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## *Enantia chlorantha*: A review

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### Abstract

*Enantia chlorantha* (Dokita Igbo, Awogba, Awopa), depending on the dialect of the Yoruba speaking people of the South west and (Erumeru), South Eastern Nigeria. It is widely distributed along the coasts of West and Central Africa and common in the forest regions of Nigeria. It belongs to the family *Annonaceae* and the trade name is Africa yellow wood. It is an ornamental tree which may grow up to 30 m high, with dense foliage and spreading crown. The plant extracts have been widely used in folk medicine for the treatment of a large number of human ailments especially in rural communities in Nigeria. The stem bark is mostly preferred (even though the roots and the leaves may also be used), and decoctions, tinctures or infusions may be prepared. In Nigeria, *E. chlorantha* preparations can be made in the form of a drink, called 'agbo', or in the form of a powder, referred to as 'agunmu'. Generally, in different places and cultures, it has found wide applications in folk medicine as a therapeutic agent for treating myriad of sickness and disease conditions such as malaria, aches, wounds, boils, vomiting, yellow fever, chills, sore, hepatitis, worms, intestinal spasms, sexual asthenia, jaundice, urinary tract infections, typhoid fever, leprosy spots, tuberculosis, gastric and duodenal ulcers. It also serves as a haemostatic agent, and as a uterine stimulant. Its medicinal properties range from preventing to curative while the pharmacological activities include antimalarial, antimicrobial and antibacterial, antioxidant, anti-*Helicobacter pylori*, anticonvulsant, anti-inflammatory, analgesic and antipyretic, antiviral, gastro protective and enhancing male fertility. Saponins, flavonoids, alkaloids, phenols, reducing sugar and cardiac glycosides are some of the bioactive constituents present in the plant extracts which support its multiple properties and uses in traditional medicine. Palmatine, coloumbamine and jatrorrhizine are specific active principles isolated from the stem bark of *Enantia chlorantha* alkaloids. The aqueous extract of *Enantia chlorantha* is not toxic in acute intake up to 500 mg/kg body weight, but doses greater than 500mg/kg body weight can cause lungs, hepatic and kidney disorders following medium to long-term use. This review attempts to highlight the novelty of *Enantia chlorantha*: evaluating the traditional uses, nutritional, phytochemistry, biochemistry, pharmacology and medicinal potentials of this plant.

**Keywords:** *Enantia chlorantha*, traditional uses, biochemistry, medicinal and pharmacological potentials

### Introduction

Tropical rain forest plants are known to have higher concentrations of secondary metabolites with greater diversity. The list of medicinal plants used for the treatment of malaria are numerous and inexhaustible [1, 2], but the one that caught our attention during our ethnobotanical survey is *Enantia chlorantha* (*Annonaceae*) or *Annickia chlorantha*.

*Enantia chlorantha* belongs to the family *Annonaceae* and is locally known as Awogba, Awopa, Osu pupa (Yoruba), Osomolu (Ikale), Dokita igbo, Erumeru (South Eastern Nigeria), Kakerim (Boki in Cross River State, Nigeria) and Erenba-vbogo (Bini). It is widely distributed along the coasts of West and Central Africa. It is also very common in the forest regions of Nigeria [3]. It is an ornamental tree which may grow up to 30 m high, with dense foliage and spreading crown. It grows in dense shade and may be recognized by its bright yellow slash and conspicuous black fruits [4]. The outer bark which is thin and dark brown is fissured geometrically while the inner bark is brown above and pale cream beneath. The stem is fluted and aromatic while the elliptic leaves are about 0.14-0.15 m long and 0.05-0.14 m broad [3, 5].

*Enantia chlorantha* is particularly sought after by the rural communities in Nigeria for the treatment of many ailments. The stem bark is mostly preferred (even though the roots and the leaves may also be used), and decoctions, tinctures or infusions may be prepared. In Nigeria, *E. chlorantha* preparations can be made in the form of a drink, called 'agbo', or in the form of a powder, referred to as 'agunmu' [6]. The powder may be sprinkled onto thin porridge for drinking, but could also be mixed with locally brewed alcohol such as ogogoro, palm wine, fermented maize water or carbonated soft drinks [6, 7] may also be used as solvents for 'soaking' the bark.

The plant is believed traditionally to have therapeutic effect but receives little or less scientific research. Studies have reported the possible use of the plant in conditions such as rickettsia fever, cough and wounds, typhoid fever and infective hepatitis or jaundice [8]. It has also been revealed that the aqueous extract of the bark of the plant possesses analgesic and antipyretic activity [9] as well as antimicrobial and antimalarial activities [1, 10, 11]. Siminialayi and Agbaje in 2005 have demonstrated the gastroprotective effects of *Enantia chlorantha* against induced-gastric ulcers in rats while Oyewopo *et al.* in 2012 evaluated the effect of aqueous extract of stem bark of the plant on the testicles of rats.

The treatment of jaundice is believed to be linked to the yellow colour of the stem bark which is used in this instance. This is a typical example of the “doctrine of signatures” commonly found in African Traditional Medicine where the colour of a plant part is linked to its ethnomedicinal use [14], and in the case of jaundice, patients exhibit a yellow skin and eye colouring. Lewis in 2001 reported that the yellow to orange colour of the plant extracts is due to the presence of the three major water soluble alkaloids, i.e. palmitine, jathorrhizine and columbamine. Traditionally, the stem bark extract is applied to ulcers and leprosy spots for quick healing, decoction is used for washing wounds, and bark sap is taken as decoction against diarrhea.

It is noted that the herbal preparation containing *E. chlorantha* are known to be kept in some households and used often, even without obvious symptoms of malaria, but rather as malaria prophylactics [6].

Kadiri *et al.* 2013 reported that aqueous extract from fermented maize was the most frequently used solvent of choice in the treatment of malaria fever in Abeokuta North Local Government Area in Ogun State, Nigeria.

This review attempts to highlight the available literature on *Enantia chlorantha* with respect to the traditional uses, nutritional, phytochemistry, biochemistry, pharmacology and medicinal potentials of this plant.

### Distribution

*Enantia chlorantha* is a dense forest tree found in the Eastern and Southern forest of Cameroon, Southern part of Nigeria, Gabon, Guinea, Ivory Coast, Liberia, Angola (Cabinda) and DR Congo (Province Bas-Congo).

**Table 1:** Botany/Taxonomy

Taxonomical classification	
Kingdom:	Plantae
Phylum:	Tracheophyta
Class:	Magnoliopsida
Order:	Magnoliales
Family:	Annonaceae
Subfamilia:	Malmeoideae
Tribus:	Piptostigmateae
Genus:	<i>Enantia</i>
Species:	<i>Chlorantha</i>
Scientific name:	<i>Enantia chlorantha</i> Oliver
Trade Name:	African yellow wood

### Vernacular names

Locally, the name varies from place to place [17]. The Ibibios of Akwa Ibom call it Uno eto while Yoruba's call it Osupupa, Dokita igbo (Ibo), Awo-opa, Osomolu (Ikale). The Edo people refer to it as Erenbav bogo, Erumeru (South Eastern Nigeria), Kakerim (Boki tribe in Cross River State Nigeria). Ikodzi konga, Moambe jaune, African yellow wood, Osopa, African yellow wood, Mfö, Mfol, Ofo'o.

### Botanical description

Small to medium-sized tree up to 30 m tall; bole branchless for up to 20 m, usually straight and cylindrical, but sometimes fluted, up to 80 (-90) cm in diameter, sometimes with small buttresses; bark smooth, often with indistinct horizontal folds, brownish grey to blackish, inner bark fibrous, bright yellow, with peppery-resinous smell; crown triangular, tall and thin, with horizontal branches, curving down towards their tips; twigs glabrous, green, later blackish (Plate 1).



**Plate 1:** *Enantia chlorantha* plant.

### Traditional medicinal uses of *Enantia chlorantha*

There are so many health benefits associated with *Enantia chlorantha*. In traditional medicine, this plant has been used for a long time in many parts of the African continent to treat various ailments of the human body. Many ethnobotanical studies supported this. According to Tsabang *et al.* 2012 a decoction of 500 g of stem bark in three liters of water for 20 min is used to treat malaria symptoms, aches, wounds, boils, vomiting, yellow fever, chills, sore and hepatitis (250 ml of this decoction orally, 3 times daily for 15 consecutive days), or a decoction of a mixture of 300 g of stem bark of each of *Enantia chlorantha*, *Rauvolfia vomitaria* and *Fagara macrophylla* and /or *Nauclea latifolia* in four liters of water for 20 min (take 250 ml of this decoction orally, three times daily for 10 consecutive days). The stem bark decoction, taken orally, has also been reported to treat intestinal worms, intestinal spasms, malaria and sexual asthenia [19]. The same decoction is effective against hepatitis, jaundice, urinary tract infections and typhoid fever [20].

Root decoction is used for malaria, jaundice and as antipyretic [21]. Dried stem bark is used to treat malaria, hepatic disorders, tuberculosis and ulcers [22]. Gill and Akinwumi, 1986 noted the use of infusion of bark for the treatment of cough and wounds in Nigeria. Vennerstrom and Klayman, 1988 reported the use of the bark of this plant against malaria in the southern forest zone of Cameroon, used for the management of stomach problems, treatment of jaundice, tuberculosis, urinary tract infections, hepatitis and some forms of ulcer.

### Proximate composition & phytochemical analysis

*Enantia chlorantha* contains many bioactive compounds which justify its numerous medicinal virtues. Dawodu *et al.* 2014 studied the nutritive potential of this plant with the objectives to determine the proximate component and the phytochemical constituents of *Enantia chlorantha* stem bark in aqueous and ethanolic extracts. The proximate analysis revealed a high content of crude fibre (72.25%) and low ash content (2.48%) with other four compounds present in varying quantities (crude protein 10.78%, carbohydrate 6.29%, moisture 3.85% and crude fat 3.78%). Adeyemi *et al.* in 2014 reported the micronutrients composition of *Enantia*

*chlordantha* stem bark. Gbadamosi *et al.* 2011 found the same six active constituents in their proximate analysis and concluded that this plant bark can be used as food supplement in weaning food, due to its nutritive potential. Some of the micronutrients reported include manganese, iron, zinc and copper.

#### Some chemical constituents of *Enantia chlordantha*

Lewis in 2001 isolated palmatine, columbamine and jatrorrhizine from *E. chlordantha* alkaloids.

Palmatine is a major component of herbal preparations mainly used in traditional medicine by Chinese, Korean and Indian major alkaloid component of the protoberberine extract from *Enantia chlordantha* and has been studied for its potential use in the treatment of jaundice, dysentery, hypertension, inflammation and liver-related diseases. It has also been proposed as a promising DNA phototherapy drug, notably due to its ability to produce in situ singlet oxygen only when interacting with DNA.

Jatrorrhizine is an active component of the traditional Chinese herb *Coptis chinensis*, which has been used to prevent and treat metabolic disorders. It is also found in plants such as *Enantia chlordantha*, *Thalictrum lucidum* and *Thalictrum revolutum*. Jatrorrhizine possesses antifungal and antibacterial activity. Antifungal activity of jatrorrhizine was tested on dermatophytes and yeast strains isolated from superficial human lesions. It has low toxicity and was studied in mouse models of obesity and hypercholesterolemia.

#### Columbamine

A quaternary isoquinoline alkaloid isolated from *Argemone mexicana*, the Mexican poppy an alkaloid [C<sub>20</sub>H<sub>21</sub>NO<sub>5</sub>] that occurs in calumba and is related in structure to berberine.

#### Pharmacological evaluation

Human life-cycle depends to a great extent on plants. *Enantia chlordantha* possesses enormous pharmacological values which support its various traditional uses for the management of health problems. These include:

##### 1. Analgesic and Antipyretic activity

Aqueous extract of the bark of *Enantia chlordantha* administered intraperitoneally into healthy adult albino mice at doses of 1.0 g/kg and 5.0 g/kg resulted in elevation of pain threshold and was about 20 times less potent than morphine, a reference drug. However, a dose of 15.0 g/kg given orally to rabbits infected with *Klebsiella* sp was capable to relieve the pyrogenic induced fever when compared to the control group<sup>[9]</sup>.

##### 2. Anticonvulsant and Anti-inflammatory activity

Agbaje *et al.* 2003 investigated the effect of boiled and evaporated extracts of *Enantia chlordantha* in reversing bicuculline-induced convulsions and carrageenan-induced inflammation in rodents. The results showed that, the evaporated aqueous herbal drug (*E. chlordantha* boiled water bark extract evaporated to dryness) increased the latency of convulsion in all the treated animals while the aqueous extract did not. The aqueous extract behaved similar to the control mice which were given distilled water. *Enantia chlordantha* did not compare well with phenobarbitone (2–6 mg/kg) which protected all the animals from seizure. On the other hand, a dose dependent anti-inflammatory action of evaporated extract of *Enantia chlordantha* (50– 250 mg/kg) in carrageenan induced inflammation was obtained showing

a better efficacy than the boiled aqueous preparation and compared favourably with aspirin. They concluded that *Enantia chlordantha*, especially the evaporated extract, exhibited significant anti-inflammatory effect on carrageenan-induced inflammatory edema in rats. They added that this effect is more gradual and more sustained than a similar effect of aspirin.

##### 3. Anti-*Helicobacter pylori* activity

The *in vitro* and *in vivo* anti-*Helicobacter/Campylobacter* activity of aqueous extract of *Enantia chlordantha* stem bark was dose-dependent for both *H. pylori* and *C. jejuni* or *C. coli*<sup>[28]</sup>. Antral mucus sample cultures from mice also treated with *Enantia chlordantha* extract did not yield any growth, indicating that, apart from its *in vitro* effects, *Enantia chlordantha* aqueous extract also possesses *in vivo* antibiotic activity against *H. pylori*<sup>[28]</sup>.

##### 4. Antimalarial activity

Reports on the antimalarial potential of *Enantia chlordantha* are numerous. Ogbonna *et al.* 2008 determined the efficacies as antimalarial compounds of ethanolic extracts from the roots of *Salacia nitida*, *Nauclea latifolia* and stem bark of *Enantia chlordantha* for antimalarial activity against chloroquine sensitive *Plasmodium berghei* in mice using a 4-day suppressive test procedure. The extracts had intrinsic antimalarial properties that were dose dependent. The comparison analysis indicated significant (p < 0.05) suppression (71.15%) of parasitemia at 250 mg/kg body weight when compared with chloroquine. Antimalaria activities of *Enantia chlordantha* and *Rauwolfia vomitoria* extracts were also carried out by Agbaje and Elueze, 2006 in rodent's malaria and the antimalarial activities of the aqueous extracts of *Rauwolfia vomitoria* and *Enantia chlordantha*, separately and in combination recorded a suppression of infection in *Plasmodium berghei* infected male albino mice when compared with the control, but no total protection was offered in all the cases investigated.

##### 5. Antimicrobial and Antibacterial activity

Nyong *et al.* in 2015 investigated the *in vitro* and *in vivo* antimicrobial activity of a purified alkaloid isolated from *Enantia chlordantha* stem bark on rats infected with fungi. The effectiveness of this compound showed sensitivity against *Trichophyton tonsurans* and *Candida glabrata*, while *Trichophyton interdigitale* and *Candida albicans* was less sensitive when compared to Tioconazole cream (1%) used as reference drug. They concluded that the alkaloid fraction exhibited significant *in vitro* and *in vivo* antifungal activities against different species of candida, dermatophytes and plants fungi. The antibacterial activity of aqueous extracts of *Enantia chlordantha* stem bark<sup>[10]</sup> showed that zones of inhibition on bacterial isolates (*Staphylococcus aureus* and *Bacillus subtilis*, *Escherichia coli*, *Salmonella typhimurium* and *Pseudomonas aeruginosa*) were proportional to the concentration of the plant extract<sup>[10]</sup>.

##### 6. Antioxidant activity

The *in vitro* antioxidant activity of methanol, n-hexane, chloroform, ethyl acetate and water extracts from stem bark of *Enantia chlordantha*, using models of DPPH(2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity,

nitric oxide scavenging property, ferric reducing property (FRAP) and hydroxyl radical scavenging property have been investigated [6, 9]. The phenolic and flavonoid contents determine the free radical scavenging potential of the extracts. This result suggest that this plant's antioxidant property justify its uses in the traditional medicine for the management of malaria, cough and wounds which are all stress related diseases.

### 7. Antiviral activity

Fasola *et al.* 2011 evaluated the antiviral effects of solvent (aqueous) bark extract of *Enantia chlorantha* on yellow fever virus (YFV) *in vitro*, using Vero cell line. This study showed that aqueous extracts exhibit significant antiviral activities against yellow fever virus. These researchers added that, the broad-spectrum antiviral activity of the plant extracts is possible due to the identified alkaloids. Wafo *et al.* 1999 also noted the antiviral activity of extracts from dried stem bark of *Enantia chlorantha*.

### 8. Male fertility enhancement

The effect of aqueous extract of stem bark of *Enantia chlorantha* on the sperm parameters and the histoarchitecture of the testicles of rats was investigated [13]. Testicles histoarchitecture showed the spermatogonia as well as the spermatids and spermatocytes that were quite obvious in the rats treated with extract as compared with those of negative control. The interstitial spaces were abnormally widened and the leydig cells were destroyed in the negative control rats. The sperm quality (sperm count, mobility, viability and progressivity) of the extracts treated rats were very good, while those of negative control were weak. This suggests that in addition to enhance fertility, this plant's extract can play a protective and a regenerative role against destroying agents when used as prophylactic. Salman and Adesokan, 2008 also showed that the extract of *Enantia chlorantha* significantly increases sperm mobility and viability in a dose-dependent manner, but they did not affect sperm counts. Hence, low doses of this plant extracts could improve sperm quality, hence male fertility.

### 9. Gastroprotective activity

Siminialayi and Agbaje in 2005 determined the Gastroprotective effects of ethanolic extract of *Enantia chlorantha* against induced-gastric ulcers in rats. The results were able to demonstrate that rats pretreated with extract before the administration of the ulcerogenic agents were well protected. The inhibition effect of extract against ethanol-induced ulcers was most effective than indomethacin-induced ulcers. These researchers suggested that the extract acts particularly as a cytoprotective agent, but also by inhibiting the secretion of gastric acid.

### 10. Toxicity

*Enantia chlorantha* is widely used in herbal medicine for the treatment of several human ailments. However, its toxicity profiles are not well documented [34]. Like other therapeutic agents, *Enantia chlorantha* may not be devoid of side effects or toxicity in both human and animal [35]. Several *in vivo* studies on both aqueous and ethanolic leaf and bark extracts of *E. chlorantha* were tested orally and sub-cutaneously indicated possible acute

and chronic toxicity on reticulocyte and haematocrit values as well as nucleated cell numbers in the spleen, bone marrow, peritoneum, liver and peripheral blood [36].

### Conclusion

This review has revealed the potential use of *Enantia chlorantha* in traditional medicine. This plant has been used extensively in traditional medicine practice in the treatment of several ailments of non-related pathophysiology. Based on the pharmacological studies and the activities or potentials demonstrated, it is reasonable to conclude that, this plant following the recent interest in its composition, shall be a novelty in phytomedicine and therapeutics. The pharmacological investigations so far, have to a great extent supported the traditional medicinal uses of this plant.

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