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REVIEW ARTICLE

ETHNOBOTANY, PHYTOCHEMISTRY AND PHARMACOLOGY OF *OCHNA SCHWEINFURTHIANA*: A REVIEW

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ABSTRACT
Ochna schweinfurthiana (*Os*, Family: Ochnaceae) is a small evergreen tree used in ethnomedicine to treat different ailments; it is also used in agri-horticulture and as ornaments, dyes among others. It is a rich source of complex dimers of flavonoids and used for treatment of pain, inflammation, and arthritis. Chemical investigations carried out on the different parts of the plant have been confined to phenolic compounds majorly, bioflavonoids, glycosides, steroids and terpenes. The plant, *O. schweinfurthiana* have shown a wide spectrum of biological and pharmacological properties which include antimicrobial, cytotoxic/antiproliferative, genotoxicity, antinociceptive, anti-inflammatory, antioxidant and antiplasmodial. This review comprehensively summarizes the potential effects of the plant *O. schweinfurthiana*, chemically and pharmacologically. However, more researches in the aspect of phytochemical and biological studies are needed to exhaustively isolate bioactive compounds and evaluate their effects on other ailments as claimed by the traditional healers.
Keywords: Anti-microbial, antimalarial, flavonoids, *Ochna schweinfurthiana*, Ochnaceae, phenolics, pharmacological.

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INTRODUCTION
Ochna schweinfurthiana (*Os*) belonging to the Ochnaceae family is a small tree that was named after a German botanical collector and taxonomist Dr. Georg August Schweinfurth; it is a small tree that measures up to 4 m tall; the plant is commonly known as the brick-red Ochna in English, Jan-taru in Hausa language, Hiéké in Yoruba and Sa'aboule in Foufouldé[1,2]. The plant has found use as medicine, for agricultural, social and religious purposes[1]. This review centered on the ethnobotanical, phytochemical and pharmacological properties of *O. schweinfurthiana*.

Botanical Description
Ochna originated from a Greek word "*Ochne*" which means wild pear and it was named by Linnaeus in 1951 as *Ochna* because of the resemblance of their leaves with those of wild pear[3]. Itis an old world genus of mainly trees, shrubs and shrublets which comprises of about 85 species[4] and it is widely distributed in tropical Asia, Africa and America[5] of which eleven (11) species are found in India[6]. Ochna's are usually called Mickey Mouse plants, because of the appearance of the black druplets fruits. The Ochnaceae family is mainly composed of trees and shrubs with an estimated 33 genera and 550 species[7] well distributed around the world especially in tropical Africa, Australia, Madagascar Asia, the Mascarene Island and America[8]. They are notably known for their unusual shiny leaves, with parallel veins that are closely spaced, alongside toothed margins with conspicuous stipules[1,7]. The largest genera are Ouratea, Ochna, *Campy lospermum*, Sauvagesia and Quiina with (200, 85, 65, 39 and 34 species) respectively (Table 1).

Table 1: Ochnaceae subfamilies and their estimated number of species

Subfamily	Estimated number of species
Ouratea	200
Ochna	85
Campylospermum	65
Sauvagesia	39
Quiina	34
Total	423

Morphology
O. schweinfurthiana is a small evergreen treeor shrub that grows up to 4 m tall and it has a dark grey bark that is fissured and cracked, separating into square segments[10]. The leaves are olive-green (1-13.5x1.7-

5.5cm) that oblanceolate to oblong or elliptic, apex somewhat rounded, base tapers into the petiole, margins rather bluntly toothed (serrulate), sometimes appearing almost scalloped, net-veining conspicuous on the upper surface and young leaves are coppery[1,11]. It bears bright yellow flowers (1.5 cm diameter) which are sweetly-scented from September to November, very short-lived, normally appearing before or with the young leaves[10]. In addition, it appears in a condensed receme with 4–10 flowers on a short central stem and the petals fall very early[11].

Figure 1: Leaf and fruits of *O. schweinfurthiana*

The fruits of *O. schweinfurthiana* are 1-5 oval appear between August and January, attached at the base are 2-4 black berries when ripe; they are enlarged, borne on brick-red persistent sepals turning cherry to brick-red. The bark is dark grey, thick, and deeply fissured into a grid-like pattern[10,11].

Figure 2: Whole plant of *O. schweinfurthiana*

Taxonomy

Kingdom: Plantae Order: Malpighiales
Family: Ochnaceae Genus: Ochna
Subfamily: Ochnoideae
Species: *O. schweinfurthiana*[9]

Common names

English: Brick-red Ochna, Hausa:Jan-taru
Yoruba: Hiéké, Fulfulde:Sa'aboule

Habitat, Distribution and Ecology

The plant grows in open deciduous woodland in tropical regions in Africa from Guinea to southern and northern Nigeria and across central Africa to Sudan, Uganda, Zimbabwe, Mozambique, Tanzania and Angola. It has medium water requirement when young and growths fast, flowers from September to November. It required low maintenance and attracts insects and birds[4,10].

USES

Ethnomedicinal uses

Several preparations (powdered and decoctions) of the leaves and/or root of the *O. schweinfurthiana* have found general use as antimicrobial (wound dressing, eye infection), analgesic, anti-inflammatory and anthelmintic agents[1]. The leaf is also used as an antiseptic, stimulant, febrifuge, laxative, enemaetc[1]. In Northern Cameroon , *O. schweinfurthiana* is used to treat different diseases such as rubella, burns, stomachache and multiple sclerosis[12]; the root of the plant is also used in the treatment ofstomach and eye aches as well as headache, while the leaves are used for toothaches treatment[2].

The pulverized bark is used to treat malaria, febrifuges and as anthelminthic, while the decocted root leaves and/or bark is used in wound dressing[12]. In Northern Nigeria, the *O. schweinfurthiana* is used to treat typhoid fever, measles and fungal skin infections[12]. The macerated roots of *O. schweinfurthiana* has been reportedly used to induce/speed the delivery process and for miscarriage[13].

Other uses

The plant is used in agri-horticulture; the bark and flowers *O. schweinfurthiana* are cultivated for ornaments, dyes, stains, inks, tattoos and mordent among others. The wood is used for farming, forestry, hunting and fishing apparatus. The leaf has social, religious, superstitious and magic values among others[1].

PHYTOCHEMISTRY

Phytochemical screening

Abdullahi *et al*.,[12] reported the presence of flavonoids, steroids/terpenes and saponins in the acetone leaf extract of *O. schweinfurthiana* and the methanol leaf extract indicated the presence of flavonoids and saponins. However, flavonoids, saponins, glycosides, tannins and steroids/terpenes were reported on the methanol stem extract of *O. schweinfurthiana*[14]. A study conducted by Ibrahim *et al*., reported the presence of carbohydrates, steroids/triterpenes, glycosides, saponins, tannins and flavonoids in the methanol leaf extract of *O. schweinfurthiana*[15].

Bioactive constituents

Chemical constituents isolated from *O. schweinfurthiana* fall under the following class of secondary metabolites phenolics-flavonoids, and glycosides. *O. schweinfurthiana* have been reported to contain phenolic derivatives (such as flavonoids, bioflavonoids) which appear as free or in polymerized forms. Isolation and characterization of quercetin-3-*O*-β-D-glucopyronosyl-(1→6)-α-rhamnoside (quercetin rutinoside) from the *n*-butanol soluble fraction of methanolic leaf extract of *O. schweinfurthiana* was reported[16]. A novel biflavonoid compound, tri-methoxy lophirone was isolated from the chloroform soluble fraction of the methanol root extract of *O. schweinfurthiana*[17].

Ndongo *et al*.,[18] reported the isolation of seven flavonoids, hemerocallone, 6,7-dimethoxy-3',4'-dimeth -oxyisoflavone, amentoflavone, agathisflavone, cupressuflavone, robustaflavone, and epicatechin, and three other chemical constituents, lithospermoside, β-D-fructofuranosyl-α-D-glucopyranoside and 3β-*O*-D-glucopyranosyl-β-stigmasterol from the ethyl acetate the stem bark extract of *O. schweinfurthiana*.

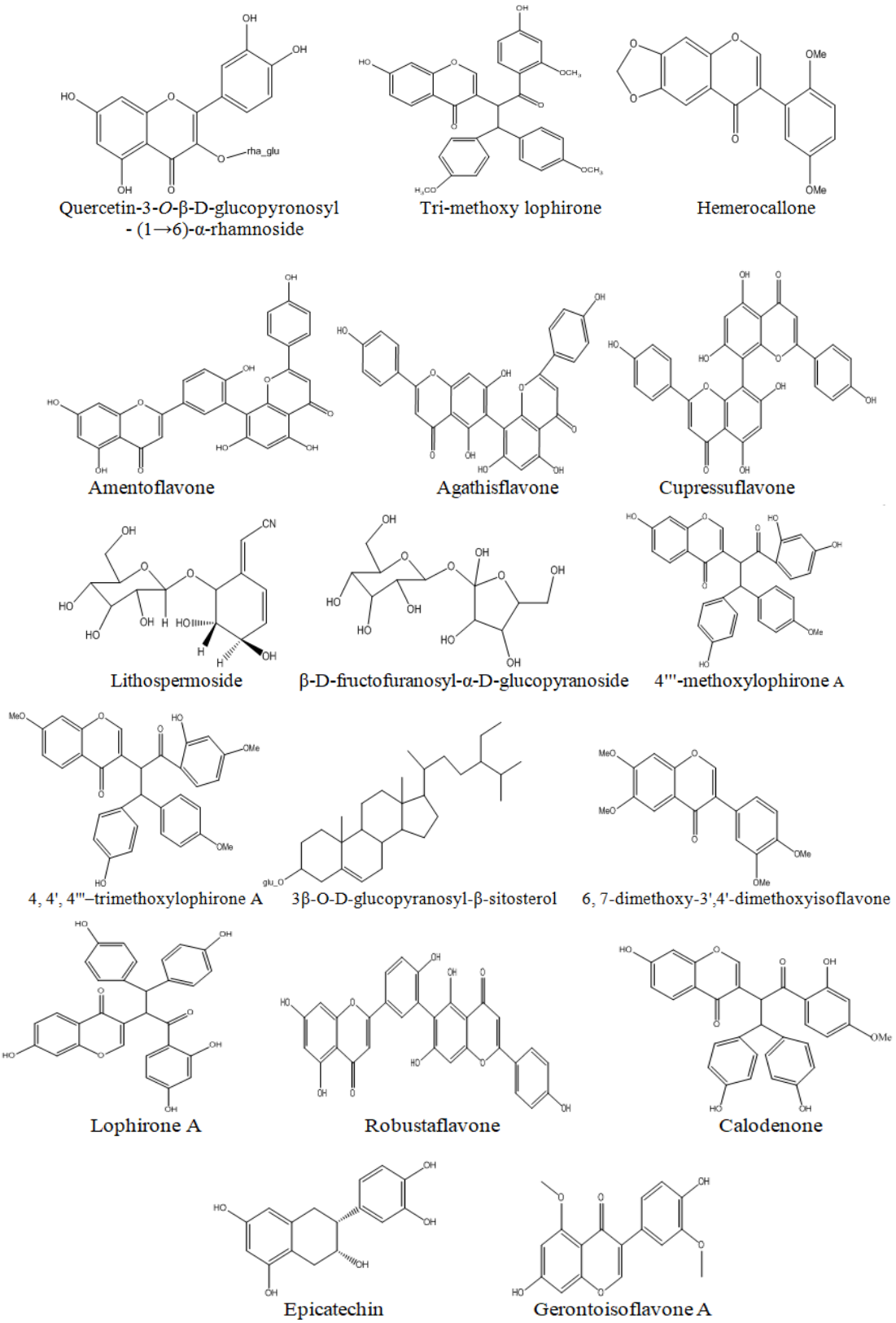

Figure 3: Chemical constituents isolated from *O. schweinfurthiana*

The roots of *O. schweinfurthiana* were reported to contain three new compounds viz; 4'''-methoxylophirone A, 4,4',4'''–trimethoxylophirone A. In addition, six known compounds were also isolated and characterized, including calodenone, calodenine B, lophirone A, gerontoisoflavone A, and 3β-*O*-D-glucopyranosyl-β-sitosterol[2]. Six known compounds were isolated from the powdered bark of *O. schweinfurthiana* and they include, hemerocallone, 6,7-dimethoxy-3'-4'-dimethoxyisofla -vone, lithosperm -oside, amentoflavone, agathisflavone and*β*-D-fructofuranosyl-*α*-D-glucopyranoside[19].

BIOLOGICAL AND PHARMACOLOGICAL ACTIVITIES

Antimicrobial activity

The acetone and methanol leaf extracts of *O. schweinfurthiana* had a remarkable antibacterial effect against *S. aureus*, *S. typhi*, *K. pneumonia* and *P. aeruginosa* with a zone of inhibition ranging from 15 – 21 mm; the extracts had an MIC and MBC values of 10–20 mg/ml and 20–40 mg/ml, respectively[12]. Quercetin-3-*O*-β-D-glucopy-ranosyl(1→6)-α-rhamnosi -de from the *n*-butanol soluble fraction of the methanolic leaf extract of *O. schweinfurthiana* showed an *in vitro* inhibitory effect against some bacterial isolates such as *S. aureus*, *MRSA*, *S. pyogenes*, *E. coli*, *K. pneumoniae*, *S. typhi* and *P. aeruginosa* with an MIC and MBC range between 2.5–5.0 and 5–20 µg/ml, but there was no effect against *B. subtilis*, *C. ulcerans* and *C. albicans*[16]. Earlier studies showed that tri-methoxy lophirone A from the chloroform soluble fraction of the methanol root extract of *O. schweinfurthiana* inhibited the growth of some selected human pathogens including *S. aureus*, *S. pyogenes*, *P. aeruginosa*, *K. pneumoniae* and *S. typhi* with an MIC and MFC values of 5 µg/ml and 20 µg/ml, respectively[17]. Crude methanol stem extract of *O. schweinfurthiana* and its chloroform (CF), ethylacetate (EF) and *n*-butanol (BF) fractions inhibited the growth of *MRSA*, *S. aureus*, *S. pyogenes*, *S. typhi*, *S. dysenteriae*, *K. pneumoniae*, *N. gonnorhea*, *P. aeruginosa*, *C. albicans*, *C. tropicalis*; the mean zone of inhibition of extract and fractions ranges from 20–29 mm; moreover, chloroform fraction showed greater antimicrobial activity with an MIC value of 1.25 mg/ml against all the test organisms except *P. aeruginosa*[14].

Cytotoxic and Antiproliferative effect

The methanol and ethylacetate stem bark extracts of *O. schweinfurthiana* demonstrated cytotoxicity against HeLa cells; amentoflavone and agathisflavone were also active[18]. Antiproliferative effect of *O. schweinfurthiana* extract was evaluated against *Glioblastoma multiforme* (GBM U-1242 MG) cell line and the extract reduced cell count by 20 % with an IC_{50} value 823.51 µg/ml[20].The aqueous stem bark of *O. schweinfurthiana* did not show any cytotoxic effect on Vero monkey kidney cell line after 48 h incubation with an LC_{50} value 50±1 µg/ml[19].

Genotoxicity

Djova *et al*., reported that the extracts of *O. schweinfurthiana* were non genotoxic in a study they carried out; as none of the plant extracts demonstrated a dose dependent increase or revertent colonies ≥ the number of negative control revertent colonies; thus, the plant *O. schweinfurthiana* may not contain any genotoxic substances that may lead to mutations either by substitution or by reversion in the genetic material[19].

Antinoceptive and anti-inflammatoryeffect: The methanol leaf extract of *O. schweinfurthiana* significantly inhibited the writhing response induced by acetic acid in a dose dependent manner; the highest dose exhibited maximum inhibition of pain (84.3 %). In addition, the extract was also able to attenuate pain response in a similar manner though with a slower onset of action in the tail flick model[15].The aqueous bark extract of *O. schweinfurthiana* exhibited good anti-inflammatory effect in both ferrous oxidation-Xylenol Orange (Fox) and BSA denaturation assays; the extract demonstrated good 15-lipoxygenase inhibitory effect with an IC_{50} value of 32.2±0.36µg/ml, however, an IC_{50} of 130±5.78µg/ml was recorded by the extract in the inhibition of heat induced albumin denaturation[19].

Antioxidant effect

Messi*et et al*., evaluated the antioxidant activity ofsome compounds including 4'''-methoxylophirone A, calodenone, calodenine B, lophirone A, gerontoisoflavone A from the roots of *O. schweinfurthiana* using DPPH radical scavenging and ferric reducing-antioxidant power (FRAP) assays[2]. In the DPPH radical scavenging assay, calodenine Bshowed prominent effect with SC_{50}=0.17±0.04 µM and EC_{50}=4.25 µM, gerontoisoflavone A exhibited weak activity in all the models applied with SC_{50}=19.00 µM and SC_{50}=78.67 µg EAA/mg/dw in DPPH and FRAP respectively. The antioxidant property of the leaf, stem bark and fraction of *O. schweinfurthiana* was evaluated[21].

Antiplasmodial effect

An *in vivo* study showed that the methanol leaf extract of *O. schweinfurthiana* exerted a suppressive effect against *Plasmodium berghei* at a lower dose (50 mg/kg); Ibrahim *et al*., concluded that, the extract possess blood schizonticidal activity as it was able to suppress malaria at the early stage[22]. Moreso, the extract reduced the level of parasitaemia with 100 % cure at the lowest dose (50 mg/kg); the percentage inhibition of parasitaemia was higher than the chemo suppression which might be due to non-selectivity of the extract to the proliferative process of the parasite[22,23].

Antiplasmodial effect of the ethylacetate roots extract of *O. schweinfurthiana* and some compounds including 4'''-methoxylophirone A,(4E,7Z)-3,8-dicarboxy-1-(*O*-β-D-glucopyranosyl-(1→6)-*O*-β-D-glucopyranosyl-2,9 dihy-droxyhexeicosa-4,7-diene,calodenine B, lophirone A and gerontoiso -flavone A were investigated *in vitro*; 4''-methoxylo-phirone A showed good antiplasmodial effect against *P. falciparum* strain 3D7; this effect as explained by Messi *et al*.,[2] might be related to the presence of a methoxy group on position C-4''' which has been known to enhance lipophilicity thereby enhancing its movement into the cells[24]; other compounds were found to be inactive[2].Cold and hot aqueous leaf extracts of *O. schweinfurthiana* possess inhibitory effect against *P. falciparum in vitro*; thus there was significant reduction of parasitaemia.

The high dose (80µg/ml) exhibited 86.42 % (cold extract) and 85.06 % (hot extract) reduction of parasitaemia. On the other hand, no significant difference was observed on the plasmodium lactate dehydrogenase (PLDH) activity of the treated extract when compared with the standard drug[25].

Toxicity

Toxicity level of *O. schweinfurthiana* was assessed in mice both orally and intraperitoneally. The methanol leaf extract of the plant produced an LD_{50} 774.6 mg/kg, i.p. while the oral LD_{50} value for the extract was about 5000 mg/kg; according to this study, the leaf of *O. schweinfurthiana* is intraperitoneal toxic and orally safe[22].

CONCLUSION

O. schweinfurthiana exhibit a variety of biological effects; the plant is considered to be effective against cancer, malaria, oxidative stress, pain, inflammation and a wide range of activity against microbes; thus, the pharmacological actions have been attributed to the presence of different classes of secondary metabolites such as biflavonoids, glycosides, steroids and terpenes among others. In addition, the mechanisms of action of the observed effects and evaluation of other pharmacological properties of *O. schweinfurthiana* need closer attention and it should be the objective of new researches on *O. schweinfurthiana*.

AUTHOR'S CONTRIBUTION

All authors have worked equally in this work.

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