Review Article

Indigenous Antidiabetic Medicinal Plants used in Nigeria: A Review

Abstract

Diabetes mellitus is among the most prevalent endocrine disease that causes morbidity and mortality in Nigeria. Traditional medical system has been used for the both prevention and treatment of diabetes mellitus since ages. This paper reviewed the use of 35 Nigerian plants with putative anti-diabetic propertieswith the help of published literature. As per the International Union for Conservation of Nature (IUCN), status of these species include Sterculia tragacantha, *Newbouldia laevis, Solanum anomalum***,** Ficus exasperate, *Raffia palm (Raphia hookeri) Azadirachta indica, Syzygium cumini, Terminalia catapp, Solanum macrocarpon, Petersianthus macrocarpus, Xylopia aethiopica, Costus aferker-gawl, Spondias mombin, Eucalyptus globulus Parkia biglobosa, Persea americana, Anacardium occidentale, Vernonia amygdalina as* least concern. While the status of *Hunteria umbellate* and *Vitex doniana* are reported as threatened and *Dacryodes edulis* and *Dennettia tripetala* as vulnerable species. However, the status of *Annona muricata, Chrysophyllum albidum, Citrus paradisi Macfad, Aloe vera (Aloe barbadensis)* are not evaluated. The following species like *Phyllanthus amarus, Phyllanthus niruri* and *Telfairia occidentalis* are data deficient. Most of the species belonging to common families like *Solanaceae, Anacardiaceae, Euphorbiaceae, Annonaceae* and *Rutaceae.* This review offers relevant information and recent scientific findings on the plants used to treat and manage diabetes in Nigeria. The cellular mechanisms through which these natural agents exert their protective and therapeutic effects on diabetes mellitus may include antioxidative stress, restricting the breakdown of glycogen, pancreatic β-cell regeneration, gluconeogenesis, anti-inflammatory and intracellular signals transduction pathways. This study concludes that indigenous medicinal herbs utilized in Nigeria have the potential to treat diabetes mellitus in Nigeria. Further studies are needed to discover the source of potential drugs from these indigenous plants.

Keywords: Diabetes, Medicinal plant, Nigeria, Traditional, Hyperglycemia

1.Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by either inadequate insulin secretion, inadequate cellular action of the insulin, or both [1]. Long-term hyperglycemia results in remodeling of the vessel wall in the retinal and renal circulations, which leads to retinopathy with a potential for vision loss and nephropathy [2]. These conditions are caused by inadequate insulin action on target tissues, which results in abnormal metabolism of carbohydrates, lipids, and proteins [1]. One of the root causes of diabetes is the environment, which includes obesity, diet, physical activity, lifestyle, and an increase in the number of senior individuals [3]. While type 2 diabetes (T2D) is the most common form of diabetes, type 1 diabetes (T1D) is characterized by the β -cells' inability to release insulin and/or the cells' inability to utilize the insulin secreted by the pancreatic β–cells [4]. Gestational diabetes mellitus (GDM), is characterized as a state of hyperglycemia that is discovered during pregnancy. GDM affects over 15% of pregnancies globally, resulting in almost 18 million births each year [5].

The prevalence of diabetes is projected to rise globally at 10.2% (578 million) by 2030 and 10.9% (700 million) by 2045 [6]. This way, there will be 41.5 million cases of diabetes in the African region by 2035 [7]. All regions of Nigeria have seen a considerable rise in the frequency of DM, with the south-south geopolitical zone seeing the highest prevalence [8]. Diabetes mellitus is treated with insulin, dietary changes, and oral hypoglycemic medications. However, because of high cost of allopathic medications and their associated side effects on the human bodies most of the population in third word countries like African and South East Asian countries the major part of the society is relying on the traditional indigenous source of medicines for many ailments including diabetes mellitus in modern times [9, 10] [10]. According to reports, out of the 1355 novel medications that were approved between 1981 and 2010, 26% were from natural sources [11,12].

Furthermore, herbs are a fundamental component of African systems, approximately 80% of people worldwide rely on herbs for treatment, maintenance, and prevention of disease [13]. Numerous medicinal plants have been identified for the treatment of diabetes in Nigeria, and the efficacy of folkloric claims of these plants has been validated by several studies; linking their therapeutic effects to their phytochemical composition. Hence, it is pertinent to identify some of these plants that have anti-diabetic properties.

2. Method

2.1 Lecture search process

The review was conducted using English keywords to search on the internet; using Google Scholar, African Journal Online, Elsevier, SCOPUS, Medline, Science Direct, Web of Science, PubMed and ResearchGate on the use of plants in Nigerian traditional medicine for the treatment and management of diabetes. The search terms utilized were ‘diabetes in Nigeria’, ‘hypoglycemic plants in Nigeria’, ‘Nigerian plants with anti-diabetic potential’ and ‘anti-diabetic medicinal plants in Nigeria’. This review only includes articles that were published. English language articles were included after language restriction was taken into account. Scientific names of plants, traditional use of the plant to treat illness, plant parts, plant extract, phytochemical components (if stated), diabetes type, and animal mode for in vivo and in vitro research were all extracted from the included papers. A total of 414 articles were found and

subsequently assessed for their applicability to the topic of interest. 120 papers were deemed relevant to the subject of this evaluation, however we only looked at 35 of Nigeria's most well-known plants used to treat diabetes.

3. Results and Discussions

A total of 35 peer-reviewed publications that discussed the use of medicinal plants in Nigeria to treat diabetes were located. The current review's primary focus is on experimental research done on the hypoglycemic activity of the plants. This paper's summary findings and discussions provide an updated overview of medicinal plants used in Nigeria for the prevention and treatment of diabetes mellitus, including *Sterculia tragacantha, Hunteria umbellate, Solanum anomalum, Gongronema latifolium, Azadirachta indica, Chrysophyllum albidum,* and *Phyllanthus niruri*. With the exception of the exotic plants such as Terminalia catappa, Persea Americana, Annona muricata, Murraya koenigii, and Citrus paradisi Macfa; most of the plants are native to Nigeria. In the current study, we emphasized their key findings in the present article. These are discussed in more detail below.

Sterculia tragacantha **Lindley**

Sterculia tragacantha (family: *Sterculiaceae).* It is referred to as 'Abalo' (Igbo) and 'Uhobo' (Yoruba). It is frequently used to treat common cold, infectious disorders, gout, diarrhea, edema, and diabetes [14]. The streptozotocin (STZ)-induced diabetic rats were treated with aqueous extract of *Sterculia tragacantha* leaf. Treatment with *Sterculia tragacantha* caused dose dependent and progressive decreases in the fasting blood glucose ($p<0.0001$) and improvement of the body weight ($p<0.001$). There was increase in the activities of superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), reduced glutathione (GSH) levels and a reduction of thiobarbituric acid reactive substances (TBARS). Additionally, it controls the anti-inflammatory response by blocking the cyclooxygenase-2/ nitric oxide (COX-2/NO) signaling axis in diabetic rats' brains, suggesting that the plant have bioactive components that may be accountable for its antidiabetic and neuroprotective activities [15]

Hunteria umbellata **K. Schum**

Hunteria umbellata (family: *Apocynaceae*). It is known as 'erin' (Yoruba) and 'nkpokiri (Ibo). *Hunteria umbellata* is used to treat diabetes, obesity, fever, leprosy sores, menstrual pain, infertility, yaws, intestinal worms, abdominal discomfort, and stomach aches [16]. The plant phytochemicals identified are saponin, flavonoids, glycosides, steroids, tannins, volatile oils, phenols, and a significant amount of alkaloids [17]. The STZ-induced diabetic rats were treated with water extract of *Hunteria umbellata* seed. The extract significantly ($P = .05$) decreased blood glucose, serum total protein, alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), bilirubin levels, and glycated hemoglobin levels while increasing hemoglobin (Hb), Red blood cell count (RBC), neutrophil, lymphocyte counts and liver glycogen levels [18,19]. Similar studies showed an increase in catalase (CAT), Glutathione S-Transferase (GST) and reduced malondialdehyde (MDA) levels; hence, extract ability to lower blood glucose may be by inhibition of intestinal glucose absorption and increased glycogenesis [20].

Newbouldia laevis Palisot de Beauvois

Newbouldia laevis (family: *Bignoniaceae)*, its local names are 'Ogirisi' (Igbo), 'Akoko' (Yoruba) and 'Aduruku' (Hausa). The plant is used to treat and manage diseases like diabetes, hypertension, inflammation, skin diseases, ulcers, tumors, constipation, pains, infectious diseases, toothache, dysentery, impotence, sore feet, wound healing, orchitis, anaemia, ulcer, epilepsy, convulsion, arthritis, migraine, eye problems, snake bites, and rheumatism [21]. Glycosides, anthraquinolones, steroids, volatile oils, tannins, terpenoids, alkaloids, flavonoids, proteins, oil, saponins, carbohydrates, resins, sterols, reducing sugar and acidic compounds are some of the phytochemical components of the plant [21,23]. When *Newbouldia laevis* leaf extract was administered to alloxan-induced diabetic rats, the blood glucose level, platelet count, and white blood cells (WBC) all decreased significantly ($P = .05$). Significantly ($P = .05$) lowered were the activities of ALT, AST, ALP, total bilirubin, urea, and creatinine. There was also an increase in serum total protein, total antioxidant status (TAS), RBC and its indicators [24].

***Vitex doniana* Sweet**

*Vitex doniana (*family: *Verbenaceae*), it is known as 'Dinya' (Hausa), 'Oori-nla' (Yoruba), and 'Uchakoro' (Igbo). Leprosy, dysentery, diarrhea, anemia, jaundice, gonorrhea, backaches and diabetes are among the conditions that are historically treated using *Vitex doniana* leaves [25]. Flavonoids, tannins, saponins, anthraquinones, balsam, sugars, resin, cardiac glycosides, and alkaloids are among the phytochemicals found in the plant [26]. Alloxan-induced diabetic rats were treated with *Vitex doniana,* which dramatically decreased serum blood glucose and MDA concentrations while considerably increasing body weight, superoxide dismutase SOD, CAT, GST, and ascorbic acid concentrations ($P = .05$). Histological studies of the diabetic rats administered aqueous and ethanolic leaves of *Vitex doniana* in streptozotocin-induced diabetic rats showed increase; in the volume density of islets, percentage of β-cells and size of islet, which suggested regeneration of β-cells. Furthermore, there was a significant decrease ($P = .05$) in ALT, AST and ALP [27].

***Solanum anomalum* Thonn. ex Schumach**

The *Solanum anomalum* (family; *Solanaceae)*, the plant is utilized to treat conditions including diabetes, gastrointestinal disorders, infections, inflammation, and aches [28,29]. *Solanum anomalum* was shown to include phytochemicals like steroidal saponins, steroidal alkaloids, flavonoids, phenolic compounds and coumarins [29]. Alloxan-induced hyperglycemia in rats was tested using *Solanum anomalum* leaf extract and hydroethanolic fractions; fasting blood glucose, glycosylated hemoglobin, triglycerides, LDL and VLDL cholesterol levels were significantly ($P = .05$) lowered. In contrast insulin and HDL cholesterol were increased [30]. Additionally, the leaf extract significantly increased the levels SOD, CAT, Glutathione peroxidase (GPx), and GSH. There was a decrease in total and direct bilirubin, ALT, AST, and ALP [31].

***Ficus exasperate* (Vahl)**

Ficus exasperata (family *Moraceae)*, is known as 'Ewe Ipin' (Yoruba), 'Baure' (Hausa), and 'Asesa' (Igbo). The plant is used as a stimulant; used to treat stomach pains, ulcers, arrest bleeding and diabetes mellitus [32]. The phytochemicals present are alkaloids, flavonoids, tannins, cyanogenic glycosides, saponins, and polyphenolic substances [33]. STZ was administered intraperitoneally many times at modest doses to produce Type 1 Diabetes Mellitus. When aqueous *Ficus exasperata* leaf extract was administered; blood glucose, blood pressure, and lipid profiles were all reduced, and the blood vessel microanatomy was nearly restored to

normal [32]. The animals' body weight, packed cell volume (PCV), Hb concentration, and RBC all improved after treatment with the plant extract [34].

***Gongronema latifolium* (Benth)**

Gongronema latifolium (family: *Asclepiadaceae*), is known as "arokeke" (Yoruba) and "utazi" (Igbo). The leaves are used to treat diabetes, hypertension, intestinal worms, colic, diarrhea, nausea, anorexia, and malaria [35]. It has phytochemicals like glycosides, alkaloids, flavonoids, saponins, saponins, tannins, essential oils, and total phenols [36]. Alloxan-induced diabetic rats received *Gongronema latifolium* leaf extract, which significantly reversed the changes in fasting blood glucose (FBG) levels. With an increase in CAT, SOD, and GPx activity in the kidneys and brains. The MDA, NO, acetylcholinesterase (AChE), butyrylcholinesterase (BChE), dopamine (DOPA), serotonin, epinephrine, nor-epinephrine, cyclooxygenase (COX-2) activity levels were decreased. Antioxidant protection against oxidative stress was strengthened and the brain's neurotransmitters are modulated as a result of *Gongronema latifolium* neuroprotective action [37]. Similar studies have found that *Gongronema latifolium* effectively increases the liver glycogen content, antioxidant enzyme activities, levels of glucose transporters (GLUT-2 and GLUT-4), and relative hexokinase gene expression. It's possible that an increase in insulin secretion is what causes the observed elevations in GLUT 2 and GLUT 4 levels [38].

Ocimum gratissimum var, suave (willd.)

Ocimum gratissimum (family: Lamiaceae), is called ‘Effinrin-na’ (Yoruba), ‘Nchanwu’ (Igbo), and ‘Daidoya’ (Hausa). *Ocimum gratissimum* has historically been used to treat diabetes mellitus, kidney infections, warts, headaches, and diarrhoea [39]. Flavonoids, saponins, polyphenols, glycosides, alkaloids, tannins, steroids, terpenoids, and carbohydrates are among the phytochemicals present in *Ocimum gratissimum* [40]. In STZ-induced diabetes, treatment with fractions (n-hexane, chloroform, ethyl-acetate, n-butanol, and water) of *Ocimum gratissimum* increased body weight, glucose tolerance, available blood insulin, insulin sensitivity; and decreased FBG (40). Similar research revealed significantly (P = .05) decreased TC, LDL, and VLDL levels and higher HDL levels [41].

***Dacryodes edulis* (G.Don)** Lamarck

Dacryodes edulis (family: *Burseraceae*), it is known as "Ube Igbo" (Igbo) and "Eleme" (Yoruba). The plant is used to treat fever, diabetes, leprosy, malaria, diarrhea, hypertension, skin illnesses, labor pain, retarded growth, oral and ear ailments [42, 43]. Flavonoids, alkaloids, glycosides, tannins, saponins, steroids, reducing sugars, hydrogen cyanide and soluble carbohydrates are among the phytochemicals found in *Dacryodes edulis* [42]. Fruit extract from *Dacryodes edulis* was used to treat alloxan-induced diabetic rats; it lowered blood glucose, total cholesterol, triglycerides, LDL-C, ALT, and ALP levels. However, the levels of HDL-C significantly increased. The pancreatic histology was nearly restored to normal, with clearly defined islets [42]. A significant (P = .05) increase in the levels of insulin, GSH, SOD, and CAT, and decrease in MDA, and concurrent inhibition of α -amylase and α -glucosidase activities [44]. Another study using fructose-STZ-induced diabetic rats, found that pancreatic morphology and β -cell function were considerably enhanced in rats treated with the butanol

fraction of the plant extract and there was repair of the pancreatic capillary networks. Along with lowering the expression of Nrf2, there was a significant (P = .05) suppression of the activities of glycogen phosphorylase, fructose 1,6 biphosphatase, glucose 6 phosphatase, and acetylcholinesterase [45].

Raffia palm (Raphia hookeri) G. Mann & H. Wendl

Raffia palm (family; Arecaceae) wine (RPW) is one of the natural products from Raffia palm. It is known by the common names 'palmy', 'oguro', 'emu' 'tombo', 'nkwu ocha' and 'nkwu enu'. Ascorbic acid, B-vitamin complex, notably thiamine, potassium, magnesium, calcium, sodium, phosphorus, and nitrogen have all been identified as being present in palm wine. For sweetness, it also contains sucrose, glucose, xylose, raffinose, and lactose [46, 47]. Palm wine is used alone or in combination with other medicinal herbs such as the fresh leaves or the stem of *Gongronema latifolium*, coconut oil, to treat diabetes mellitus, digestive health, and the overall welfare of breastfeeding women [48]. When administered to STZ-induced diabetic rats; RPW produced a significant (P = .05) increase in insulin, GSH, SOD, catalase, ATPase and HDL-c, whereas the blood glucose, fructosamine, ALT, uric acid, triglycerides, LDL-c, MDA, NO and myeloperoxidase activity were reduced. The activities of fructose 1, 6-bisphosphatase, glucose-6-phosphatase, and acetylcholinesterase were also reduced. RPW restored the shape and capillary networks of beta-cells while enhancing pancreatic beta-cell function. RPW controls glucose homeostasis by increasing insulin secretion and preventing redox imbalance in diabetes [49].

Azadirachta indica **A. Juss.**

Azadirachta indica (family: *Meliaceae)*, is known as 'Maina' (Hausa), 'Ogwu-akom' (Igbo), and 'Dogonyaro' (Yoruba). It is used to treat diabetes mellitus, malaria, headaches, stomach ulcers, jaundice, anemia, dental issues, and bacterial, fungal, and viral infections [50, 51]. Alkaloids, cardiac glycosides, flavonoids, oxalate, phenol, phytate, saponin, steroid, tannin, and triterpenoids are among the phytochemicals found in *Azadirachta indica* leaves [52]. The effect of aqueous extract of *Azadirachta indica* leaf on STZ-induced diabetes revealed an enhanced Hb concentration, PCV, RBC, platelet count and an increase in HDL-c. The total cholesterol, LDL-c, triglycerides, and VLDL were all significantly (P = .05) decreased. Additionally, pancreatic islet regeneration was demonstrated by histological studies [53].

Terminalia catappa **Linnaeus**

Terminalia catappa (family: *Combretaceae)*, it goes by the Yoruba name 'Furutu' and is referred to as 'fruit' by other tribes in Nigeria. Rheumatism, diarrhea, dysentery, diabetes, gonorrhea, stomach pains, headache, sexual dysfunction, anti-diabetic, itching, anti-indigestion, skin conditions, arthritis and colic are all treated with all parts of the plant [54]. The plant phytochemicals include vitamins, carotenoids, alkaloids, tannins, flavonoids, terpenoids, saponins, phenols and steroids [55]**.** High-fat diet and low dose STZ induced diabetic rats were treated with aqueous root bark and flower extracts of *Terminalia catappa;* the blood glucose, total cholesterol, triglyceride, LDL, serum liver marker enzyme, kidney indicators, and bilirubin levels significantly (P = .05) decreased, while albumin, total protein, electrolytes, certain hematological markers and antioxidants showed a significant (P = .05) increase and there was an improved β-cell function and insulin resistance indices. The microanatomy of the pancreas

was also enhanced [56]. The expression of the mRNA for the glucose transporter isoform 4 (GLUT-4), protein kinase B (AKT), phosphatidylinositol 3-kinase (PI3K), and insulin receptor substrate 1 (IRS-1) were unaffected. Therefore, *Terminalia catappa* reverses insulin resistance, enhances glucose transport, and activates PI3K/AKT signaling to provide its antidiabetic activities [57].

Syzygium cumini Linn

Syzygium cumini (family; *Myrtaceae*), is called 'Ori' (Yoruba) and 'Malmoo' (Hausa). The plant is used to treat diabetes, hypertension, fever, diarrhea, abdominal aches, and strengthening of the teeth and gums [58]. The phytochemical screening identified the presence of sterols, phlobatanins, volatile oil, saponins, tannins, terpenes, and flavonoids [58]. In alloxan-induced diabetes, treatment with *Syzygium cumini* leaf extract decreased fasting blood glucose, glycated hemoglobin levels (HbA1C), MDA, glucose-6-phosphatase activity. Additionally, there was a significant (P = .05) increase in the levels of GLUT 2, the pancreatic beta-cell scores, SOD, CAT, and GPx, and hexokinase activities [59].

Solanum macrocarpon Linn

Solanum macrocarpon Linn (family: Solanaceae), it is called 'gbagba pupa' (Yoruba), 'aara' (Igbo), and 'Ganyen Gauta' (Hausa). The plant is used in lowering blood cholesterol levels, controlling high blood pressure, losing weight, possessing anti-haemorrhoidal and anti-glaucoma characteristics [60]. It contains phytochemicals such as tannin, phenol, saponins, cardiac glycoside, flavonoid, alkaloid, reducing sugar, terpenoids, phytates and cyanides [61]. The effect of aqueous extract of *Solanum macrocarpon* leaf on alloxan-induced rat model of diabetes showed a significant (P = .05) decreased in FBG levels, glycated Hb, serum lipid profiles, lipid peroxidation, and glucose-6-phosphatase. Hexokinase activity, liver glycogen level, antioxidant enzyme activities, and the expression of the GLUT-2 and GLUT-4 glucose transporter genes all increased significantly (P = .05) [62]. Similar findings reported a significantly reduced levels of neurotransmitters, cholinesterases, cyclooxygenase-2 and nitric oxide in the brain of an alloxan-induced rat model of diabetes. Solanum macrocarpon leaf aqueous extract may be helpful in the treatment of diabetic neuropathy [63].

Chrysophyllum albidum G.Don

Chrysophyllum albidum (family: *Sapotaceae*), its common names include 'Agbalumo' (Yoruba), 'udara' (Igbo), and 'Agwaliba' (Hausa). The plant is used for treating skin eruptions, stomach ache, diarrhea, diabetes, sleeping sickness, yellow fever, and malaria [64]. Among the phytochemicals found are tannins, alkaloids, terpenoids, flavonoids, saponins, reducing sugar, steroids, and cardiac glycosides [65]. *Chrysophyllum albidum* leaf extract was utilized to treat STZ-induced diabetes. The body weight, SOD, CAT, glutathione, HDL, and insulin levels significantly (P = .05) increased, while the MDA, LDL, triglycerides, and total cholesterone levels were significantly (P = .05) decreased. Histologically there was a recovery of damaged islets and an improvement in the number of islet cells [66, 67].

*Petersianthus macrocarpus (*P.Beauv.) Liben

Petersianthus macrocarpus (family: *Lecythidaceae*), the Igbo's call it 'Ogbu Onya'. It is used to relieve pain and fever associated with malaria, headaches, "recurrent" fever, constipation,

hemorrhoids, and venereal illnesses. It also works as an abortifacient and has hypotensive effects [68]. Alkaloids, saponins, tannins, phenols, flavonoids, cardiac glycosides, steroids, terpenoids, anthocyanins, and anthraquinones were all detected during phytochemical screening [68]. Treating STZ-induced diabetes with *Petersianthus macrocarpus* resulted in a significantly lower blood glucose levels and histologically there was evidence of a granulated and conspicuous pancreatic islet of Langerhans. [69].

.

***Costus afer Ker-Gawl* K.Schum.**

Costus afer Ker-Gawl (family: *Costaceae),* it is known as 'tete-egun' (Yoruba), 'Okpete' or 'Okpoto' (Igbo), and 'Kakizawa' (Hausa). It is used to treat malaria, diabetes mellitus, measles, arthritis, sore throats, headache, stomach disorders, coughs, urethral discharges, venereal infections, jaundice, miscarriage, and respiratory issues [70]. Alkaloids, flavonoids, tannins, phenols, glycosides, terpenoids, steroidal sapogenins, and saponins are among the phytochemicals present in the plant [71]. Ethanolic leaves extract of *Costus afer Ker-Gawl* was used to treat alloxan-induced diabetes, the result showed a significant (P = .05) decreased in blood glucose levels. Histologically, the islets of Langerhans were restored [72].

***Senecio biafrae* (Oliv. & Hiern)**

Senecio biafrae (family Asteraceae), is known locally as 'worowo' (Yoruba) and 'Ota eke' (Igbo). It is used to treat cases of infertility in women, diabetes, pulmonary defects, cough, bleeding from cuts, sore eyes, rheumatic pain, and localized oedema [73, 74]. Alkaloids, saponin, glycosides, tannin, phlobatannin, phenol, flavonoids, steroids and chalocones are among the phytochemicals present in *Senecio biafrae* [75]. Studies on the effects of aqueous leaf extract of *Senecio biafrae* on alloxan-induced diabetic rats revealed a significant reduction ($P< 0.05$) in blood glucose, total cholesterol, triglycerides, LDL-c and VLDL levels and an increase in HDL levels, Hb, RBC, platelets, PCV, WBC, Mean corpuscular hemoglobin concentration, mean corpuscular volume, and mean corpuscular hemoglobin [76,77].

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

Xylopia aethiopica (family: *Annonaceae*), the fruit is called 'uda' (Igbo), 'Kimba' (Hausa), and 'eeru' (Yoruba). It can be used as an abortifacient; and used to treat diabetes, dysentery, diarrhea, stomach disorders, menstrual irregularities, nasopharyngeal infections, arthritis, rheumatism and infections [78]. Phytochemical analysis shows the presence of alkaloids, saponins, flavonoids, tannins, terpenes, steroids, and cardiac glycosides [78]. A near-normal islet of Langerhans was observed during histological analysis of the pancreas in STZ-induced diabetic rats treated with an aqueous leaf extract of *Xylopia aethiopica*. There was more pronounced insulin staining, also a significant (P = .05) increase in the proportion of immunolabelled surface area was observed. Hence, the extract can cause β-cells to release insulin [79]. Similar research revealed significantly decreased levels of blood glucose, fructosamine, LDH, and serum lipids and increased serum insulin, β -cell function (HOMA-) and glucose tolerance ability [80].

***Carica papaya* Linnaeus**

Carica papaya (family: *Caricaceae),* the plant is known as 'Ibepe' (Yoruba) 'Gwanda' (Hausa) and 'Okwere' (Igbo) in the Yoruba, Hausa, The plant is used to treat diabetes, obesity, infections, dengue fever, jaundice, stomach pain and malaria [81]. Phytochemical analyses revealed the presence of alkaloids, flavonoids, saponins, tannins, anthraquinones, anthocyanosides, and reducing sugars [81]. Diabetic rats induced with STZ received oral administration of *Carica papaya* seed extracts. The extract significantly lowered blood glucose,

inhibit α -amylase and α -glucosidase enzymes [82]. In alloxan-induced diabetes, the *Carica papaya* extract significantly decreased plasma total cholesterol, triglycerides, LDL-C and increase plasma HDL-C [83].

***Spondias mombin* Linn.**

Spondias mombin (family: *Anacardiaceae)*, is called *'Iyeye'* (Yoruba), *'Ngulungwu'* (Igbo*) and 'isada'* (Hausa). *Spondias mombin* is used to treat gonorrhea, diabetes, diarrhea, and the placenta ejection in goats and women [23]. Phenolic acids, flavonoids, tannins, triterpenes, steroids, reducing sugar, alkaloids, anthraquinones, and saponins are among the phytochemicals present in *Spondias mombin* [84]. *Spondias mombin* was used to treat STZ induced diabetic rats; there was a significant decrease in the levels of blood glucose, ALT, ALP, total bilirubin, urea, creatinine, total serum cholesterol, triglyceride, LDL-C, VLDL, and there was an increased in plasma insulin, total protein, albumin, globulin and HDL-C (84). A similar report was observed in treating alloxan induced diabetic rats with *Spondias mombin*. The extract exhibited a significant blood glucose-lowering effect in the oral glucose tolerance test [85].

Anacardium occidentale Linnaeus

Anacardium occidentale, (family: *Anacardiaceae)*, is called 'Kash' (Hausa),' Okpokpo' (Ibo), and 'Kaju' (Yoruba). Diarrhea, diabetes, dysentery, colonic pain, malaria, asthma, leprosy, internal worm infections, constipation, warts, and sore throat are all conditions that the plant is used to treat [86]. Phytochemicals present include; saponin, phenolics, tannins, flavonoids, coumarins, terpenoids, glycoside, oxalate, phytate, quercetin, vitamins, and selenium [87]. Treatment of STZ-induced diabetes with the leave extract of *Anacardium occidental* resulted in a significant decrease in fasting blood sugar ($P = .05$) and regeneration of beta cells [86]. A similar study was reported on aqueous and methanolic *A. occidentale* stem-bark extracts, which significantly reduced ($P < 0.001$) basal blood glucose concentrations of fasted normal and fasted STZ- induced diabetic rats.

Eucalyptus globulus Labillardière

Eucalyptus globulus (family: *Myrtaceae*), commonly referred to as Tasmanian Blue Gum. Fresh leaves of the plant are traditionally used to treat conditions like cough, lung problems, diabetes, catarrh, inflammation, flu, and liver infections [88]. Phytochemicals present includes; cardiac glycosides, alkaloids, tannins, terpenoids saponins, steroids, and phenolic compounds [89]. The effects of *Eucalyptus globules* leaves on alloxan-induced diabetic rats showed a significantly reduced fasting glucose level, MDA, HC03-, and liver enzymes. There was a significantly ($P = .05$) increase in serum levels of xantine oxidase and CAT [90].

***Phyllanthus amarus* Schumach. &Thonn.**

Phyllanthus amarus (family: *Euphorbiaceae*), is called 'Iyin-Olobe' (Yoruba) and 'ngwu' (Igbo). It is used to treat liver diseases, renal stone diseases, diabetes mellitus, menstrual disorders, infections, inflammation, pain, skin ulcers, typhoid fever, hyperlipidemia, hypertension and anemia [91]. Alkaloids, tannins, saponins, anthraquinones, cardiac glycosides, and flavonoids are among the phytochemicals present in *Phyllanthus amarus* [92]. Diabetes was induced in rats using alloxan and it was treated with aqueous leaf extract of *Phyllanthus amarus*; there was a significant reduction in fasting blood glucose. Histologically, the architecture of the pancreas appeared intact [93].

***Phyllanthus niruri* Linn**

Phyllanthus niruri L (family: *Euphorbiaceae*), is known as 'enyikwonwa and ngwu' (Igbo); 'geeron-tsuntsaayee' (Hausa) and 'ehin olobe' or' yin-olobe.' (Yoruba). It is used as a diuretic, laxative, dysentery and to treat tumors, kidney stones, fever, diabetes, constipation, tuberculosis, jaundice, hepatitis B, syphilis, gonorrhea [94]. Flavonoids, alkaloids, terpenoids, polyphenols, tannins, coumarins, and saponins are the active phytochemicals present in *Phyllanthus niruri* [95]. The methanol extract of aerial parts of *Phyllanthus niruri* was used to treat alloxan induced-diabetic rats. *Phyllanthus niruri* significantly (P = .05) reduced fasting blood sugar and suppressed the postprandial rise in blood glucose. There was a decrease total cholesterol and triglycerides levels. Additionally, *Phyllanthus niruri* treated had increased body weight and the histological studies showed that the pancreas architecture was restored [94]. Okoli et al [96] reported a decrease in Hb glycation and an increased in the liver glycogen levels; in vitro, the extract also inhibited α-amylase and α-glucosidase activities. Hence, *Phyllanthus niruri* may owe their blood glucose-lowering properties to the inhibition of glucose absorption and enhancement of glucose storage [96].

Parkia biglobosa (Jacq.) G. Don

Parkia biglobosa (family: *Fabaceae*), is called 'Dawadawa' (Hausa), 'Ogiri' (Igbo), and 'iru' (Yoruba). *Parkia biglobosa* is used to treat diabetes mellitus, infections, malaria, and inflammatory diseases [97]. The plant is reported to contain phenols, flavonoids, sugars, tannins, terpenoids, steroids, saponins, alkaloids, glycosides, alkaloids, and phenols [98]. The hydromethanol extract from *Parkia biglobosa* stem bark significantly attenuated serum glucose level and glycosylated Hb in fructose-STZ induced type 2 diabetics. There was also an increase in the hepatic hexokinase activity and glycogen level; increase pancreatic SOD, CAT and decreased in MDA level. The seed extract of *Parkia biglobosa* also decreases the blood glucose levels in glucose-loaded and alloxan-induced diabetic rats [99].

***Persea Americana* (Cham. & Schltdl.)**

Persea americana (family: *Lauraceae*), it local names are ''Ewé pia' (Yoruba), 'Akwukwo Ube oyibo' (Igbo), and 'Ganyen piya' (Hausa). The leaves have been used as an effective antihypertensive, antidiabetic, anti-inflammatory remedies, analgesic, and for treating malaria [100]. The phytochemicals present includes; flavonoids, tannins, alkaloid, saponins, glycosides, phenolic, and triterpenoid [101]. The aqueous extract of *Persea americana* seeds was used to treat alloxan-induced diabetes, the in vitro analyses showed the potency of the extract against free radicals and its enzyme inhibitory potential. *Persea americana* seeds showed a marked decrease in FBG, TG, LDL-c, G6P, F-1, 6-BP, MDA, IL-6, TNF-α, and NF-κB and increase in liver glycogen, hexokinase, and HDL-c. The HPLC revealed luteolin and myricetin to be the phytochemicals that were present in the highest concentration in the extract. Hence, *Persea americana* seeds can promote the activation of the phosphatidylinositol 3-kinase - PI3K/AkT pathway and the inhibition of β-cell death, which may be the primary mechanism by which *Persea americana* seeds promote insulin sensitivity and regulates glycolipid metabolism [102].

Annona muricata Linnaeus

Annona muricata (family: *Annonaceae*), is called 'ebo' or 'apekan' (Yoruba), 'fasadarur' or 'tuwon biri' (Hausa), and 'sawansop' (Ibo). it is used as a laxative, purgative; used to treat fever, wound healing, skin diseases, diabetes, and internal and external parasites [103,104]. The presence of the following phytochemical were detected in Annona muricata; flavonoids, alkaloids, terpenoids, tannins, carbohydrates, saponins, cardiac glycosides, phytosterols, and proteins [104]. Alloxan-induced diabetic rats treated with *Annona muricata* peel inhibited α-amylase and α-glucosidase enzymes and reduced FBG levels, Homeostatic Model Assessment for Insulin Resistance (HOMA-IR), glucose 6-phosphatase (G6P), fructose1,6-bisphosphatase (F-1,6-BP), MDA, TG, TC, IL-6, TNF-α, and NF-Kb. Furthermore, *Annona muricata* improved serum insulin levels, homeostasis model assessment of β-cell function (HOMA-β), hexokinase, CAT, GST, and HDL-c. *Annona muricata* significantly up-regulated expression of AKT and Bcl2 in the liver and pancreatic tissue [103].

***Ocimum basilicum* Linnaeus**

Ocimum basilicum (family: *Lamiaceae*), is called 'Effirin' (Yoruba), 'Nchanwu' (Igbo), Dodoya' (Hausa). It is used to treat headaches, coughs, diabetes, diarrhea, constipation, digestive problems, warts, worms, tooth decay, kidney malfunction and inflammation [105]. Phytochemicals presents in the plant are terpenoids, alkaloids, flavonoids, tannins, saponin glycoside, and ascorbic acid [106]. The treatment with the extract of *Ocimum basilicum* on alloxan induced diabetes rats significantly ($P = .05$) reduced FBG concentration, ALT, AST, serum cholesterol and triglycerides and slightly increased mean body weight. Also, oral glucose tolerance was significantly ($P = .05$) improved. The extract increase liver glycogen content and produce significant ($P < 0.001$) inhibition of α-glucosidase and α amylase [107].

***Vernonia amygdalina* (Delile)**

Vernonia amygdalina (family: *Compositae*), is called 'ewuro' (Yoruba), 'Onugbu' (Igbo), 'doki' (Hausa). The plant act as a remedy against diabetes, bacterial infection, GIT disorders, kidney problems, liver diseases, malaria, infertility, helmintic diseases, nausea and hypertension [108]. Phytochemicals present are saponins, alkaloids, terpenes, flavonoids, steroids, phenolic acids and coumarins [108]. The chloroform fraction of *Vernonia amygdalina* was administered to STZ-induced diabetic rats. There was a significant decrease ($P = .05$) in the expression of the gluconeogenic enzymes; F-1,6-BP, phosphoenol pyruvate carboxykinase and G6P in the liver and muscle. The extract also significantly increased glucose oxidation via the pentose phosphate pathway (PPP) i.e. increased expression of the glucose 6-phosphate dehydrogenase (G6PDH) gene ($P = .05$) in the liver. Conversely, the expression of the G6PDH in the muscle and adipose tissues significantly decreased ($P = .05$), suggesting enhanced utilization of NADPH and ribose in the clearance of reactive oxygen species (ROS) and for expression of other relevant genes respectively. Also, transcription of the cell proliferation regulatory enzyme, PI3K increased in the liver. The extract also caused a decrease in the expression of key enzymes of glycolysis namely hexokinase and PFK, suggestive of a glucose sparing for ribose and NADPH production in PPP [109].

***Dennettia tripetala* Baker f.**

Dennettia tripetala (family: *Annonaceae*), is called 'Mmimi' (Igbo), 'Ata igbere' (Yoruba). It is used as a remedy for diabetes, cough, fever, toothache, and nausea [110]. The phytochemicals

constituents of *Dennettia tripetala* includes; tannins, alkaloids, steroids, flavonoids, cardiac, glycosides, saponins, terpenoids proteins, and carbohydrates [110]. The fractions (methanol, n-hexane, ethyl acetate, butanol and water) of *Dennettia tripetala* leaves extract in treating alloxan- induced diabetic rats, showed significantly (P = .05) decreased in FBG levels, serum triglyceride, serum cholesterol and LDL and a significant (P = .05) increase in HDL levels. The body weight gain was moderate. Also there was marked rejuvenation of the pancreatic β cells [111].

***Murraya koenigii* (Linnaeus)**

Murraya koenigii (family: *Rutaceae*), is called 'efirin oso' (Yoruba), 'marugbo sanyan' (Hausa), 'akwukwo curry' (Igbo). *Murraya koenigii* is used as tonics for inducing digestion and flatulence, reducing fever, treating diabetes, manage renal pains, analgesic, body heat reducer, thirst quencher, reducing inflammation, managing blood disorders, cure dysentery, treating piles, itching, fresh cuts, dysentery, bruises, edema, itching [112]. Alkaloids, tannins, flavonoids, phenols, reducing sugars, saponins, and terpinoids are present in *Murraya koenigii* [113]. Aqueous and ethanolic leaf extracts of *Murraya koenigii* was used to treat alloxan induced diabetic rats. Significant decrease (P = .05) in the blood glucose levels was observed (114)

***Telfairia occidentalis* Hook. f.**

Telfairia occidentalis (family: *Cucurbitaceae*), is called 'ugu' (Igbo), iroko" or "apiroko" (Yoruba), 'kabewa' (Hausa). The plant is useful in the management of diabetes, cholesterolemia, anaemia, malaria, chronic fatigue, liver problems, impaired defense immune systems, has potential to regenerate testicular damage and also increase spermatogenesis [115,116]. The phytochemical screening revealed the presence of alkaloid, flavonoids, phenol, tannins, saponins, steroids, terpenes and balsam [117]. The blood glucose lowering effect of the extract of the seed of *Telfairia occidentalis* on alloxan-diabetic rats showed a reduced blood glucose concentration [118]. Similar report showed significant (P = .05) decrease in the FBG in alloxan induced diabetic rats, and also, lowering of FBG in normal (non-diabetic) [119].

***Citrus paradisi Macfad* Macfad**

Citrus paradisi Macfad (family: *Rutaceae*), is called 'Abefa' (Yoruba) and 'Kalgo' (Hausa). *Citrus paradisi Macfad* is reputed for the management of anemia, diabetes mellitus and obesity; it decreases the symptoms of cold, relieves the symptoms of rheumatoid arthritis, asthma, and decreases the risk of heart attack [120]. Phytochemical present are alkaloids, saponin, flavonoids, tannins and cardiac glycosides [121]. The seed extract of *Citrus paradisi Macfad* was used to treat alloxan-induced diabetic rats; the extract showed a significant (P = .05) reductions in FBG, TG, TC, LDL-c, VLDL-c. The extract also caused a significant (P = .05) increase in HDL-c [121].

***Aloe vera (Aloe barbadensis)* Linnaeus**

Aloe vera (Aloe barbadensis) (family: *Liliaceae*), it is called 'aloe' (Igbo). Therapeutic claims of Aloe vera include teeth and gum treatment, constipation, diabetes, induced foot ulcers, antimicrobial and antioxidant properties and protection from irradiation. *Aloe vera* is also used commercially as an ingredient in yogurts, beverages, and some desserts [122]. The phytochemical constituents of aloe vera leaf include saponin, alkaloids, flavonoids, glycosides,

phenol and tannins [123]. Treatment with *Aloe barbadensis* leaf extract on STZ induced- diabetic rats showed a decrease in blood glucose, increased SOD activities and significantly reduced MDA [122].

Conclusion

Diabetes is one of the most prevalent endocrine condition that affects millions of people globally. Over the past ten years, Nigeria has seen an alarming rise in the country's diabetes population. The progress of contemporary medicine has led to the development of several pharmaceutical products. Despite their ability to lower blood sugar levels, these drugs are frequently linked to a number of side effects. For these reasons, researchers are focusing on herbal medicine to find more effective alternatives with fewer negative effects. This review has summarized a list of 35 Nigerian medicinal plants that have glucose-lowering abilities that can help manage diabetes and its associated consequences. Many indigenous groups have traditionally treated diabetes with these plants. Furthermore, the results of these studies can serve as a basis for the development of possible anti-diabetic medications. Furthermore, pharmacological and clinical study is needed to prove the effectiveness of the plants in treating and managing diabetes. Also, the focus of future research may be on the identification, purification, and isolation of the anti-diabetic bioactive compounds present in these plants and its possible mechanisms.

.

References

1. Ahmed, SAH, Ansari, SA. Mensah-Brown, EPK. *et al.* The role of DNA methylation in the pathogenesis of type 2 diabetes mellitus. Clin Epigenet. 2020;12,(104). https://doi.org/10.1186/s13148-020-00896-4
2. Rask-Madsen C, King GL. Vascular complications of diabetes: mechanisms of injury and protective factors. Cell Metab. 2013;17(1):20–33.
3. Dendup T, Feng X, Clingan S, Astell-Burt T. Environmental Risk Factors for Developing Type 2 Diabetes Mellitus: A Systematic Review. Int J Environ Res Public Health. 2018;15(1).
4. Kuo CC, Moon K, Thayer KA, Navas-Acien A. Environmental chemicals and type 2 diabetes: an updated systematic review of the epidemiologic evidence. Curr Diab Rep. 2013;13(6):831–49.
5. Modzelewski R, Stefanowicz-Rutkowska MM, Matuszewski W, Bandurska-Stankiewicz EM. Gestational Diabetes Mellitus-Recent Literature Review. J Clin Med. 2022;11(19).
6. Saeedi P, Petersohn I, Salpea P, Malanda B, Karuranga S, Unwin N, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045:

Results from the International Diabetes Federation Diabetes Atlas, 9(th) edition. Diabetes Res Clin Pract. 2019;157:107843.

7. Peer N, Kengne AP, Motala AA, Mbanya JC. Diabetes in the Africa Region: an update. Diabetes Res Clin Pract. 2014;103(2):197–205.

8. Uloko AE, Musa BM, Ramalan MA, Gezawa ID, Puepet FH, Uloko AT, et al. Prevalence and Risk Factors for Diabetes Mellitus in Nigeria: A Systematic Review and Meta-Analysis. Diabetes Ther Res Treat Educ diabetes Relat Disord. 2018;9(3):1307–16.

9. Chaudhury A, Duvoor C, Reddy Dendi VS, Kraleti S, Chada A, Ravilla R, et al. Clinical Review of Antidiabetic Drugs: Implications for Type 2 Diabetes Mellitus Management. Front Endocrinol (Lausanne). 2017;8:6.

10. Idm'hand E, Msanda F, Cherifi K. Ethnopharmacological review of medicinal plants used to manage diabetes in Morocco. Clin Phytoscience [Internet]. 2020;6(1):18. Available from: https://doi.org/10.1186/s40816-020-00166-z

11. Ngan Tran, Bao Pham, and Ly Le. Bioactive Compounds in Anti-Diabetic Plants: From Herbal Medicine to Modern Drug Discovery. Biology (Basel). 2020; 9(9): 252.

12. Newman DJ, Cragg GM. Natural products as sources of new drugs over the 30 years from 1981 to 2010. J Nat Prod. 2012;75(3):311–35.

13. Ekor M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol. 2014;4:177.

14. Bibi Sadeer N, Llorent-Martínez EJ, Bene K, Fawzi Mahomoodally M, Mollica A, Ibrahime Sinan K, et al. Chemical profiling, antioxidant, enzyme inhibitory and molecular modelling studies on the leaves and stem bark extracts of three African medicinal plants. J Pharm Biomed Anal. 2019;174:19–33.

15. Onikanni A, L B, AO O, Janet O Olugbodi J, Sani S, Ajiboye B, et al. Sterculia tragacantha Lindl Leaf Extract Ameliorates STZ-Induced Diabetes , Oxidative Stress , Inflammation and Neuronal Impairment. J Inflamm Res. 2021;14:6749–64.

16. Fadahunsi OS, Adegbola PI, Olorunnisola OS, Subair TI, Adepoju DO, Abijo AZ. Ethno-medicinal, phytochemistry, and pharmacological importance of Hunteria umbellate (K. Schum.) Hallier f. (Apocynaceae): a useful medicinal plant of sub-Saharan Africa. Clin Phytoscience [Internet]. 2021;7(1):54. Available from: https://doi.org/10.1186/s40816-021-00287-z

17. Aderele OR, Rasaq AK and Momoh JO. Phytochemical Screening, Mathematical Analysis and Antimicrobial Activity of Methanolic Seed Extract of Hunteria Umbellata European Journal of Medicinal Plants. 2020; 31(16): 1-17.

18. Nwaogwugwu J, Nosiri C, Aguwamba C, Aaron C, Ike U. Effect of Hunteria umbellata Methanolic Seed Extracts on Streptozotocin-induced Diabetic Albino Rats. Asian J Biochem Genet Mol Biol. 2022;14–27.

19. Nwaogwugwu JC, Nosiri CI , Aguwamba C, Aaron C F and Ike UW. Effect of Hunteria Umbellate Methanolic Seed Extracts on Streptozotocin-induced Diabetic Albino Rats. Asian Journal of Biochemistry, Genetics and Molecular Biology . 2022; 12(3): 14-27.

20. Longe A. Effects of Methanolic seed extract of Hunteria umbellata (abere) on blood

glucose level, hematological and lipid profile parameters in alloxan- induced diabetes in male rats. In 2014. Available from: https://api.semanticscholar.org/CorpusID:54942473

21. Osigwe CC, Akah PA, Nworu CS, Okoye TC, Tchimene MK. Antihyperglycemic Studies on the Leaf Extract and Active Fractions of <i>Newbouldia laevis</i> (Bignoniaceae). Pharmacol & Pharm. 2015;06(11):518–32.

22. Okagu IU, Ndefo JC, Agbo MO. Trado-Medical Uses, Chemical Constituents and Biological Activities of Newbouldia laevis (Bignoniaceae): A Review. Pharm Sci [Internet]. 2022 Jan 30;28(1):51–75. Available from: https://ps.tbzmed.ac.ir/Article/ps-34095

23. Iwu M. AFRICAN MEDICINAL PLANTS [Internet]. 2nd Editio. London: CRC Press; 2014. 183–184 p. Available from: https://www.routledge.com/Handbook-of-African-Medicinal-Plants/Iwu/p/book/9781466571976

24. Osigwe CC, Akah PA, Nworu CS. Biochemical and Haematological Effects of the Leaf Extract of Newbouldia laevis in Alloxan-Induced Diabetic Rats. 2017;18–36.

25. Ajiboye TO. Standardized extract of Vitex doniana Sweet stalls protein oxidation, lipid peroxidation and DNA fragmention in acetaminophen-induced hepatotoxicity. J Ethnopharmacol [Internet]. 2015;164:273–82. Available from: https://www.sciencedirect.com/science/article/pii/S0378874115000410

26. Ezekwesili C, Ogbunugafor H, Ozioma E ofili J. Anti-diabetic Activity of Aqueous Extracts of Vitex doniana Leaves and Cinchona calisaya Bark in Alloxan – Induced Diabetic Rats. Int J Trop Dis Heal. 2012;2(4):290–300.

27. Obasi E, Iheanacho K, Nwachukwu N, Agha N, Chikezie PC. Evaluation of body weight , serum glucose level and oxidative stress parameters of diabetic rats administered phenolic aqueous leaf extract of Vitex doniana. 2019;6(9):3359–67.

28. Okokon JE, Nyong EE, Thomas PS, Udoh AE. Antioxidant and antiulcer activities of ethanol leaf extract and fractions of solanum anomalum. 2019;6(2):20–5.

29. Kaunda JS, Zhang YJ. The Genus Solanum: An Ethnopharmacological, Phytochemical and Biological Properties Review. Nat Products Bioprospect. 2019;9(2):77–137.

30. Okokon JE, Etuk IC, Thomas PS, Drijfhout FP, Claridge TDW, Li WW. In vivo antihyperglycaemic and antihyperlipidemic activities and chemical constituents of Solanum anomalum. Biomed Pharmacother. 2022;151:113153.

31. Etuk IC, Udobang JA, Ebong NO, Okokon JE. Solanum anomalum Leaf Extract and Fractions Attenuate Oxidative Stress and Liver Injuries in Alloxan-Induced Diabetic Rats. 2023;12(1):33–44.

32. Adewole SO, Adenowo T, Naicker T, Ojewole JAO. Hypoglycaemic and hypotensive effects of Ficus exasperata vahl. (Moraceae) leaf aqueous extract in rats. African J Tradit Complement Altern Med AJTCAM. 2011;8(3):275–83.

33. Nimenibo-Uadia, R. Chemical Composition and Phytochemical Screening of Ficus exasperata (Vahl) Leaf. Nigerian Journal of Pharmaceutical and Applied Science Research, 2020; 6(1), 12–18

34. Adeyi AO, Idowu AB, Mafiana CF, Oluwalana SA, Ajayi OL. Effects of aqueous leave

extract of Ficus exasperata on pathophysiology and histopathogy of alloxan-induced diabetic albino rats. 2012;6(46):5730–6.

35. Amrelia M, Marg S. Nutritive and Medicinal value of Gongronema latifolium. Journal of Natural Products Discovery. 2022;1(2):1–14.

36. Christopher B, Bello S, Elaigwu M, Achimugu L, State B, State K. Phytochemical analysis and Ethno-botanical Uses of Gongronema latifolium Benth. 2022;10(3):38–46.

37. Ojo OA, Okesola MA, Ekakitie LI, Ajiboye BO, Oyinloye BE, Agboinghale PE, et al. Gongronema latifolium Benth. leaf extract attenuates diabetes-induced neuropathy via inhibition of cognitive, oxidative stress and inflammatory response. J Sci Food Agric. 2020;100(12):4504–11.

38. Ajiboye BO, Oyinloye BE, Agboinghale PE, Onikanni SA, Asogwa E, Kappo AP. Antihyperglycaemia and related gene expressions of aqueous extract of Gongronema latifolium leaf in alloxan-induced diabetic rats. Pharm Biol. 2019;57(1):604–11.

39. Hamzah RU, Jigam AA, Makun HA, Egwim EC Antioxidant Properties of Selected African Vegetables, Fruits and Mushrooms: A Review. Mycotoxin and Food Safety in Developing Countries. 2013; Chpt 9: 203-250. DOI: 10.5772/52771

40. Okoduwa SIR, Umar IA, James DB, Inuwa HM. Anti-Diabetic Potential of Ocimum gratissimum Leaf Fractions in Fortified Diet-Fed Streptozotocin Treated Rat Model of Type-2 Diabetes. Med (Basel, Switzerland). 2017;4(4).

41. Enyievi PB, Mgbeje BIA, Nja GME, Edu BC, Ejemot-Nwadiaro RI. Effect of Ocimum gratissimum Leaf-extract on Hematological Indices and Lipid Profile of Streptozotocin-induced Diabetic Wistar Rats. Pakistan J Biol Sci PJBS. 2020;23(12):1523–9.

42. Okolo CA, Ejere VC, Chukwuka CO, Ezeigbo II, Nwibo DD, Okorie AN. Hexane Extract of Dacryodes edulis fruits possesses Anti-diabetic and Hypolidaemic potentials in Alloxan Diabetes of Rats. African J Tradit Complement Altern Med AJTCAM. 2016;13(4):132–44.

43. Conrad OA, Uche AI. Assessment of In vivo antioxidant properties of Dacryodes edulis and Ficus exasperata as anti-malaria plants. Asian Pacific J Trop Dis [Internet]. 2013;3(4):294–300. Available from: https://www.sciencedirect.com/science/article/pii/S2222180813600729

44. Ononamadu CJ, Alhassan AJ, Ibrahim A, Imam AA, Ihegboro GO, Owolarafe TA, et al. Methanol-Extract/Fractions of Dacryodes edulis Leaves Ameliorate Hyperglycemia and Associated Oxidative Stress in Streptozotocin-Induced Diabetic Wistar Rats. J evidence-based Integr Med. 2019;24:2515690X19843832.

45. Erukainure OL, Ijomone OM, Chukwuma CI, Xiao X, Salau VF, Islam MS. Dacryodes edulis (G. Don) H.J. Lam modulates glucose metabolism, cholinergic activities and Nrf2 expression, while suppressing oxidative stress and dyslipidemia in diabetic rats. J Ethnopharmacol. 2020;255:112744.

46. Erukainure OL, Chukwuma CI, Islam MS. Raffia palm (Raphia hookeri) wine: Qualitative sugar profile, functional chemistry, and antidiabetic properties. Food Biosci [Internet]. 2019;30:100423. Available from: https://www.sciencedirect.com/science/article/pii/S221242921830590X

47. Nwaiwu O, Itumoh M. Chemical Contaminants Associated with Palm Wine from Nigeria Are Potential Food Safety Hazards. *Beverages* 2017, *3*(1), 16

48. Lucky GB, Cookey GA, Tubonimi J.K. Ideriah TJK Physicochemical and Nutritional Parameters in Palm Wine from Oilpalm Tree (Elaies guineensis) and Raffia Palm (Raphia hookeri) in South-South Nigeria. Chemistry Research Journal, 2017, 2(6):146-152

49. Erukainure OL, Oyebode OA, Ijomone OM, Chukwuma CI, Koorbanally NA, Islam MS. Raffia palm (Raphia hookeri G. Mann & H. Wendl) wine modulates glucose homeostasis by enhancing insulin secretion and inhibiting redox imbalance in a rat model of diabetes induced by high fructose diet and streptozotocin. J Ethnopharmacol. 2019;237:159–70.

50. Iyare EE, Obaji NN. Effects of aqueous leaf extract of azadirachta indica on some haematological parameters and blood glucose level in female rats. Niger J Exp Clin Biosci. 2014;2(1):54–8.

51. Ogbuewu I, Odoemenam V, Obikaonu H, Opara M, OO E, M. U. The growing importance of neem (Azadirachta indica a. juss) in agriculture, industry, medicine and environment: A review. Res J Med Plants. 2011;5:230–245. doi: 10.3923/rjmp.2011.230.245. Res J Med Plant. 2011;5(3):230–45.

52. June M, Christian EO, Chukwuemeka EF, Ngozi NN. Phytochemistry and antidiabetogenic property of aqueous extract of Azadirachta indica leaf in streptozotocin-induced diabetic rats. 2020;9(3):155–63.

53. Ezeigwe OC, Ezeonu FC, Okani CO, Onwusulu DN, Onuegbu ME. Aqueous extract of Azadirachta indica leaves favorably alters the course of streptozotocin-induced diabetes in rats : A comparative prospective cohort study. 2017;7(7):3877–89.

54. Akharaiyi FC, Ilori RM, Adesida JA. Antibacterial effect of Terminalia catappa on some selected pathogenic bacteria. Int J Pharm Biomed Res [Internet]. 2011;2(2):64–7. Available from: https://api.semanticscholar.org/CorpusID:96426078

55. Iheagwam FN, Dania OE, Michael-Onuoha HC, Ogunlana OO, Chinedu SN. Antidiabetic Activities of Terminalia Species in Nigeria. In: Akram M, editor. Alternative Medicine [Internet]. Rijeka: IntechOpen; 2020. p. Ch. 11. Available from: https://doi.org/10.5772/intechopen.94474

56. Philip CJ, Carrol LD, Longdet IY, Chinyere AJ. Antidiabetic Activities of the Aqueous Root Bark and Flower Extracts of Terminalia catappa on Streptozotocin - Induced Diabetes in Male Wister Rats. 2017;20(2):1–9.

57. Iheagwam FN, Iheagwam OT, Onuoha MK, Ogunlana OO, Chinedu SN. Terminalia catappa aqueous leaf extract reverses insulin resistance, improves glucose transport and activates PI3K/AKT signalling in high fat/streptozotocin-induced diabetic rats. Sci Rep [Internet]. 2022;12(1):10711. Available from: https://doi.org/10.1038/s41598-022-15114-9

58. Ugbabe G., Ezeunala M., Edmond I., Apev J, Salawu O. Preliminary Phytochemical , Antimicrobial and Acute Toxicity Studies of the Stem, bark and the Leaves of a cultivated Syzygium cumini Linn. (Family: Myrtaceae) in. 2010;9(41):6943–7.

59. Ajiboye BO, Ojo OA, Akuboh OS, Abiola OM, Idowu O, Amuzat AO. Anti-Hyperglycemic and Anti-Inflammatory Activities of Polyphenolic-Rich Extract of Syzygium cumini Linn Leaves in Alloxan-Induced Diabetic Rats. J evidence-based Integr Med. 2018;23:2515690X18770630.

60. Oyesola OA, Sampson II, Augustine AA, Adejoke OB, Taiwo GE. Comparison of phytochemical constituents of ethanol leaf extracts of Solanum macrocarpon and Vernonia amygdalina. 2022;20(1):6–10.

61. Chidiebere ME, Samuel EC, Vincent E, Ikechukwu NE, Chigozie UG. Phytochemistry , acute toxicity and blood profile of albino rats treated with fruit extract of Solanum macrocarpon. 2019;11:43–51.

62. Ajiboye BO, Oyinloye BE, Owero-Ozeze OS, Okesola MA, Ekakitie IL, Ojo OA, et al. Aqueous extract of Solanum macrocarpon Linn leaves abates hyperglycaemia and expression of glucose transporters gene in alloxan-induced diabetic rats. J Endocrinol Invest. 2021;44(2):265–76.

63. Okesola MA, Ajiboye BO, Oyinloye BE, Osukoya OA, Owero-Ozeze OS, I Ekakitie L, et al. Effect of Solanum macrocarpon Linn leaf aqueous extract on the brain of an alloxan-induced rat model of diabetes. J Int Med Res. 2020;48(6):300060520922649.

64. Idowu TO, Ogundaini AO, Adesanya SA, Onawunmi GO, Osungunna MO, Obuotor EM, et al. Isolation and characterization of chemical constituents from Chrysophyllum albidum G. DON–HOLL. Stem-bark extracts and their antioxiadant and antibacterial properties. African J Tradit Complement Altern Med AJTCAM. 2016;13(5):182–9.

65. Ojemekele O, Irabor F, Ebohon O, Omoregie ES. A Comparative Study on the Phytochemical Screening and in vitro Antioxidant Activity of Methanol Leaf Extracts of Chrysophyllum albidum and Irvingia gabonensis. Haya Saudi J Life Sci.2017;2(3):58–64.

66. Idaguko C, Oremosu A, Duru A, Awopetu P. Protective Effect of Ethanolic Leaf Extract of Chrysophyllum albidum (Sapotaeae G. Don) on Histological Changes in the Pancreas of Streptozotocin-induced Diabetic Sprague Dawley Rats. J Anat Sci. 2018;9(1):1–6.

67. Idaguko C, Duru F, Oremosu A. Antioxidant, hypolipidemic and Hypoglycemic Effect of Ethanol Leaf Extract of Chrysophyllum albidum on Streptozotocin- Induced Diabetic Rats. J Anat Sci. 2017;8(1):67–73.

68. Orabueze CI, Adesegun SA, Coker HA. Analgesic and Antioxidant Activities of Stem Bark Extract and Fractions of Petersianthus macrocarpus. Pharmacognosy Res. 2016;8(3):181–5.

69. Ugochukwu AA, Anna IC. Phytochemical Evaluation and Anti-Diabetic Effects of Ethanolic Leaf Extract of Petersianthus macrocarpus on Streptozotocin-Induced Diabetic Rats. J Adv Med Med Res. 2021;33(3):39–47.

70. Omokhua G. Medicinal and Socio-Cultural Importance of Costus Afer (Ker Grawl) in Nigeria. Int Multidiscip Journal, Ethiop. 2011;5(22):282–7.

71. Ezejiofor AN, Orish CN, Orisakwe OE. Effect of aqueous leaves extract of Costus afer Ker Gawl (Zingiberaceae) on the liver and kidney of male albino Wistar rat. Anc Sci Life. 2013;33(1):4–9.

72. Nwakanma AA, Idaguko C, Elemuo C, Mada J, Onuigbo K. Histological studies of ethanolic extract of. 2020;11(2):102–6.

73. Sanni TA, Ogunbusola EM, Alabi OO, Jaiyeoba CN, Oni KO, Adubiaro HO and Gbadamosi SO. Evaluation of chemical and functional properties of protein isolates from Basella alba and Senecio biafrae leaves. FUW Trends in Science & Technology Journal. 2019: 4(1): 001 – 007

74. Bello OA, Ayanda OI, Aworunse OS, Olukanmi BI, Soladoye MO, Esan EB, et al. Solanecio biafrae : An Underutilized Nutraceutically - Important African Indigenous Vegetable. Pharmacogn Rev. 2018;12:128-32. 2018;

75. Basiru A, Ibukun E, Edobor G, Ojo OA. Qualitative and Quantitative analysis of phytochemicals in Senecio biafrae leaf Int. J. Inv. Pharm. Sci. 2013. 1(5); 428-432.

76. Ajiboye BO, Ojo OA. Effect of aqueous leaf extract of senecio biafrae on hyperglycaemic and haematological parameters of alloxan-induced diabetic rats. Pharmacologyonline. 2014;3:163–9.

77. Ajiboye BO, Edobor G, Ojo AO, Onikanni SA, Olaranwaju OI, Muhammad NO. Effect of aqueous leaf extract of Senecio biafrae on hyperglycaemic and serum lipid profile of alloxan- induced diabetic rats. 2014;57–64.

78. Erhirhie E, Moke G. Xylopia Aethiopica : A Review of its Ethnomedicinal , Chemical and Pharmacological Properties. Am J PharmTech Res. 2014; 4(6).

79. Ofusori DA, Komolafe OA, Adewole OS, Arayombo BE, Margolis D, Naicker T. Morphological study of the effects of aqueous leaf extract of Xylopia aethiopica on the pancreas in diabetic rats. Ital J Anat Embryol. 2016;121(1):77–87.

80. Mohammed A, Koorbanally NA, Islam MS. Anti-diabetic effect of Xylopia aethiopica (Dunal) A. Rich. (Annonaceae) fruit acetone fraction in a type 2 diabetes model of rats. J Ethnopharmacol. 2016;180:131–9.

81. Adeneye A, Olagunju J. Preliminary hypoglycemic and hypolipidemic activities of the aqueous seed extract of Carica papaya Linn . in Wistar rats Preliminary hypoglycemic and hypolipidemic activities of the aqueous seed extract of Carica papaya Linn . in Wistar rats. Biol Med. 2009;1(1):1–10.

82. Agada R, Usman WA, Shehu S, Thagariki D. In vitro and in vivo inhibitory effects of Carica papaya seed on α-amylase and α-glucosidase enzymes. Heliyon. 2020;6(3):e03618.

83. Airaodion AI, Ogbuagu EO, Ekenjoku JA, Ogbuagu U. Antidiabetic Effect of Ethanolic Extract of Carica papaya Leaves in Alloxan-Induced Diabetic Rats. Am J Biomed Sci Res,. 2019;5(3):227–34.

84. Gobinath R, Parasuraman S, Sreeramanan S, Enugutti B, Chinni S V. Antidiabetic and Antihyperlipidemic Effects of Methanolic Extract of Leaves of Spondias mombin in Streptozotocin-Induced Diabetic Rats. Front Physiol [Internet]. 2022;13. Available from: https://www.frontiersin.org/articles/10.3389/fphys.2022.870399

85. Fred-Jaiyesimi AA, Wilkins RM and ABO KA. Glucose lowering activities of mombintane I and mombintane II isolated from the leaves of Spondias mombin L. Int. J. Biol. Chem. Sci. 2017. 11(3): 1315-1319.

86. Ukwenya V, Ashaolu J, Adeyemi A, Akinola O, Caxton-Martins E. Antihyperglycemic activities of methanolic leaf extract of Anacardium occidentale (Linn.) on the pancreas of streptozotocin-induced diabetic rats. J Cell Anim Biol. 2012;6(11):169–74.

87. Amira PO, Daramola AS, Muoghalu CE, Ojo OB. Comparative Studies on Phytochemical Screening and in Vitro Antioxidant Activities of Aqueous Extracts of Anacardium Occidentale Leaves and Nuts. *European Journal of Biology and Biotechnology*. 2020; *1*(4). https://doi.org/10.24018/ejbio.2020.1.4.49

88. Okpashi VE, Bayim BPR, Obi-Abang M. Comparative Effects of Some Medicinal Plants: *Anacardium occidentale*, *Eucalyptus globulus*, *Psidium guajava*, and *Xylopia aethiopica* Extracts in Alloxan-Induced Diabetic Male Wistar Albino Rats. Ng TB, editor. Biochem Res Int [Internet]. 2014;2014:203051. Available from: https://doi.org/10.1155/2014/203051

89. Dey B, Mitra A. Chemo-profiling of eucalyptus and study of its hypoglycemic potential. World J Diabetes. 2013;4(5):170–6.

90. Saka W., Akhigbe R., Ajayi A., Ajayi L., Nwabuzor O. Anti-Diabetic and Antioxidant Potentials of Aqueous Extract of Eucalyptus Globulus in Experimentally-Induced Diabetic Rats. African J Tradit Complement Altern Med. 2017;14(6):20–6.

91. Adeneye AA. The leaf and seed aqueous extract of Phyllanthus amarus improves insulin resistance diabetes in experimental animal studies. J Ethnopharmacol [Internet]. 2012;144(3):705–11. Available from: https://www.sciencedirect.com/science/article/pii/S0378874112006897

92. Adedapo A, Ofuegbe S, Oguntibeju O. The Antidiabetic Activities of the Aqueous Leaf Extract of Phyllanthus Amarus in some Laboratory Animals. In: Oguntibeju O, editor. Antioxidant-Antidiabetic Agents and Human Health [Internet]. Rijeka: IntechOpen; 2014. p. Ch. 5. Available from: https://doi.org/10.5772/57030

93. Adedapo AA, Ofuegbe SO. The Antidiabetic Activities of the Aqueous Leaf Extract of Phyllanthus amarus In Some Laboratory Animals. FASEB J [Internet]. 2013 Apr 1;27(S1):1167.9-1167.9. Available from: https://doi.org/10.1096/fasebj.27.1_supplement.1167.9

94. Okoli C, Ibiam A, Ezike A, Akah P, Okoye T. Evaluation of antidiabetic potentials of Phyllanthus niruri in alloxan diabetic rats. African J Biotechnol. 2010;9(2):248–59.

95. Bagalkotkar G, Sagineedu SR, Saad MS, Stanslas J. Phytochemicals from Phyllanthus niruri Linn . and their pharmacological properties : a review. J Pharm Pharmacol. 2006;(Burkill 1996):1559–70.

96. Okoli CO, Obidike IC, Ezike AC, Akah PA, Salawu OA. Studies on the possible mechanisms of antidiabetic activity of extract of aerial parts of Phyllanthus niruri. Pharm Biol. 2011;49(3):248–55.

97. Joseph B, Joseph B, George J, Mohan J, Joseph B. Parkia biglobosa (African Locust Bean Tree) . World J Pharm Res. 2013;2(3):596–605.

98. Abioye EO, Akinpelu DA, Aiyegoro OA, Adegboye MF, Oni MO, Okoh AI. Preliminary phytochemical screening and antibacterial properties of crude stem bark extracts and fractions of Parkia biglobosa (Jacq.). Molecules. 2013;18(7):8485–99.

99. Ogunyinka BI, Oyinloye BE, Osunsanmi FO, Kolanisi U, Opoku AR, Kappo AP. Protein Isolate from *Parkia biglobosa* Seeds Improves Dyslipidaemia and Cardiac Oxidative Stress in Streptozotocin-Induced Diabetic Rats. Antioxidants (Basel). 2019; 12;8(10):481. doi: 10.3390/antiox8100481. PMID: 31614841; PMCID: PMC6826478.

100. Evbuomwan IO, Stephen Adeyemi O, Oluba OM. Indigenous medicinal plants used in folk medicine for malaria treatment in Kwara State, Nigeria: an ethnobotanical study. BMC Complement Med Ther. 2023; 16;23(1):324.

101. Setyawan HY, Sukardi S, Puriwangi CA. Phytochemicals properties of avocado seed: A review. IOP Conf Ser Earth Environ Sci [Internet]. 2021;733(1):12090. Available from: https://dx.doi.org/10.1088/1755-1315/733/1/012090

102. Ojo OA, Amanze JC, Oni AI, Grant S, Iyobhebhe M, Elebiyo TC, et al. Antidiabetic activity of avocado seeds (Persea americana Mill.) in diabetic rats via activation of PI3K/AKT signaling pathway. Sci Rep. 2022;12(1):2919.

103. Ojo OA, Grant S, Amanze JC, Oni AI, Ojo AB, Elebiyo TC, et al. Annona muricata L. peel extract inhibits carbohydrate metabolizing enzymes and reduces pancreatic β-cells, inflammation, and apoptosis via upregulation of PI3K/AKT genes. PLoS One. 2022;17(10):e0276984.

104. Agu KC, Okolie PN. Proximate composition, phytochemical analysis, and in vitro antioxidant potentials of extracts of Annona muricata (Soursop). Food Sci Nutr. 2017 Sep;5(5):1029–36.

105. Tsasi G, Mailis T, Daskalaki A, Sakadani E, Razis P, Samaras Y, et al. The Effect of Harvesting on the Composition of Essential Oils from Five Varieties of Ocimum basilicum L. Cultivated in the Island of Kefalonia, Greece. Plants. 2017. 6

106. Khair S, Bariyah U, Ahmed D. Ocimum Basilicum : A Review on Phytochemical and Pharmacological Studies Ocimum Basilicum : A Review on Phytochemical and Pharmacological Studies. Pakistan J Chem. 2012;2(2):78–85.

107. Ezeani C, Ezenyi I, Okoye T, Okoli C. Ocimum basilicum extract exhibits antidiabetic effects via inhibition of hepatic glucose mobilization and carbohydrate metabolizing enzymes. J Intercult Ethnopharmacol. 2017;6(1):22–8.

108. Farombi EO, Owoeye O. Antioxidative and chemopreventive properties of Vernonia amygdalina and Garcinia biflavonoid. Int J Environ Res Public Health. 2011;8(6):2533–55.

109. Atangwho IJ, Yin KB, Umar MI, Ahmad M, Asmawi MZ. Vernonia amygdalina simultaneously suppresses gluconeogenesis and potentiates glucose oxidation via the pentose phosphate pathway in streptozotocin-induced diabetic rats. BMC Complement Altern Med. 2014;14:426.

110. Iseghohi SO. A Review of the Uses and Medicinal Properties of Dennettia tripetala (Pepperfruit). Med Sci (Basel, Switzerland). 2015;3(4):104–11.

111. Abonyi U, Omoiri M, Akah P. Evaluation of the anti-diabetic effect of the methanol leaf extract and fractions of Dennettia tripetala G. Bak (Annonaceae) in alloxan- induced diabetic mice. J Drug Deliv Ther. 2020;10(2):129–39.

112. Balakrishnan R, Vijayraja D, Jo SH, Ganesan P, Su-Kim I, Choi DK. Medicinal Profile, Phytochemistry, and Pharmacological Activities of Murraya koenigii and its Primary Bioactive Compounds. Antioxidants (Basel, Switzerland). 2020;9(2).

113. Igara CE, Omoboyowa DA, Ahuchaogu AA, Orji NU, Ndukwe MK. Phytochemical and nutritional profile of Murraya Koenigii (Linn) Spreng leaf. J Pharmacogn Phytochem. 2016;5(5):7–9.

114. Oise AE, Inyang JO, Echekoba CA, Abubakar AN. Phytochemical Constituents and Hyperglycemic effect of Aqueous and Ethanolic extracts of murraya koenigii in alloxan induced diabetic rats. IJBAIR. 2018;7(4):134–8.

115. Salman TM. Effects of Telfairia Occidentalis Leaf Extract on Plasma Lactate and Liver Glycogen in Rats. *Nigerian Journal of Physiological Sciences*. 2021; *33*(2), 169–175

116. Osonuga IO, Faponle AS, Ezima EN, Adenowo TK, Adelegan AA. Effects of aqueous leaf extract of Telfairia occidentalis on haematological parameters and liver enzymes in male Wistar rats. Annals of Health Research. 2020; 6(1)

117. Anthony OE, Ojeifo UP. Phytochemical screening and acute toxicity evaluation of Telfairia occidentalis aqueous extracts on rats. Pak J Pharm Sci. 2016;29(3):913–7.

118. Agu FU, Kalu AA, Akunneh-Wariso C, Chinedu IB, Dimgba UC. Evaluation of the anti-diabetic potential of methanol seed extract of Telfairia occidentalis. GSC Biological and Pharmaceutical Sciences, 2023, 24(03), 274–278.

119. Onyeka O, Umezurike Eg, Ozoemena M, Nwabunwanne O. Hypoglycemic effect of aqueous extract of Telfairia occidentalis leaf extract in alloxan induced diabetic wistar rats. Am J Physiol Biochem Pharmacol. 2018;7(1):42–7.

120. Stephen, E. U. ., Josephine, O. O. ., & Olapeju, B. I. Evaluation of the Effects of Citrus paradisi (Rutaceae) Fruit Juice on Electrolyte, Hepatic, Haematological and Histological Derangements in Streptozotocin-Induced Diabetic rats. *Nigerian Journal of Pharmaceutical and Applied Science Research*. 2019; *8*(1), 1–15.

121. Adeneye AA. Hypoglycemic and hypolipidemic effects of methanol seed extract of Citrus paradisi Macfad (Rutaceae) in alloxan-induced diabetic Wistar rats. Nig Q J Hosp Med. 2008;18(4):211–5122.

122. Ikpe V, Eze C, Mbaoji P, Joshua P. Phytochemical Analysis and Antifungi Activity of Aloe Vera Leaves. Bio-Research. 2017; (15):974–9.

123. Adeyi AO, Nneji, LM, Idowu BA. Ameliorative potentials of medicinal plants on the pathophysiological complications of diabetes mellitus: A review. Journal of Medicinal of Plant Research. 2015. 9(8), pp. 262-288.