

Review Article

A Review of the Pharmacological and Biological Activities of the Aerial Parts of *Telfairia occidentalis* Hook.f. (Cucurbitaceae)

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Abstract

Telfairia occidentalis Hook.f. (Cucurbitaceae) is cultivated in West Africa. The purpose of this article is to review information available in scientific literature on the pharmacological and biological activities of the plant. Searches were made and relevant information obtained from online resources such as Google Scholar, PubMed and Medline. Only literature highlighting the pharmacological, biological and biochemical activities of the plant were selected for this review. The antioxidant, antidiabetic, hepatoprotective, haematological, antiparasitic, antimicrobial, testiculoprotective, anticancer, antiinflammatory, anxiolytic, sedative and anticonvulsant properties of the plant are documented in this paper. Some of these properties are attributable to the high antioxidant activity of the plant. The medicinal value of *Telfairia occidentalis* is no longer in doubt. It is expected that this review will be useful to researchers, herbal medical practitioners and agriculturists, and would also enhance optimum exploitation of the plants for its several benefits

Keywords: *Telfairia occidentalis*, Fluted pumpkin, Antioxidant, Antidiabetic, Haematological, Antiparasitic, Testiculoprotective, Anticancer, Antiinflammatory, Anxiolytic, Sedative, Anticonvulsant

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INTRODUCTION

Charles Telfair (1778-1835), an Irish botanist who lived in Mauritius, sent an African genus of the cucumber family (Cucurbitaceae) from Mauritius to Sir Williams Jackson Hooker (1785-1865) for identification. In honor of Dr Telfair, the plant *Telfairia occidentalis* was named after him by Sir Hooker [1]. However, the earliest reference to *Telfairia* was made by Oliver in 1871 and it recorded its presence in Upper Guinea areas of Sierra Leone, Fernando Po, and Abeokuta (Nigeria) [2]. The ethno botanical use of *Telfairia occidentalis* in India has also been

reported [3]. The geographical distribution of the plant is shown in Figure 1.

Telfairia occidentalis is widely cultivated for its palatable and nutritious leaves. The leaves when compared with other tropical vegetables have high nutritive value. Its protein content (21 %) is higher than those of other commonly used leafy vegetables. The leaves are rich in vitamins and minerals such as Ca, P, Fe etc. The seed is also eaten as food. The oil obtained from the seed is used in cooking [2].

There are claims that the plant possesses some medicinal value. This article is a review of the pharmacological and biological properties of *Telfairia occidentalis* as reported in scientific literature.



Figure 1: Geographical distribution of *Telfairia occidentalis* [4]

BOTANICAL CLASSIFICATION OF TELFAIRIA OCCIDENTALIS

Integrated Taxonomy Information System gave the taxonomic hierarchy of *Telfairia occidentalis* as follows:

Kingdom (Plantae–plantes, Planta, Vegetal, plants), **Subkingdom** (Viridaeplantae – green plants), **Infrakingdom** (Streptophyta – land plants), **Division** (Tracheophyta – vascular plants, tracheophytes), **Subdivision** (Spermatophytina – spermatophytes, seed plants, phanérogames), **Infradivision** (Angiospermae – flowering plants, angiosperms, plantas com flor, angiosperma, plantes à fleurs, angiospermes, plantes à fruits), **Class** (Magnoliopsida), **Superorder** (Rosanae), **Order** (Cucurbitales), **Family** (Cucurbitaceae – gourds, squashes, citrouilles, gourdes), **Genus** (*Telfairia* Hook.), **Species** (*Telfairia occidentalis* Hook. f.– oysternut). **Taxonomic Serial No.:** 505897 [5].

Popular and common names

Telfairia occidentalis is popularly known in different languages and countries as follows: Fluted pumpkin, oyster nut, oil nut, fluted gourd and Telfairia nut (English); Costillada (Spanish); Krobonko (Ghana); Oroko, pondokoko and Gonugbe (Sierra Leone); Ugwu (Igbo-Nigeria), Aworoko, Eweroko (Yoruba-Nigeria) and Ikong (Efik/Ibibio-Nigeria) [6].

DESCRIPTION

Telfairia occidentalis is a large perennial plant which climbs by means of bifid and tendrils which are usually coiled. The stem has five ridges often

covered with multi-cellular hairs, especially when young. The leaves of the plant are compound, usually 3-5 foliate, with blades and petioles also covered with multicellular hairs. The fruits are marked by 10 conspicuous longitudinal ridges and are among the largest known (16-50 cm length, 9 cm diameter). The seeds which are embedded within a bright-yellow fibrous endoscarp are large, non endospermic and usually dark red in colour [2]. Photograph of the plant is shown in Figure 2.



Figure 2: Photo of *Telfairia occidentalis* [7]

PHARMACOLOGICAL AND BIOLOGICAL ACTIVITIES

Antioxidant property

Telfairia occidentalis has been reported to possess antioxidant property. The aqueous extract had a higher total phenol, reducing power and free radical scavenging ability (12.2 %, 1.9 OD700 and 92 %, respectively) than the ethanolic extract which had total phenol, reducing power and free radical scavenging ability of 5.5 %, 1.5 OD700 and 25 %, respectively [8]. The free soluble polyphenols content in the leaf of the plant which were higher than the bound polyphenols had higher antioxidant activity as typified by their higher reducing power and free radical scavenging ability than the bound polyphenols [9]. *Telfairia occidentalis* leaf contained a significantly high amount of vitamin C, total flavonoids and phenolics than *Psidium guajava* stem bark. The leaf inhibited more free radicals than *Psidium guajava* stem bark [10]. The n-hexane fraction had the highest flavonoid content and free radical scavenging activity comparable to that of the commercial antioxidant BHT [11]. The ability of the leaf of *Telfairia occidentalis* to reduce iron (III) to iron (II) was also reported. The antioxidant property of *Telfairia occidentalis* is attributable to the high content of polyphenols, especially flavonoids.

Many human diseases are caused by oxidative stress which is usually initiated by free radicals such as superoxide anions, hydrogen peroxide, hydroxyl radical and nitric oxide. These free radicals react with macromolecules such as DNA, proteins and lipids, thereby damaging them. The consequences of this damage are diseases such as diabetes, hypertension, atherosclerosis, cancer, myocardial infarction, arthritis, anemia, asthma, inflammation, neurodegenerative diseases [12]. Endogenous antioxidants such as super oxide dismutase, catalase, glutathione reductase, ascorbic acid and tocopherol protect the body against the damaging effects of free radicals. Certain pathologic situations may disrupt the protective effects of these endogenous antioxidants. To protect man from the destructive effects of free radicals in such situations the administration of exogenous antioxidants is required. Unfortunately, commercially available synthetic antioxidants are toxic. But natural products of plant origin have been found to exhibit strong antioxidant activity due mainly to the presence of antioxidant components such as flavonoids, phenols, flavonols, proanthocyanins, vitamin C, carotenoids and lycopene, some of which are present in *T. occidentalis*. The antioxidant property of *Telfairia occidentalis* which has been well documented therefore makes the plant medicinally useful. Consumption of the plant has the potential of protecting the consumer from oxidative stress and its attendant health implications.

Antidiabetic activity

Diabetes is the fourth main cause of death in most developed countries and is reaching epidemic proportions in the developed world. According to the International Diabetes Federation, if adequate measures are not taken, the global trend of diabetes will reach about 330 million by the year 2025. Between 5 and 10 % of the world's health care budget is currently spent on diabetes, and this figure could increase to 40 % in the year 2025 in some countries. The World Health Organization (WHO) has called for greater recognition of traditional (herbal) medical practitioners [13]. Due to custom, religion, folklore, poverty or lack of access to orthodox medicine, many people in developing countries depend more on traditional herbal remedies.

The fruits and seeds of various plants in the curcubitaceae family (such as the fruit of *Mormodica charantia* and the seed of *Mormodica cochinchinensis*) are known to have antidiabetic effects. It is therefore not surprising that *Telfairia occidentalis* has been reported to

possess antidiabetic activity. From available records, Aderibigbe and Lawal [14] were the first to document the antihyperglycaemic effect of the plant in mice. They reported that the aqueous extract of the leaf of the plant reduced glucose level significantly in streptozotocin induced diabetic and glucose induced hyperglycaemic rats. Other researchers have also confirmed the antidiabetic activity of the leaf of the plant [15-17]. The antidiabetic activity of the ethanolic leaf extract of the plant was traced to the ethyl acetate fraction of the leaf [18]. The leaf polysaccharides of the plant have also been reported to possess antidiabetic activity [19]. The leaf extract inhibited the in vitro activities of α -amylase and α -glucosidase in a dose dependent manner [20]. The seed of the plant has also been shown to possess antidiabetic activity [21].

Free radicals are implicated in diabetes. Hyperglycaemia which characterizes diabetes lead to the non-enzymatic glycation of circulating proteins (such as hemoglobin), tissues (e.g collagen) and DNA to produce advanced glycated end products. Reactive oxygen is always generated in this reaction. The reactive oxygen species generated from the glycation process increase cross linking of extracellular (EC) matrix, quench nitric oxide (NO) and may damage DNA [22]. It is therefore possible that the antidiabetic activity of *Telfairia occidentalis* may be connected to its antioxidant property which enables it to mop up free radicals.

Hematological activity

Telfairia occidentalis is used ethno pharmacologically for the treatment of anaemia [3,23]. The haematonic properties of the leaf was reported [24]. Aqueous extract of the leaf increased the haematocrit value and the reticulocyte count of rabbits [25]. The administration of *T. occidentalis* leaves led to a modest increase in haemoglobin (Hb) levels in anaemic mice that were comparable to the Hb repletion in anaemic mice given FeSO₄ [26]. There was a dose-dependent increase in all the measured haematological indices (PCV, RBC, WBC and haemoglobin concentration) in rats fed with the plant [27,28]. Human erythrocytes exposed to hypotonic and heat stress were stabilized by the extract of *Telfairia occidentalis* in a dose dependent manner [29]. The inhibitory and reversal activities of the leaf extract on sickle cell has also been reported [30].

It is obvious from these reports that consumption of the leaf of *Telfairia occidentalis* can enhance various haematological parameters and would therefore improve the physiological and

nutritional status of its consumers. This may be due to the high content of iron and proteins in the leaf of the plant. The reports of these researchers have further justified the ethnobotanical use of the plant as a blood tonic and antianemic.

Anticancer activity

Cancer is a generic term for a large group of diseases that can affect any part of the body. One characteristic feature of cancer is metastasis. According to WHO, cancer is a leading cause of death worldwide, accounting for 7.6 million deaths (around 13 % of all deaths) in 2008. Deaths from cancer worldwide are projected to continue to rise to over 13.1 million in 2030.

Reports show that *Telfairia occidentalis* possesses anticancer potential. The crude extract of the seed of *Telfairia occidentalis* showed anticancer activity by prominently inhibiting oxidative burst activity in whole blood, isolated polymorphonuclear cells (PMNs) and mononuclear cells (MNCs). The potency order was hexane fraction > dichloromethane fraction > ethyl acetate fraction > butanol fraction > aqueous fraction > crude extract [31]. The seed of *T. occidentalis* decreased serum prostatic acid phosphatase concentrations, increased testosterone: estradiol ratio, and reduced the mass and secretory activity of the enlarged prostate, thereby proving to be useful in managing experimental benign prostatic hyperplasia in rats [32]. It reduced the mean relative prostate weight, protein content (mg/tissue) of the rats' prostates and serum prostatic acid phosphatase, inhibiting the induction of BPH in rats [33], possibly by increasing the level of serum testosterone while concomitantly lowering the level of serum estradiol. 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.

There have been recent reports linking the anti-oxidative and superoxide scavenging activities of individual active components of herbal medicine with their anti-cancer properties. Herbal medicine is also used in nutrient supplement for anti-cancer activity. Numerous *in vitro* studies of herbal medicine on different cell lines and *in vivo* study of herbal medicine have also been reported. Since the high antioxidant property of *Telfairia occidentalis* has been established, it is therefore likely that the cancer chemopreventive

activity of the seed could be attributed to the antioxidant components and activity of the plant.

Anti-inflammatory and analgesic activity

The leaf of *T. occidentalis* significantly inhibited Carrageenan-induced oedema in the sub-planar hind paw of vegetable extracts [34]. The seed extract showed significant anti-inflammatory activity against egg albumin and xylene-induced oedema and exhibited a dose-dependent inhibition of pains in acetic acid-induced writhing, formalin-induced hind paw licking and thermal-induced pain models. The inhibition of neurogenic and non-neurogenic pains as well as narcotic pains by the extract may in part explain the mechanisms of its action [35].

Male fertility activity

Telfairia occidentalis produced a dose-dependent improvement in the seminal fluid analysis and the histology of the testes, showing a near complete morphological regeneration and increased spermatogenesis [36]. The leaf extract of *T. occidentalis* increased sperm motility, sperm viability and sperm count in rat [37]. The seed oil at a dose of 400 mg/kg also improved semen parameters but had no effect on testicular histology, testosterone and luteinizing hormone level of rat [38]. The oil increased the level of testosterone, luteinizing hormone, sperm count, sperm motility and testicular weight compared to the alcohol treated rats.

T. occidentalis demonstrated a prophylactic effect on alcohol induced testicular damage and improved semen quality. In addition, it also improved serum testosterone and luteinizing hormone levels [39]. *Telfairia occidentalis* seeds-incorporated diet resulted in a modest reduction of biochemical castration and an improvement in secretory capacity of the testes in rats, thus showing that it may be useful in inhibiting the induction of experimental andropause [40].

The spermatogenic activity of *T. occidentalis* may be as a result of the carbohydrate content which could have increased sperm motility and viability by increasing glucose metabolism leading to the generation of energy and pyruvate which is the preferred substrate essential for the activity and survival of sperm cells. Other components of the plant such as arginine, vitamin C and zinc may also play important roles since studies have shown that nutritional therapies with zinc, vitamin C, vitamin E and arginine proved to be of benefit in the treatment of male infertility. The beneficial effect of the plant on male fertility may be as a result of the antioxidant components of the plant

since antioxidants such as vitamins A, C and E have been reported to have good protective effects on the testis [39].

Hepatoprotective property

Both aqueous and ethanolic extracts of *T. occidentalis* leaf have hepatoprotective properties, although the aqueous extract was more effective than the ethanolic extract, which could be attributed to the higher antioxidant activity of the aqueous extract than the ethanolic extracts of *T. occidentalis* leaves [41]. *T. occidentalis* proved to be a better vegetable in preventing garlic-induced hepatotoxicity compared with the other vegetables used in the study [42]. The lyophilised aqueous extracts of the plant showed good potential as a safe antidote for cyanide poisoning when administered concomitantly or very shortly after ingestion of sub-lethal dose of cyanide [43]. Free soluble polyphenols which had higher antioxidant activity also had higher protective effect on the liver than the bound polyphenols in acetaminophen induced liver damage, thereby showing the link between the antioxidant and hepatoprotective properties of the leaf [7]. Rats pretreated with ethanolic leaf extract of *Telfairia occidentalis* had protective function against paracetamol toxicity in rats liver enzymes by increasing their levels toward normal [44]. From the various reports highlighted above, it appears that the hepatoprotective activity of *Telfairia occidentalis* also has a link with the high antioxidant activity of the plant.

Antimalaria activity

Malaria is a tropical disease that affects more than 40 % of the world's population. It is most endemic in sub-Saharan Africa where over 90 % of cases occur, causing over 2 million deaths annually. The spread of resistance of Plasmodium parasite to chloroquine which until the advent of artemisinin has been the mainstay antimalarial drug has been given as the main reason for the dramatic increase in mortality from malaria in Africa. Unfortunately, resistance to the recommended artemisinin-based combination therapy has also been reported in some parts of the world.

Many of the antimalarial drugs in use today such as quinine and artemisinin were either obtained directly from plants or are derivatives of plant components. As such, plants have always been considered to be a possible alternative and rich source of new drugs. The root of *Telfairia*

occidentalis exhibited significant blood schizonticidal activity both in 4 day early infection test and in established infection with considerable mean survival time comparable to that of standard drug, chloroquine (5 mg/kg) [45]. Similarly, the leaf extract exhibited antiplasmodial activity both in the 4-day early infection test and in established infection with a marked increase of the mean survival time, which, however, remained lower than that achieved with the standard drug, chloroquine (5 mg/kg/day). The seed extract also demonstrated a promising blood schizonticidal activity in early and established infections [46]. The plant showed very high *in vitro* synergistic activities in combination with chloroquine, and also against CQ-tolerant *P. berghei* isolates [47]. These studies show that the plant possesses significant antiplasmodial activities, which may be exploited in the control of malaria.

Antimicrobial activity

The antibacterial activity of the leaf of *Telfairia occidentalis* (fluted pumpkins) against selected intestinal pathogens was investigated using the agar diffusion technique. The extract showed a higher antibacterial activity against *E. coli*, *S. faecalis* and *S. typhi*. MIC was 0.5, 5.0 and 500 mg/ml for *E. coli*, *S. typhi* and *S. faecalis*, respectively [48]. Similarly, the ethanolic leaf extract had a higher inhibitory effect on some of the commonly encountered Enterobacteriaceae in Nigeria, namely *Escherichia coli* (4.0 nm), *Pseudomonads aeruginosa* (8.0 nm) and *Proteus* sp (4.0 nm), except *Salmonella typhii* (2.0 nm). The aqueous extracts had a higher inhibition of the growth. The crude extract inhibited the growth of 93.1 % of the tested microorganisms and showed synergistic effects at MIC/2 and MIC/5 with seven of the tested antibiotics on more than 70 % of the tested bacteria [49]. The extracts of the plant caused concentration-dependent paralysis and death of the worms, with the aqueous extracts showing higher worm inhibitory and destructive activities compared to the methanol extracts [52].

Toxicity and biochemical activities

It is believed that the root of *T. occidentalis* is poisonous [51]. The aqueous extract of the root demonstrated a potent detrimental action on the mucosa lining of the stomach [52]. It was suggested that the root of *Telfairia occidentalis* may be nephrotoxic [53]. But when administered orally, ethanolic extract of the root may not be as toxic as claimed.

CHEMICAL COMPOSITION OF TELFAIRIA OCCIDENTALIS

Leaves and stem

The proximate chemical composition of fluted pumpkin leaf extract was given as: crude protein (21.31), crude fibre (6.41), ether extract (5.50), ash (10.92), nitrogen free extracts (55.56), metabolisable energy (3121.00 kcal/kg), gross energy (4420.00 kcal/kg), Ca (0.67), P(0.40), K(0.15), N (3.41), Mg (0.43), Na (0.02), Zn (7.50 mg/100g), Fe (18.5 mg/100g), Mn (1.18 mg/100g), Phytate (510.51 mg/100g), Tannin (0.184 mg/100g), Oxalate (0.0034 mg/100g) [55]. The proportions of the various minerals vary with the age of the plant. Anti-nutrient composition of the young stems and leaves of the plant was found to be higher than that found in the older leaves and stems [2].

The high content of Fe in the young tender fluted pumpkin leaves was given as the basis for which the leaf extract is administered traditionally as blood tonic in treatment of anemia and to convalescing patients. The crude fiber content of 20.17 ± 0.12 % in the leaves of *Telfairia occidentalis* indicated that the leaves of this plant are good sources of dietary fibers. Higher carbohydrate of 39.64 % leads to a corresponding increase of energy value recorded as 290.16 kcal/100g which further confirmed that this plant leaves could serve as a good source of energy. The leaves are good sources of K, Cu, Fe and Mn, moderate sources of Mg and Zn which are essential in human and animal nutrition [55]. Total amino acid in *T. occidentalis* was 455.3 mg/g with total essential amino acid of 256.1 mg/g or 56.3 %, showing the plant proteins to be high in essential amino acids. Aqueous extract of the leaf contain 5.07 mg/100ml and 40 mg/100ml of Vitamins E and C, respectively.

Seed

The proximate composition of the seed was reported as follows: Moisture content (6.30 %), ash (3.44 %), carbohydrate-Starch-(16.5- (62.5), crude protein (16.0 %). Also present are glucose, fructose, sucrose and sixteen amino acids with glutamic acid (16.4 g/100g) being the highest while lysine (2.6 g/100g) was lowest. Compositions of phospholipids, glyco-lipids and neutral lipids were obtained as follows: Phospholipids (58.0%), phosphatidyl ethanolamine (6.5 %), phosphatidyl inositol (4.4 %), phosphatidyl choline (26.2 %), phosphatidyl serine (5.3 %), lysophosphatidyl choline (14.0 %), phosphatidylglycerine (1.6 %), glycolipids (26.0 %), monogalactosyldiglyceride (11.7 %),

digalactosyldiglyceride (8.2 %), Steryl glycoside (3.6 %), cerebroside (0.8 %), unidentified (0.5 %), unidentified (0.8 %), unidentified (0.4 %), neutral lipids (16.0 %), triglycerides (5.6 %), diglycerides (3.8 %), sterylesters (2.5 %), Free sterols (1.1 %) and monoglycerides (3.0 %) [56]. Oleic acid is the major occurring fatty acid, constituting about 36 % of the total fraction. Significant levels of vitamins A and C are also present. The high content of unsaturated fatty acids in the seed confers a high nutritive value on these seeds. The younger seeds are nutritionally preferable as food since they contain fewer anti-nutrients and have sweeter taste than the mature seeds [2]. In terms of amino acids, glutamic acid was highest in value (13.65 mg) followed by aspartic acid (10.78 mg) and leucine (10.26 mg). Methionine was the lowest (1.12 mg). Other parameters are as follows: weight per milliliter (1.755), acid value (3.65), iodine value (7.12), saponification value (12.2), ester value (8.55), viscosity (0.0035), specific gravity (0.7227) and refractive index (1.426) [57].

Root

Composition of the roots of fluted pumpkin also varies with the age of the plant. The highest mineral elements in older roots were found to be potassium, calcium, magnesium and sodium. Generally, the highest concentrations of all the anti-nutrients (almost 100 fold for oxalates) were found in the root. Oxalate composition was very high in both young (1083 mg/100g) and old roots (2600 mg/100g) [2].

Pod and pulp

Not much has been documented on this part of the plant. The pod and pulp contain the following: moisture (91.3 and 92.8), crude protein (1.4 and 1.3), crude fibre (0.85 and 0.46), ether extract (0.50 and 0.30), ash (0.40 and 0.30), and nitrogen free extract (5.60 and 4.84), respectively [58].

Phytochemical constituents of *Telfairia occidentalis*

The presence of tannins, reducing sugars, glycosides, saponins and sterol and triterperoids in the root, and only tannins, flavonoids, alkaloids, saponins, steroids, anthraquinones, and reducing sugars in the stem and leaves have been reported. Long chain n-3-unsaturated fatty acid have been isolated from the leaf using an arginated silica gel column (8 cm, 0.5 mm diameter) eluted with n-hexane. Palmitoleic acid (16.62 %) and elaidic acid (0.85 %) are the predominant omega 9 fatty acid present in the

leaf [59]. GC-MS analysis of hexane and dichloromethane fractions of the seed showed that the seed contained compounds such as pentadecanoic acid, hexadecanoic acid; 16-octadecenoic acid methyl ester; 9, 12-octadecadienoyl chloride (Z,Z); 9-Octadecadienoic acid (Z)-, 2, 3-dihydroxypropyl ester; Octadecanoic acid ; hexadecanoic acid, 2,3-bis[(trimethylsilyl)oxy] propyl ester in the hexane fraction and 2,4-heptadien-6-ynal,(E,E); benzoic acid ; dodecanoic acid ; linoleic acid ethyl ester ; hexadecanoic acid, methyl ester ; α -phellandrene ; α -campholene aldehyde; terpinen-4-ol ; trans- β -ocimene ; borneol ; stigmastan-3-ol, in the dichloromethane fraction [35]. Information obtained from Dr. Duke's Phytochemical and Ethnobotanical Databases [60] shows that some of these compounds have the following biological activities: palmitoleic acid (5- α reductase inhibitor); elaidic acid (anti-inflammatory and antileukotriene-D4). Pentanoic acid (antioxidant property); benzoic acid (allergenic, anesthetic, antibacterial, antipyretic, antiseptic, choleric); Linoleic-acid (5-Alpha-Reductase-Inhibitor, antiallopecic, Antiarteriosclerotic, Antiarthritic, Anticoronary, Antifibrinolytic, Antihistaminic, Antiinflammatory, Antileukotriene-D4, Antimenorrhagic, Antiprosthetic, Cancer-Preventive, Carcinogenic, Comedolytic, Hepatoprotective, Hypocholesterolemic, Immunomodulator). Terpinen-4-ol (Antiacetylcholinesterase, Antiallergic, Antiasthmatic, Antibacterial, Antioxidant, Antiseptic, Antispasmodic; Antitussive, Antiulcer, Bacteriostatic, Diuretic, Fungicide, Herbicide, Herbicide); Borneol (Analgesic, Antiacetylcholine, Antibacterial, Antibronchitic, Antiescherichic, Antifeedant, Antiinflammatory, Antitoxic, Antipyretic, Antispasmodic, Antistaphylococcic, Antiyeast, CNS-Stimulant, Hepatoprotective, Myorelaxant, Nematicide, Sedative, Tranquilizer).

CONCLUSION

The medicinal potential of the leaf and seed (oil) of *Telfairia occidentalis* is no longer in doubt. It is now obvious that the plant has been proven to possess beneficial antioxidant, antidiabetic, hepatoprotective, haematological, antiplasmodial, antimicrobial, testiculoprotective, anticancer, antiinflammatory, anxiolytic and sedative properties. Many of these activities confirm the claims of herbal medical practitioners, although clinical tests, using human subject, still need to be done. Many researchers have also attributed some of the medicinal activities of the plant to the high level of antioxidant components (such as phenolics, flavonoids, Vitamins C and E) and

antioxidant property of the plant. However, the presence of other phytochemicals such as saponins may also play valuable roles in the activities of the plant. As researchers continue to focus their investigation on this plant, it is expected that more of the medicinal properties of the plant will be unravelled. However, not much has been done on the chemistry of the plant, especially the leaf. This is a major drawback. Therefore, researchers should focus their investigation on the isolation and identification of bioactive components of the plant. It is necessary to know the identity of the components that are responsible for each of the identified medicinal properties of the plant. This may provide a "lead" to the discovery of novel drugs from the plants. It will also enhance the effective exploitation of the medicinal benefits of this popular and important plant.

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REFERENCES

1. Seychelles Weekly. [assessed on February 14, 2013]. http://www.seychellesweekly.com/March%207,%202010/top6_cerf_island.html:
2. Akoroda M. Ethnobotany of *Telfairia occidentalis* (Cucurbitaceae) among Igbos of Nigeria. *Econ Bot* 1990; 44(1): 29-39.
3. Verma KS, Baksh Z. Ethno-medicinal Plant Resources of Jabalpur District, Madhya Pradesh. *J Res Dev* 2013; 12:39-48.
4. Odiaka, N.I. & Schippers, R.R., 2004. *Telfairia occidentalis* Hook.f. [Internet] Record from PROTA4U. Grubben, G.J.H. & Denton, O.A. (Editors). PROTA (Plant Resources of Tropical Africa / Ressources végétales de l'Afrique tropicale), Wageningen, Netherlands. <<http://www.prota4u.org/search.asp>>. Accessed 22 May 2014.
5. http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_to_pic=TSN&search_value=505897; assessed on September 22, 2013)
6. Gbile ZO. Vernacular names of Nigerian plants (Yoruba). Ibadan: Forestry Research Institute of Nigeria.-. *En Geog*, 1984; p 101.
7. <http://www.freshplaza.com/article/1827/The-fluted-pumpkin,-a-West-African-delicacy>
8. Oboh G, Nwanna E, Elusiyan C. Antioxidant and Antimicrobial Properties of *Telfairia occidentalis*(Fluted pumpkin) Leaf Extracts. *J Pharmacol Toxicol* 2010; 5(8): 539-547.

9. Nwanna E, Oboh G. Antioxidant and Hepatoprotective Properties of Polyphenol Extracts from *Telfairia occidentalis* (Fluted Pumpkin) leaves on acetaminophen induced liver damage. *Pak J Biol Sci* 2007; 10(16): 2682-2687.
10. Aminu M, Bello MS, Abbas O, Aliyu M, Malam BS, Auwalu G, Muhammad HA, Shafi'u M, Hussaina NN, Hasiya A, Sani A. Comparative in vitro antioxidant studies of ethanolic extracts of *Psidium guajava* Stem Bark and *Telfairia occidentalis* leaf. *Int. J. Modern Biochem* 2012; 1(1): 18-26.
11. Nkereuwem AO, Eseyin OA, Udobre SA, Ebong A. Evaluation of antioxidant activity and chemical analysis of the leaf of *Telfairia occidentalis*. *Nig J Pharm Appl Sci Res* 2011; 1 (1): 21-28.
12. Potterat O. Antioxidants and free radical scavengers of natural origin. *Curr org chem* 1997; 1(4): 415-440.
13. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995–2025: prevalence, numerical estimates, and projections. *Diabetes care* 1998; 21(9): 1414-1431.
14. Aderibigbe A, Lawal B, Oluwagbemi J. The antihyperglycaemic effect of *Telfairia occidentalis* in mice. *Afr J. Med Med. Sci* 1999; 28: 115-171.
15. Eseyin O, Ebong P, Eyong E, Awofisayo O, Agboke A. Effect of *Telfairia occidentalis* on oral glucose tolerance in rats. *Afr J Pharm Pharmacol*, 2010. 4: p. 368-372.
16. Eseyin OA, Ebong P, Eyong UE, Umoh E, Attih E. Comparative hypoglycaemic effects of ethanolic and aqueous extracts of the leaf and seed of *Telfairia occidentalis*. *Turk J Pharm Sci* 2010; 7 (1): 29-34.
17. Nwozo SO, Adaramoye OA, Ajaiyeoba EO. Anti-Diabetic And Hypolipidemic Studies of *Telfairia occidentalis* on alloxan Induced Diabetic Rabbits. *Nig J Nat Prod Med* 2004; 8: 45-47
18. Eseyin OA, Ebong P, Eyong EU, Umoh E, Agboke H. Hypoglycaemic activity of ethyl acetate fraction of the leaf extract of *Telfairia occidentalis*. *Pak J Pharm Sci* 2010; 23(3): 341-343.
19. Eseyin O A, Sattar M A, Rathore H A, Ahmad A, Afzal S, Lazhari M, Ahmad F, Akhtar S. Hypoglycemic Potential of Polysaccharides of the Leaf Extract of *Telfairia occidentalis*. *Ann Res Rev Biol* 2014; 4(11): 1813-182.
20. Oboh G, Akinyemi A, Ademiluyi A. Inhibition of α -amylase and α -glucosidase activities by ethanolic extract of *Telfairia occidentalis* (fluted pumpkin) leaf. *Asian Pac J Trop Biomed* 2012; 2(9): 733-738.
21. Eseyin OA, Ebong P, Ekpo A, Igboasoiji A, Oforah E. Hypoglycemic effect of the seed extract of *Telfairia occidentalis* in rat. *Pak J Biol Sci* 2007; 10(3): 498-501.
22. Stanaway S, Gill G. Protein glycosylation in diabetes mellitus: biochemical and clinical considerations. *Pract Diabetes Int* 2000; 17(1): 21-25.
23. Nwauzoma A, Dappa MS. Ethnobotanical Studies of Port Harcourt Metropolis, Nigeria. *ISRN Botany* 2013; 2013:1-11
24. Dina OA, Adedapo AA, Oyinloye OP, Saba AB. Effect of *Telfairia occidentalis* extract on experimentally induced anaemia in domestic rabbits. *Afr J Biomed Res* 2006; 3: 181-183.
25. Ajayi AI, Ajayi TC, Omokaro EU, Halim NKD. Erythropoietic value of pumpkin leaf extract in rabbits—a preliminary study. *Nig. J. Physiol. Sci* 2000; 16: 1-3.
26. Hamlin F, Latunde-Dada GO. Iron bioavailability from a tropical leafy vegetable in anaemic mice. *Nutr metab* 2011; 8(1): 9.
27. Alada A. The haematological effect of *Telferia occidentalis* diet preparation. *Afr J Biomed Res* 2000; 3(3): 185-186.
28. Odede T, Ikusagba B, Odetola A. Effect of *Telfairia occidentalis* on erythrocyte indices of rats following acute blood loss. *Afr J Med Med Sci* 2010; 39: 117.
29. Osuntoki A, Sanusi A. *Telfairia occidentalis* extract stabilizes human erythrocyte membranes. *Nig Quart J Hosp Med* 2007; 17(3): 116-119.
30. Cyril-Olutayo C, Agbedahunsi J, Elufioye O. Antisickling properties of some indigenous and exotic plant species in Nigeria. *Planta Medica* 2012; 78(11): 12-17.
31. Okokon JE, Farooq AD, Choudhary MI, Antia BS. Immunomodulatory, Anticancer and Anti-inflammatory Activities of *Telfairia occidentalis* Seed Extract and Fractions. *Int J Fd Nutr Safety* 2012; 2(2): 72-85.
32. Ejike C, Ezeanyika LU. Management of experimental benign prostatic hyperplasia in rats using a food-based therapy containing *Telfairia occidentalis* seeds. *Afr J Trad Complement and Altern Med* 2011; 8(4): 398-404
33. Ejike CE, Ezeanyika LU. Inhibition of the Experimental Induction of Benign Prostatic Hyperplasia: A Possible Role for Fluted Pumpkin (*Telfairia occidentalis* Hook f.) Seeds. *Urologia Intern* 2011; 87(2): 218-224.
34. Oluwole E, Falode A, Ogundipe O. Anti-inflammatory effect of some common Nigerian vegetables. *Nig J Physiol Sci* 2005; 18(1): 35-38.
35. Okokon JE, Dar A, Choudhary MI. Chemical constituents and analgesic activity of *Telfaria occidentalis*. *Phytopharmacol* 2012; 3: 359-366.
36. Nwangwa EK, Mordi J, Ebeye OA, Ojeh AE. Testicular regenerative effects induced by the extract of *Telfairia occidentalis* in rats. *Caderno de Pesquisa, sér Bio* 2007; 19: 27-35.
37. Saalu LC, Kpela T, Benebo AS, Oyewopo AO, Anifowope EO, Oguntola JA. The Dose-Dependent Testiculoprotective and Testiculotoxic Potentials of *Telfairia occidentalis* Hook f. Leaves Extract in Rat. *Intern J Appl Res Nat Prod* 2010; 3(3): 27-38.
38. Akang EN, Oremosu AA, Dosumu OO, Noronha CC, Okanlawon AO. The effect of fluted pumpkin (*Telfairia occidentalis*) seed oil (FPSO) on testis and *Trop J Pharm Res*, October 2014; 13(10): 1768

- semen parameters. *Agric. Biol. J N Am* 2010; 1(4): 697-703.
39. Akang E, Oremosu A, Dosumu O, Ejiwunmi A. *Telfairia occidentalis*, a Prophylactic Medicine for Alcohol's Damaging Effect on the Testis. 2011; *Macedon J Med Sci* 4(4): 380-387.
 40. Ejike C, Ezeanyika L. A *Telfairia occidentalis* seed-incorporated diet may be useful in inhibiting the induction of experimental andropause. *Annals Med Health Sci Res* 2013; 2(1): 41-45.
 41. Oboh G. Hepatoprotective property of ethanolic and aqueous extracts of fluted pumpkin (*Telfairia occidentalis*) leaves against garlic-induced oxidative stress. *J Med fd* 2005; 8(4): 560.
 42. Oboh G. Tropical green leafy vegetables prevent garlic-induced hepatotoxicity in the rat. *J Med food* 2006; 9(4): 545-551.
 43. Bolaji O, Olabode O. Modulating effect of aqueous extract of *Telfairia occidentalis* on induced cyanide toxicity in rats. *Nig J Physiol Sci* 2011; 26(2): 185-191.
 44. Danladi J, Abayomi KB, Dahiru AU. Comparative Study of The Hepatoprotective Effect of Ethanolic Extract of a *Telfairia occidentalis* (Ugu) Leaves And Silymarin on Paracetamol Induced Liver Damage in Wistar Rats. *Int J Animal Vet Adv* 2012; 4(4): 235-239
 45. Okokon J, Ekpo A, Eseyin O. Antiplasmodial activity of ethanolic root extract of *Telfairia occidentalis*. *Res J Parasitol* 2007; 2: 94-98.
 46. Okokon JE, Ekpo AJ, Eseyin OA. Evaluation of In Vivo Antimalarial Activities of Ethanolic Leaf and Seed Extracts of *Telfairia occidentalis*. *J Med fd* 2009; 12(3): 649-653.
 47. Chenniappan K, Kadarkarai M. In vitro antimalarial activity of traditionally used Western Ghats plants from India and their interactions with chloroquine against chloroquine-resistant *Plasmodium falciparum*. *Parasitol Res* 2010; 107(6): 1351-1364.
 48. Oyewole O, Abalaka M. Antimicrobial Activities of *Telfairia occidentalis* (fluted pumpkins) Leaf Extract against Selected Intestinal Pathogens. *J Health Sci* 2012; 2(2): 1-4.
 49. Noumedem JA, Mihasan, MK, Jules RS, Marius C, Dumitru D, Jean PK. In Vitro antibacterial and antibiotic-potential activities of four edible plants against multidrug-resistant gram-negative species. *BMC Complem Altern Med* 2013; 13(1): 190.
 50. Okpo S, Nnajekwu O. In vitro anthelmintic activity of the seed extracts of three plants of the Cucurbitaceae family on *Lumbricus terrestris*. *J Pharm Biores* 2013; 9(2): 92-98.
 51. Akubue P, Kar A, Nnachetta F. Toxicity of extracts of roots and leaves of *Telfairia occidentalis*. *Planta Medica* 1980; 38(04): 339-343.
 52. Morcos A, Sarkis T. Histo-Pathological Alterations of the Stomach of Guinea Pigs Following Administration of Root Aqueous Extract of *Telfairia occidentalis*. *Eur J Med Sci* 2013; 11(2): 1-5.
 53. Ekanem TB, Ekeoma, AO, Eluwa, MA, Akpantah, AO. Influence of crude extract of root of *Telfairia occidentalis* (fluted pumpkin) on the cytoarchitecture of the rat kidney and body weight. *Global J Pure Appl Sci* 2010; 16(3): 353-358
 54. Akwaowo EU, Ndon BA, Etuk EU. Minerals and antinutrients in fluted pumpkin (*Telfairia occidentalis* Hook f.). *Fd Chem* 2000; 70(2): 235-240.
 55. Idris S. Compositional Studies of *Telfairia occidentalis* leaves. *Ame J Chem* 2011; 1(2): 56-59.
 56. Asiegbu JE. Some biochemical evaluation of fluted pumpkin seed. *J Sci Fd Agric* 1987; 40(2): 151-155.
 57. Ezugwu C, Nwodo N. Studies on *Telfairia occidentalis* (fluted pumpkin) and the characterization of fixed oils from the seeds. *Nig J Nat Prod Med* 2000; 4(1): 37-42.
 58. Essien A, Eban R, Udo H. Chemical evaluation of the pod and pulp of the fluted pumpkin (*Telfairia occidentalis*) fruit. *Fd Chem* 1992; 45(3): 175-178.
 59. Inuwa HM, Aimola IA, Muhammad A, Habila N, Okibe P, Latayo M, Ahmed Z. Isolation and determination of omega-9 fatty acids from *Telfairia occidentalis*. *Intl J Fd Nutr Safety* 2012; 1(1): 9-14.
 60. Dr. Duke's Phytochemical and Ethnobotanical Databases <http://www.ars-grin.gov/duke/chem-activities.html>