A Review on Traditional Uses, Phytochemical Composition and Pharmacological Profile of *Canarium Schweinfurthii* Eng

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Abstract: Medicinal plants have recently become a focus of interest because it is said that they play key roles in the treatment of a majority of diseases with minimal or no side effects. All parts of *Canarium schweinfurthii* have been reported to be used in traditional medicine by people from tropical countries to manage some health problems such as anemia, eyes diseases, helminthes infection, diarrhea, goiter hypertension, gastro-intestinal disorder, toothache, cardiovascular, condition, yellow fever, fever, malaria, constipation, post-partum pain, rheumatism, sexually transmitted diseases, dysentery, gonorrhea, coughs, chest pains, pulmonary affections, stomach complaints, food poisoning, roundworm infections and other intestinal parasites, skin affections, eczema, leprosy, ulcers, diabetes mellitus, colic, gale and to ward off evil spirits. *Canarium schweinfurthii* has been scientifically studied for its numerous pharmacological profiles such as: antimalarial, anticancer, antioxidant, antimicrobial and antibacterial, anti-diabetic, analgesic, nephroprotective, growth promoting, food preservative, anthelminthic and termiticidal. some bioactive constituents such as phenolic compounds, triterpenes, steroids, saponins, glycosides, tannins, flavonoids, alkaloids, significantly present in the plant extract, account for its multiple uses in traditional medicine and justify its pharmacological profile; while the rich nutrients composition validate its high nutritional value. The aim of this study is to collect data obtained from various studies carried out by different authors concerning the traditional uses, phytochemical composition and pharmacological profiles of *Canarium schweinfurthii*.
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1. Introduction

There are very ancient references for utilization of plants in clinical treatments. This information of using plants parts for clinical treatment is very well known to common people living in rural areas of developing countries. These people are using plants traditionally, for the treatment of many sicknesses. Medicinal plants have the ability to synthesize a wide variety of chemical compounds which are used to perform biological functions and to defend against attack from predators such as insects, fungi, yeasts, bacteria, virus and other pathogens (Tapsell et al., 2006). Chemical compounds in plants mediate their effect on the human body through processes identical to those already well understood for the chemical compounds in conventional drugs (Lai and Roy, 2004). Thus, herbal medicines do not differ greatly from conventional drugs in terms of how they work. *Canarium schweinfurthii* is one of those plants usually used by indigenous persons for it nutritional value and to manage some health problems. It belongs to burseraceae family. This family consists of 18 genera and about 700 species of tropical trees. The members of the genus Canarium L. consist of medium to large buttressed trees up to 40-50m tall, or rarely a shrub (Mogana et al., 2011). *Canarium schweinfurthii* is a tree growing in the equatorial forest region and is widely distributed in tropical Africa, particularly across East, Central and West Africa (Keary, 1989). The old tree is up to 40 m high with very slight blunt buttress and a diameter which can reach 4.5m. A cut on it bark exudes gum which solidifies to a whitish resin, the flowers are creamy white and unisexual, and the ripe fruit is dark brown/purplish plum like containing a hard shaped trigonous stone (Ngbebe et al., 2008). The purplish ripe fruits are common in forest zone, while the dark brown fruits are common on the savannah region. The fruit pulp contains 30-50% oil, used as essential oil and known to have analgesic effect. This plant has different names depending on the language and country where it grows: English (purple canary tree, incense tree, gum resin tree, bush candle tree, African elemi); French (elemier d'Afrique, elemi de Moahum, elemi d'ouganda); Luganda (muwafu); Swahili (mpafu, mbani); Beh (in West Cameroon).The Trade names are white mahogany and African canarium. Scientific classification of the plant and its images are shown on figure 1.

The aim of this study is to collect data obtained from various studies carried out by different authors concerning the traditional uses, phytochemical composition and pharmacological profiles of *Canarium schweinfurthii*.

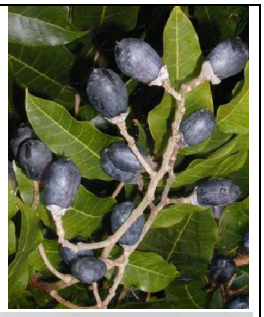
Kingdom: Plantae	
Order: Sapindales	
Family: Burseraceae	
Genus: Canarium L.	
Species: *Canarium schweinfurthii*	
Scientific name: *Canarium schweinfurthii* Eng.	
Scientific name: *Canarium schweinfurthii* Eng.	

Figure 1. Scientific classification of the plant and its images

2. Traditional uses

Canarium schweinfurthii has been used traditionally, for long time, to treat various ailments of the human body in many countries of Africa. The root, bark, fruit, seed, leaf, flower, gum and resin are extensively used in traditional medicine by people of rural areas to manage health problems or as source of their food. Its decoction is used to cure anemia, eyes diseases, helminthes infection, diarrhea, goiter hypertension, gastro-intestinal disorder, toothache, cardiovascular, condition, yellow fever or to ward off evil spirits (Ngbebe et al., 2008; Okullo et al., 2014). The leaves are used as stimulant against fever, malaria, constipation, diarrhea, post-partum pain, rheumatism and sexual transmitted diseases (Koudou et al., 2005). Whole plant decoction is a treatment against insects, dysentery, gonorrhea, coughs, chest pains, pulmonary affections, stomach complaints, food poisoning, purgative and emetic, roundworm infections and other intestinal parasites, emollient, stimulant, diuretic, skin-affections, eczema, leprosy, ulcers (Orwa et al., 2009); diabetes mellitus (Kouambou et al., 2007); colic, stomach pains, pains after child birth, gale (Berhaut, 2010); fever, constipation, malaria, sexually transmitted infection and rheumatism (Koudou et al., 2005). The stem bark decoction of *Canarium schweinfurthii* is used as a remedy for roundworms, colic, stomach pains, pain after child birth, gale, dysentery and gonorrhoea (Berhaut, 2010). In Cameroon, this plant's resin is burned and its smoke is supposed to ward off evil spirits. The seed is burned (3 or 4 seeds) and the live coal is soaked in a cub of drinkable water, after 5 min approximately, the filtrate is drunk to treat sore throat. A decoction prepared with a mixture of leaf and stem bark of *Canarium schweinfurthii* is taken as a treatment against anemia, diarrhea, helminthes, toothache, rheumatism, roundworms, fever, malaria, pulmonary diseases, gastro-intestinal disorder and sexually transmitted diseases. The same decoction is given to women, against post-partum pains.

3. Reported phytoconstituents

Several scientific researches have been carried out on *Canarium schweinfurthii*, in order to determine its chemical composition. Almost all parts of the plant are concerned by these researches. The phytochemical screening of *Canarium schweinfurthii* revealed the presence of chemical active compounds in all its parts. From leave: Saponins, tannins, cardiac glycoside, steroids and flovonoid (Ngbebe et al., 2008); from fruit oil:Phenolic compounds (Atawodi, 2010); From bark: triterpenes, steroids, saponins, lipids and glycosides (Kouambou et al., 2007); from resin: Triterpenoic acids (Yousuf, 2011); from seed: Tannins, balsams, cardiac glycosides, phenols and flavonoids (Uzama et al., 2012), canarene (Tamboue et al, 2000). The presence of alkaloids, tannins, phenolic compounds, flavonoids, cardiac glycoside, saponins and steroids in the leaf and stem bark of *Canarium schweinfurthii* has also been reported by Okoli et al (2015). Some pure molecules have been isolated from this plant extracts. Yousuf et al (2011) isolated three triterpenoic acids, namely 3a-Hydroxytirucalla-8, 24-dien-21-oic acid, 3α-hydroxytirucalla-7,24-dien-21-oic acid (or epielemadienolic acid) and 3β-fluorotirucalla-7,24-dien-21-oic acid, from the resin of *Canarium schweinfurthii* Engl. The analyses of the fruit mesocarp oil of *Canarium schweinfurthii* revealed the presence of phenolic compounds such as catechol, p-hydroxybenzaldehyde, dihydroxyphenylacetic acid, tyrosol, p-hydroxybenzoic acid, dihydroxybenzoic acid, vanillic acid, phloretic acid, pinoresinol, secoisolariciresinol (Orwa et al., 2009). From oil: Limonene, phellandrenes were isolated (Orwa et al., 2009). Schweinfurthinol, *p*-hydroxybenzaldehyde, coniferaldehyde, *p*-hydroxycinnamaldehyde, ligballinol, amantoflavone (Tamboue et al, 2000); catechol, dihydroxyphenylacetic acid, tyrosol, *p*-hydroxybenzoic acid, dihydroxynezoic acid, vanilic acid, phloretic acid, pinoresinol, secoisolariciresinol (Atawodi, 2010) were isolated from its seed. The *Canarium schweinfurthii* fruit pulp from Ivory Coast was found to contain 5.6% protein, 30–50% fat, 8.2% starch, 11.8% cellulose and 8.3% ash (the highest

mineral elements being potassium, 1.2% and calcium, 0.4%) (Agbo et al., 1992). The fatty acid composition of the oil revealed a high content of oleic (89.4%) or stearic (67.7–84.0%) acids in the liquid, semi-solid and solid forms of the oil. One realizes that, the content of these two acids in *Canarium schweinfurthii* oil is much higher than in any other vegetable oil (Agbo et al., 1992). Some of the general characteristics of flavonoid include potent water soluble super antioxidants and free radical scavenger; they prevent oxidative cell damage, have strong anticancer activity and protect against all stages of carcinogens (Omodamiro et al., 2016). Flavonoids in intestinal tract lower the risk of heart disease and inflammation (Salah et al., 1995). Isolated pure form of alkaloids and their synthetic derivatives are used as basic medicinal agents for their analgesic and bacterial effects (Stray, 1988), antihypertensive, antiarrhythmic, antimalarial and anti-cancer activities (Wink et al., 1998). Tannin rich medicinal plants are used to heal a lot of illnesses; such as leucorrhoea, rhinorrhea and diarrhea. More recently, tannins have gained medical interest, because of the high prevalence of deadly ailments such as AIDS and numerous cancers (Blytt et al., 1988). In the dyestuff industry, tannins are useful as caustics for dye and ink production. Also, in the food industry, tannins have proved usefulness in the purification of wine, beer and fruit juices and also as coagulants in rubber production (Gyamfi et al., 2002). Saponins are responsible for antimicrobial, antifungal, anti-inflammatory, anti-yeast and antidote activates. The function of saponins in plants generally serves as anti-feedant and to protect the plant against microbes and fungi (Skene et al., 2002). Phenols have been extensively researched as disease preventives (Duke, 1992). Steroids are antioxidants *in vitro*, and have a link with reproduction in humans (Rice-Evans et al., 1995). The results obtained from phytochemicals and micronutrients screening of *Canarium schweinfurthii* give credence to the medicinal benefits that this herb have been used for, in the past years and supports its traditional uses for the management of various health problems, its nutritional value and its pharmacological profile.

3. Pharmacological profiles

Scientific investigations on *Canarium scheinfurthii* indicate that it possesses tremendous pharmacological and nutritional values which support its various traditional uses for the management of health problems. The most important are:

Antimalarial activity: Ramadhani et al have conducted a study on the antiplasmodial activity against chloroquine-resistant *Plasmodium falciparum* (Dd2) strain of some of the documented plants using the parasite lactate dehydrogenase method (Ramadhani et al., 2015). *In vitro* antiplasmodial activity of 80% ethanol crude extracts of *Canarium scheinfurthii* at 100µg/ml caused a percentage growth inhibition rate of 61.94 ± 15.61 on *Plasmodium falciparum* Dd2 strain. It was concluded that this plant extract is one of the most active against *plasmodium falciparum*.

Anti-cancer activity: A work designed to assess the cytotoxicity on leukemia cells of six selected Cameroonian medicinal plants, including *Canarium Scheinfurthii* was done by Kuete et al (2015). Preliminary experiments on leukemia CCRF-CEM cells at 40 µg/mL showed that the leaves and bark extracts from *Canarium schweinfurthii* induced more than 50% growth of this cell line. The results of this study demonstrate the cytotoxicity of *Canarium schweinfurthii extracts* on leukemia drug-resistant cancer cells. It has been also proved that fruit mesocarp oil extract (Atawodi, 2010) and seed kernel oil extract (Uzama et al., 2012) might be used for chemoprevention of cancers and other oxidative damage-induced diseases (Atawodi, 2010).

Antioxidant activity: In a study, *Obame et al* investigated the antioxidant activity of the essential oil from *Canarium schweinfurthii*, using 2,2-diphenylpicrylhydrazyl (DPPH) radical scavenging assay and the carotene bleaching test (Obame et al., 2007). Butylate hydroxytoluene (BHT) was employed as a positive control. The essential oil showed antioxidant and DPPH radical scavenging activities, and it displayed the inhibition of lipid peroxidation. The results suggest that *Canarium schweinfurthii* essential oil could be a natural antioxidant agent.

Antimicrobial and antibacterial activity: A study designed to evaluate the *in vitro* antibacterial activities of the methanol extracts of five Cameroonian edible plants namely *Colocasia esculenta*, *Triumfetta pentandra*, *Hibiscus esculentus*, *Canarium schweinfurthii* and *Annona muricata* against a panel of 19 multidrug resistant Gram-negative bacterial strains was conducted by Dzotam et al (2015). The liquid broth microdilution was used to determine the minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) of the extracts. The results showed that all extracts contained compounds belonging to the classes of polyphenols, triterpenes and steroids, other classes of chemicals being selectively distributed. *Canarium schweinfurthii* extract showed the best activity with MIC values ranging from 64 to 1024 µg/mL against 89.5% of the 19 tested bacteria strains. The antibacterial and antifungal activities of the essential oil of *Canarium schweinfurthii* has been previously demonstrated by obame et al (2007).

Anti-diabetic activity: The anti-diabetic effects of the methanol/methylene chloride extracts of the stem barks of *Canarium schweinfurthii* on streptozotocin (STZ)-induced diabetes was conducted by Kamtchouing et al (2007). The result revealed that at a dose of 300mg/kg, these extracts showed at least 69.9% reduction in blood glucose level. The authors also reported that this plant species can reverse hyperglycemia; polyphagia and polydipsia caused by streptozotocin, and thus, has anti-diabetic properties.

Analgesic activity: The essential oil obtained by hydro-distillation of the resin of Canarium schweinfurthii from Central African Republic revealed that at the doses of 1, 2 and 3 ml/kg, essential oil shows a significant analgesic effect using acetic acid-induced writhing and hot plate methods. However, it was unable to reduce inflammatory process in cotton pellet induced granuloma method (Koudou et al., 2005).

Nephroprotective activity: *Okwuosa et al* conducted a study aimed at evaluating the protective effects of aqueous and methanol extracts of stem bark of *Canarium schweinfurthii* on the kidney, when acetaminophen is used to induce renal injury in rats (Okwuosa et al., 2009). Twenty-eight male albino rats weighing from 150 to 200g were used for this study. They were divided into seven groups (A-G) of four rats per group. Two cumulative doses of aqueous extract and methanol extract were administered to groups A-D prior to oral administration of acetaminophen (500mg/kg). Groups E-G served as acetaminophen, negative (vehicle) and baseline controls respectively. The baseline control group was given only distilled water. Drug administration was pursued for thirty days. Blood urea and serum creatinine levels were significantly higher ($p<0.01$) in acetaminophen and negative control groups compared to baseline control group and the AE and ME groups. Histopathological examination shows that the extracts preserved the renal histo-architecture, while the acetaminophen and negative control groups showed varying degrees of inflammatory cells infiltration, necrosis, tubular casts, tubular erosion and increased urinary pole. The fall in plasma levels of urea and creatinine in aqueous extract and methanol extract treated groups in the presence of acetaminophen suggests an improvement of renal function which is further supported histologically by a well preserved histo-architecture in these groups.

Growth promoting effect of charcoal from its seeds as substitute for antibiotic in broiler diets: Effects of an antibiotic growth promoter (Doxycycline) and charcoal from *Canarium schweinfurthii* seeds on growth performance have been examined with 192 day-old broiler chicks in a completely randomised design (Kana et al., 2012). Corn-soybean-based broiler starter and grower diets were formulated as basal diets for control treatment. Basal diets were supplemented with 0.1% Doxycycline as antibiotic growth promoter, 0.2% or 0.4% charcoal from Canarium seeds. The main results reveal that, feed intake and carcass yield were not affected ($P>0.05$) by dietary treatments throughout the experiment. However, feed conversion ratio and intestine density of antibiotic group were significantly ($P<0.05$) less than that of the basal diets supplemented with plant charcoal. Antibiotic significantly($P<0.05$) increased live body weight gain as compared to basal diet and charcoal treatments. Although, charcoal showed similar effect as control diet, it tends to ameliorate weight gain and feed conversion ratio. This result is very important, since the use of antibiotic as growth promoter has been forbidden in many countries of the world (Vicente et al., 2007), because of the resistances developed by pathogenic microbes of enterococcus group and the deposit of chemical residues on farmed products which might have bad consequences on the consumer's health.

Food preservative: Evaluation of the antifungal activities of the essential oils of the resins of *Canarium schweinfurthii* harvested in Mbouda (West Region), Lolodorf (South Region) and Aucoumea klaineana harvested in Lolodorf was the main objective of a study conducted by Agwanande et al (2014). After analyses by the incorporation technique, *Canarium schweinfurthii* (Lolodorf and Mbouda) were more active with minimum inhibitory concentrations (MIC) of 1800 ppm and 4500 ppm respectively against *Aspergillus flavus*, 2800 ppm and 3500 ppm respectively against *Aspergillus niger* and 1300ppm and 3800ppm respectively against *Aspergillus fumigatus*. Essential oil from Aucoumea klaineana inhibited fungal growth (% inhibition >50% at 5000 ppm). The MIC for the reference preservative, sorbic acid was 1200 ppm, 250 ppm and 800 ppm respectively against *Aspergillus flavus*, *Aspergillus niger* and *Aspergillus fumigatus*. The three essential oils showed antifungal properties due to a possible synergy among their different compounds. These essential oils can thus be employed as a natural source for food preservation.

Anthelminthic activity: The anthelminthic effect of *Canarium schweinfurthii* was also screened by Okoli *et al* (2016). Preliminary antimicrobial screening of the extract at 50 mg/mL showed 66.7% inhibitions against the test organisms. The isolated 3β-hydroxylolean-12,18-diene showed inhibitory activity at 6.25 µg/mL against *Staphylococcus aureus*, *Eschoriahia coli*, *Shigella dysenteria*, *Bacillcis subtlis*, *Kebsiella pneumonia*, *Candida stellatoidea* while *Salmonella typhi*, *Candida albicans* and *Candida tropicalis* were inhibited at 12.5µg/mL. The

ovacidal and larvacidal activities of 3β-hydroxyl olean-12,18-diene against the pre-infective and infective stages of *Ascaris suum*, showed percentage inhibition between 62 to 65% and 76 to 86% as compared to the standard drug Albendazole which showed inhibition ranging between 96.1 to 97.5%. The results of this investigation clearly shows that the plant has potential that can be explore in the search for anthelminthic drug from nature.

Termiticidal activity: It has been scientifically demonstrated that the essential oil from Canarium schweinfurthii is a potent termiticide (Nagawa et al., 2015). The oil consists mostly (96%) of monoterpenes. The individual terpenes were tested and show high termiticidal activity.

4. Conclusion

Canarium schweinfurthii has been used for long time, in african traditional medicine to treat numerous ailments of the human body. All parts of the tree, including leaves, bark, root, fruit, seeds, flower, gum and resin are used by traditional healers. Some biological tests carried out on the plant for antimalarial, anticancer, anti-diabetic, analgesic, antioxidant, antimicrobial and antibacterial, growth promoting, nephroprotective, food preservative, anthelminthic and termiticidal activities, revealed positive results without adverse side effects. some bioactive constituents such as phenolic compounds, triterpenes, steroids, saponins, glycosides, tannins, flavonoids, alkaloids, significantly present in the plant extract, account for its multiple properties and uses in traditional medicine, while the rich nutrients composition validate its high nutritional value. We sincerely hope that the diversity of secondary metabolites and pharmacological profiles reviewed in this paper will serve as a data base for proper evaluation of this plant extracts (since we think that there is much to be discovered in this medicinal plant) and for pharmaceutical applications of its bioactive components.

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References

1 Tapsell LC, Hemphill I, Cobiac L, Sulliva, DR, Fenech M, Patch CS, Roodenrys S, Keogh JB, Clifton PM, Williams PG, Fazio VA, Inge KE. "Health benefits of herbs and spices: the past, the present, the future". Med J Aust 2006;185(4):S4-24.

2 Lai PK, Roy J. "Antimicrobial and chemopreventive properties of herbs and spices". Curr Med Chem 2004;11(11):1451-60.

3 Mogana R, Wiart C. Canarium L: A Phytochemical and Pharmacological Review. J Pharm Res 2011;4(8):2482-89.

4 Keary RWJ. A revised version of Nigeria trees. Lavendon Press, Oxford, England, 1989;476.

5 Ngbebe J, Yakubu RA, Nyam DA. Phytochemical screening for active compounds in *Canarium schweinfurthii* (Atile) Leaves from Joss North, Plateau State Nigeria. Res J biol sci 2008;3(9):1076-8

6 Okullo JBL, Omujal F, Bigirimana C, Isubikalu P, Malinga M, Bizuru E, Namutebi A, Obaa BB, Agea JG. Ethno-Medicinal Uses of Selected Indigenous Fruit Trees from the Lake Victoria Basin Districts in Uganda. J Med Plants Studies 2014;2(1):78-88.

7 Koudou J, Abena AA, Ngaissona P, Bessière JM. Chemical composition and pharmacological activity of essential oil of *Canarium schweinfurthii.* Fitoterapia 2005;76(7-8):700-3.

8 *Orwa C, Mutua A, Kindt R, Jamnadass R, Simons A. Agroforestree Database: a tree reference and selection guide version 4.0.* World Agroforestry Centre, Nairobi, *Kenya, 2009*: 1.

9 Kouambou C, DimoT, Dzeufiet P, Ngueguim F, Tchamadeu M, Wembe E et al. Antidiabetic and hypolipidemic effects of *Canarium schweinfurthii* hexane bark extract in streptozotocin-diabetic rats. Pharmacologyonline 2007;1:209–19.

10 *Berhaut J. Flore illustrée du Sénégal. Dicotylédones. Tome II, Balanophoracées. Dakar*, *Senegal,*1974;414.

11 Atawodi SE. Polyphenol composition and in vitro antioxidant potential of Nigerian *Canarium schweinfurthii* Engl. Oil. *Adv Biol Res* 2010;4(6):314-22.

12 Yousuf S, Kamdem RST, Wafo P, Ngadjui BT, Fun HK. A cocrystal of 3 -hydroxytirucalla-8, 24-dien-21-oic acid and 3 -fluorotirucalla-7, 24-dien-21-oic acid. Acta Cryst 2011; E67: o1015-o6.

13 *Uzama D, Bwai DM, Oguntokun JO, Olutayo OO. Antioxidant and phytochemicals of hexane and ethanolic extracts of Canarium schweinfurthii Burseraceae. Asian J Pharm Biol Res 2012;2:188-90.*

14 *Tamboue H, Fotso S, Ngadjui BT, Dongo E, Abegaz B. Phenolic metabolites from seeds of Canarium schweinfurthii. Bull Chem Soc of Ethiop 2000;14:155-9.*

15 Okoli BJ, Ayo RG, Habila JD, Ndukwe GI, Jummai AT. Inhibition of Methicillin Resistance Staph. aureus (MRSA) and Fungi by *Canarium schweinfurthii* (Engl) Extracts. Scholars Acad J Biosci 2015; 3(5):413-20.

16 Yousuf S, Kamdem RS, Wafo P, Ngadjui BT, Fun HK. 3a-Hydroxytirucalla-8, 24-dien-21-oic acid. Acta Cryst 2011;E67:o937-o8.

17 Agbo NG, Kouamé CO, Simard RE. *Canarium schweinfurthii* Engl. Chemical composition of the fruit pulp. J Am Oil Chem Soc 1992; 69(4):317-20.
18 Omodamiro OD, Jimoh MA, Ewa IC. Hepatoprotective and haemopoeitic activity of ethanol extract of *Persea americana* seed in paracetamol induced toxicity in wistar albino rat. Int J Pharm Pharm Res 2016;5(3):149-65.
19 Salah W, Miller NJ, Panganga G, Tijburg, Bolwell GP, Rice-Evans CA. Polyphenolic flavanols as scavengers of aqueous phase radicals as chainbreaking antioxidant. Arch Biochem Biophys 1995; 322(2):339-46.
20 Stray F. The national guide to medicinal herbs and plants. Tiger Books International, London, England, 1988;12.
21 Wink M, Schmeller T, Laty-Bruning B. Modes of action of allele-chemical alkaloids: interaction with neuroreceptor, DNA and othe molecular targets. J Chem Ecol 1998;24:1881-937.
22 Blytt HJ, Guscar TK, Butler LG. Antinutritional effects and ecological significance of dietary condensed tannins may not be due to binding and inhibiting digestive enzymes. J Chem Ecol 1988;14:1455-65.
23 Gyamfi MA, Aniya Y. Antioxidant properties of Thonningianin A, isolated from the African medicinal herb, *Thonningia sanguine*. Biochem Pharmacol 2002;63:1725-37.
24 Skene CD, Sutton P. Saponin-adjuvanted particulate vaccines for clinical use. Methods 2002;40:53-9.
25 Duke J. Handbook of biological active phytochemicals and their activities. CRC Press, BICA Ration (FL), USA, 1992; 99.
26 Rice-Evans CA, Miller NJ, Paganga G. The relative antioxidant activity of plant derived polyphenolic flavonoids. Free Rad Res, 1995; 2214(4): 375-85.
27 Ramadhani Nondo SO, Zofou D, Moshi MJ, Erasto P, Wanji S, Ngemenya MN, Titanji VPK, Kidukuli AW, Masimba PJ. Ethnobotanical survey and *in vitro* antiplasmodial activity of medicinal plants used to treat malaria in Kagera and Lindi regions, Tanzania. J Med Plants Res 2015; 9(6):179-92.
28 Kuete V, Sandjo LP, Mbaveng AT, Seukep AJ, Ngadjui BT, Efferth T. Cytotoxicity of selected Cameroonian medicinal plants and *Nauclea pobeguinii* towards multi-factorial drug-resistant cancer cells. BMC Compl Alt Med, 2015;15:309-18.
29 Obame LC, Koudou J, Kumulungui BS, Bassolé IH, Edou P, Ouattara AS, Traoré AS. Antioxidant and antimicrobial activities of *Canarium schweinfurthii* Engl. Essential oil from Centrafrican Republic. Afr J Biotechnol 2007; 6 (20):2319-23.
30 Dzotam Jk, Touani Fk, Kuete V. Antibacterial activities of the methanol extracts of *Canarium schweinfurthii* and four other Cameroonian dietary plants against multi-drug resistant Gram-negative bacteria. Saudi J Biolo Sci, 2015. Accepted manuscript
31 Kamtchouing P, Kahpui SM, Djomeni PD, Tédong L, Asongalem EA, Dimo T. Anti-diabetic activity of methanol/methylene chloride stem bark extracts of *Terminalia superba* and *Canarium schweinfurthii* on streptozotocin-induced diabetic rats. J Ethnopharmacol 2008;104(3):306-9.
32 *Okwuosa CN, Achukwu Achukwu PU, Nwachukwu DC, Eze AA, Azubuike NC.* Nephroprotective activity of stem bark extracts of *Canarium Schweinfurthii* on Acetaminophen-Induced renal injuries in rats. Int J Med Health Dev 2009;14(1):6-13.
33 Kana JR, Defang Fulefack H, Teguia A, Takoumbo Tchegne BD, Kana Y, Mongo B. Growth promoting effect of charcoal from seeds of *Canarium schweinfurthii* Engl as substitute for antibiotic in broiler diets. Livest Res Rural Dev 2012;24 (8):1-8
34 Vicente JL, Avina L, Torres-Rodriguez A, Hargis B, Tellez G. Effect of a *Lactobacillus* spp-based probiotic culture product on broiler chick performance under commercial conditions. Int J Poult Sci 2007;6(3):154-6.
35 Agwanande Ambindei W, Tatsadjieu Ngouné L, Sameza ML, Tchinda Sonwa E, Nguimatsia F, Jazet Dongmo PM. Antifungal Activities against some Aspergillus species of the Essential oils of *Canarium schweinfurthii* and *Aucoumea klaineana* growing in Cameroon. Int J Curr Microbiol Appl Sci 2014;3(5):691-701.
36 Okoli BJ, Ndukwe GI, Ayo RG, Habila JD. Inhibition of the Developmental Stages of *Ascaris suum* and Antimicrobial Activity of 3β-Hydroxylolean-12,18-diene Isolated from the Aerial Parts of *Canarium schweinfurthii* (Engl). Am Cheml Sci J 2016;11(3): 1-11.
37 Nagawa C, Böhmdorfer S, Rosenau T. Chemical composition and anti-termitic activity of essential oil from *Canarium schweinfurthii* Engl. Ind Crops and Prod 2015;71:75-9.

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