoside, quercetin 3-Oneohesperidoside, quercetin 3-O-robinoside, quercetin 3-O-a-rhamnosyl-(1-6)-b-sophorside, quercetin 3-O-a-rhamnosyl and quercetin-Orutinoside annomuricin A, annomuricin B,annomuricin C, muricatocin A, muricatocin B, and muricatocin C. Muricoreacin and Murihexocin C, Annomuricin E, Annonacin, robinetin, taxifolin (+), quercetin, apigenin-6-C-glucoside, gallic acid, and luteolin 3′7-di-O-glucoside. Cinnamic acid, coumaric acid, daidzein, emodin, gallocatechin, genistein, glycitein, homooorientin, isoferulic acid, and vitexin.[75] Acetogenins- joolanin, squamocin, desacetyluvaricin, chamuvarinin, tripoxyrollin, dieporeticanin-1, dieporeticanin-2 and dieporeticeninJoolanin cis-bullatencin, bullatencin, annotemoyin-1, solamin, uvariamicin-I, II, -III, cis-eticulatacin and cis-uvariamicin-I andchamuvarinin.[76]
9	*Anthocleista vogelii* Planch (Gentianaceae)	stem bark	1-Hydroxy-3,7,8–trimethoxyxanthone, Sesquiterpene, Tritepenoid, Anthocleistenoloide.[77]
10	*Azadirachtaindica A. Jus* (Meliaceae)		isoprenoids (like diterpenoids and triterpenoids containing protomeliacins, limonoids, azadirone and its derivatives, gedunin and its derivatives, vilasinin type of compounds and C- secomeliacins such as nimbin, salanin and azadirachtin) and non-isoprenoids,An average composition of neem oil fatty acids is, Linoleic acid,Oleic acid ,Hexadecanoic acid, Octadecanoic acid along with alphaliolenicacid and 9-hexadecenoic acid.[78]
11	*Buchholzia coriacea* Engler (Capparaceae)		Beta-sitosterol and α–sulphur.[79]
12	*Carica papaya*	leaves	2-methoxy-4-vinylphenol.[80]

	Linnaues (Caricaceae)		
13	*Chrysophyllum albidum* G. Don (Sapotaceae)	Stem bark	Stigmasterol, epicatechin, epigallocatechin, Eleagnin and procyanidin B5. 1-Nonadecene, Linoleic acid ethyl ester, Octadecanoic acid, methyl ester, 11-Octadecenoic acid methyl ester,9,12-octadecadienoic acid methyl ester, Hexadecanoic acid ethyl ester, 6-Octadecanoic acid,(z)-octadecanoic acid, 2,2,3-Trimethyl-2-3-methyl-buta 1,3-dienyl Squalene ,Chondrillasterol , 7,22- Ergostadienone , 17-(1,5-Dimethyl-3-phenylthiohex-4-enyl)-4 , Beta.-Amyrin , Lup-20(29)-en-3-ol, acetate, (3- beta) and Phthalic acid, di(2-propylpentyl) ester.[81]
14	*Cinnamoniumverum J. Presi* (Lauraceae)	bark	Trans-cinnamaldehyde, 1,2-naphthalenedione, Ethanone, Borneol, 2H-1-benzopyran-2-one, 3-methyl-4undecene, and 3- phenyl-2-propenal.[82]
15	*Citrus aurantifolia (Chrism) Swingle* (Rutaceae)	Peel and leaves	3,7-dimethyl-2,6-octadien-1-ol , geraniol , *E*-citral, *Z*-citral, and β-ocimene Limolinene, β-lpinene,γ-terpinene,citral, sabinene, citronella, geranial, linalool α-thujene, α-phellandrene, caryophyllene oxide, β-santalene,[83] Hesperitin, naringin, tangeretin, naringenin, erioctrin, hesperidin., Bergapten, bergamottin, beragaptol, byakangelicin, citropten (limettin), imperatorin, isoimperatorin, isopimpinellin, phellopterin, prangol, scopoletin**.**5-geranyloxypsoralen**,**5-geranyloxy-7-methoxycoumarin. 5,8-dimethoxy-psoralen (isopimpinellin), 5,7-dimethoxycoumarin**,** 3-methyl-1,2cyclopentanedione, 1-methoxy-cyclohexene, corylone, palmitic acid, α-terpineol, and umbelliferone.[84]
16	*Citrus limon* (Linnaues) Burman (Rutaceae)	Juice	Caffeoyl N-Tryptophan, hydroxycinnamoyl-Oglucoside acid, vicenin 2. Erioccitrin, kaempferol-3-O-rutinoside, quercetin-3-rutinoside. Limonin, nomilin, eriodictyol, neoeriocitrin, isonaringin, naringin, hesperidin, neohesperidin, and limonin 6,8-di-*C*-β-glucosyldiosmin (LE-B) and 6-*C*-β-glucosyldiosmin, β-pinene,terpinen-4-ol m, α-terpinolene geranial, neral, α-bisabolol, (E)-αbisabolene, β-santalene, (Z)-α-bisabolene Campherenol, 6-methyl-5hepten-2-one.[85]
17	*Cucumis sativus* Linnaues (Cucurbitaceae)	Stem	(2S,3S,4R,10E)-2-[(2'R)-2-hydroxytetracosanoylamino]-1,3,4-octadecanetriol-10-ene, 1-Oβ-D-gluco-pyranosyl-(2S,3S,4R,10E)-2-[(2'R)-2-hydroxy-tetracosanoylamino]-1,3,4-octadecanetriol-10-ene and soya-cerebroside I, ar-turmerone, β-sesquiphellandrene, and curcumenol, Curcumin [86]
18	*Cymbopogon citratus (*de		Geranial, neral α-cardinol, selina-6-en-4-ol, β-eudesmol, geranial, Citral α, citral β (neral), nerol,

	Candolle) Stapf (Poaceae)		geraniol, citronellal, terpinolene, geranyl acetate, myrecene, terpinol, ethylheptenone, cymbopogone, cymbopogonol, luteolin, Dipentene, Limonene, Linalool, Borneol β-myrcene, Citronello.[87]
19	*Dioscoreaalata*L innaues (Dioscoreaceae)	Tubers Tuber Peel Tuber	Hydro-Q(9) chtomene, gamma-tocopherol-9, RRRalpha-tocopherol, coenzyme Q(9), 1-ferloylglcerol.[88] Diosgenin.[89] 3,3-dihydroxy-5-methoxybibenzyl or batatasin III.[90] 3-O-(6-O-(6-O-(E)-sinapoyl-β-D-glucopyranosyl)-βD-glucopyranosyl)-7-O-(6-O(E)-sinapoyl-β-D-glucopyranosyl)cyanidin, 3-O-(6-O-(3-O-(β-Dglucopyranosyl)-6-O-(E)-sinapoyl-Dglucopyranosyl)-β-D-glucopyranosyl)cyanidin, 3-O-(6-O-(6-O-(E)-sinapoyl-β-Dglucopyranosyl)-βD-glycopyranosyl)peonidin, 3-O-(6-O-(6-O-(E)feruloyl-β-D-glucopyranosyl)-β-Dglucopyranosyl)cyanidin, alatanin A, alatanin B, alatanin C, and 3-O-(6-O-β-D-glucopyranosyl)-β-Dglucopyranosyl)cyaniding.[91]
20	*Garcinia kola* Heckel (Clusiaceae)	seed	linoleic acid, 1,2-benzenedicarboxylic acid and 2,3-dihydro-3,5-dihydroxy-6-methyl ester, naringin-7-rhamnoglucoside (4^{I}, 5, 7-trihydroxy flavanone, rhamnoglucose), 1 pentadecanecarboxylic acid, (Z)-11-Octadecenoic acid and octadecanoic acid, 2-(2-hydroxyethoxy) ethyl ester.[92]
21	*Glycyrrhiza glabra* Linnaues (Fabaceae)	Roots	Glycyrrhizin, glycyrrhetic acid 3-O-glucuronide, glycyrrhetinic acid glycycoumarin, glycyrin and glycyrol, liquiritin and liquiritigenin, isoliquiritigenin and licochalcone, glabridin, dihydrostilbenes. 3,3′,4,4′-tetrahydroxy-2′-methoxy-5-prenylchalcone, 5′-formyl glabridin, (2*R*,3*R*)-3,4′,7-trihydroxy-3′prenylflavanone, 7,8-dihydroxy-4′-methoxy-6prenylisoflavanone.[93] Echinatin ,lichocalcone B, morachalcone A, 2′,3,4′-trihydroxy-3′-γ,γ-dimethylallyl-6″, 6″-dimethylpyrano[2″,3″: chalcone, 1-(2′,4′dihydroxyphenyl)-2-hydroxy-3-(4″-hydroxyphenyl)1-propanone , kanzonol Y, (3R)-vestitol , (3R)2′,3′,7-trihydroxy-4′-methoxyisoflavan , kanzonol X , glabridin ,4′-O-methylglabridin , 3′-hydroxy-4′-Omethylglabridin, hispaglabridin A, hispaglabridin B, glabrene, kanzonol W, labrocoumarin, shinpterocarpin, O-methylshinpterocarpin, licoagrocarpin, licoflavanone A, glabrol , shinflavanone ,euchrenone a5, xambioona, gancaonin L, glabrone, kanzonol U, and 8,8-dimethyl-3,4-dihydro-2H,8Hpyrano[2,3-f]chromon-3-ol, Glycyrrhizin, Glycyrrhetic acid,

			Liquiritin, Isoliquiritin, glabrene, hispaglabridins A and B, glabridin,[94] isoliquiritin, isoliquritinapioside, neoliquiritinapioside, liquiritinapiosideliquiritigenin, isoliquiritin, licuraside,glycycoumarin, glycyrin, glycyrol and liquiritigenin, isoliquiritigenin, licochalcone A and glabridin.rhamnoliquirilin, liquiritigenin, prenyllicoflavone A, glucoliquiritinapioside, 1-metho-xyphaseolin, shinpterocarpin, shinflavanone, licopyranocoumarin, glisoflavone, licoarylcoumarin, and coumarin-GU-12, and saponins, namely, glycyrrhizin, isoprenoid-substituted phenolic constituents (isoangustone A, semilicoisoflavone B, licoriphenone, and 1-methoxyficifolinol), kanzonol R (prenylated isoflavan derivative),[95]
22	*Gongronema latifolium* Bentham (Apocynacaeae)		Cinchonidine, Oxoassoanine, Lupanine, Buphanidrine, (Alkaloids), Hyperoside, Quercetin and Kaemferol.[96]
23	*Irvingia gabonensis* (Aubry-Lecomte) ex O'Rorke) Bill (Irvingiaceae)		3,8-Trio-O-methyl ellagic acid, methyl-ellagic acid-*O*-rhamnosyl-rhamnoside, mono-methyl-ellagic acids, di-*O*-methyl ellagic acids, kaempferol 3-*O*-glucoside and quercetin 3-*O*-rhamnoside, isomangiferin.[97]
24	*Magnifera indica* Linnaues (Anarcadiaceae)	Leaves Leaves	mangiferolate A and mangiferolate, gallic acid, 3,4-dihydroxy benzoic acid, gallic acid methyl ester, gallic acid propyl ester, mangiferin, (+)catechin, (-) epicatechin, quercetin O-glycosides, one kaempferol O-glycoside, four xanthone C-glycosides and the flavonolhexoside, Phellandrene, α-pinene, ambolic acid, ascorbic acid, β-carotene, gallic acid, gallotannic acid, mangifelic acid, mangiferol peroxidase, phenyl alanin and proline.[98] Mangiferin,isomangiferin,andhomomangiferincatechin-(4α→8)-catechin , catechin-(4α→6)- catechin , and epicatechin-(4β→8)-catechin , have been isolated for the first time in addition to the known flavanols catechin, epicatechin , and epigallocatechin. Epigallocatechin-3-O-gallat-(4β→8)-epigallocatechin-((4β→8)-catechinK. Mangiferin,friedelin and lupeol [99]
25	*Moringa oleifera* Lam (Moringaceae)	Seed Leaves leaves, seed andflower Stem Root	4-[(*α*-L-rhamnosyloxy)benzyl] nitrile or niazirine., O-ethyl-4-[(*α*-L-rhamnosyloxy)benzyl] thiocarbamate orniazimicine.[100] tangutorid E, tangutorid F, niazirin, benzaldehyde 4-O-α-L-rhamnopyranoside, 4-O-β-D-glucopyranosidebenzoic acid, 4-caffeoylquinic acid,methyl 4-caffeoylquinate,caffeoylquinic acid, methyl caffeoylquinate, uridine, adenosine,quercetin

			3-O-β-D-glucopyranoside.[101] 3-O-(6'-O-oleoyl-*β*-D-glucopyranosyl)-*β*sitosterol,*β*-sitosterol-3-O-*β*-D-glucopyranoside, niazirine, *β*-sitosterol, and glycerol-1-(9-octadecanoate), niazimicine. Roridin E, Veridiflorol, 9-Octadecenoic acid 9-Octadecen – 1- ol, (Z) – (CAS) cis - 9 – Octadecen – 1 – ol, Oleol, Satol, Ocenol, Sipo, Decanoic acid, Dodecanal.[102] niazinine A, niazinineBniazinine, niazimicine, and niazinine A + B.[103] Tricosanoic acid. gamma-sitosterol, Stigmasterol,Cholest-5-en-3-ol Benzyl isothiocyanate, O-ethyl benzyl thiocarbamate, 4-(a-L-rhamnopyranosyloxy) benzylnitrile (niazirin), N-ethoxythiocarbonyl-4-(a- rhamnopyranosyloxy) benzylamine (niazimicin), benzylamine.[104]
26	*Musa acuminate* Colla (Musaceae)		kaempferol-3-O-rutinoside and rutin
27	*Musa paradisiacal* Linnaues (Musaceae)	Peels	Ellagic acid, gallic acid , ferulic acid , o-coumaric acid , catechol , salicylic acid ,cinnamic acid , rutin, myricetin , and naringenin, lutein,α- and β-carotene, auroxanthin, violaxanthin, neoxanthin, β - cryptoxanthin, isolutein, and α– cryptoxanthin.[105]
28	*Nauclea diderichii* (de Wild &T.Durand) Merr (Rubiaceae)		Harman, 3-Carbomelhoxyharman, I-Carbomelhoxynorharman, I-Corboxomidonorhorman, 3-Acefyl-5-carbomefhoxypyridin, 3-Corbomefhoxy-5-(1'-hydroxyefhy1)pyridine. Quinovic acid glycosides.[106]
29	*Nauclea latifolia* Smith (Rubiaceae)		*trans*-3,4-dihydroxycinnamic acid (caffeic acid), quercetin, quercetin-3-*O*-β-glycopyranoside, 3-caffeoylquinic acid (chlorogenic acid), and 3,5-*O*-dicaffeoylquinic acid.[107]
30	*Ocimum gratissimum* Linnaues Lamiaceae	leaves	Eugenol, 1,8-cineol vicenin-2 and chicoric acid, L-caftaricacid , L-chicoricacid, eugenyl-β-Dglucopyranoside and vicenin-2. Thujone, Thujanol, Borneol (1,8 cineole), Linalool, Eudesma-4(14), 11-diene, 1-terpinen-4-ol, 1-Terpinen-4-ol, Durenol.[108]
31	*Persea americana* Miller (Lauraceae)	leaves	(*E*,*Z*,*Z*)-1-Acetoxy-2-hydroxy-4-oxo-heneicosa-5,12,15-triene. Persin(Z,Z)- 1- (acetyloxy)- 2-hydroxy- 12,15 -heneicosadien-4- one).[109]
32	*Petersianthus Macrocarpus* (P.Beauv.) Liben (Rubiaceae)	Stem bark	Petersaponins III and IV (21-O-benzoyl-22-Oacetylbarringtogenol C and 21-O-2-furoxyl-22-Otiglolbarrintogenol. 3,3'-Dimethoxy ellagic acid and 3,3'-dimethoxy-4O-/l-D-glucopyranosyl ellagic acid.[110]

33	*Psidium guajava* Linnaues (Myrtaceae)	leaves	Corosolic acid, (2α-hydroxyursolic acid), Jacoumaric acid, 16,24,25-Trihydroxy-3-oxoeuph-7en-21-oic acid ,2,3-Dihydroxy-12-oleanen-28-oic acid; 3-O-(3,4-Dihydroxy-E-cinnamoyl), GuajadialB, Medicagenic acid , 4,23-Dihydroxy-22-oxo-3,4seco-12-oleanen-3- oic acid.[111] (Z)-3-hexernal, 3-sulfanyl-L-hexanol, 4- hydroxyl-2,5-dimethyl-3(Sh)-furannone, 3-Sulfanylhexyl acetate, hexanal, ehylbutanoate, cinamyl acetate and methional, Morin-3-O-α-lyxo-pyranoside, morin-3-α-arabinoside,nguaijavarin and quercetin. 20β-acetoxy-2α3β-dihydroxyurs-12-en-28-oic acid (guavanoic acid) and 2α,3β-dihydroxy-24-*p*-*z* coumaroyloxyurs-12-en-28-oic acid (guavacoumaric acid), (2α-hydroxyursolic acid, jacoumaric acid, isoneriu-coumaric acid, asiatic acid, ilelatifol D and β-sitosterol-3-O-β-D-glucopyranoside),betulinic acid and lupeol.[112]
34	*Securidacalonge pedunculata* Fresen. (Polygalaceae)		Securidacaside A, securidacaside B, 3-O-β-Dglucopyranosylpresenegenin-28-O-β-Dapiofuranosyl-(1,3)-β-D-xylopyranosyl-(1,4)[β-Dapiofuranosyl-(1,3)]-α-L-rhamnopyranosyl-(1,2)-{4O-[(E)-3,4,5trimethoxycinnamoyl]}-β-Dfucopyranosyl ester, Quercetin-3-O-D-xyloside, ΔStigmasterol-3-O-D-glucopyranoside, β-D-(3,4-disinapoyl)fructofuranosyl-α-D(6sinapoy1)glucopyranoside and β-D-(3-sinapoyl) fructofuranosyl-α-D(6 sinapoylyl)glucopyranoside.[113]
35	*Strophanthus hispidus* De Candolle (Apocynaceae)		Strophanthidin, Sarmentocymarin and Sametogenin.[114]
36	*Tapinanthusglobiferas* (Richard) van Tieghem (Loranthaceae)		Lupeol, Lupeol Acetate.[115]
37	*Uvaria chamae* P.Beauv. (Annonaceae)	Root stem	Chamuvaritin Grandifloranol, zeylenone. Dimetoxy-p-cymene, t-cadinol, methylthymol. stigmasterol and betasitosterol.[116]
38	*Vernonia amygdalina* Delile (Compositae)	Flower Leaf	Luteolin, Tricosane, Vernolid, Isorhamnetin. Vernolide and vernodalol.[117]
39	*Xylopia aethiopica* (Dunal) A. Rich. (Annonaceae)	Fruits	3-carene, eucalyptol, 2-hydroxy-4-methylbenzoic acid, abietic acid, 3,21-dihydroxypregnan-4-oneXylopioxyde (16,17β-epoxy-15-oxo-ent-kauran-19oic acid),15α-acetoxy-ent-kaur-16-en-19 oic acid (xylopic acid), 15-oxo-ent-kaur-16-en-19-oic acid, and ent-kaur-16-en-19-

			oic acid. Xylopic acid.[118]
40	*Zingiber officinale* Roscoe (Zingiberaceae)	Rhizome Powdered rhizome	shogaols, gingerols, shogaols and gingerdiols, [6]-gingerdiol 3,5-diacetates.[119] 6-gingerol,8-gingerol, and 10-gingerol, methyl-6gingerol, 6-gingerdiol, acetoxy-10-ingerol,diacetoxy-4-gingerdiol and diacetoxy-8-gingerdiol, methyldiacetoxy-6-gingerdiol, 1-dehydro-6gingerdione, and diacetoxy-8-gingerdiol.[120]

DISCUSSION

Diabetes of all types can lead to complications in many parts of the body and can increase the overall risk of dying prematurely. Possible complications include heart attack, stroke, kidney failure, leg amputation, vision loss and nerve damage. In pregnancy, poorly controlled diabetes increases the risk of fetal death and other complications. Diabetic retinopathy is an important cause of blindness and occurs as a result of long-term accumulated damage to the small blood vessels in the retina. Diabetes is among the leading causes of kidney failure.[121] The antidiabetic use of these plants in Nsukka LGA is not an isolated case neither is it by chance because the result of our review of available literature showed that most of the plants have similar use in other places as demonstrated by scientific investigations. There are many pharmacological active compounds isolated from the plants [Tables 2]. Considering the fact that some of these plants are used as food or componenets of foods it can be said that people in some areas knowingly or unknowingly take medicinal items as food. The shift in nutritional preferences in favour of processes food items can at least in part explain the generation difference in incidence of the diseases with the older generation having a lower case.

CONCLUSION

There are plants with diverse medicinal activities and uses in the forests and gardens of Nsukka LGA of Enugu state Nigeria. Though a great percentage of the plants identified as being used in the treatment of diabetes in Nsukka LGA of Enugu state is low compared to the many plants in our forests with other activities. Irrespective of culture and/or geographical location the world is united in the use of plants as therapeutic agents.

Conflict of interest

None to declare.

Authors' contributions: Odoh UE, Uzor PF anad Osadebe PO designed the work. The interview was conducted by Ezema CO and data compiled by Ezema CO under the supervision of Odoh UE, Osadebe PO and Uzor PF. Literature search and data analysis were done by Odoh UE, Chukwuma MO, Ezema CO, Odoh LC and Agubata CW. The first draft of the manuscript was written by Odoh UE, Chukwuma MO and Ezema CO. All authors approved the final draft of the manuscript.

Funding: No funding was received for this research.

Abbreviations

LGA	Local Government Area
WHO	World Health Organization
DM	Diabetes Mellitus
GDM	Gestational Diabetes Mellitus
BMI	Body mass index
OGTT	Oral glucose tolerance test
FPG	Fasting plasma glucose

REFERENCES

1. Aguwa CN. Therapeutic Basis of Clinical Pharmacy in the Tropics, Snapp Publishers: Enugu, Nigeria, 2012; 4: 349 – 370.
2. Chisholm-Burns MA, Kwong WJ, Mulloy LL, Spivey CA. Nonmodifiable characteristics associated with nonadherence to immunosuppressant therapy in renal transplant recipients. Am J Health Syst Pharm, 2008; 1, 65(13): 1242 - 7. doi: 10.2146/ajhp070630. PMID: 18574014.
3. Seuring T, Archangelidi O, Suhrcke M. The Economic Costs of Type 2 Diabetes: A Global Systematic Review. *PharmacoEconomics*, 2015; *33*(8): 811 – 831. https://doi.org/10.1007/s40273-015-0268-9
4. Bloom DE, Cafiero ET, Jané-Llopis E, Abrahams-Gessel S, Bloom LR, Fathima S, Feigl AB, Gaziano T, Mowafi M, Pandya A, Prettner K, Rosenberg L, Seligman B, Stein A, Weinstein C. The Global Economic Burden of Non-communicable Diseases. Geneva: World Economic Forum, 2011.
5. Odoh UE, Ezugwu CO, Udofot EE. Evaluation of the anti-diabetic and toxicological profile of the leaves of Stachytarphetajamaicensis (L.) Vahl (Verbenaceae) on alloxan-

induced diabetic rats. Journal of Pharmacognosy and Phytochemistry, 2020; 9(3): 477-484.

6. Odoh U. E, Ndubuokwu RI, Inya-Agha SI, Osadebe PO, Uzor PF, Ezejiofor M. Antidiabetic activity and Phytochemical Screening of Acalyphawilkesiana (Euphorbiaceae) Mull Arg. roots in alloxan-induced diabetic rats. Sci Res Essay, 2014; 9(7): 204-12.
7. Osadebe PO, Uzor PF, Omeje EO, Agbo MO, Obonga WO. Hypoglycemic Activity of the Extract and Fractions of *Anthocleistavogelii* (Planch) Stem Bark. Tropical Journal of Pharmaceutical Research, 2014; 13(9): 1437 – 1443. http://dx.doi.org/10.4314/tjpr.v13i9.9
8. Laleye FOA, Mensah S, Assogbadjo AE, Ahissou H. Diversity, Knowledge, andUse of Plants in TraditionalTreatment of Diabetes inthe Republic of Benin Ethnobotany Research & Applications, 2015; 14: 231 – 257. http://dx.doi.org/10.17348/era.14.0.231-257,
9. Burkill HM. The Useful Plants of West Tropical Africa, Royal Botanical Gardens, Kew, London, 2000; 2, 5: 77 - 79.
10. Chukwuma D, Chukwuma E, Oluwapenlumi O. An Ethnobotanical Survey of Malaria-treating Plants in Ado-Ekiti Local Government Area of Ekiti State, Nigeria. Ethnobotany Research and Applications, 2015; 18: 1 – 10. www.https://doi.10.32859/era.18.37.1-10
11. Gray, A. M, Flatt, P R. Pancreatic and extra-pancreatic effects of the traditional anti-diabetic plant, Medicago sativa (lucerne). *The British journal of nutrition*, 1997; *78*(2): 325–334. https://doi.org/10.1079/bjn19970150
12. Chikezie, P.C., Ojiako, O.A. &Nwufo, K.C. Overview of Anti-Diabetic Medicinal Plants: The Nigerian Research Experience, J Diabetes Metab, 2015; 6: 6. https://doi.10.4172/2155-6156.1000546
13. Kumar S, Mishra CS, Ahuja A, Rani A, Nema. Phytoconstituents and Pharmacological activities of *Musa Paradisiaca* Linn. Asian Journal of Biochemical and Pharmaceutical Research, 2013; 4(2): 204.
14. Ibe AE, Nwufo MI.Identification, collection and domestication of medicinal plants in southern Nigeria. *African Dev*, 2005; 30(3): 66 - 77. https://doi.10.4314/ad.v30i3.22230
15. Mathew PT, Augusti. KT. Hypoglycemic effects of onion (*Allium cepa* Linn). On diabetes mellitus: A preliminary report. Ind J physio Pharmacol, 1975; 9: 213 – 217.

16. Timbo BB, Ross MP, McCarthy PV, Lin CT. Dietary supplements in a national survey: Prevalence of use and reports of adverse events. *Journal of the American Dietetic Association*, 2006; *106*(12): 1966 – 1974. https://doi.org/10.1016/j.jada.2006.09.002
17. Surjushe A, Vasani R, Saple DG. Aloe vera: A short review. Indian J Dermatol, 2008; 53(4): 163 - 6. https://doi.10.4103/0019-5154.44785. PMID: 19882025; PMCID: PMC2763764.
18. Osadebe PO. Anti-inflammatory properties of the root bark of *Alstoniaboonei*. Nig. J. Nat. Prdt. Med, 2002; 6: 39 - 41. https://doi.10.4314/njnpm.v6i1.11691
19. Taylor L. The Healing Power of Rainforest Herbs: A Guide to Understanding and Using Herbal Medicinals. 2005; Square One Publishers, Garden City Park, NY 11040 USA.
20. Adewole SO. Ojewole JA. Protective effects of *Annona muricata* Linn. (Annonaceae) leaf aqueous extract on serum lipid profiles and oxidative stress in hepatocytes of streptozotocin-treated diabetic rats. *African journal of traditional, complementary, and alternative medicines: AJTCAM*, 2009; *6*(1): 30–41. https://doi.org/10.4314/ajtcam.v6i1.57071
21. Adewole SO, Caxton-Martins EA. Morphological changes and hypoglycemic effects of *Annona muricata* Linn. (Annonaceae) leaf aqueous extract on pancreatic B-cells of streptozotocin-treated diabetic rats. Afr. J. Biomed. Res, 2006; 9: 173 – 187. https://doi.10.4314/ajbr.v9i3.48903
22. Holdsworth DK.Traditional Medicinal Plants of Rarotonga, Cook Islands." Part I. Int. J. Crude Drug Res, 1990; 28(3): 209 - 218. https://doi.org/10.3109/13880209009082815
23. Jegede IA, Ibrahim JA, Kunle OF. Phytochemical and pharmocognostic studies of the leaf and stem-bark of *Anthocleistavogelii* (Planch). J. Med. Plants Res, 2011; 5: 6136-6139.
24. Maithani A, Parcha V, Pant G, Dhulia I, Kumar D. Azadirachta Indica (Neem) Leaf: A Review. Journal of Pharmacy Research, 2011; 4(6): 1824 – 1827. http://jprsolutions.info
25. Irvine FR. Woody Plants of Ghana with Special Reference to Their Uses. Oxford University Press, London, 1961; 143 - 144.
26. Anowi CF, Nnabuife CC, Ezugwu CO, Utoh-Nedosa UA. Antimicrobial Properties Of The Chloroform Extract Of The Stem Bark Of Nauclea Latifolia. International Journal of Pharmacy and Pharmaceutical Sciences, 2012; 4(2): 744 – 750.
27. Corral-Aguayo RD, Yahia EM, Carrillo-López A, González-Aguilar G. Correlation between some nutritional components and the total antioxidant capacity measured with

six different assays in eight horticultural crops. J Agric Food Chem, 2008; 56: 10498 –10504.

28. Idowu TO, Ogundaini AO, Adesanya SA, Onawunmi GO, Osungunna MO, Obuotor EM, Abegaz BM. Isolation and characterization of chemical constituents from *Chrysophyllum albidum* G. Don-holl. Stem-bark extracts and their antioxidant and antibacterial properties. *African journal of traditional, complementary, and alternative medicines: AJTCAM*, 2016; *13*(5): 182–189. https://doi.org/10.21010/ajtcam.v13i5.24
29. Aneja K, Joshi R, Sharma C. Antimicrobial activity of dalchini (*Cinnamomum zeylanicum* bark) extracts on some dental caries pathogens. *Journal of Pharmacy Researc*, 2009; 2(9): 1387–1390. http://jprsolutions.info
30. Narang N &Jiraungkoorskul W. Anticancer Activity of Key lime, *Citrus aurantifolia*. Pharmacogen. Rev, 2016; 10(20): 118 – 122. https://10.4103/0973-7847.194043.
31. Khalid H, Nisar M, Majeed A, Nawaz K, Bhatti K. Ethnobotanical survey of important plants of JalalpurJattan district Gujjrat Punjab Pakistan.Ethnobotanical Leaflets, 2010; 14: 807-25. https://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1670&context=ebl
32. Pritesh S, Swati D, Yadunath J, Vilasrao K. A review on *Cucumis sativus (Cucumber).* Research J. Pharmacognosy and Phytochemistry, 2013; 5(2): 49 - 53. http://rjpponline.org
33. Nambiar VS, Patel K, Gosai C, Nithya S, Desai, R.Effect of Beta Carotene from Dehydrated Drumstick Leaf Powder on theHaematological Indices of Non-Pregnant Non-Lactating Young Women Aged 18 – 25 Yrs (Preliminary Trials). International Journal of Pharmaceutical & Biological Archives, 2012; 3(3): 646 - 653. www.ijpba.info
34. Kumar S, Das G, Shin H-S and Patra JK. Dioscorea spp. (A Wild Edible Tuber): A Study on Its Ethnopharmacological Potential and Traditional Use by the Local People of Similipal Biosphere Reserve, India. Front. Pharmacol, 2017; 8: 52. https://doi.10.3389/fphar.2017.00052
35. Iwu M, Duncan AR, &Okunji CO. New Antimicrobials of Plant Origin, 1999; 457 – 462. ASHS Press, Alexandria, VA, USA
36. Zadeh J.B, Kor ZM, Goftar MK. Licorice (*Glycyrrhiza glabra* Linn) as a valuable medicinal plant. *International Journal of Advanced Biological and Biomedical Research*. 2013; 1(10): 1281-1288. http://www.ijabbr.com
37. Arseculeratne SN. Gunatilaka AAL, Panabokke RG. Studies on medicinal plants of sri lanka. part 14: toxicity of some traditional medicinal herbs.Journal of Ethnopharmacology, 1985; 13(3): 323 – 335. https://doi.org/10.1016/0378-8741(85)90078-9

38. Eleyinmi AF. Chemical composition and antibacterial activity of *Gongronemalatifolium*Journal of Zhejiang University-Science B (Biomedicine & Biotechnology), 2007; 8(5): 352-358. https://doi.10.1631/jzus.2007.B0352
39. Parvez GMM. Pharmacological activities of mango (*Mangifera Indica*): A review. Journal of Pharmacognosy and Phytochemistry, 2016; 5(3): 1-7
40. Anwar F, Latif, S., Ashraf, M., Gilani, A.H. *Moringa oleifera*: a food plant with multiple medicinal uses, 2007; 21(1): 17-25. https://doi.org/10.1002/ptr.2023
41. Dhakar RC, Maurya SD, Pooniya BK, Bairwa N, Gupta M. Chronicles of Young Scientists, 2011; 2(3): 119-125. https://doi.org/10.4103/2229-5186.90887
42. Alam U, Asghar O, Azmi S, Malik RA. General aspects of diabetes mellitus. Handbook of clinical neurology, 2014; 126: 211–222. https://doi.org/10.1016/B978-0-
43. Swathi D, Jyothi BC, Sravanthi C. A Review: Pharmacognostic studies and Pharmacological actions of Musa Paradisiaca International Journal of Innovative Pharmaceutical Research, 2011; 2(2): 122-125.
44. Mustapha AA, Owuna G, Ishaq UI. Plant Remedies Practiced by Keffi People in the Management of Dermatosis. Journal of Medicinal Plants Studies, 2013; 1(5): 112-118. https://www.plantsjournal.com
45. Benoit-Vical F, Valentin A, Cournac V, Pélissier Y, Mallié M, Bastide JM. In vitro antiplasmodial activity of stem and root extracts of Nauclea latifolia S.M. (Rubiaceae). J Ethnopharmacol, 1998; 61(3): 173 - 8. https://doi.10.1016/s0378-8741(98)00036-1. PMID: 9705007.
46. Matasyoh LG, Josphat CM, Francis NW, Miriam GK, Anne WTM, Titus KM. Chemical composition and antimicrobial activity of the essential oil of *Ocimumgratissimum*L. growing in Eastern Kenya. Afr J Biotech, 2007; 6: 760 - 5.
47. Argueta A, Cano L, Rodarte M. Atlas de las Plantas de la Medicina Tradicional Mexicana. México, D.F: Editorial Instituto Nacional Indigenista, 1994; 2: 3.
48. Asase, A. & Oppong-Mensah, G. Traditional antimalarial phytotherapy remedies in herbal markets in southern Ghana. Journal of Ethnopharmacology, 2009; 126: 492 – 499. https://doi.org/10.1016/j.jep.2009.09.008
49. Mabeku LJK, Kuiate JR, Oyono ELL. Screening of some plants used in the Cameroonian folk medicine for the treatment of infectious diseases. Int. J. Biol, 2011; 3(4): 13 – 21.
50. Conway P.Tree Medicine: A comprehensive Guide to the Healing power of over 170 trees Judy Piatkus Publishers Ltd, 2001; 2173 – 2177.

51. Ogunmefun OT, Gbile ZO. An Ethnobotanical Study of Anti-Rheumatic Plants in South-Western States of Nigeria. Asian Journal of Science and Technology, 2012; 4(11): 063-066.
52. Ishola IO, Olayemi SO, Yemitan OK, Ekpemandudiri NK. Mechanisms of anticonvulsant and sedative actions of the ethanolic stem-bark extract of *Ficus sur*Forssk (Moraceae) in rodents. *Pakistan journal of biological sciences: PJBS*, 2013; *16*(21): 1287–1294. https://doi.org/10.3923/pjbs.2013.1287.1294
53. Abedo JA, Jonah OA, Abdullahi RS, Mazadu MR, Idris HY, Muhammed H, FT, Shettima, Ombugadu S, Daudu M, Garba J, Abdulmalik U, Kugu BA, Usman AO. Evaluation of trypanosomal activity of *Tapinanthusglobiferus* and *Gongronemalatifolium*on *Trypanosoma congolense*. Bioscience Research, 2013; 10(1): 20-28.
54. Muritala HF, Akolade JO, Akande SA, Abdulazeez AT, Aladodo RA, Bello AB. Antioxidant and alpha-amylase inhibitory potentials of *Cocos nucifera* husk. *Food science & nutrition*. 2018; *6*(6): 1676–1683. https://doi.org/10.1002/fsn3.741
55. Farombi EO, Owoeye O. Antioxidative and chemopreventive properties of Vernonia amygdalina and Garcinia biflavonoid. *International journal of environmental research and public health*, 2011; *8*(6): 2533–2555. https://doi.org/10.3390/ijerph8062533
56. Ijeh II, Ejike CC. Current perspectives on the medicinal potentials of *Vernonia amygdalina* Del., Journal of Medicinal Plants Research, 2011; *5*: 1051–1061. http://www.academicjournals.org/JMPR
57. Getahun A. Some Common Medicinal and Poisonous Plants Used In Ethiopian Folk Medicine, 1976
58. Soh D, Nkwengoua E, Ngantchou I, NyasseB, Denier C, Hannaert V, Shaker KH, Schneider B. Xylopioxyde and other bioactive kaurane-diterpenes from *Xylopia aethiopica*Dunal (Annonaceae). *Journal of Applied Pharmaceutical Science*, 2013; *3*(12): 13 - 19. https://doi.10.7324/JAPS.2013.31203
59. Mshana NR (N. Robert). 1954-2000. Traditional medicine and pharmacopoeia: contribution to the revision of ethnobotanical and floristic studies in Ghana. Organization of African Unity/Scientific, Technical & Research Commission, 2000.
60. Baligar NS, Aladakatti RH, Ahmed M, Hiremath MB. Hepatoprotective activity of the neem-based constituent azadirachtin-A in carbon tetrachloride intoxicated Wistar rats," Canadian Journal of Physiology and Pharmacology, 2014; 92(4): 267 – 277. https://doi.10.1139/cipp-2013-0449

61. Liao H, Liu H, Yuan, K. A new flavonol glycoside from the Abelmoschus esculentus Linn. *Pharmacognosy magazine*, 2012; *8*(29): 12 – 15. https://doi.org/10.4103/0973-1296.93303
62. Jia L, Li HF, Jin LL. Chemical constituents in N-butanol extract of *Abelmoschus esculentus* L. *Chinese Traditional and Herbal Drugs*, 2011; *41*: 1771 – 1773.
63. Amin E, Radwan, MM, El-Hawary SS, Fathy MM, Mohammed R, Becnel JJ, Khan I. Potent Insecticidal Secondary Metabolites from theMedicinal Plant *Acanthus montanus.* Rec. Nat. Prod. 2012; 303 6:3:301-305 https://www.acgpubs.org
64. Igwe OU, Nnaji JC. Chemical Characterization and Investigation of the Bio-effects of the Leaves of *Acanthus montanus* (Acanthaceae) on Some Selected Microorganisms. International Journal of ChemTech Research, 2014; 6(14): 5554 – 5561. https://www.sphinxsai.com
65. Abdel-Lateef E, Abdel-Gawad M, Abdel-Aziz M, El-Sayed M, El-Wakil E. In vitro Antioxidant, Total Phenolic and Flavonoid Contents of Six Allium Species Growing in Egypt. J Microbiol Biotech Food Sci, 2014; 3(4): 343 – 346. https://www.jmbfs.org/wp-content/uploads/2014/01/jmbfs
66. Fredotovi´c Z, Šprung M, Soldo B, Ljubenkov I, Budi´c-Leto I, Bilušic´ T, C˘ikeš-C˘ulic´ V, and Puizina J. Chemical Composition and Biological Activity of *Allium cepa* L. *and Allium* x*cornutum*(Clementi ex Visiani 1842) Methanolic Extracts. Molecules, 2017; 22: 448. https://doi:10.3390/molecules22030448.
67. Bora, K.S, Sharma, A. Phytoconstituents and Therapeutic Potential of Allium cepa Linn.–A Review Phcog Rev, 2009; 3, 5: 170 - 180. www.phcogrev.com
68. Yoo M, Lee S, Kim S, Hwang JB, Choe J, Shin D. Composition of organosulfur compounds from cool- and warm-type garlic (*Allium sativum* L.) in Korea. *Food Sci Biotechnol*, 2014b; 23: 337 – 344. https://doi.org/10.1007/s10068-014-0047-y
69. Tanaka M, Misawa E, Ito Y, Habara N, Normaguchi K, Yamada M, Toida T, Hayasawa H, Takase M, Inagaki M, Higuchi R. Identification of five phytosterols from *Aloe vera* gel as anti-diabetic compounds. Biol. Pharm. Bull, 2006; 29(7): 1418 -1422. https://doi.10.1248/bpb.29.1418
70. Oshomo EA, Imoyera J. 2018. Phytocomponents and effect of aqueous extract of the leaves of *Alstoniaboonei* (de Wild) on serum electrolyte levels in wistar rats. IOP Conf. Series: Earth and Environmental Science 2016; 210: 01. https://iopscience.iop.org/article/10.1088/1755-1315/210/1/012016

71. Okoye NN, Ajaghaku DL, Okeke NH, Ilodigwe EE, Nwaoru CS, Okoye FBC. Journal of pharmaceutica biology, 2014; 52(11): 1478 – 1486. https://doi.org/10.3109/13880209.2014.898078
72. Zhuang J-X, Hu Y-H, Yang M-H, Liu F-J, Qiu L, Zhou X.-W, Chen Q.-X. Irreversible Competitive Inhibitory Kinetics of CardolTriene on Mushroom Tyrosinase. *J. Agric. Food. Chem*, 2010; 58: 12993–12998.
73. Tedong L, Madiraju P, Martineau LC, Vallerand D, Arnason JT, DesireDD, Lavoie L, Kamtchouing P, Haddad PS. Hydro-ethanolic extract of cashew tree (Anacardium occidentale) nut and its principal compound, anacardic acid, stimulate glucose uptake in C2C12 muscle cells. *Molecular nutrition & food research*, 2010; *54*(12): 1753–1762. https://doi.org/10.1002/mnfr.201000045
74. Matsushige A, Kotake Y, Matsunami, K, Otsuka H, Ohta S, Takeda Y. Annonamine, a new aporphine alkaloid from the leaves of *Annona muricata*. Chemical & pharmaceutical bulletin, 2012a; 60(2): 257–259. https://doi.org/10.1248/cpb.60.257
75. George VC, Kumar DN, Suresh P, and Kumar RA. Antioxidant, DNA protective efficacy and HPLC analysis of *Annona muricata* (soursop) extracts. *J. Food Sci. Technol*, 2015; 52: 2328 – 2335. https://doi.10.1007/s13197-014-1289-7
76. Ragasa CY,Geneveve S, Torres OB, Don MJ,Shen CC. Acetogenins from *Anona muricata*. Phcog J, 2012; 32(32): 32-37. https://doi.10.5530/pj.2012.32.7
77. Abubakar ANF, Achmadi SS, Suparto IH. Tritepenoid of avocado (*Persea americana*) seed and its cytotoxic activity toward breast MCF-7 and liver Hep G2 cancer cells. Asian Pac. J Trop Biomed, 2017; 7(5): 397 – 400.
78. Alok M, Versha P, Geeta P, Deepak K, Ishan D. iaAnti-hyperglycemic activity guided fractionation of aqueous extract of *Azadirachta indica* on alloxan induced diabetic rats International Journal of Research in Pharmaceutical Sciences, 2011; 2(3): 488-491. www.ijrps.pharmascope.org
79. Nweze EI, Okafor J, Njoku O. Antimicrobial Activities Of Methanolic Extracts Of Trema guineensis (Schumm And Thorn) and Morinda lucida Benth Used In Nigerian. Journal of Biological Research and Biotechnology, 2004; 2. https://doi.10.4314/br.v2i1.28540
80. Farida Y, Iswahyuni I. Isolation, identification, and antioxidant activity of chemical compound in ethanol extract of papaya leaves (Carica papaya L.). Asian Journal of Pharmaceutical and Clinical Research, 2018; 11(13): 118-21, https://doi.10.22159/ajpcr.2018.v11s1.26583

81. Osuntokun OT, Ogechi P, Yusuf-Babatunde AM, Ige OO, Mishna S. Evaluation of Antimicrobial Activity, Phytochemical Screening and Gas Chromatography-Mass Spectrophotometric Profile of Essential Oil from Persea americana & Citrus sinensis Asian Journal of Medicine and Health, 2017; 5(1): 1-1733766. https://doi.10.9734/AJMAH/2017/33766
82. Kasim NN, Ismail SN, Masdar ND, Hamid FA, Nawawi WI. Extraction and Potential of Cinnamon Essential Oil towards Repellency and Insecticidal Activity. International Journal of Scientific and Research Publications, 2014; 4(7): 1-6. www.ijsrp.org
83. Zhang M, Viennois E, Prasad M, Zhang Y, Wang L, Zhang Z, Han MK, Xiao B, Xu C, Srinivasan S, Merlin D. Edible ginger-derived nanoparticles: A novel therapeutic approach for the prevention and treatment of inflammatory bowel disease and colitis-associated cancer. *Biomaterials*, 2016; *101*: 321 – 340. https://doi.org/10.1016/j.biomaterials.06.018
84. Sandoval-Montemayor NE, García A, Elizondo-Treviño E, Garza-González E, Alvarez L, del Rayo Camacho-Corona M. Chemical composition of hexane extract of *Citrus aurantifolia* and anti-*Mycobacterium tuberculosis* activity of some of its constituents. Molecules, 2012; 17(9): 11173-84. https://doi.10.3390/molecules170911173. PMID: 22992784; PMCID: PMC6268961.
85. Cannon RJ,Kazimierski A, Carlo NL, Jing Li, Trinnaman L, Jabczuk AJ, Agyemang D, Da Costa NC, Chen MZ.Identification, Synthesis, and Characterization of Novel Sulfur-
86. Abdel-LateefE.Mahmoud F, Hammam O, El-Ahwany E, El-Wakil EA, Kandil S. Bioactive chemical constituents of *Curcuma longa* L. rhizomes extract inhibit the growth of human hepatoma cell line (HepG2) Acta Pharmaceutica, 2016; 66(3). https://doi.10.1515/acph-2016-0028
87. Mogoşanu DA,Alexandru MG,Bejenaru C, Bejenaru LE. Natural products used for food preservation. Nanotechnology in the Agri-Food Industry, 2017; 65 - 411. https://doi.org/10.1016/B978-0-12-804303-5.00011-0
88. Cheng, JF, Lu, Z. Y, Su, Y. C, Chiang, L. C, Wang, R. Y. A traditional Chinese herbal medicine used to treat dysmenorrhoea among Taiwanese women. *Journal of clinical nursing*, 2008; *17*(19): 2588–2595. https://doi.org/10.1111/j.1365-2702.2008.02382.x
89. Shah HJ Lele SS. Extraction of Diosgenin, a Bioactive Compound from Natural Source *Dioscoreaalata*Varpurpurae. Journal of Analytical & Bioanalytical Techniques, 2012; 3: 141. https://DOI.10.4172/2155-9872.1000141

90. Augustina W, Kristanti AN, Takaya Y, Fitriana E, Aminah NS. Batatasin III a derivative of dihydrostilbene compound from yam peel of Uwituban and its antioxidant avtivity. IOP Conf. Series: Journal of Physics: Conf. Series, 2018; 1116: 042003. https://doi:10.1088/1742-6596/1116/4/042003
91. Moriya C, Hosoya T, Agawa S, Sugiyama Y, Shin-ya IK, Terahara N, Kumazawa S. New acylated anthocyanins from purple yam and their antioxidant activity, Bioscience, Biotechnology, and Biochemistry, 2015; 79(9): 1484 – 1492. https://doi.10.1080/09168451.2015.1027.652
92. Zakariya AM, Dabmalam HU, Aliyu N, Sallau AB, Shehu S, Hassan SM, Ibrahim G. Isolation and Phytochemical Characterization of Bioactive Constituents from the Seeds of Garcinia kola, Heckel (Clusiaceae) British Journal of Pharmaceutical Research, 2016; 9(5): 1 – 9. https://doi.10.9734/BJPR/2016/22118
93. Kuroda M, Mimaki Y. Phenolics from Glycyrrhiza glabra and G. uralensis Roots and Their PPAR-γ Ligand-Binding Activity: Possible Application for Amelioration of Type 2 Diabetes In Biological Activities and Action Mechanisms of Licorice Ingredients, 2017; 77 - 90. http://dx.doi.org/10.5772/67406
94. Sharma V, Agrawal RC, Pandey S. Phytochemical screening and determination of Phytochemical Screening and Determination of Anti-Bacterial and Anti-oxidant Potential of*Glycyrrhiza Glabra* Root Extracts. J. Environ. Res. Develop, 2018; 7(4A): 1552 - 1558. https://www.msjonline.org
95. Batiha GE, Beshbishy AM, Wasef LG, Elewa YHA, Al-Sagan AA, El-Hack MEA, Taha AE, Abd-Elhakim YM, Devkota HP. Chemical Constituents and Pharmacological Activities of Garlic (Allium sativum L.): A Review Nutrients, 2020; 12: 872. https://doi.10.3390/nu120308721-21
96. Imo C, & Uhegbu FO. Phytochemical Analysis of *Gongronemalatifolium* Benth Leaf Using Gas Chromatographic Flame Ionization Detector International Journal of Chemical and Biomolecular Science, 2015; 1(2): 60 – 68. http://www.aiscience.org/journal/ijcbs
97. Sun J, Chen P. Ultra high-performance liquid chromatography with high-resolution mass spectrometry analysis of African mango (Irvingiagabonensis) seeds, extract, and related dietary supplements. *Journal of agricultural and food chemistry*, 2012; *60*(35): 8703–8709. https://doi.org/10.1021/jf302703u
98. Kabuki T, Nakajima H, Arai M, Ueda S, Kuwabara Y. Characterization of novel antimicrobial compounds from mango (*Mangifera indica* L.) kernel seeds Food Chemistry, 2000; 71(1): 61 – 66. https://doi.org/10.1016/S0308-8146(00)00126-6

99. Fitria F, Fatmawati S, Ersam T. Isolation of Antioxidant Compounds from *Mangifera indica* L. Leaves IPTEK Journal of Proceedings Series, 2015. http://dx.doi.org/10.12962/j23546026.y2015i1.1155
100. Costa CARA, Gargano AC, Costa M. Anxiolytic-like effect of the essential oil from *Cymbopogon citratus* in experimental procedures in mice. European Neuro psychopharmacology, 2006; 16: S475–S1475.
101. Li FH, Wang HQ, Su XM, Li CK, LiBM, Chen RY, Kang J. Constituents isolated from n-butanol extract of leaves of *Moringa oleifera*. *China journal of Chinese materia medica*, 2018; *43*(1): 114–118. https://doi.org/10.19540/j.cnki.cjcmm.20171027.009
102. Napolean P, Anitha J, Emilin RR. Isolation, analysis and identification of phytochemicals of antimicrobial activity of *Moringa oleifera* Lam. Current Biotica, 2009; 3(1): 33 – 37.
103. Gilani AH, Aftab K., Suria A, Siddiqui S, Salem R., Siddiqui, B.S, Faizi S. Pharmacological studies on hypotensive and spasmolytic activities of pure compounds from *Moringa oleifera*, Phytotherapy research, 1994; 8(2): 87-91. https://doi.org/10.1002/ptr.2650080207
104. Kaur G, Sarwar Alam M, and Atha MR. Nimbidin suppresses functions of macrophages and neutrophils: relevance to its anti-inflammatory mechanisms," Phytotherapy Research, 2004; 18(5): 419–424.
105. Subagio A, Morita N, Sawada S. Carotenoids and their fatty-acid esters in banana peel. *Journal of nutritional science and vitaminology*, 1996; *42*(6): 553–566. https://doi.org/10.3177/jnsv.42.553
106. Lamidi M, Ollivier E, Faure R, Debrauwer L, Nze-Ekekang L, Balansard G. Quinovic acid glycosides from Naucleadiderrichii. *Planta medica*, 1995; *61*(3): 280–281. https://doi.org/10.1055/s-2006-958075
107. Ajayi OS, Aderogba MA, Akinkunmi EO, Obuotor EM, Majinda RRT.Bioactive compounds from *Nauclea latifolia* leaf extracts Journal of King Saud University of Science, 2020; 32(4): 2419-2425. https://doi.org/10.1016/j.jksus.2020.03.031
108. Okoye NN, Ajaghaku DL, Okeke NH, Ilodigwe EE, Nwaoru CS, Okoye FBC. Chemical composition and anti-inflammatory activity of essential oils from the leaves of *Ocimum basilicum* L.and *Ocimum gratissimum* L. (Lamiaceae). Journal of pharmaceutica biology, 2014; 52(11): 1478-1486 https://doi.org/10.3109/13880209.2014.898078

109. Oelrichs PB, Ng JC, Seawright AA, Ward A, Schäffeler L, MacLeod JK. 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*, 1995; *3*(5): 344–349. https://doi.org/10.1002/nt.2620030504
110. Massiot G, Lavaud C, Benkhaled M, Men-Olivier L. Soya saponin VI, A New Maltol Conjugate from Alfalfa and Soybean. Journal of Natural Products - J NAT PROD, 2004; 55. https://doi.10.1021/np50087a031
111. Phakeovilay, CBourgeade-Delmes S, Perio P, Valentin A, Chassagne F, Deharo E, ReybierK, Marti G.Antileishmanial Compounds Isolated from *Psidium Guajava* L. Using a Metabolomic Approach. *Molecules*, 2019; *24*(24): 4536. https://doi.org/10.3390/molecules24244536
112. Ghosh, P, Mandal A, Chakraborty P, Rasul MG., Chakraborty C, Saha A. Triterpenoids from Psidium guajava with biocidal activity. Indian Journal of Pharmaceutical Sciences, 2010; 72: 504 – 507. DOI: https://doi.10.4103/0250-474X.73936
113. Mongalo NI, McGraw LJ, Finnie JF, Van Staden J. Pharmacological properties of extracts from six South African medicinal plants used to treat sexually transmitted infections (STIs) and related infections South African Journal of Botany, 2017; 112: 290-295. https://doi.org/10.1016/j.sajb.2017.05.031
114. Knittel DN, Lorenz P, Huber U, Stintzing FC, Kammerer DR. Characterization of the cardiac glycoside and lipid profiles of *Strophanthus kombé* Oliv. seeds. Z Naturforsch C J Biosci, 2016; 71(3-4): 55-64. doi: 10.1515/znc-2015-0186. PMID: 26974139.
115. Stevenson PC, Dayarathna TK, Belmain SR, Veitch NC. Bisdesmosidic saponins from *Securidacalongepe dunculata* roots: Evaluation of deterrency and toxicity to Coleopteran storage pests. *Journal of Agricultural and Food Chemistry*, 2009; 57: 8860–8867.
116. Ogbiko. C, Chuks E, Tambuwal AD. Extraction and Fractionation of Whole Black Seed Plantain (Plantago rugelii Decne) for in-vitro Antioxidant, Antibacterial and Phytochemical Screening, 2018; 10.4314/jasem.v22i5.01.
117. Oladipupo RA, Alaribe SC, Balogun TO, Akere TH, Ayanda AF, Toye TE, Coke AB.Haematological and Genotoxicity Evaluations of Phytochemical Compounds from n-Hexane Extract of *Uvaria chamae* Stem on Selected Organs in Mice.Herbert Annals of Science and Technology – B, 2018; 3(1): 28 - 34. https://doi.10.2478/ast-2018-0012

118. Abay SM, Lucantoni L, Dahiya N. DoriG, Dembo EG, Esposito F, Lupidi G, Ogboi S, Ouédraogo, R.K., Sinisi A, Taglialatela-Scafati O,Yerbanga RS, Bramucci M, Quassinti L, Ouédraogo JB, Christophides G, Habluetzel A. . *Plasmodium* transmission blocking activities of *Vernonia amygdalina* extracts and isolated compounds. *Malar J*, 2015; 14: 288. https://doi.org/10.1186/s12936-015-0812-2
119. Nishidonoa Y, Saifudinb A, Nishizawac M, Fujitaa T, Nakamotoa M, Tanakaa K. Identification of the Chemical Constituents in Ginger (*Zingiber officinale*) Responsible for Thermogenesis Natural Product Communications, 2018; 13 (7): 869-873. https://doi.org/10.1177/1934578X1801300722
120. Samad MB, Mohsin MNAB, Razu BA, Hossain MT, Mahzabeen S, Unnoor N, Muna IA, Akhter F, Kabir AU, Hannan JMA. [6]-Gingerol, from Zingiber officinale, potentiates GLP-1 mediated glucose-stimulated insulin secretion pathway in pancreatic β-cells and increases RAB8/RAB10-regulated membrane presentation of GLUT4 transporters in skeletal muscle to improve hyperglycemia in Lepr$^{db/db}$ type 2 diabetic mice. BMC Complement Altern Med, 2017; 17(1): 395. https://doi.10.1186/s12906-017-1903-0.
121. World Health Organization. Global report on diabetes. WHO Press, World Health Organization, 2016; 20, 1211: 27. Switzerlandhttps://www.who.int/publications/i/item/9789241565257