Nutritional And Health Values Of African Walnut (Tetracarpidium Conophorum)

A. M. Kanu, J. E. Kalu, A. C. Okorie

Abstract: African walnut (Tetracarpidium conophorum) which belongs to the family Euphorbiaceae is a perennial climber widely distributed and consumed by the inhabitants of Sub-Saharan Africa. The plant is cultivated principally for the nuts which are consumed as snacks. T. conophorum are a rich source of protein, carbohydrate, fats and oil, vitamins and minerals that are essential for growth and overall nutritional wellbeing. T. conophorum contain wonderful plant based polyunsaturated fatty acids such as alpha linolenic acid. They also contain healthful monosaturated fats. T. conophorum carries many notable plant derived chemical compounds that are known to have disease preventing and health promoting properties. Over all T. conophorum is an important plant with a wide array of potential nutritional and health benefits which demands for development of value added products from them

Index Terms: T. conophorum, nutritional, health benefits, medicinal, chemical composition, seeds, African walnut.

1 INTRODUCTION

African walnut (*Tetracarpidium conophorum*), a tropical rambling perennial woody plant of the family Euphorbiaceae is widely distributed and consumed by the inhabitants of Africa (1). The African walnut (*T. conophorum*) is often found growing wild as a climber in the forest regions of Africa and India (2), (3). *T. conophorum* has a long history as food plant and is grown by peasant farmers. Its plant is mostly cultivated for its nuts which can be cooked or consumed as snacks. In Nigeria, it is “Asala or Awusa” in Yoruba, “Ukpa” in Igbo and “Okhue or Okwe” in Edo. *T. conophorum*, like many plants in Africa and other parts of the world has been proven to have decorative, nutritive, medicinal, agricultural and industrial values over the years. Phytochemical analysis of Africa walnut indicates that it contains bioactive compounds such as oxalates, phytates, tannins, saponins and alkaloids which partly shows the use of the seeds, leaves and roots in herbal medicine (4), (5). The presence of tannin supports its anti-inflammatory property. As a rich source of alkaloids, coupled with the presence of the essential vitamins and minerals, *T. conophorum* can be seen as a potential source of useful food and drugs. High content of ascorbic acid also indicates that the plant can also be used to prevent or at least minimize the formation of carcinogenic substances from dietary material (4). Studies show that the nuts are rich in protein, carbohydrate, fats and oils, vitamins and minerals (1), (4), (6). Its seed are rich in fat, nearly eighty percent of unpolysaturated fat with proven cholesterol lowering properties. Chauhan *et al.* (7) reported that walnut extracts which are rich in dietary omega-3-fatty acids play a role in the prevention of some disorders including depression as well as dementia. Its bark and leaves are used in traditional medicine to ease dysentery and other diseases. In Nigeria, its seeds are reportedly used to treat male fertility (8). Decoction of leaves and seeds serve as beverage which relieves abdominal pains and fever (9). Extracts of *T. conophorum* leaves have been shown to possess good antibacterial activities especially against Gram positive organisms (10). They can be cooked, roasted or sun dried and the roasted seeds could be ground like melon seeds and used as a thickener in soup preparation. Dried walnuts can be ground and turned into flour which can be used as composite flour during baking or in place of milk in tea preparation (11). Despite its health and medicinal values, *T. conophorum* is still included in the list of lesser known food stuff hence this review was undertaken to discuss the health and medicinal benefits of African walnut (*T. conophorum*).

- *Anulika M. Kanu, E-mail: anulikanu@yahoo.com Emmanuel J. Kalu,Chukwuemeka A. Okorie Department of Biology/Microbiology, Abia State Polytechnic, Aba, Nigeria.*

Origin and Description

African walnut (*Tetracarpidium conophorum*) has a long history as food plant and is grown by peasant farmers across West African rain forest. *T. conophorum* is widely distributed and consumed by the inhabitants of the Guinea Zone of West and Central Africa (1). The climbers bear capsules that are greenish in colour when young and greenish yellow when fully ripe. The leaves are broadened and are rounded up to 53 inches with slender petioles up to 3 inches long. The fruits are four winged ridged between wings and up to 3 inches in diameter. The testa of the seed is hard and the cotyledons are white in colour. The seeds take 4 – 6 months to mature and are found in the local markets between the months of June and September (12). It twines around any support, especially trees in its vicinity. It is an alley farmed crop, grown alongside cocoa and kola nut and uses these trees as support for its growth. The economic importance of the species lies in the edibility of its oil rich endospermous seed, which is consumed by diverse populations in Nigeria, Sierra Leone and the Lower Congo region. It grows along the African Coastline and it is thought to originate in South Western Nigeria (13). It is usually cultivated by subsistence farmers in the hot and humid zones of tropical Africa in compound gardens and backyards, just for the family and local market consumption. *T. conophorum* is a woody climber about 6-18m long on attainment of reproductive phase with a stem (13). As a successful, long-stemmed woody climbing plant that grows from ground level to the canopy of other trees. It is well adapted to the tropical forests. It has stems which could be as long as 70m or more. It climbs up and over the tops of other very tall trees in other to benefit from full sunlight at maturity. Sometimes it may bind the trees together such that if one of the trees dies, it is held in position until it decays (14). The stem can be up to 16cm in girth and dark grey when old, but green and glabrous when young. The root is mainly fasciculated. The leaves (10cm long and 5cm broad) are simple, crenate and ovate with a serrated margin; they are also alternate, abruptly acuminate and rounded at the base. The leaves are three-nerved at the base with the petiole up to

5cm long. Conophor plant is monoecious with separate male and female flowers on the same plant. The male flowers are in narrow raceme-like panicles about as long as the leaves, with one or two female flowers near the base. The flowers are arranged alternately on the axis of the raceme inflorescence. The style is stout and quadrangular with four spreading stigmas. The stamens are many, about 40 in number (13). They are forest scrambler, seed contained in compartmentalized fruits. They are found in both primary and secondary forests. The fruit is a four-winged, ribbed capsule, containing subglobose seeds with a thin, brown shell and yellowish kernel. Each seed loculus ends in a wing thereby creating ridges in between the wings. The seed is about 2.5cm in diameter. The fruit (7cm across) are light green to brown when ripe, while the seeds are round dark brown at maturity (covered with a hard testa). Sometimes not all the seeds develop in which cases the fruit has fewer wings. The vine is found in the moist forest zones of tropical Africa between 4°15'Nand 8°N of the Equator .This exotic wild fruit is grown in the traditional farming system of the lowland humid regions. It can tolerate any type of soil, provided it is well drained with moderate moisture-retention capabilities (13). A woody liane to over 30m long, of the bushy Savanna in Sierra Leone and from Dahomey to West Cameroons and Fernando Po and extending to Zaire. Though well-recorded from Sierra Leone and cultivated there, it is apparently indigenous. It is not recorded from Liberia, Ghana and Togo. Its presence in Sierra Leone may be due to returning slaves for it is known to the Krio by its Yoruba (Nigerian) name. Cultivation trials have been carried out in Nigeria. It is also present in Central African Republic, Congo, Gabon, and Niger (15). In Nigeria, the conophor plant flowers between November and early January and fruits between February and September with peak production in July. The immature fruits are usually green in color, but turn dark brown as they mature (16). They are plants having swollen, fleshy, sparsely branched stems and sometimes candlebroid in appearance (13). The fruit is a capsule 6-10cm long by 3-11cm wide containing sub-globular seeds 1- 2.5cm long with a thin brown shell resembling the temperate walnut, hence the English name.

Figure 1: *Unshelled T. Conophorum nuts*

Figure 2: *Shelled T. Conophorum nuts*

Popular and Common Names

It is commonly referred to as African walnut because of its origin in the West Africa rainforest and as Nigerian walnut by Nigerians. It is known as 'Ekporo' by Efik and Ibibio's of Cross River and Akwa Ibom, 'Ukpa' (Igbo), 'Awusa' or 'Asala' (Yoruba), 'Okhue' or 'Okwe' (Edo), 'Gawudi bairi' (Hausa), 'Kaso' or 'Ngak' (Littoral and the Western Cameroon) (17), (4).

Nutritional Composition and Nutritional Value

T. conophorum have been taken as snacks when the unshelled nuts are boiled and cracked (3). A bitter taste is usually observed upon drinking water immediately after eating the nuts. The proximate composition of *T. conophorum* revealed that the nut is rich in protein, fat, carbohydrate but lower fibre and ash content (18). The nuts have also been found to be very good sources of Vitamins A, B_1, B_2, B_6, E, folate, sodium, potassium, manganese, copper, chloride, iron and ascorbic acid (2). Their green hulls or the immature fruits are good sources of vitamin C. The nut is a good source of energy being a good source of carbohydrate (16.9%) and calories about 600J (12). The value of protein content of *T. conophorum* fall within the protein content range of 3.2 – 43.1% for fruits and nuts. Any plant food that provides more than 12% of its energy from protein is considered a good source of protein (19). Assuming complete absorption, the nut meets this requirement by contributing about 23.0 – 28% of daily protein needs. *T. conophorum* nuts could be used to boost the carbohydrate and protein content of most food products sold in the markets. *T. conophorum* contain plant based polyunsaturated fatty acids such as alpha-linolenic acid. Furthermore, nuts of *T. conophorum* contain omega – 3- essential fatty acids and since it cannot be manufactured within our bodies and must therefore be ingested (20). *T. conophorum* provide more Omega 3 per pound than any other food. It contains mono saturated fats (15%). Other fatty acid compositions of the nut oil include palmitic, palmitioleic, arachidic and eicosenic. It is very rich in ascorbic acid and could be used to boost ascorbic acid content of most food products sold in our markets (2). Report from a study revealed that the nuts have a preponderance amount of vitamin A, vitamin C and vitamin E. Other vitamins though in trace amounts are essential for body metabolism. African walnut is a rich source of mineral elements such as calcium, magnesium, sodium, potassium and phosphorus (21). However, the lower sodium content of *T. conophorum* is an added advantage because of direct relationship of sodium nitrate with hypertension in human.

Chemical Composition and Medicinal Value of T. conophorum

T. conophorum have innumerable health benefits although it is still included in the list of lesser known foodstuff. Phytochemical analysis of *T. conophorum* nuts, leaves and roots indicates that it contains bioactive compounds such as oxalates, phytates, tannins, saponins, alkaloids, flavonoids and terpenoids (22), (20), (4), (5), (6). The presence of these phytochemicals partly shows the use of *T. conophorum* in herbal medicine.

Wound Healing Activity

Wound healing is an intricate process in which the skin or other organ tissue repairs itself after injury. Studies have shown that *T. conophorum* possess some properties that are required for wound healing like antibacterial (10), antioxidant (24) and immuno stimulating activities (25). A study by Ezealisiji *et al.* (26) revealed a faster healing pattern of wound closure was observed in rates treated with 5%, 10%. *T. conophorum* or gentamicin within 8 days compared to rats treated with pure ointments. When compared to standard groups the percentage wound contraction on day 4 for 10% n-hexane group was significant , while no significant ($p<0.05$) different was observed in the wound contraction activity of other groups below the 16th day. The percentage mean wound contractions on day 18 were 69.18, 84.14, 90.60, 88.36, 96.50 and 98.09 respectively for the negative control, 50% n-hexane, 10% n-hexane, 5% methanol, 10% methanol and gentamicin respectively.

Antioxidant Activity

Akomolafe *et al.* (27) evaluated the anti-peroxidative activity of the leaves of *T. conophorum* by determining their capacity to reduce malondialdehyde (MDA) level in reproductive organs and accessory glands of rats. Adult male rats were administered orally with the aqueous leaf extract from *T. conophorum* at 50, 500 and 1000 mg/kg body weight for 21 consecutive days while clomiphene citrate (1.04 mg/kg body weight), a fertility drug was used as standard. The results of the study indicated that there was increase in relative organ weight, body weight, mean total food and water consumed by the treated groups. Testicular MDA level was highly significantly different from that of the control although a tentatively decreased MDA level was observed. However, MDA levels in the reproductive accessory glands, epididymis, seminal vesicle and prostate gland were insignificantly () lower than those of controls. The highest percentage decrease of MDA level (66.35, 42.68, 62.50 and 63.36%) was observed at the highest concentration of the extract (1000 mg/kg) in the testis, epididymis, seminal vesicle and prostate gland respectively. These values were two-fold greater than the values obtained for the standard drug. Interestingly, the treatment of rats with the extract significantly increased the activities of superoxide dismutase, catalase (CAT), glutathione peroxidase (GPx), glutathione-S-transferase (GST) and the levels of GSH, vitamin C and total protein. Collectively, the results suggest that the extract from *T. conophorum* leaves had greater capacity to reduce lipid peroxidation in reproductive organs and accessory glands and thus, this plant may be useful in the treatment/management of reproductive cellular damage involving reactive oxygen species. A study by Amaeze *et al.* (24) evaluated the antioxidant activity of *T. conophorum* extracts of fresh and dried leaves. The result revealed revealed that ethanol extract of the dried leaves had the highest antioxidant activity with 50% inhibition of DPPH at a concentration of 0.017mg/ml compared to the standard, Vitamin C and Vitamin E with inhibition of 0.019 and 0.011mg/ml respectively. The extract also showed nitric oxide radical inhibition activity comparable to that of nitin. Ferric reducing power was also comparable to that of ascorbic acid.

Male fertility Activity

Following an investigation carried out by Obianime and Uche (28) on the effects of the aqueous extract of the seed of *T. conophorum* and the effect of proviron (as standard) on the hormonal parameters of male guinea pigs. The claims of the use of the seeds of this plant by traditional medicine practitioners as a male fertility agent were supported. In their study, they compared the effects of the seeds of *T. conophorum* and proviron. Using standard testing methods, they observed that the aqueous extracts of *T. conophorum* seeds (100 – 400mg/ml) caused a statistically significant increase in the level of testosterone of male guinea pigs. These effects were dose and time specific. The optimum effect on testosterone level under dose dependent study (4.70 $\pm$ 0.45) mg/mL was obtained at 300mg/mL of *T. conophorum* after 7 days treatment. A study Adekunle and Oluwafunmilayo (29) investigated the effect of *T. conophorum* seed powder as dietary supplementation on the reproductive indices in male African catfish (*Clarias gariepinus*) broodstocks. Fifteen outdoor concrete tanks consisting of triplicates for each treatment group were used. Triplicate groups of male *C. gariepinus* were fed with four diets supplemented *T. conophorum* seed powder respectively, a control diet without *T. conophorum* seed powder 2 times a day of 3% of body weight for 70 days. Male *C. gariepinus* broodstocks were randomly distributed with density of 10 fish into 15 outdoor concrete tanks. At the end of 70 day experiment, fish fed experimental diets showed significantly improved gonado-somatic index and reproductive indices over the control treatment. A study by Ikpeme *et al.* (30) indicates that the seeds of *T. conophorum* could enhance the production of reproductive hormones and may be used in the formulation of useful fertility drugs. In their research, they investigated the effects of *T. conophorum* seeds on the hormone and sperm profile of male albino rats. Forty eight albino rats of about twelve weeks weighing between 130 – 180g each were divided into four groups (A, B, C and D) with twelve rabbits in each group. The test extracts were incorporated unto the feed of the rats. Group A served as the control (without test substance) while groups B, C and D were fed with 4, 8 and 12g/kg body weight (Bw) of the test substance for a period of 63 days. The results revealed that there was significant difference ($P < 0.05$) in the serum level of follicle stimulating hormone (FSH) and luteinizing hormone (LH) of the rats between the different treatment groups. Results of semen quality showed that there were significant differences ($p<0.05$) in the sperm count, sperm morphology, sperm viability and semen pH among rats between the different groups.

Antihyperglycaemic Activity

Results from a study conducted by Onwuli *et al.* (31) suggest that *T. conophorum* nut have antihyperglycaemic effect. In the study, rats were grouped into five groups (A- E) of four rats each. Diabetes was induced in the rats except for group A which served as positive control. Group B (negative control),

C, D and E contained diabetic rats each with blood sugar level > 17.00mmol/L. Groups A and B were fed on 85.2g of top feed grower over the test period. Test groups C, D and E were fed on 21.3g, 42.6g and 85.2g of walnuts respectively and their fasting blood glucose levels of the test groups were significantly lower than negative control $P < 0.05$ for 3rd, 7th and 10th days of the test. There was also significant increase in the body weight and haemoglobin concentration and a decreased urine output of the test group compared with the controls.

Antiulcer Activity

Antiulcer activity of African walnut (*T. conophorum*) in albino wistar rats was determined by Ezealisiji *et al.* (32). Methanol extract of *T. conophorum* was investigated in pylorus ligation and ethanol induced models in experimental animals. METC at doses of 250 and 500mg/kg orally was used to determine whether the extract could produce significant protection of the gastric lesions by pylorus ligation and ethanol. Parameters such as gastric volume, pH, total and free acidity and ulcer index were used as indicator for antiulcerogenic activity in both models. The extracts at dose levels of 250 and 500mg/kg exhibited significant ($p<0.05$) decrease in the gastric volume, total and free acidity while the pH of gastric juice was significantly ($p<0.05$) increased in both models.

Antichelating Activity

Tetracarpidium conophorum extract may be explored in the industrial production of iron chelators due to its high chelating ability in vitro at low doses, which will be of clinical relevance in the treatment of iron overload disorders such as thalessemia, a group of genetically inherited blood disorders characterized by defective globin chain of haemoglobin and iron overload (33). A study conducted by Olabinri *et al.* (33) assessed the vitro chelating ability of aqueous extract of *T. conophorum*. The plant extract showed a dose dependent decrease in chelating ability in vitro. The values of chelating ability for graded doses (2%, 4%, 6%, 8% and 10% w/v) were 97.38, 90.56, 89.00, 87.46 and 82.80% respectively. The dose (2%, w/v) had the highest chelating ability. At 8% concentration, a strong positive significant correlation was observed between chelating ability and total phenolics concentration ($r = 0.89$; $p= 0.01$). At 2% concentration, the chelating ability of the extract showed a high positive significant correlation with antioxidant activity ($r = 0.68$; $p = 0.001$).

Anticholesterol Activity

The ability of *T. conophorum* to reduce cholesterol seems to be the heart of their health benefits. A research conducted by Lendeu *et al.* (34) discovered that male sprague Dawley rat fed with a standard, commercial diet (control group) or a diet *containing T. conophorum* oil for 60 days reduced the level of cholesterol and triglyceride in the rats compared with the control group fed with standard diets.

Antimicrobial Activity

Results of studies have shown that *T. conophorum* has a high potential as an antimicrobial medicinal plant. A research conducted by Ajaiyeoba and Fadare (10) investigated the antimicrobial activity of leaf stem bark, kernels and root extracts of *T. conophorum.* Extracts and fractions were tested against four clinical strains of 2 gram positive, 2 gram negative bacteria and two fungi. The extracts exhibited concentration dependent antimicrobial properties. The extracts displayed higher activities to the gram positive organisms. The edible nut was devoid of any antimicrobial property. The leaf extract was most active and it inhibited the growth of all the microorganisms used in the study. Bello *et al.* (35) investigated the potentials of walnut (*T. conophorum*) as an antimicrobial agent for fish. The antimicrobial activity of methanolic and ethanolic extracts of walnut leaves were evaluated against six pathogenic bacteria (*Pseudomonas aeruginosa, Staphylococcus aureus, Bacillus subtilis, Pseudomonas fluorescens*, *Escherichia coli* and *Salmonella typhi* using the cup plate method. The zone of inhibition varied with the bacteria and type of extract. The diameter of inhibition zones was 10 ± 0.00 for methanolic and ethanolic extracts of walnut leaves. Minimuim inhibitory concentration of walnut leaves extracts on the bacteria tested were both 500ug/mL. The result indicated that walnut leaves had antibacterial activity on the tested organisms.

Other health benefits

The anti-inflammatory nutrients in African walnuts may play a special role in support of bone health. Given the wide variety of antioxidant and anti-inflammatory nutrients found in *T. conophorum,* it is not surprising seeing research on this plant showing measurable anticancer benefits. The antioxidant properties of African walnut help lower risk of chronic oxidative stress and the anti-inflammatory properties help lower risk of chronic inflammation and it is precisely these two types of risk when combined, pose the greatest threat for cancer development (36). *T. conophorum* extracts which are rich in dietary Omega – 3 fatty acids may play a role in the prevention of some disorders including depression as well as dementia especially Alzheimer's disease.

CONCLUSION

The nutritional analysis of *T. conophorum* reveal it as a fair source of carbohydrate and fibre with appreciable protein content but significantly rich in edible and industrially useful oil as well as dependable quantity of essential dietary minerals for both children and adults. It also has amazing medicinal benefits. Further research studies are needed on health benefits of *T. conophorum.*

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