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Review

Medicinal and Economic Value of *Dialium Guineense*

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ABSTRACT

Dialium guineense (Velvet tamarind, family: Fabaceae) is reported for its food and nutritional value throughout Africa. The medicinal properties of *D. guineense* leaves and other parts of the plant are also well known in traditional system of medicine. The plant has been studied by various scientists and researchers for its pharmacological activities and therapeutic approaches such as antibacterial, anti-ulcer, antioxidant, analgesic, anti-hepatotoxic, antimicrobial, anti-plasmodial, anti-hemmorrhoidal, anti-vibrio, anti-diarrheal, molluscicidal, oral care and vitamin supplement. We reviewed the folk medicinal value of *D. guineense* with the correlated research findings on its uses. The plant was described with habitat, the local uses, including the uses of its parts mentioned, the ethno medicinal uses, the biological activities, the nutritional value and phytochemistry.

Keywords: *Dialium guineense*; ethno medicinal uses; biological activity; nutritional value; phytochemistry

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INTRODUCTION

The use of plants in the maintenance of good health is well documented (Burkil, 1995; Moerman, 1996; Edeoga and Eriata, 2001). It has also been reported that the bases of many modern pharmaceuticals used today for the treatment of various ailments are plants and plant based products (Kamba and Hassan, 2010). About 80% of world population depends on plants based medicine for their health care (WHO, 2001). Medicinal plants are plants which contain substances that could be used for therapeutic purposes or which are precursors for the synthesis of useful drugs (Abolaji *et al.*, 2007). A plant becomes a medicinal plant only when its biological activity has been ethno botanically reported or scientifically established (Elujoba, 1997).

Medicinal plants, since time immemorial have been used virtually in all cultures as a source of medicine. The use of medicinal plants is increasing worldwide, in view of the tremendous expansion of medicine and a growing interest in herbal treatments. Plants are used in medicine to maintain and augment health physically, mentally and spiritually as well as to treat specific conditions and ailments. Medicinal plants are divine gifts to us from Mother Nature who has kept those remedies in her plant kingdom for mankind to use to fight death from diseases and cure themselves from ailments. It is up to us to seek, to explore, search, and reap the benefits of these treasures.

Over 500 plants are known to be useful for medicinal purposes in Africa, but only a few have been described or studied (Taylor *et al.*, 2001). Natural products from plants can be another potent source for the discovery of excellent activities such as blood booster, antioxidant, anti-ulcer, anti-cancer, antimicrobial etc. The World Health Organization (WHO) emphasized the importance of scientific research into herbal medicine. Many developing countries of the world look upon native medicinal plants as possible addition to the WHO's list of "essential drugs" once their value have been clinically proven. Our survival and continued existence in turn depends on the efficiency with which man, with all the resources and technology available to him, harnesses, develops, utilizes plants and plant products (Ayoka *et al.*, 2008). One of the emerging plants of interest is *Dialium guineense*. It is a medicinal plant commonly known as *Velvet tamarind* (or, black velvet), a genus of a legume belonging to the family of Fabaceae and sub-family of Caesalpinioideae. This review is aimed at highlighting the medicinal and economic importance of *Dialium guineense.*

The Plant: *Dialium guineense*

Botanical description: *Velvet tamarind* also known as black velvet is a common name for *Dialium guineense*, a genus of a legume belonging to the family of Fabaceae and sub-family of Caesalpinioideae. The genus *Dialium* comprises five (5) species in West Africa but *D. guineense*, *D. dinklagel*, *D.*

packyphylum are represented in Nigeria (Omotayo, 1999). It is a tree of an average height of 30m with a densely leafy crown, but often shrubby. Bole without buttresses, bark smooth, grey, slash reddish, yielding a little red gum (Hutchinson and Daniel, 1958).

The leaves are finely hairy, with a common stalk of 5 to 13 cm long, with an odd terminal leaflet and usually two pairs of opposite or alternate leaflets, the lower pair being somewhat smaller, mostly 3.5 to 10 x 2.5 to 5 cm, elliptic to broadly elliptic, sometimes slightly obovate, blunt at the apex or abruptly and shortly acuminate, symmetrical and rounded or slightly cuneate at the base; leathery, glabrous above and with the midrib slightly sunken, sometimes finely hairy beneath.

Flowers are usually whitish in large terminal, or occasionally axillary, panicles up to 30 cm long; branches spreading out widely and more or less horizontally (Szolnok, 1985). The whole inflorescence at first covered with very short, brownish hairs. Individual flowers with short stout stalks, the buds about 2 cm.

Fruits are usually abundant, more or less circular and flattened, but sometimes almost globose, up to 2.5 cm in diameter, densely velvety, black; each fruit with a stalk about 6 cm long with a little collar near the apex, with a brittle shell enclosing one seed or exceptionally two, embedded in a dry brownish, sweetly, acidic, edible pulp (Hong *et al.*, 1996).

Figure 1: The plant of *Dialium guineense* (Orwa *et al.*, 2009)

Origin of *Dialium guineense*: The origin of the generic name is not known; J.E Smith, a noted 18th century English botanist sought it and could not discover it, nor have modern botanists. The specific name means "of Guinea" suggesting that it probably originated in Guinea; subsequently it was introduced as a plantation crop in tropical and subtropical regions.

Ecology: *Velvet tamarind* grows in dense savannah forests, shadowy canyons and gallery forests. It is found from Senegal to Sudan along the southern border of the Sahel. It is naturally found on moist, sometimes brackish soils with mean annual rainfall of less than 2100-2600 mm.

Distribution: It is also found in Central and West African countries such as Cameroon, Central African Republic, Chad, Benin, Burkina Fasso, Ivory Coast, Ghana, the Guineas, Liberia, Mali, Senegal, Sierra Leone, and Togo. It is the most common and widespread *Dialium* in Nigeria. It is commonly known as "icheku" among the Igbo in the eastern part of Nigeria, as "awin" among the Yoruba in the western part of Nigeria and as "tsamiyar kurm" among the Hausa in the northern part of Nigeria (Nwosu, 2000; Akinpelu *et al.*, 2011). It is also known as "yoyi" in Ghana, "Sierra Leone tamarind" in Sierra Leone and "tamarinier noir" in French.

In Nigeria the tree flowers from September to October and fruits from October to January (Keay, 1998). The wild fruits are dietary supplement for rural dwellers in Nigeria during dry season when fruits are scarce (George, 2011). The ripe fruits are available from January till May; but the peak period for harvest is between March and April according to Okafor, (1975). Animals which like to eat the pulp in which the seeds are embedded help disperse the fruits, however, the fruit can also be transported by water since it floats; transport by sea currents may lead to long-distance dispersal.

Table 1:
Local uses of *Dialium guineense*

S/N	Morphological part	Non-medicinal uses
1	Wood	In Africa, it is used as fuel: firewood and charcoal. It is also used for construction materials for making vehicles, tools, weapons, furniture, packing cases, houses and flooring. Also used in making "fufu" pestle.
2	Bark	It is used in artwork in carving figures like amulet, statuettes and various ornamental objects. It is also used in making chewing sticks commonly used in eastern Nigeria.
3	Gum	It is obtained from seed and is added to many kinds of foods to improve their viscosity in Japan.
4	Seed	Tamarind seed powder is used as coffee substitute by village people in India. Dehulled seeds are soaked overnight in water and eaten in addition with sugar or salt in India.
5	Leaves	The young leaves are chewed for its tangy taste. It is used as paste or whole in various cuisines or as tempering in India. It is also cooked as vegetables in India or "domoda" a dish in Ghana.
6	Fruits	Edible-can be soaked in water and drunk as beverage. It is also used to provide jam and jellies. When peeled, pulp can be eaten raw in Nigeria or as flavor in snacks.
7	Flowers	They are used for decoration.

Non-Medicinal Uses of *Dialium guineense*: It is commonly used for food; the pulp is red, with a sweet-sour astringent flavor similar to baobab, but sweeter. It can be eaten raw when dry by man and animal (Matsuda, 2006). The pulp when peeled is also eaten raw in south-east Nigeria because of its refreshing properties and pleasant scorching taste (Ubbaonu *et al.*, 2003). The thirst quenching, refreshing pulp can also be soaked in water and drunk as a beverage and also provides jam and jellies (FAO, 2004). It could also be used as flavor in

snacks and non alcoholic beverages (Adame, 2002; Efiong *et al.*, 2009).

The young leaves are sometimes chewed for its tangy taste. They are also used as paste or whole in various cuisines or as tempering in India. The leaves are bitter and are used to cook "domoda" a Ghanaian dish that tastes both sweet and bitter.

The seed are roasted, seed coats are removed mechanically, and dehulled tamarind seeds are soaked overnight in water and eaten with the addition of salt or sugar by the rural people of certain ethnic groups such as kurumba, irulas, malayali and Dravidian tribes in India (Siddhuraju *et al.*, 1995). Nonetheless, hot water extract of dry heated tamarind seed powder is used as a coffee substitute by village people.

The flowers and leaves are eaten as vegetables and the gum obtained from the seed is added to many kinds of food in Japan to improve their viscosity (Siddhuraju, 2007), and the low cost tamarindus kernel powder could be used as a good substitute for costly pectin for making jelly (Bhattacharya *et al.*, 1994).

The tree is used for fuel; it is used to make firewood and charcoal. It is also used for timber: sapwood is white with distinct ripple marks; the heartwood is red brown. Because of the high silicate content of the timber, axes and saws get blunt. The wood is hard, durable, heavy, light brown with a fine texture and is traded internationally. It is used for vehicles, for construction material, for making houses and flooring, tools, weapons, furniture, packing cases and fufu pestle. The bark is used as chewing stick (indigenous tooth brush) among Nigerian populace (Akinpelu *et al.*, 2011). It is also used in artwork in carving figures like amulet, statuettes and various ornamental objects.

Ethnomedicinal Uses of *Dialium guineense*: Different parts of the tree have been used in folkloric medicine for treatment of different diseases: the bark in cancer, headache, and pains. Idu *et al*., (2009) reported the usefulness of the bark for oral hygiene and stomach ache among the Esan tribe of Edo state; the leaves are used as a remedy in fever, prenatal pains and edema; the fruits in diarrhea (Arbonnier *et al.*, 2004). The pulp of the fruit is edible and sweet, fairly low levels of ascorbic acid and tannin are present. It is a good source of proteins and minerals (Arogba *et al.*, 2006). The fruits of the plant are chewed among some women in south-east Nigeria to improve lactation and check genital infection (Nwosu, 2000). The leaves and stem bark are used as folklore remedies for the treatment of infections such as diarrhea, severe cough, bronchitis, wound, stomach ache, malaria fever, jaundice, anti-ulcer and hemorrhoids (Bero *et al.*, 2009). The leaves can also be squeezed and applied on wounds as practiced by Wolof of Senegal (Devendra, 1988). *D. guineense* fruits and leaves are used in the prevention of cancer. The extracts of leaves and seed coat have been reported to be very rich in vitamin C (Maduaka, 1988). Presence of antioxidant and vitamin C makes it an ideal food additive to boost the body's immunity level. Okegbile *et al.* (1990) found high content of vitamin c and other micronutrients in wild fruits when compared with nutrition supplied by other fruits such as oranges, avocado pear, pineapple, paw-paw and commercially produced fruits. *D. guineense* is used as chewing stick among Nigeria populace (Akinpelu *et al*., 2011). Previous studies have shown that the plant contains saponins which are presumed to add to the cleaning effect of teeth and at the same time prevent carries and plaque (Okwu and Okeke, 2003). Lawal *et al.* (2010) reported in their findings that *D. guineense* is used as antiulcer and as vitamins supplements among some tribes in the southern part of Nigeria. Traditionally, it is used for the treatment of heart disease, Lawrence *et al.* (1997) reported that the tannins component possess excellent cardio protective qualities in addition to the antioxidant action. It precipitates lipoprotein which carries cholesterol and thus reduces the level of in-take cholesterol. Mensah *et al.* (2009) also reported the usefulness of tannins in the management of hypertension among the Esan people of Edo state. The fruit pulp contains over 13% of dietary fiber which increases its bulk and augments bowel movement, thereby help prevent constipation. The fiber also bind to toxins in the food thereby help protect the colon mucus membrane from cancer causing chemicals. In addition, it binds to bile salt and decrease their re-absorption in the colon thereby help in expulsion of bad cholesterol.

Table 2:
Medicinal uses of different morphological parts of *Dialium guineense*

S/N	Morphological part	Medicinal uses
1	Bark	It is chewed for oral hygiene and stomach ache among the Esan people of Edo state. It is also used as a remedy for cancer, pains, headache and infections such as diarrhea, severe cough, bronchitis, wound, malaria fever, jaundice, ulcer and hemorrhoids. Also used in the prevention of dental carries and plaque formation (mouth wash) in south east Nigeria.
2	Leaves	Remedy for fever, prenatal pains, edema and infections such as diarrhea, severe cough, bronchitis, wound, malaria fever, jaundice, ulcer and hemorrhoids. It is also used as vitamin supplement among some tribes in southern Nigeria.
3	Fruits	Remedy for diarrhea. It also is used to improve lactation and check genital infection in South East Nigeria.

Biological Activities of *Dialium guineense:* Different parts of the plant possess remarkable therapeutic actions that can support the traditional usage of this plant in the treatment of some ailments. There are several reports on the therapeutic properties and pharmacological actions of *D. guineense* based on modern scientific investigations:

Anti-ulcer activity; Aqueous extract of *D. guineense* was evaluated for its anti- ulcer activity using ethanol/HCL and indomethacin as ulcerogens. The effect of the extract on gastric mucous secretion was also investigated. The extract

was administered orally at the doses of 100 and 200 mg for the experimental groups while the control and reference groups received distilled water (5 ml/kg, p.o) and cimetidine (32 mg/kg, p.o) respectively. The extent of healing was determined via reduction in ulcer index. The results showed that the extract significantly ($p<0.05$) reduce the ulcer index from 4.75±0.17 to 0.20±0.12 and from 3.95±0.19 to o.14±0.09 in the ethanol/HCL and indomethacin induced ulceration respectively. The extract also significantly ($p<0.05$) increased the gastric mucus secretion. This study showed that aqueous extract of *D. guineense* has anti-ulcer effects which might be due to its ability to increase gastric mucus secretion. The findings from this study also justify the folkloric use of *D. guineense* for the treatment of gastric ulcer (Balogun *et al.*, 2013). Hence, further studies are needed to elucidate the gastro protective mechanism(s) of *D. guineense* plant.

Antimicrobial activity: In a study, determination of antimicrobial activity of *D. guineense* leaf extract was carried out against clinical isolates of 6 bacterial species (*Staphylococcus aureus, Streptococcus mutans, Escherichia coli, Bacillus cerus, Pseudomonas aeruginosa, Klebsiella pneumonia)*, and 4 fungal species (*Candida albicans, Microsporum gypseum, Trichophyton mentagrophytes* and *Trichophyton rubrum)* using agar well diffusion method of Rath *et al.*. (2002). Inhibition zones formed by the extract were compared with the standards: ciprofloxacin and griseofulvin. The leaf extract at a concentration of 250, 125, 62.5 µg/ml was effective against *S. mutans* (25.9 mm), and *P. mirabilis* (10.2mm) being the most and lowest sensitive isolates. The results also revealed that significant ($p<0.05$) diameter zones of inhibitions were obtained with 125 and 250 µg/ml against bacterial isolates when compared with the reference drug. Generally, the Gram positive bacteria were found to be the most sensitive organisms, followed by the fungi, and the Gram negative bacteria. The results of the leaf extract of *D. guineense* demonstrated antimicrobial activity against the organisms tested. This study substantiates its popular and wide traditional applications in diverse ailments (Gideon *et al.*, 2013). While in another study, stem bark extract revealed a broad spectrum of activity of *D. guineense* with *Salmonella typhi* and *S. aurus* showing the greatest zones of inhibition (18.0mm). Only *Candida albicans* among the fungi tested was inhibited by the extract. (Alajubu *et al.*, 2012).

Antioxidant activity: The in vivo antioxidant of methanolic leaf extract of *D. guineense* was studied using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging activity and reducing power assay. In addition, the total phenolic content was also analyzed. The results of the DPPH scavenging activity of the extract showed a concentration dependent antioxidant activity with maximum scavenging activity observed at 250ug/ml concentration and comparable to those of ascorbic (95.75%) and gallic acids (93.67%). The reducing potential of the extract (0.069±0.003nm) was also comparable to that of gallic acid (0.078±0.022nm), while the total phenolic content was 69.45±0.002mg/g gallic acid equivalent. In this study it was found that the extract possesses in vitro antioxidant activity (Gideon *et al.*, 2013).

Antibacterial activity: Effects of ethanolic leaf and bark extract of *D. guineense* using agar well diffusion technique against clinical isolates of *Klebsiella pneumonia* and *Staphylococcus aureus* were carried out. Results showed that the extract at varying concentration exerted antibacterial activity on the test organism. The highest inhibition diameter (18mm) at 0.8g/ml was recorded for cold water leaf extract against *Staphylococcus aureus* and ethanol extract inhibited the growth of the bacterial isolates in a concentration dependent manner with minimum inhibitory concentration with minimum inhibitory concentration (MIC) at 0.2g/ml. (Orji *et al.*, 2012).

Analgesic activity: The analgesic activity of the methanolic stem bark extract of *D. guineense* using 3 anti-nociceptive models; acetic-induced abdominal constriction or writhing, tail immersion and hot plate analgesic models in rats was evaluated. Tests of analgesic drugs commonly measure nociception and involve the reaction of animals to painful stimuli (Rang *et al.,* 2003) the stimuli may be thermal (tail immersion or hot plate tests), chemical (acetic acid-induced writhing or formalin tests or mechanical (tail or paw pressure tests) (George *et al.*, 2009). Three test doses (250, 500, 1000mg/kg) of extract were administered orally via gastric gavage. The activity was compared *D. guineense* produced a significant analgesic activity in a dose dependent manner in the acetic acid-induced writhing model. All the doses (250,500,1000mg/kg) had shown a good analgesic activity. In the tail immersion model, the extract at the dose of 1000mg/kg significantly increased the pain reaction time while in hot plate model the extract and drug also significantly increased the mean pain reaction time at the doses of 500 and 1000mg/kg (Ezeja *et al.*, 2011).

Anti-diarrheal activity: In this study, the effect of *D. guineense* stem bark extract on diarrheal-induced rats was investigated. The effect of the extract at oral doses of 50-200mg/kg body weight on the castor oil-induced diarrhea, gastrointestinal motility (charcoal meal) and castor oil-induced intestinal fluid accumulation (enterpooling) was examined in rats. The results showed that the extract produced a dose dependent significant reduction (31.3-80.8%). In the watery nature and frequency of fecal droppings over 4hrs, while lope amide gave 85.8% reduction on gastrointestinal motility and enterpooling, the extract also dose dependently reduced the small intestine transit time of charcoal meal (28.90%-45.54%) and intestinal fluid volume (46.27%-73.88%) in a manner comparable to 5mg/kg each of atropine (58.20%) motility time inhibition and lope amide (76.12%) enterpooling inhibition. This finding justifies its use as folklore remedies for the treatment of infection such as diarrhea (Gideon *et al.*, 2012).

Anti-hepatotoxic activity: In this study, the ability of *D. guineense* pulp phenolic extract to protect against aflatoxin B_1-induced hepatotoxicity and oxidative stress was investigated in rats. Results showed that aflatoxin B_1 mediated elevation in the concentration of oxidative stress biomarkers; malondialdehyde, conjugated diene, lipids hydroperoxides,

protein carbonyl, and percentage DNA fragmentation were significantly lowered by *D. guineense* phenolic extract ($p<0.05$). Likewise aflatoxin B1 mediated decrease in the activities of reactive oxygen species detoxifying enzymes (super oxide dismutase, catalase, glutathione peroxidase, glutathione reductase and glucose 6 phosphate dehydrogenase) was significantly attenuated. Overall the in vivo effects suggest that *D. guineense* phenolic extract elicited reactive oxygen scavenging and detoxification potential as well the capability to prevent lipid per oxidation, protein oxidation and DNA fragmentation (Abdulwasiu *et al.*, 2014).

Anti-vibrio activity: The determination of anti-vibrio activity of the leaf extract of *D. guineense* on 18 strains of vibrio was carried out by Akinpelu *et al.*, (2011). It was found to possess bioactivity against 14 out of 18 environmental strains of vibrio species tested at a final concentration of 20mg/ml. On the other hand, the standard antibiotics used ampicillin inhibited the growth of fifteen out of the eighteen tested strains of the vibrio species. The zones of inhibitions exhibited by the extract against the tested isolates ranged between 12 and 20mm. Zones of inhibition exhibited by ampicillin against the tested isolates ranged between 7 and 40mm. *D. guineense* leaf extract exhibited minimum inhibitory concentration ranging between 0.313 to 5.0mg/ml against vibrio isolates while the minimum bactericidal concentration exhibited ranged between 0.625 and10mg/ml by the leaf extract.

Anti-plasmodial activity: Twenty volunteers adults infected with malaria parasites were selected for this study. The antimalaria drug (artesunate) and the plant extract (leaves) (5mg two times daily) were administered separately in some, and then co-administered in others for 3 days. The studies of the anti-plasmodial effects alone showed only moderate clearance of malaria parasites after 3 days. Likewise *D. guineense* extract alone showed a moderate anti-plasmodial effect after 3 days of treatment while co-administration of *D. guineense* and artesunate showed that the combination cleared the malaria parasites after 3 days suggesting that *D. guineense* has a synergistic anti-plasmodial effect (Adumanya *et al.*, 2013). In another study, 85 medicinal plants including *Dialium guineense* were investigated for their potency as antimalaria. *D. guineense* was found to inhibit the growth of plasmodium falciparum, the malaria parasite responsible for the illness (Bero *et al.*, 2009).

Molluscicidal activity: The molluscicidal effect of the fruit and leaves of *D. guineense* have been reported. It was found to be due to glycosides of the triterpenoid oleanic acid. Three glycosides were isolated from the fruit and a fourth the leaves. The amount of total saponins present in *D. guineense* makes it a good candidate for readily available molluscicide in Nigeria villages (Odukoya *et al.*, 1996).

Oral care: In southern Nigeria, the twigs are used as chewed sticks and the presence of bioactive compounds comprised of saponins, tannins, flavonoids, alkaloids is responsible for their effectiveness. Chewing sticks when used without toothpaste are very efficient, effective, and reliable for cleaning teeth. The teeth of chewing stick users are usually strong, clean, fresh, and devoid of dental plaque carries (Okwu and Okeke, 2003).

Anti-hemorrhoidal activity: *D. guineense* extract was found to possess an astringent effect which helps heal mucous membranes and exposed tissue and bring about contraction and firm up tissue. The herbal treatment in hemorrhoid therapy involves use of astringents. This astringent effect is caused by tannins, which reduce lubrication by precipitating proteins. It is proposed that this astringent herb accomplish anti-hemorrhoid activity by causing coagulation of proteins in the cells of the perianal skin or the lining of the anal canal. They plug up minute leaks and holes in the veins and capillaries, promote vein elasticity and act as vasoconstrictors in the perianal area. Thus promote dryness of the skin, which in turn helps relieve burning, itching and pain associated with hemorrhoids (Odukoya *et al.*, 2009).

Table 3:
Tested biological activities demonstrated by *D. guin*eense extracts

S/N	Activity	Author(s)
1	Anti-ulcer	Balogun *et al.*, 2013
2	Anti-microbial	Gideon *et al.*, 2013; Olajubu *et al.*, 2012.
3	Anti-bacterial	Orji *et al.*, 2012
4	Analgesic	Ezeja *et al.*, 2011
5	Molluscicidal	Odukoya *et al.*, 1996
6	Anti-oxidant	Gideon *et al.*, 2013
7	Anti-hepatotoxic	Abdulwasiu *et al.*, 2014
8	Anti-plasmodial	Adumanya *et al.*, 2013; Bero *et al.*, 2009.
9	Anti-vibrio	Akinpelu *et al.*, 2011
10	Anti-diarrheal	Gideon *et al.*, 2012
11	Vitamin C substitute	Maduaka, 1988
12	Oral care	Okwu and Okeke, 2003
13	Anti- hemorrhoidal	Odukoya *et al.*, 2009

Mineral Composition of *Dialium guineense*

Fruit: According to Nicholas *et al.* (2014), the high performance liquid chromatography (HPLC) analysis of *D. guineense* fruits revealed the followings: high glucose and fructose content (90.8% of total soluble sugar), total quantity of proteins (5.3%) containing all the essential amino acids, lipids (3.1%) and essential vitamins such as ascorbic acid, B-carotene and tocopherol in trace were found to be relatively low by comparison. The mineral composition includes phosphorus, potassium, zinc, calcium, manganese. It is also a potential source of iron (4.8-8.4mg/100g), magnesium (0.1g/100g) and copper (0.7mg/100g) and would contribute towards meeting the recommended daily allowances of these micronutrients in combating malnutrition especially in sub-Saharan Africa (Nicholas *et al.*, 2014).

Seed and pulp: This was done according to the method described by Association of Official Analytical Chemist (AOAC) and carried out in duplicate. Values obtained for the proximate analysis of whole seed and pulp were: moisture (10.13% and 10.53%), dry matter (90.15% and 88.40%), ash (2.55% and 12.50%), organic matter (12.60% and 41.55%), crude fat (35.33% and5.34%), crude fiber (13.52% and 1.05%), carbohydrate 943.90% and 58.65%), protein (17.44% and 3.94%), and total nitrogen free extract (2.79% and 0.65%) respectively. The proximate mineral composition was: magnesium (0.16mg/l and0.40mg/l), sodium (2.42md/l and 2.88mg/l), iron (0.91mg/l and 1.43mg/l), calcium (0.54mg/l and0.35mg/l) and potassium (0.34mg/l and 1.21mg/l) (Folake *et al.*, 2013).

Table 4:
Nutritive value of *D. guineense* fruit (Nicholas *et al.*, 2014)

Constituents	*D. guineense* fruit
Carbohydrates	58.65%
Proteins	3.94%
Crude fat	5.34%
Iron	14.3mg/100g
Magnesium	4.0mg/100g
Sodium	28.8mg/100g
Calcium	3.5mg/100g
Potassium	12.1mg/100g
Moisture	10.53%
Ash	12.50%
Crude fiber	1.05%

Phytochemistry of Dialium guineense

According to Gideon and Raphael (2013), crude extract of stem bark revealed the presence of bioactive compounds comprising cardiac glycosides, tannins, phlobatannins, saponins, terpenoids, resins, steroids, triterpenes, alkaloids, flavonoids, reducing sugars and carbohydrates while phytochemicals identified in the leaf extract are tannins, alkaloids, flavonoids, saponins, steroids and cardiac glycosides (David *et al.*, 2011; Ogu and Amiebenemo, 2012). Phytochemical screening was done using standard procedures described by Harbone (1984) and Trease and Evans (1984). Most of the effects observed with extracts of *D. guineense* may be attributed to the constituent compounds of phenols which play important roles in health in addition to enhancing antimicrobial activity in this plant. The medicinal value of *D. guineense* lies in these chemical substances that produce a definite physiological action in human body. These phenolic compounds include tannins, flavonoids, saponins, cardiac glycosides among others. These are known to be biologically active and their presence has been reported for several activities like antibacterial (Orji *et al.*, 2012), molluscicidal (Odukoya *et al.*, 1996), anti-plasmodial (Bero *et al.*, 2009; Adumanya *et al.*, 2013), anti-diarrheal (Gideon *et al.*, 2012), anti-vibrio (Akinpelu *et al.*, 2011), analgesic (Ezeja *et al.*, 2011), anti-hepatotoxic (Abdulwasiu *et al.*, 2014), anti-ulcer (Balogun *et al.*, 2013), anti-microbial (Gideon *et al.*, 2013; Olajubu *et al.*, 2012), antioxidant (Gideon *et al.*, 2013), anti-hemorrhoid (Odukoya *et al.*, 2009), oral care (Okwu and Okeke, 2003). Currently, the active ingredients in the plant that could be responsible for these activities are not yet known, however further studies are needed to isolate pure compounds of pharmacological importance from the plant crude extract.

Table 5:
Phytochemical constituents of *D. guineense*

S/N	Compounds	Biological Effect	Author(s)
1	Tannins	Wound healing. Cardio-protection and antioxidant.	James and Friday, 2010 Lawrence *et al.*, 1997
		Diarrhea and hemorrhoid.	Dharmanda, 2003
2	Alkaloids	Antimalaria	Hermans *et al.*, 2010
3	Flavonoids	Anti-inflammatory antioxidant and Anti-ulcer.	Nijveldt *et al.*, 2001; Di carlo *et al.*, 1999; Borrelli *et al.*, 2001; Galati *et al.*, 2001.
4	Cardiac glycosides	Anti- cancer. Inotropic effect	Katarzyna *et al.*, 2006. Shi *et al.*, 2010.
5	Saponins	Mouth wash	Okwu and Okeke, 2003.

Conclusion

Dialium guineense has been indicated in the treatment of various health ailments in traditional system of medicine. The review carried out so far have shown *D. guineense* as a medicinal plant with a lot of potentials, valuable, untapped resource of active drugs for combating various diseases. Further research is indispensable to reveal the detailed molecular mechanism(s) behind these biological activities in order to exploit their medicinal potentials.

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