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Xylopia Aethiopica: A Review of its Ethnomedicinal, Chemical and Pharmacological Properties

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ABSTRACT

Xylopia aethiopica (Annonaceae), commonly called negro pepper, African pepper, Guinea pepper and spice tree, is an ever green aromatic tree growing up to 15-30 m high. It is a native to the low land rain forests and moist fringe forests in the savanna zones and coastal regions of Africa. Folklore medicine claimed it to be useful as abortifacients, ecbolics as well as in the treatment of diarrhoea, dysentery; stomach disorder, menstrual disorder, naso-pharyngeal infections, arthritis, rheumatism, infections, among others. This present article is a collection of up to date information regarding the ethnopharmacology, phytochemistry, Pharmacology and Toxicological studies carried on *Xylopia aethiopica* by different researchers (authors).

Keywords: *Xylopia aethiopica*, essential oil, ethno-medicine, phytochemistry, antimicrobial, anti-infertility.

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INTRODUCTION

Herbal medicine or phytomedicine is acknowledged as the most common form of alternative medicine (Ogbonnia, *et al*., 2011)[1]. Long in the creation of mankind, plants have been used medicinally (Chang, 1987)[2]. The World Health Organization (WHO) estimates that about 80% of the world's population relies on these "unconventional" plant-based medicines as their primary medical intervention especially in the developing as well as in the developed countries where modern medicines are largely used (Rickert, *et al*., 1999)[3]. Scientific evaluation of ethnopharmacological information from medicinal plants is necessary for the development of accessible, affordable and high safety herbal therapies (Alam, *et al.*, 2011)[4]. One of such commonly used medicinal plants is *Xylopia aethiopica* (Annonaceae). Several of its documented traditional uses had been authenticated and published in several scientific journals. Thus, the need to assemble these numerous scientific findings had prompted for this present review which would draw the interest of natural product researchers throughout the world to focus on the explored potential of *Xylopia aethiopica.*

Botanical Description

Xylopia aethiopica is an aromatic tree which grows up to 15–30 m high and about 60–70 cm in diameter (Orwa, *et al.*, 2009)[5]. It is native to the lowland rainforest and moist fringe forest in the savanna zones of Africa, but largely found in West, Central and Southern Africa. These trees are widely distributed in the humid forest zones especially along rivers in the drier area of the region (Orwa, *et al.*, 2009)[5]. *Xylopia* is a Greek word ('xylon pikron') for 'bitter wood', while aethiopica refers to its Ethiopian origin (Ethiopia). Its common names include; African pepper, Guinea pepper, spice tree, negro pepper, West African pepper and Senegal pepper (Jirovetz, *et al.*, 1997)[6]. An attractive spicy flavor is obtained after Negro pepper is smoked during the drying process.

Xylopia aethiopica leaves are simple, alternate, oblong, elliptic to ovate. Its flowers are bisexual, solitary or in 3-5 flowered fasicles or in strange, sinuous, branched spikes, or cymes, up to 5.5 by 0.4 cm and creamy-green. Fruits of *Xylopia aethiopica* look like small, twisted bean-pods which are dark brown, cylindrical, 2.5 to 5 cm long and 4 to 6 mm thick. Each pod houses about 5 to 8 kidney-shaped seeds grains of approximately 5 mm length. (Orwa, *et al.*, 2009)[5].

Botanical classification

Xylopia Aethiopica belongs to the following category;

Kingdom: Plantae

Order: Magnoliids

Family: Annonaceae

Genus: *Xylopia*

Specie: *Xylopia aethiopica*

Uses

The bark of *Xylopia aethiopica*, due to its resistant to termite is used to make doors and partitions during construction of building, boat, paddle and spars. Its wood was traditionally used to make bows and crossbows for hunters and warriors in Togo and Gabon (Burkill, 1985)[7]. The mixture of its fruit with Capsicum peppers and kola nuts is used as a weevil repellent. The seeds have cosmetic, repulsive and stimulant applications. *Xylopia aethiopica* is also a good source of firewood.

Ethno-medicinal values

In Congo, the mixture of *Xylopia aethiopica* bark with palm wine is useful in the management of rheumatism. A decoction of the fruit or bark is useful in the treatment of bronchitis, asthma, stomach-aches and dysenteric conditions. The powdered root is used as a dressing for sores and to rub on gums for pyorrhoea and in local treatment of cancer in Nigeria. Mixture of *Xylopia aethiopica* with salt serves as a cure for constipation. Its decoction is used in Gabon against rheumatism and as an emetic (Burkill, 1985)[7]. The leaf-sap mixed with kola nut is given to treat epileptic fits (Burkill, 1985). It is taken to encourage fertility and to ease childbirth. When crushed, *Xylopia aethiopica* is rubbed on the forehead to treat headache and neuralgia. An extract of the seeds is also used as a vermifuge for roundworms (Dalziel, 1973)[8].

EXPERIMENTAL Studies on *XYLOPIA AETHIOPICA*

Chemical Constituents

In negro pepper fruits, the essential oil (2 to 4.5%) has been found to contain β-pinene, 1,8-cineol, α-terpineol, terpinene-4-ol, paradol, bisabolene and other terpenes. In other work, linalool (E)-β-

ocimene, α-farnesene, β-pinene, α-pinene, myrtenol and β-phellandrene were found (Tairu, *et al.*, 1999)[9] Among the non-volatile constituents, tetracyclic diterpenes of the kaurane type have been identified (Choudhury, *et al.*, 1982)[10]. The bark oil has abundance of pinene, trans-pinocarveol, verbenone and myrtenol. However, the leaf oil is rich in spathulenol, cryptone, beta-caryophyllene and limonene (Ayedoun, *et al.*, 1996)[11]. The plant is said to contain anonaceine, which is an alkaloid resembling morphine. The fruit contains volatile aromatic oil, a fixed oil and rutin (Watt and Breyer-Brandwijk, 1962)[12].

Comparative Characterization of Phytomedicinal Constituents of *Xylopia Aethiopica*.

Nworah, *et al.*, (2012)[13] preliminarily characterized and isolated the phytomedicinal components of dried black fruits of *Xylopia aethiopica* in hydro-methanolic (1:4 v/v), hydro-ethanolic (1:4, v/v), methanolic, ethanolic and aqueous extracts comparatively. Their results showed variability and significant differences in phytomedicinal compositions and the potency were ranked as follows: hydro-methanolic > hydro-ethanolic > methanolic > ethanolic = aqueous and the percentage difference was 75%, 54%, 45.8%, 29% =29% which perhaps validates the efficacy of the therapeutic potentials of *Xylopia aethiopica* for many of the traditional medicinal applications. Anthraquinone and combined anthraquinone were exclusively found in hydro-methanolic and methanolic concentrates and accounted for 44.4% and 33.3% respectively. Glycosides (-terpene, sterols and deoxy-sugar) accounted for 100% in hydro-alcoholic concentrates respectively. Alkaloids and the phenolic compounds flavonoids and tannins with the exception of saponin which was negligible or absent in the solvents was also the phytomedicinal constituents. Nworah and co-workers recommended the isolation and characterization of economically important medicinal plants of medical interest.

Phytochemical and comparative studies of the stem bark and root of *Xylopia aethiopica*

The ethanol extract of the stem bark and root of *Xylopia aethiopica* were used in the study. Preliminary phytochemicals present were quantified using standard procedures. The result of the screening of the two samples showed the presence of alkaloids, saponins, flavonoids, tannins, terpenes, steroids and cardiac glycosides and both samples were tested negative for anthraquinones. The result indicates that alkaloids and cardiac glycosides in the root were significantly ($p<0.05$) higher than those of stem bark while the phenol content in the stem bark was significantly ($p<0.05$) higher than that of the roots. Ekpo, *et al* did not observe significant ($p>0.05$) difference between the flavonoid content of the samples. They recommended the plant parts as a potential source of useful drugs (Ekpo, *et al.*, 2012)[14].

Chemical variability of essential oil of the leaf of *Xylopia aethiopica*

According to Yapi, *et al.*,(2012)[42], the chemical composition of 48 essential-oil samples isolated from the leaves of *Xylopia aethiopica* harvested in six Ivoirian forests was investigated by GC-FID and (13) C-NMR analyses. In total, 23 components accounting for 82.5-96.1% of the oil composition were identified. The composition was dominated by the monoterpene hydrocarbons β-pinene (up to 61.1%) and α-pinene (up to 18.6%) and the sesquiterpene hydrocarbon germacrene D (up to 28.7%). The chemical composition of the oils of Group I (38 oil samples) was clearly dominated by β-pinene, while those of Group II (10 samples) were characterized by the association of β-pinene and germacrene D. The leaves collected in the four inland forests produced β-pinene-rich oils (Group I), while the oil samples belonging to Group II were isolated from leaves harvested in forests located near the littoral.

Phytochemical analysis and *in vitro* anthelmintic potentials of *Xylopia aethiopica* (Dunal), a rich (Annonacea) from Nigeria.

Ekeanyanwu and Tienajirhevwe (2012)[15] investigated the phytochemical constituents of the aqueous, ethanol and methanol fruits extracts and their anthelmintic activity against *Eudrilus eugeniae*. The four concentrations (10, 20, 50 and 100 mg/ml) of extracts were studied *in vitro* in the bioassay for their anthelmintic activity in experimental worm, Albendazole (15 mg/ml) was used as a standard reference drug in the assay. At the concentration of 100 mg/ml, the aqueous, ethanol and methanol extracts showed very significant activities as compared to the standard drug, Albendazole (15 mg/ml), the time of paralysis and death being 1.63 ± 0.36 and 6.77 ± 0.11 in the case of the aqueous extract, 2.91 ± 0.10 and 8.86 ± 0.66 in the case of ethanol extract, 3.19 ± 0.56 and 6.44 ± 0.83 in the case of the methanol extract and 32.00 ± 0.87 and 38.87 ± 0.65 as in the case of the standard drug Albendazole respectively. The extract of *X. aethiopica* produced a significant anthelmintic activity.

Chemical Composition and Cytotoxic Activity of *Xylopia aethiopica* (Dun) A. Rich. (Annonaceae) Fruit Essential Oil from Togo.

According to Koffi, *et al.*, (2008)[16], essential oil extracted (4.4% in yield) from air-dried fruits of *Xylopia aethiopica* harvested in Togo was investigated for percentage composition and *in vitro* cytotoxicity. The chemical composition of the essential oil was examined by GC and GC/MS. Thirty-five compounds were identified representing 89.9% of total oil. The major constituents were β-pinene (23.6%), α-pinene (11%), sabinene (9.8%), germacrene D (8.3%) and 1, 8 cineole (8.2%). The cytotoxicity of the volatile oil was evaluated *in vitro* on the human epidermal cell line HaCaT. The tested sample did not show any cytotoxicity (IC_{50} >3000 µg.ml-1) effect at concentrations around 3000 µg.ml-1. Koffi, *et al* suggested that further testing in bioassay would

probably help in validating some of medicinal uses of *X. aethiopica* in topical drugs and/or in cosmetics as natural products.

Preliminary studies on aqueous fruit extract of *Xylopia Aethiopica* obtained in Calabar, Nigeria.

In 2013, Okwari[17], *et al.*, screened the fruit of *Xylopia aethiopica* for the presence of phytoconstituents, minerals and vitamin content using standard methods. Food intake, water intake and weight changes were also studied. Albino Wistar rats were divided into three groups of ten rats each namely: control, low and high dose *Xylopia aethiopica*-treated groups. The low and high dose groups received orally, 100 and 200 mg/kg body weight of *Xylopia aethiopica* respectively for 28 days. Daily food and water intake as well as weight changes were determined throughout the period. Their result showed the presence of alkaloids, cardiac glycosides, saponins, tannins, flavonoids, polyphenols, and reducing sugars. Vitamins A, C and β – carotene, as well as Fe^{3+}, Cu^{2+}, Zn^{2+}, Mn^{2+}, P^{3+}, Ca^{2+}, Mg^{2+}, Na+ and K+ were present in the fruit extract. The low dose group had significantly ($p<0.01 – 0.001$) higher food, water intake and weight changes compared with control, while the high dose group had a significantly ($p<0.01$) higher water intake than the control. The fruit extract caused increase in water and food intake as well as body weight at low dose. *Xylopia aethiopica* contains bioactive substances that may be beneficial to health. Although, the mechanism(s) underlying these effects in the rat was not properly understood and was suggested for further investigation by Okwari, *et al.*

Phytochemical and antimicrobial studies of the fruit extract of *Xylopia aethiopica* for medicinal importance.

According to John-Dewole, *et al*., (2012)[18], phytochemical screening of the fruit of *Xylopia aethiopica* confirmed the presence of saponin, saponin glycoside, tannin, balsam, cardiac glycoside and volatile oil. Spectrophotometric analysis for trace metals (such as Mg, Zn, Cu, Ni and Fe), Phosphorus and Sulphur showed that *X. aethiopica* contained Mg (0.370 + 0.002 mg/100g), Zn (1.020 + 0.001 mg/100g), Cu (0.274 + 0.004 mg/100g), Ni (1.099 + 0.001 mg/100g), Fe (0.690 + 0.002 mg/100g), P (30.62 + 0.02 mg/100g) and S (100.50 + 0.51 mg/100g). The medicinal properties were evaluated *in-vitro* by antimicrobial and antifungal assays. The aqueous and petroleum ether extracts showed growth inhibitory effects on *Staphylococcus aureus* and *Eschericha coli* but *Pseudomonas aeruginosa* and *Saccharomyces cerevisiae* were resistant to the fruit extract and the antibiotic controls. The minimum inhibitory concentration (MIC) on *S. aureus* and *E. coli* were 12.50 mg and 6.25 mg respectively. The Minimum bactericidal concentration (MBC) of the crude extract against the test organism ranged from 12.50 mg to 25.00 mg.

Antimicrobial activity of essential oils of *Xylopia Aethiopica*

Study by Fleischer, *et al*., (2008)[19] showed that the fresh and dried fruits, leaf, stem bark and root bark essential oils in *Xylopia aethiopica* produced various degrees of activity against the gram positive bacteria, *Bacillus subtilis* and *Staphylococcus aureus*, the gram negative bacteria *Pseudomonas aeruginosa* and the yeast-like fungus *Candida albicans*, using the cup plate method. However, none of the oils showed activity against *Escherichia coli*.

Anti-anaphylactic and anti-inflammatory actions of aqueous ethanol extract of the fruit of *Xylopia aethiopica* (Annonaceae) in mice.

According to study carried out by David and Newman, (2013)[20], systemic anaphylaxis was induced by the injection of either compound 48/80 or lipopolysaccharide, LPS and survival rates of mice monitored for 1 h or 7 days respectively while IgE-mediated anaphylaxis in a local allergic reaction was studied in the pinnal inflammation model in mice. Clonidine-induced catalepsy in mice was used to evaluate the indirect antihistamine effect of *Xylopia aethiopica*, XAE. The effects of XAE assessed on the maximal and total oedema responses in the carrageenan-induced paw oedema in mice was used to evaluate the anti-inflammatory action of the extract. Administered at 30, 100, 300 and 1000 mg kg−1 p.o., XAE dose dependently suppressed compound 48/80-induced mouse systemic anaphylactic shock and offered 63% protection to mice against LPS-induced endotoxic shock at a dose of 300 mg kg−1. In addition, the extract (30–300 mg kg−1) in a dose dependent manner significantly inhibited by 23–62% the mouse pinnal inflammation. Clonidine-induced catalepsy in mice was significantly suppressed in a dose and time dependent manner when administered both prophylactically and therapeutically. In the same doses, when administered before the induction of the mouse carrageenan-induced paw oedema, the mean maximal swelling attained during 6 h was reduced to 41.02 ± 6.94%, 35.61 ± 4.30%, and 29.09 ± 4.90% of the inflamed control response respectively and total paw swellings induced over the 6 h were also dose-dependently and significantly suppressed to 74.84 ± 14.84%, 63.95 ± 9.37%, and 48.13 ± 10.90% of the inflamed control response respectively. Administered after the induction of the carrageenan paw oedema the mean maximal swelling attained during 6 h was suppressed to 49.84 ± 3.95%, 43.62 ± 1.01%, and 35.97 ± 1.34% of the inflamed control response respectively while the total paw swellings induced over the 6 h were also dose-dependently and significantly suppressed at 100 and 300 mg kg−1 to 72.39 ± 4.38% and 60.81 ± 3.25% of the inflamed control response respectively. Their findings suggested that XAE inhibits mast cell-dependent immediate allergic reactions and exhibit anti-inflammatory actions through the inhibition of histamine release from mast cells via stabilization of the cell membrane. Their results contribute towards validation

of the traditional use of *Xylopia aethiopica* in the treatment of bronchitis, asthma, arthritis and rheumatism.

Characterization of the antiproliferative activity of *Xylopia aethiopica*

Aphrodite, *et al.*, (2012)[21] characterize the effects of extracts of *Xylopia aethiopica*. They reported that *X. aethiopica* extract prepared with 70% ethanol has antiproliferative activity against a panel of cancer cell lines. The IC_{50} was estimated at 12 µg/ml against HCT116 colon cancer cells, 7.5 µg/ml and > 25 µg/ml against U937 and KG1a leukemia cells, respectively. Upon fractionation of the extract by HPLC, the active fraction induced DNA damage, cell cycle arrest in G1 phase and apoptotic cell death. By using NMR and mass spectrometry, they determined the structure of the active natural product in the HPLC fraction as ent-15-oxokaur-16-en-19-oic acid. The main cytotoxic and DNA-damaging compound in ethanolic extracts of *Xylopia aethiopica* was ent-15-oxokaur-16-en-19-oic acid.

Effects of *Xylopia aethiopica* (Annonaceae) fruit methanol extract on gamma-radiation-induced oxidative stress in brain of adult male Wistar rats.

Adaramoye, *et al.*, (2012)[22] investigated the effects of XA fruit methanol extract on oxidative stress in brain of rats exposed to whole body gamma-radiation. Vitamin C (VC) served as standard antioxidant. Forty-four rats were divided into 4 groups of 11 rats each. One group served as control, two different groups were treated with XA and VC (250 mg/kg), 6 weeks before and 8 weeks after irradiation, and fourth group was only irradiated. Rats were sacrificed 1 and 8 weeks after irradiation. The antioxidant status, viz. Lipid peroxidation (LPO), superoxide dismutase (SOD), catalase (CAT), glutathione-s-transferase (GST) and glutathione (GSH) were estimated. Their results showed a significant increase ($p < 0.05$) in levels of brain LPO after irradiation. LPO increased by 90% and 151%, after 1 and 8 weeks of irradiation, respectively. Irradiation caused significant ($p < 0.05$) decreases in levels of GSH and GST by 61% and 43% after 1 week and, 75% and 73%, respectively, after 8 weeks of exposure. CAT and SOD levels were decreased by 62% and 68%, respectively, after 8 weeks of irradiation. Treatment with XA and VC ameliorated the radiation-induced decreases in antioxidant status of the animals. These suggest that XA could have beneficial effect by inhibiting oxidative damage in brain of exposed rats.

Antifertility effects of ethanol extract of *Xylopia aethiopica* on male reproductive organ of Wistar rats.

In Eze's study, a total of twenty-four adult male rats were randomly divided into three experimental groups (n=8). Group 1 (control) was given rat chow and distilled water *ad libitum*, Group II and III received 0.5 ml and 1.0 ml of ethanol extract of *Xylopia aethiopica* once daily for

a period of 28 days. Their results showed a significant (P<0.05) and dose dependent decrease in the semen parameters (count, motility) and a non significant decrease in the percentage of sperm with normal morphology. The testicular photomicrograph also shows dose dependent degenerative changes. The author suggested that the extract may have some anti fertility effects which may be further explored for a possible use as male contraceptive agent (Eze, 2012)[23].

***In-vivo* effects of *Xylopia aethiopica* on haemorheological parameters in guinea pigs.**

Nwafor, *et al.,* (2009)[24] investigated *In-vivo* effects of *Xylopia aethiopica* on haemorheological parameters in guinea pigs. Eighteen adult guinea pigs were randomly distributed into three groups, comprising two tests and one control. Aqueous extracts of *Xylopia aethiopica* fruits were administered to the test animals at doses of 10 mg/kg body weight and 20 mg/kg body weight respectively. The results were compared with those of the control group. There was no significant difference in the mean values of the measured haemorrheological parameters: PCV, Hb, RBC and ESR respectively. Similarly, the haematological indices do not show any significant difference in all the test groups when compared with their respective control groups. The authors suggested that the extract will not likely affect the haemorrheological parameters in guinea pigs and possibly, man (Nwafor, *et al.*, 2009).

Effects of *Xylopia Aethiopica* fruits on reproductive hormonal level in rats.

In this study, twenty (20) rats were divided into 2 groups (10 rats per group). Group I was control (untreated), while group II was given *Xylopia aethiopica* fruits extract 80 mg/kg body weight intragastrically twice per 7 days for 28 days respectively. The levels of follicle stimulating hormone, luitenizing hormone, testosteerone, prolactin and estradiol was significantly decreased when compared with the control (P<0.05). The authors suggested that the consumption of extract of *Xylopia aethiopica* in males may cause reproductive disorders (Nnodim, *et al.*, 2013)[25].

Investigations into the use of *Xylopia aethiopica* in the treatment of psoroptic mange in rabbits.

According to the study of Adeyemo, *et al*., (2011)[26], the efficacy of dried and grounded (30 g and 40 g) of *Xylopia aethiopica* respectively mixed with 20 ml of palm oil was tested on different sets of mange infested rabbits and this was compared with sulphur, using 80 g of sulphur mixed with 20 ml of palm oil. XA was found to be more potent at 40 g relative to 80 g of sulphur, also the rabbits treated with 30 g and 40 g XA's weight gain during treatment was more significant (p< 0.05) than the control. Their study showed that *Xylopia aethiopica* exhibits remarkable anti-mange activity against psoroptic mange in rabbits. A further investigation into the isolation of the active constituent responsible for this action was recommended by Adeyemo and co-workers.

Hypolipidemic and antioxidant potentials of *Xylopia aethiopica* seed extract in hypercholesterolemic rats.

A short-term study was carried out by Sarah, *et al.*, (2011)[27] on Wistar strain rats to determine the effects of *Xylopia aethiopica* extract on serum and post mitochondrial fractions (PMFs) of visceral organs in experimental hypercholesterolemia. Animals received normal diet and were administered cholesterol orally by intubations at a dose of 40 mg/kg/0.3 mL, plant extracts at 250 mg/kg, and cholestyramine at 0.26 g/kg five times a week for 8 consecutive weeks. The hypolipidemic effects were assessed by measuring total cholesterol, low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol, and triglycerides, whereas the extent of oxidative stress was assayed by measuring thiobarbituric acid–reactive substances and enzymatic antioxidants such as superoxide dismutase, catalase, and reduced glutathione (GSH) in serum and PMF of liver and kidney. Two liver biomarkers—alanine aminotransferase and aspartate aminotransferase were assayed —for safety of *X. aethiopica* at the dose given in this experiment. Cholesterol feeding resulted in a significant increase ($P < .05$) in body weight of the hypercholesterolemic animals relative to control animals, and administration of *X. aethiopica* (250 mg/kg) caused a more than 60% reduction in body weight. Simultaneous treatment with *X. aethiopica* and Questran elicited 33.75% and 23.94% reductions, respectively, in serum cholesterol levels of hypercholesterolemic rats. In addition, the LDL-C level decreased significantly ($P < .05$) by 49.09% and 78.92% in serum and by 64.97% and 37.29% in the liver with co-treatment with the plant extract and Questran, respectively, compared to untreated hypercholesterolemic rats. *X. aethiopica* counteracted the decrease in enzymatic antioxidants, especially in GSH, where there was a greater than 300% increase compared with hypercholesterolemic animals. The authors' study showed that intake of *X. aethiopica* reduced the composition of lipids and produced a favorable lipid profile in the serum and PMF of visceral organs in experimental hypercholesterolemia.

Influence of *Xylopia Aethiopica* fruits on some hematological and biochemical profile.

According to the study of Nnodim, *et al*., (2011)[28], different concentrations of *Xylopia aethiopica* fruit extract were given to Wistar rats for 14 days. 200 mg/body weight, 150 mg/body weight and 100 mg/body weight of the extract were given to different groups while the control group received distilled water. The result showed the increase in haematological parameters was dose dependent. Haemoglobin concentration, packed cell volume, red blood cell count and platelet were significantly increased when compared with the control ($P<0.05$). Serum cholesterol, triglyceride and LDL were significantly decreased when compared with the control ($P<0.05$). Also, serum potassium and sodium were increased when compared with the control ($P<0.05$). The result

of their findings justified the folklore claim of *Xylopia aethiopica* in arresting bleeding among women that put to bed as well as treating cardiovascular and diabetic diseases. Nnodim *et al* also suggested that the plant may be a good agent in the maintenance of electrolyte balance.

Effect of ethanolic fruit extract of *Xylopia aethiopica* on reproductive function of male rats.

Study by Woode, *et al.*, (2011)[29] evaluated the effect of 70% alcoholic extract of *Xylopia aethiopica* on reproductive function of adult male rats. Ethanol fruits extract of *X. aethiopica* was administered orally to groups of male Sprague Dawley rats at the doses of 30, 100 and 300 mg/kg for 60 days. The reproductive organ weights, change on animal body weight, caudal epididymal sperm count, motility and viability, histology of testes and androgenic hormones levels were evaluated. Increase in body weight as well as weight of testis and epididymis and a significant increase in caudal sperm count was noticed. Transverse sections of testis exhibited spermatogenesis. The extract treatment also showed significant increase in serum testosterone and luteinizing hormone levels. The studies clearly revealed androgenic activity of the extract and its effects on hypothalamic pituitary gonadal axis.

Effect of aqueous fruit extract of *Xylopia aethiopica* on intestinal fluid and glucose transfer in rats.

Okwari, *et al.*, (2010)[30] studied the intestinal fluid and glucose absorption in jejunal and ileal segments in *Xylopia aethiopica* fed rats using inverted sac technique. Thirty male Wistar rats were assigned into three groups of 10 rats each; control, 100 mg/kg and 200 mg/kg *Xylopia aethiopica* treated groups. The control group received normal rat chow and water while the low dose and high dose groups received oral administration of *Xylopia aethiopica* extract at doses of 100 mg/kg and 200 mg/kg body weight respectively in addition to daily rat chow and water intake for 28 days. The results showed significant reduction and increase in fluid transfer in the jejunum and ileum respectively ($P<0.01$) compared with control. 100 mg/kg increased gut fluid uptake in the ileum while 200 mg/kg treatment reduced uptake in jejunum compared with control. Both doses significantly increased jejunal and ileal glucose transfer. Gut glucose uptake was increased in jejunum and ileum of *Xylopia aethiopica* treated groups. Both doses increased the crypt depth but significantly decreased the villus height in the ileum ($P<0.05$). Okwari and co-worker concluded that increased ileal gut fluid uptake may be beneficial in diarrheal state while an enhanced glucose uptake implies that glucose substrate may be made available to cells for synthesize of ATP for cellular activities.

Analgesic effects of an ethanol extract of the fruits of *Xylopia aethiopica* (Dunal) A. Rich (Annonaceae) and the major constituent, xylopic acid in murine models.

Itmad, *et al*., (2009)[31] evaluated the analgesic properties of the ethanol extract of *X. aethiopica* (XAE) and xylopic acid (XA), in murine models. XAE and XA were assessed in chemical (acetic acid-induced abdominal writhing and formalin tests), thermal (Tail-flick and Hargreaves thermal hyperalgesia tests), and mechanical (Randall-Selitto paw pressure test) pain models. XAE and XA exhibited significant analgesic activity in all the pain models used. XAE (30-300 mg kg $^{-1}$ *p.o.*) and XA (10-100 mg kg $^{-1}$, *p.o.*) inhibited acetic acid-induced visceral nociception, formalin- induced paw pain (both neurogenic and inflammatory), thermal pain as well as carrageenan-induced mechanical and thermal hyperalgesia in animals. Morphine (1-10 mg kg $^{-1}$, i.p.) and diclofenac (1-10 mg kg $^{-1}$, i.p.), used as controls, exhibited similar anti-nociceptive activities. XAE and XA did not induce tolerance to their respective anti-nociceptive effects in the formalin test after chronic administration. Morphine tolerance did not also cross-generalize to the analgesic effects of XAE or XA. Their findings established the analgesic properties of the ethanol fruit extract of *X. aethiopica* and its major diterpene, xylopic acid.

Contraceptive efficacy of hydro-methanol fruit extract of *Xylopia aethiopica* in male albino rats.

Ologhaguo, *et al*., (2013)[32] evaluated the contraceptive efficacy of hydro-methanol fruit extract of *Xylopia aethiopica* in male albino rats. Forty eight adult male and 48 female wistar rats were used for the study. The males, randomly selected into two groups: 30 days treatment and 30 days reversal groups; each further divided into 3 test and 1 control group of 6 animals each. Daily oral doses of 0.5, 2.0 and 10.0 mg/kg body weight respectively were given to the test groups for 30 days followed by 30 days of extract withdrawal. 6 animals were sacrificed from each treatment group animals on day 31 and on day 61 for the reversal group animals. Body weights of the animals were measured at beginning of study and before each sacrifice. Fertility test was done after 30 days of extract treatment and after 30 days withdrawal while testicular and epididymal weight, testosterone as well as sperm parameters were assessed on the day of each sacrifice. Their results showed a reversible dose dependent negative effect in body and organ weight, sperm parameters and in fertility parameters. Ologhaguo, *et al*. suggested *Xylopia aethiopica* to possess ant fertility potentials which could be explored for contraceptive purposes.

The effect of *Xylopia aethiopica* (Udu) on intraocular pressure.

Uzodike and Onuoha (2010)[33] evaluated the effect of *Xylopia aethiopica* on intraocular pressure. Fifty volunteers between the ages of 18 to 30 (mean age of 22.58 ± 12.75) years were used for the study. They were given 20 ml (1.16 g/ml) of extract. The baseline and induced intraocular pressure (IOP) of the volunteers were measured at 30 minutes interval after the ingestion of *Xylopia*

aethiopica. Their result showed an initial 1.26% increase in IOP at 30 mins post ingestion of which started reducing from 60 mins with a maximum reduction of 2.60% at 90 mins. The test for significance using Z-test showed the cumulative effect to be statistically significant at 95% confidence interval (P>0.05). The effects were transient as the induced mean IOP approximates the baseline IOP after 90 minutes of ingestion.

Biosorption of aqueous solution of lead on *Xylopia aethiopica* (Ethiopian pepper).

Chijioke, *et al.*, (2011)[34] studies the absorption of Pb on *Xylopia aethiopica* at 25^{o}C. The effect of pH on the biosorption of heavy metal Pb was evaluated. They found that increase in pH increases the biosorption of Pb by *Xylopia aethiopica*. The maximum uptake capacity for Pb was 7.69 mg g^{-1}.The biosorption isotherm of *Xylopia aethiopica* was determined. The Langmuir and Freundlich models give good fit (R^2= 0.99 and R^2= 1.00 respectively).The values of 1/n was 0.97 for the adsorbate, Pb, which indicate favourable biosorption. The findings from their study indicate the possibilities that exist in the clean-up of the environment with the use of natural resources.

Other studies on *Xylopia aethiopica*.

Addition to the above scientific studies on *Xylopia aethiopica*, are; effect of geographical location on essential oil content and composition of *Xylopia aethiopica* (Itmad and Saad, 2014)[35], histological effects of *Xylopia aethiopica* on the kidney of adult Wistar rats (Obhakhan, *et al.*, 2014)[36], suppressive potentential of *Xylopia aethiopica* (Annonaceae) fruit extract on Freund's adjuvant-induced arthritis in Sprague-Dawley rats (Obiri, *et al.*, 2014)[37], effects of dietary *Xylopia aethiopica* on the gonads of male Wistar rats (Onyebuagu, *et al.*, 2014a)[38], effects of dietary *Xylopia aethiopica* on hematological parameters and plasma lipids in male Wistar rats (Onyebuagu, *et al.*, 2014b)[39], effect of *Xylopia aethiopica* plant extract on semen quality of the Sprague dawley rats (Uyovwiesevwa, *et al.*, 2011)[40] and ameliorative potential of methanol extract of *Xylopia aethiopica* on Acetaminophen-induced liver damage in male Wistar rats (Folorunso, *et al.*, 2013)[41].

CONCLUSIONS

At this moment, there is a growing demand globally in herbal medicines associated with improved laboratory investigation into the pharmacological properties of the bioactivities from natural source and their ability to manage an assortment of diseases. Exploration of herbal medicines had created an avenue for several conventional and alternative therapies. Although several scientific studies have been carried out on traditional plants, this present review article will be valuable to those

researchers interested in validating some hidden folklore claims of *Xylopia aethiopica*, which are yet to be scientifically validated as well as to advance on its bioactivities as useful drugs.

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