

REVIEW OF THE TOXICITY, MEDICINAL BENEFITS, PHARMACOLOGICAL ACTIONS AND MORPHOLOGICAL EFFECTS OF *TELFAIRIA OCCIDENTALIS* HOOK. F.***Innocent O. Imosemi**

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ABSTRACT

The importance of herbal medicine occupying distinct position right from ancient period cannot be overemphasized. *Telfairia occidentalis* also known as fluted pumpkin and locally referred to as 'ugu' in Nigeria, is a vegetable popularly consumed in soup and employed in folk medicine preparation in the management of various diseases such as anaemia, vitamin deficiencies, diabetics and gastrointestinal disorders. *Telfairia occidentalis* which belongs to the family of cucurbitaceae, is a partial drought-tolerant, dioecious perennial plant cultivated mainly in Nigeria and indigenous to southern Nigeria. The high nutritional value and antioxidant, antidiabetic, hepatoprotective, haematological, antiplasmodial, antimicrobial, testiculoprotective, anticancer, anti-inflammatory, anxiolytic, sedative and anticonvulsant properties of the leave and seed of the plant, increases its popularity. However, in spite of the numerous nutritional, medicinal and pharmacological attributes of *Telfairia occidentalis*, the root part of the plant is believed to be poisonous, hepatotoxic, nephrotoxic, testiculotoxic and detrimental to the mucosal lining of the stomach. This review, obtained from literature search, highlights the toxicity, medicinal values, pharmacological actions and morphological effects (on some organs/systems) of *Telfairia occidentalis*.

KEYWORDS: Vegetables, *Telfairia occidentalis*, Toxicity, Pharmacological actions, Morphological effects.**INTRODUCTION**

Vegetables and fruits include a diverse group of plant foods that vary greatly in content of energy and nutrients, and are universally promoted as healthy.^[1] Additionally, vegetables and fruits supply dietary fiber which has been linked to lower incidence of cardiovascular disease, obesity and diabetes.^[2] Vegetables and fruits are important sources of vitamins and minerals in diets which contain phytochemicals that function as antioxidants and reducing the incidence of oxidative stress.^[3] The anti-inflammatory, antidiabetic, antibacterial, antipyretic and antioxidant activities of some medicinal plants such as *Vernonia amygdalina*, *Calotropis procera*, *Ocimum gratissimum*, *Carica papaya*, *Telfairia occidentalis* and *Garcinia kola* (Kolaviron) are well documented.^[4,11]

Telfairia occidentalis Hook f. also known as fluted pumpkin is one of the most commonly consumed leafy vegetables in Nigeria, employed both for culinary and medicinal purposes.^[12] The plant is grown in the rain forest zone of many nations of West Africa but occurs mostly in its cultivated form in various parts of southern Nigeria.^[13] It is popularly called 'ugu' in Iboland and ikong-ubong in the Efik/Ibibio language, where the

young shoots and leaves are the main ingredient of Nigerian edikang ikong soup.^[14]

Telfairia occidentalis is a darkish green leafy vegetable popularly used in soup and folk medicine for the management of many diseases in Nigeria.^[15] *Telfairia occidentalis* which belongs to the family of cucurbitaceae, is a dioecious, perennial vine shrub and partially drought-tolerant.^[16] The plant consists of a root, stem, leaves, fruit and seed. The stem has branching tendril, the leaves are divided into 3-5 leaflets, the fruits are pale green weighing between 3 and 10 kg and the seeds are 3-5 cm wide.^[17]

Fasuyi^[18] reported that *Telfairia occidentalis* contains nutrients such as carbohydrates, proteins, vitamins, oils, minerals and fiber. Phytochemical evaluation of the vegetable reveals that it contains oxalates, saponins, glycosides, flavonoids, alkaloids and resins.^[19,20] The toxicity of *Telfairia occidentalis* has been attributed to the alkaloids and saponins present in the roots and leaves,^[20] while the free radical scavenging activity, chemopreventive and protective effects of the plant have been reported to be due to the presence of high amount of flavonoids and phenolic compounds.^[21,23] This review therefore, provides an insight into the toxicity, high

nutritional value and antioxidant, antidiabetic, anxiolytic/sedative, nociceptive/analgesic, hepatoprotective, nephroprotective, reproductive, and neuroprotective activities of *Telfairia occidentalis*.

Taxonomy of *Telfairia occidentalis*

The taxonomic Hierarchy of *Telfairia occidentalis* are given below;^[24]

Kingdom - Plantae
 Subkingdom - Viridiplantae
 Infrakingdom - Streptophyta
 Superdivision - Embryophyta
 Division - Tracheophyta
 Subdivision - Spermatophytina
 Class - Magnoliopsida
 Superorder - Rosanae
 Order - Cucurbitales
 Family - Cucurbitaceae
 Genus - *Telfairia* Hook.
 Species - *Telfairia occidentalis* Hook. f.



Figure 1: *Telfairia occidentalis* (fluted pumpkin) showing the stem, leaf, fruit and tendrils.

Phytochemical analysis of the root, stem, leaves and of *Telfairia occidentalis*

Many researchers have reported the phytochemical constituents, nutritional contents and isolates of *Telfairia occidentalis*. Akubue et al.^[20] reported the presence of tannins, reducing sugars, glycosides, saponins and sterol and triterpenoids in the root of the plant, while the presence of its bioactive components in the root include saponins, alkaloids and resins.^[25] The high alkaloid content of the root and their extracts are therefore used for controlling pest and rodents.^[20,25]

The stem and leaves of *Telfairia occidentalis* have been reported to contain tannins, flavonoids, alkaloids, saponins, steroids, anthraquinones and reducing sugars.^[26,27] The leaves of *Telfairia occidentalis* showed the presence of phenolic compounds, flavonoids, phytosterols, tannins, saponins, chlorophyll and

glycosides which have been reported to exhibit chemosuppressive activity.^[27] Oboh et al.^[28] reported that both the ethanolic and aqueous extracts of *Telfairia occidentalis* leaves contain saponin, alkaloid and tannins, while Usunobun and Egharebva^[29] reported the presence of flavonoids, alkaloids, tannins, saponins and phenolics in dried and powdered leaves of *Telfairia occidentalis*, and absence of glycosides, steroids, triterpenes and phylobatannins.

Phytochemicals present in the seed of *Telfairia occidentalis* include alkaloids, flavonoids, saponins, terpenoids, steroid and anthraquinones.^[30] Eseyin et al.^[31] using 2,2-diphenyl-1-picryl hydrazyl (DPPH) radical and employing Gas Chromatograph Mass Spectrometry (GC-MS) analysis, 2 Dimensional Nuclear Magnetic Resonance (2D NMR) and Fourier transform infrared (FTIR) spectroscopy reported a high free radical scavenging activity, two pure compounds (9-octadecenoic acid and 10-hydroxyoctadecanoic acid) and four oily isolates from the seed of *Telfairia occidentalis* and concluded that the seed of *Telfairia occidentalis* can be consumed for its antioxidant property.

Nutritional and anti-nutritional constituents of *Telfairia occidentalis*

The highest nutritional mineral constituents found in the older root of *Telfairia occidentalis* include, sodium, potassium, calcium and magnesium.^[32] The mineral constituents of the leaves, stem and seed of *Telfairia occidentalis* include potassium, sodium, calcium, iron, phosphorus, zinc, magnesium, manganese and copper, while the proximate analysis of the leaves and seed of *Telfairia occidentalis* were reported to contain Moisture content, ash, carbohydrate-Starch, crude protein, glucose, fructose, sucrose and amino acids.^[33,29] The aqueous extract of the leaves has been reported to contain vitamins C and E which are standard antioxidants that help scavenge for oxygen free radicals and prevent oxidative stress.^[33] Fasuyi^[18] and Enujiugha et al.^[34] reported that the nutritional composition of the leaves includes water, energy, protein, fat, carbohydrates and fibre.

The root of *Telfairia occidentalis* has been reported to contain considerable amounts of anti-nutrients such as oxalates,^[32] phytic acid, tannin and saponin which could have some hazardous health effects on its consumers.^[35] Unprocessed *Telfairia occidentalis* seed has been shown to contain anti-nutrients such as trypsin inhibitors and lecithins in animal diet which can impair feed conversion efficiency and significantly lower body weight gain.^[36] Trypsin inhibitors interfere with the physiological process of digestion through disruption of the normal functioning of pancreatic proteolytic enzymes in non-ruminants leading to severe growth depression.^[37]

Toxicity of *Telfairia Occidentalis*

The use of medicinal plants in the treatment and management of diseases in more than 70% of the world's

population is on the increase all over the world.^[38] Herbal preparations have been reported to be 'natural'. However, in spite of the belief and claim of being natural and safe, their usage are without side effects and toxicity, which have been attributed to contamination during preparation by heavy metals or microorganisms and hepatic toxicity of the main constituents.^[39]

Acute Toxicity Test carried out by Akindele et al.^[40] on *Telfairia occidentalis* up to 5000 mg/kg orally, showed no mortality and signs of toxicity within the 14 days post-treatment observation period. However, the LD₅₀ of intraperitoneal administration of *Telfairia occidentalis* in mice was calculated as 3200 mg/kg. In the experiment, the mice manifested decreased locomotion, calmness, writhing and increased breathing at the higher doses (3000-5000 mg/kg).

Agwu et al.^[41] reported that the root extracts of *Telfairia occidentalis* was toxic to *Clarias gariepinus* fingerlings and the percentage mortality was concentration dependent. The highest mortality, 100% was observed in 75 mg/L treated group when compared to the other groups. They also reported that no literature is available on the toxicity of root of *Telfairia occidentalis* on *Clarias gariepinus* or other fish species. The erratic swimming, loss of balance and discoloration observed in the behavior of the test animal suggests possible nervous disorder. From their study, it was concluded that aqueous root extract of *Telfairia occidentalis* is capable of interfering with the haematological parameters of *Claria gariepinus* fingerlings and may prove detrimental to survival in nature. Aqueous extract of *Telfairia occidentalis* root is therefore toxic to *Claria gariepinus* and its cultivation close to banks of water utilized for *Claria gariepinus* aquaculture should be discouraged.^[41]

The roots of *Telfairia occidentalis* are not edible, but confirmed potent human poisons due to the presence of high amount of alkaloid and saponins,^[20] as such the root extract is used for controlling pest and rodents,^[20,42,25] and as an antibacterial agent.^[43]

Eseyin et al.^[44] reported the toxicity of the fruit extract of *Telfairia occidentalis*, as it caused significant increase in serum concentrations of cholesterol, triglycerides and total proteins when 100, 500 and 1000 mg/kg body doses was administered to rats and suggested that the hypercholesterolaemic, hyperproteinaemic, hypertriglyceridaemic and hyperconjugated bilirubinaemic effects of the fruit extract of *Telfairia occidentalis*, makes the fruit unsafe for consumption.

The aqueous extract of the root demonstrated a potent detrimental action on the mucosa lining of the stomach.^[45] The observation of significant reduction in weight of the animals, loss of appetite and death of some rats may be associated with the lethal effect of the alkaloids, saponin and glycoside content of the crude extract of the root of *Telfairia occidentalis*. Saponins

when taken orally are relatively harmless as they are only slightly absorbed by the digestive tract.^[46] Saponins have hemolytic properties and when injected into the blood stream is largely toxic especially to cold blooded animals and many saponins are used as fish poisons.^[46]

Ekanem et al.^[47] reported that the crude extract of the root of *Telfairia occidentalis* is hepatotoxic and should be used with great caution. Ekanem et al.^[48] also suggested that the root of *Telfairia occidentalis* may be nephrotoxic when administered intraperitoneally at doses of 0.38 mg/kg and 0.75 mg/kg but when administered orally at doses of 0.38 mg/kg and 0.75 mg/kg, ethanolic extract of the root may not be as toxic as claimed. Histologically, renal corpuscles, proximal and distal convoluted tubules were adversely affected by the oral and intraperitoneal administration of the crude extract of root of *Telfairia occidentalis* to rats in a manner similar to the report of Samter and Parker,^[49] that the morphological sites for the adverse effect of drugs include, the tubules, interstitium, glomeruli and blood vessels. The dilation of the tubules and enlarged glomeruli seen in animals that received the crude extract of the root of *Telfairia occidentalis* orally and intraperitoneally may be due to increased tubular secretion, a mechanism employed to clear harmful toxins and drugs from the blood.^[50] Distortion and degeneration of glomeruli and total distortion of the kidney cytoarchitecture observed in the study may have been due to the effect of some components of the root of *Telfairia occidentalis* like the anthraquinone.^[48] Anthraquinone is not excreted by the kidney, on resorption stimulates calcium-binding proteins in the kidney to bind calcium. This therefore deposits calcium in the renal interstitium causing lithiasis. Lithiasis destroyed the interstitium, blood vessels and nephrons.^[51] The death of rats observed may have been due to renal failure. It has been reported that toxins and drugs may cause subtle but cumulative injury to the tubules; this might take years to become manifest resulting in chronic renal insufficiency. Renal failure is therefore a manifestation of cumulative effect of injury to the morphological sites of the kidney and may eventually lead to death.^[50] From their work, it can be concluded that the crude extract of the root of *Telfairia occidentalis* is nephrotoxic, with the effects being more pronounced in the animals, which were administered intraperitoneally.

Saalu et al.^[15] evaluated the effects of oral administration of graded doses of *Telfairia occidentalis* leaf extracts (200, 400 and 800 mg/kg/day) on testis of Sprague-Dawley rats and reported poor histomorphometric profiles, deranged sperm characteristics and increased evidence of testicular oxidative stress in the groups of rats treated with 400 and 800 mg/kg/day. They concluded that, while the lower dose of *Telfairia occidentalis* leaf extract (200 mg/kg/day) is testiculoprotective, the higher doses (400 and 800 mg/kg/day) demonstrated testiculotoxicity in the rat.

Thus the dose of application of the extract in folk medicine should be regulated to forestall possible reproductive impairment.

Adisa et al.^[52] also, in a dose-dependent study, reported the testiculotoxic effects of *Telfairia occidentalis* leaf extract in rats, indicated by testicular basement membrane distortions, cellular degeneration, haemorrhage, interstitial space exudations and cellular necrosis when 100 and 200 mg/kg body weight of aqueous extract of *Telfairia occidentalis* was administered orally to adult male Wistar rats for 4 weeks and concluded that *Telfairia occidentalis* has a reducing effect on semen quality, plasma testosterone values and has potentials for testicular cell damage in a dose dependent fashion. In fact, the roots and leaves of *Telfairia occidentalis* have been shown to contain highly toxic alkaloids and saponins,^[20] while Taitzoglou et al.^[53] as well as Nworgu et al.^[54] reported that even though *Telfairia occidentalis* extract contains tannins which are classified as antioxidants, at a high dose, they could become pro-oxidant, increasing lipid peroxidation and inducing oxidative stress.

Medicinal Benefits of *Telfairia Occidentalis*

The World Health Organization (WHO) estimates that up to 80% of world's population still rely mainly on traditional medicine and for thousands of years, medicinal plants have been an important source of medicine. The role of medicinal plants in disease prevention or control has been attributed to antioxidant properties of their constituents.^[55]

Telfairia occidentalis (Fluted Pumpkin), a leaf and seed vegetable is of high nutritional value. The leaves of this vegetable are rich in minerals such as iron, potassium, sodium, phosphorus, calcium and magnesium, and contain antioxidants such as thiamine, riboflavin, nicotinamide, ascorbic acid and amino acids such as alanine, aspartate glycine and leucine.^[19,56] Research has shown that *Telfairia occidentalis* leaf and seed extracts are used in the treatment of anemia, convulsion, atherosclerotic cardiovascular disorders, high blood pressure, hyperglycemia, dyslipidemia, arthritis, liver problems and inflammatory conditions.^[57,62]

Phytochemically, it contains flavonoids, a potent antioxidant compound that scavenges for free radicals and reducing oxidative stress,^[63] tannins, hence it purgative, anti-asthmatic, antitussives (cough suppressants) and anti-hay fever effect.^[64,65,63] *Telfairia occidentalis* extracts also contain terpenoids, an anti-feedant with insecticidal property.^[64,63] Osukoya et al.^[30] reported that the seed of *Telfairia occidentalis* is usually consumed in the form of herbal decoctions/concoctions as a blood tonic, to treat sudden attacks of convulsions, pain, malaria and anaemia. The flour produced from the seeds can be used for high-protein breads and the shoots and leaves consumed as vegetables.^[32,66] Iwu^[67] reported the usefulness of the leaves of *Telfairia occidentalis* in

the maintenance of high degree of blood alkalinity, provision of roughage which stimulates peristalsis and proper elimination of waste matter from the colon, as such helps prevent constipation with all its associated problems like colitis, appendicitis, haemorrhoid and fissure. The leaves have been documented to stimulate bone marrow to produce blood cells and maintain body resistance to infection.^[68]

Pharmacological Actions and Morphological Effects of *Telfairia Occidentalis* Extract on Some Organ/System

Antioxidant activity of *Telfairia occidentalis*

The main protective action of vegetables has been attributed to the antioxidants present in them. The oxidative stress experienced by a tissue, organelle or organ results from the balance between the production and removal of potentially damaging reactive oxygen species. Antioxidants can prevent the chemical damage caused by reactive oxygen species such as free radicals that are generated by a variety of sources including pesticides, tobacco smoke, exhaust fumes, certain pollutants and organic solvents.^[69]

Studies have shown that quite a number of human diseases occur as a result of oxidative stress, induced by the generation of free radicals such as superoxide anions, hydrogen peroxide, hydroxyl radical and nitric oxide, causing cellular damage by modifying macromolecules such as DNA, carbohydrates, proteins and lipids thereby damaging them.^[70,71] The consequences of oxidative damage are diseases such as diabetes, hypertension, atherosclerosis, cancer, myocardial infarction, arthritis, anemia, asthma, inflammation and neurodegenerative diseases (Alzheimer's disease, Parkinson's disease, epilepsy and Amyotrophic lateral sclerosis).^[72] However, exposure to free radicals from a variety of sources has led organisms to develop series of defense mechanism, the antioxidant defense mechanism.^[73]

The antioxidant system, classified into exogenous and endogenous antioxidants help to neutralize the excess free radicals, protect the cell against their toxic effects and to contribute to disease prevention.^[74] The exogenous antioxidants are mainly derived from food and medicinal plants, such as fruits, vegetables, cereals, mushrooms, beverages, flowers, spices and traditional medicinal herbs.^[75,79] Natural antioxidants derived from medicinal plant materials are mainly polyphenols (phenolic acids, flavonoids, anthocyanins, lignans and stilbenes), carotenoids (xanthophylls and carotenes), lycopenes and vitamins (vitamin C and E),^[80] some of which are present in *Telfairia occidentalis*.^[21,22] Polyphenols and carotenoids, exhibit a wide range of biological effects, such as anti-inflammatory, antibacterial, antiviral, anti-aging, and anticancer.^[78,81,83] Consumption of these natural medicinal plants has the potential of protecting against oxidative stress and its attendant health implications by protecting the body against the damaging effect of free radicals. The free

radical scavenging property of *Telfairia occidentalis* attributed to the presence of high amount of polyphenols, especially flavonoids and vitamin C has been documented.^[21,22,84] Nkereuwem et al.^[85] reported that the n-hexane fraction had the highest flavonoid content and free radical scavenging activity than the aqueous and ethanolic extract.

Antidiabetic activity of *Telfairia occidentalis*

Diabetes is one of the biggest challenges to public health globally and the fourth leading cause of death in developed countries.^[86] Diabetes is a chronic metabolic disorder occasioned by abnormally high level of glucose in the blood and it is caused by the abnormality of carbohydrate metabolism which is linked to low blood insulin level or insensitivity of target organs to insulin.^[87] The consequences of untreated diabetes include blindness, kidney disease, neurodegenerative disease, cardiovascular disease among others. The current antidiabetic therapies (insulin, sulfonylureas, biguanides and glinides) have been reported to produce serious adverse effects such as cataract, neuropathy and nephropathy,^[88] hence the need for a more effective and relatively safe hypoglycaemic agents.

Aderibigbe et al.^[89] were the first to report the hypoglycaemic activity of *Telfairia occidentalis* leaf extract in mice. In their report, aqueous extract of *Telfairia occidentalis* leaves decreased blood glucose level significantly in streptozotocin-induced diabetic and glucose-induced hyperglycaemic rats. Eseyin et al.^[90] Eseyin et al.^[60] and James et al.^[91] showed that ethanolic leaf extract of *Telfairia occidentalis* significantly decreased blood glucose level in alloxan-induced diabetic rat. Eseyin et al.^[90] also reported that the antidiabetic activity of *Telfairia occidentalis* leaf extract was comparable to the standard antidiabetic drug, glibenclamide and concluded that the leaves of *Telfairia occidentalis* possess hypoglycemic activity in normoglycemic and alloxan-induced diabetic rats, and could be a source of potentially useful antidiabetic therapy for diabetics. Oboh et al.^[92] documented the *in-vitro* activities of *Telfairia occidentalis* leaf extracts as it inhibited α -amylase and α -glucosidase in a dose-dependent manner. The ethanolic seed extract of *Telfairia occidentalis* has also been shown to possess antidiabetic activity^[60] by decreasing the blood glucose level of alloxan-induced diabetic rats but not in normoglycaemic rats, as such could be useful in the ethnotherapy of type 2 diabetes.

Anxiolytic/sedative activities of *Telfairia occidentalis*

Ajao and Akindele^[93] investigated the anxiolytic and sedative activities of the hydroethanolic leaf extract of *Telfairia occidentalis* in mice using the hole-board, elevated plus maze, open-field, light-dark and social interaction tests and reported that *Telfairia occidentalis* at doses of 50 and 100 mg/kg, increased the number of sectional crossings, duration of head dips, increased number of entries into open arms, increased number of

central squares. At a dose of 400 mg/kg, *Telfairia occidentalis* leaf extracts reduced number of head dips and sectional crossings, reduced time spent in open arms and increased time spent in closed arms, while at doses of 200 and 400 mg/kg, reduced number of assisted rearings, increased latency of entry into and time spent in dark box and reduced number of social interactions. They suggested that *Telfairia occidentalis* possess anxiolytic property at doses of 50 and 100 mg/kg, and sedative activity at doses of 200 and 400 mg/kg.

Antinociceptive/Analgesic activity of *Telfairia occidentalis*

The analgesic and anti-inflammatory activities of the leave of *Telfairia occidentalis* are well documented.^[62] The seeds of *Telfairia occidentalis* have been known to possess different biological properties and are used in traditional medicine in Africa and Asia to treat many ailments. Osukoya et al.^[30] evaluated the antinociceptive activity of methanolic seed extract of *Telfairia occidentalis* in albino rats to substantiate its ethnomedical use. The analgesic activity was analyzed using formalin-induced paw licking test in albino rats at 100, 200 and 400 mg/kg body weight seed extract. They reported significant reduction in formalin-induced paw licking in both neurogenic and inflammatory phases of formalin-induced paw licking test in a dose dependent manner and suggested that *Telfairia occidentalis* seed extract could be used as an analgesic for treatment of pain.

Hepatoprotective activity of *Telfairia occidentalis*

Bolaji and Olabode^[94] investigated the effect of lyophilized aqueous leaf extracts of *Telfairia occidentalis* on cyanide (3 mg/kg body weight)-induced toxicity in the liver, kidney and brain of 3 weeks old albino rats and reported that *Telfairia occidentalis* ameliorated cyanide toxicity by increasing the average body weight of the rats, reducing ocular lesion, and nasal discharge, and decreasing elevated levels of ALP and AST. Morphological evaluation showed that *Telfairia occidentalis* mitigated the multifocal degeneration and necrosis of the liver, mild congestion of blood vessels in the kidney and brain induced by cyanide ingestion in rat. They concluded that, lyophilised aqueous leaf extracts of *Telfairia occidentalis* showed good potential as a safe antidote for cyanide poisoning when administered concomitantly or very shortly after ingestion of sub-lethal dose of cyanide and recommended that, further bioassay guided fractionation and analytical studies should be done to identify the actual chemical compound or molecule in the vegetable responsible for or associated with the observed effects.

Owoade et al.^[95] reported the antioxidant and hepatoprotective activities of *Telfairia occidentalis* leaf extracts in carbon tetrachloride (CCl₄)-induced oxidative stress and liver damage in rats, by increasing the decreased activities of superoxide dismutase (SOD), catalase (CAT), and reduced glutathione (GSH), and

decreasing the elevated levels of malondialdehyde (MDA), alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) and lactate dehydrogenase (LDH). They concluded that, the antioxidant and hepatoprotective activities observed in the study could be due to the polyphenolic contents of *Telfairia occidentalis* capable of absorbing, neutralizing and mopping up free radicals.

Oladele et al.^[96] evaluated the hepatoprotective effect of aqueous extract of *Telfairia occidentalis* on cadmium chloride-induced oxidative stress and hepatotoxicity in rats. In the research, leaf extracts, decreased elevated levels of ALP, ALT, AST, acid phosphatase (ACP) and MDA, and increased the decreased levels of GSH, glutathione-S-transferase (GST), SOD activity and catalase activity. Morphological evaluation showed that *Telfairia occidentalis* leaf extracts attenuated cadmium chloride-induced hepatic injury by improving the liver cytoarchitecture, decreasing hepatocellular degeneration and necrosis. They concluded that, aqueous extract of *Telfairia occidentalis* exhibited hepatoprotection by scavenging free radicals, reversing/inhibiting oxidative stress pathways and protecting the structural integrity of the liver.

Ogunka-Nnoka et al.^[97] reported the antioxidant and hepatoprotective activities of methanolic leaf extracts of *Telfairia occidentalis* against copper-induced oxidative stress by increasing the decreased levels of GSH, glutathione peroxidase (GPx), catalase and SOD activities, and decreasing the elevated levels of MDA, AST, ALP, ALT and bilirubin induced by intraperitoneal injection of 0.3 mg/kg body weight of copper sulphate to rats, and suggested that *Telfairia occidentalis* could ameliorate the antioxidant status in copper.

Nephroprotective activity of *Telfairia occidentalis*

In spite of the documented medicinal benefits and pharmacological actions of *Telfairia occidentalis*, it is yet to be established that its aqueous extract is safe in conditions of renal impairment. Maduka et al.^[98] investigated the effects of *Telfairia occidentalis* aqueous leaf extracts on gentamycin-induced renal damage and reported that *Telfairia occidentalis* leaf extract decreased elevated levels of creatinine and uric acid levels, suggesting that *Telfairia occidentalis* extracts could be nephroprotective in renal impairment. Ogunka-Nnoka et al.^[97] also reported that methanolic leaf extracts of *Telfairia occidentalis* restored disrupted renal functionality in rats treated with copper intraperitoneally by decreasing elevated levels of urea and creatinine, and increasing the decreased concentration of serum electrolytes, thus suggesting the nephroprotective activity of *Telfairia occidentalis* leaf extracts.

Reproductive activity of *Telfairia occidentalis*

High dose (800 mg/kg body weight) of *Telfairia occidentalis* leaf extracts has been reported to be testiculotoxic but at low doses (200 mg/kg body weight),

it is testiculoprotective.^[15] Sakpa et al.^[99] reported the reproductive activity of aqueous leaf extracts of *Telfairia occidentalis* in adult male Wistar rats, as there was increased sperm count, sperm viability and sperm motility. They also reported increased spermatozoa in the lumina of the seminiferous tubules and epididymis, enhanced spermatogenesis with elevated levels of testosterone, associated with increased levels of luteinizing and follicle stimulating hormones, and concluded that the aqueous leaf extracts of *Telfairia occidentalis* has pro-fertility potentials.

Aghei et al.^[100] investigated the testiculoprotective effects of *Telfairia occidentalis* seed extract on sperm characteristics, biochemical parameters and epididymal histology in adult male rats treated with cyclophosphamide, an anti-cancer chemotherapy drug, used to suppress the immune system, and reported that the co-administration of 300 mg/kg body weight *Telfairia occidentalis* seed extract could increase the total antioxidant capacity level significantly, reversed the histopathological changes (vacuolisation, disorganisation and separation of epididymal epithelium) induced by cyclophosphamide. They suggested that, *Telfairia occidentalis* seed extract might be used as protective agent against cyclophosphamide-induced reproductive toxicity.

Akang et al.^[101] documented the testiculoprotective effects of aqueous leaf extracts of *Telfairia occidentalis* on alcohol-induced toxicity in male Sprague-Dawley rats. They reported depletion in the seminiferous epithelium, decreased sperm quality, increased levels of MDA and SOD activity in the alcohol-treated rats, and that administration of *Telfairia occidentalis* leaf extracts at doses of 250 mg/kg and 500 mg/kg body weight, significantly increased the seminiferous epithelium and sperm quality with decreased MDA levels. They concluded that *Telfairia occidentalis* leaf extracts attenuated the deleterious effects of alcohol, protected the seminiferous epithelium, reduced oxidative stress and promoted spermatogenesis.

Neuroprotective property of *Telfairia occidentalis*

The nervous system is highly vulnerable to oxidative stress due to limited antioxidant capacity, consumes 20 percent of the metabolic oxygen, neurons cannot synthesize glutathione and contains more of polyunsaturated fatty acids.^[102,103] Oboh et al.^[104] investigated the *in-vitro* inhibitory effect of some tropical green leafy vegetables (*Telfairia occidentalis*, *Amarantus cruentus* and *Struchium sparganophora*) on acetylcholinesterase and butyrylcholinesterase (key enzymes linked to Alzheimer's disease) and some pro-oxidant- (iron sulphate, sodium nitroprusside and quinolinic acid) induced lipid peroxidation in rats' brain, and reported that all the vegetables inhibited acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) activity as well as the pro-oxidant-induced lipid peroxidation in rat brain in a dose dependent manner.

They suggested that some of the possible mechanism by which green leafy vegetables exert their neuroprotective activities could be through the inhibition of acetylcholinesterase and butyrylcholinesterase activities and prevention of lipid peroxidation in the brain.

Adejuwon et al.^[7] evaluated the protective role of *Telfairia occidentalis* leaf extracts at doses of 400, 800 and 1600 mg/kg body weight in irradiation-induced oxidative stress in rat brain. They reported that *Telfairia occidentalis* leaf extracts at doses of 400 and 800 mg/kg body weight, attenuated elevated levels of MDA and hydrogen peroxide induced by radiation, and increased the decreased levels of GSH, SOD, GPx and GST activities in the rat brain and concluded that supplementation with *Telfairia occidentalis* leaf extracts could reduce radiation-induced biochemical disorders in brain tissues.

Owoeye and Gabriel^[10] evaluated the possible protective role of aqueous leaf extracts of *Telfairia occidentalis* against mercuric chloride (HgCl₂)-induced behavioural, biochemical and morphological changes in rat brain. *Telfairia occidentalis* leaf extract mitigated the elevated MDA levels, catalase and SOD activities, increased grooming and locomotor frequencies as well as increased GSH levels. Morphological evaluation of the hippocampus and cerebellum showed that *Telfairia occidentalis* leaf extracts reversed the loss of granule, pyramidal and Purkinje cells induced by HgCl₂. They suggested that aqueous leaf extract of *Telfairia occidentalis* has the capacity to protect rat brain from HgCl₂-induced oxidative stress and degeneration of hippocampal and cerebellar neurons possibly via its antioxidant activity.

Imosemi et al.^[11] evaluated the protective effects of *Telfairia occidentalis* leaf extracts (400 mg/kg body weight) against cisplatin (an antineoplastic chemotherapy drug used for the treatment of solid tumours)-induced oxidative stress in the cerebellar cortex of Wistar rat, employing biochemical and morphological (histological and immunohistochemical) analyses. They reported that *Telfairia occidentalis* leaf extracts ameliorated the decreased body weight, increased lipid peroxidation, decreased catalase activity, decreased Purkinje cell density and increased astrocyte population induced by cisplatin and concluded that oral administration of aqueous leaf extracts of *Telfairia occidentalis* decreased the rate of oxidative damage induced by cisplatin via its antioxidative pathway.

CONCLUSION

Telfairia occidentalis Hook f. is widely used by ethnomedical practitioners in Nigeria in the treatment of various ailments, including diabetes, anaemia, malaria, liver and kidney diseases, and ulcer. It has also been used as fungicide, herbicide and rodenticide. This review has contributed to the base line information about the poisonous nature of the root and fruit of *Telfairia*

occidentalis, its medicinal benefits, pharmacological actions and morphological effects on some organ/system, which may be of benefit in advising ethnomedical practitioners on the usage of the plant, as the benefits derived from the consumption of *Telfairia occidentalis* if properly processed, outweighs the harmful toxic effects.

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