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Review Article

Review of the Phytochemical and Pharmacological Studies of the Genus *Ormocarpum*

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ABSTRACT

Secondary metabolites from medicinal plants play an integral role in the modern drug discovery. *Ormocarpum* species have been used to effectively manage various disease conditions in both human and animal traditional medicines. This review identifies five species in *Ormocarpum* namely; *Ormocarpum kirkii* S. Moore, *Ormocarpum sennoides* (Willd.) DC., *Ormocarpum trichocarpum* (Taub.) Engl, *Ormocarpum cochinchinense* (Lour.)Merr) and *Ormorcarpum keninse* Gillet. Secondary metabolites in different classes of compounds have been isolated in various studies and are herein reported. This review analyses previously reported data from the ethnomedicinal and pharmacological studies of plants in the genus *Ormocarpum*.

Keywords: Ormocarpum, Pharmacology, Phytochemistry, Secondary metabolites, Ethnomedicine, Compounds.

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INTRODUCTION

The genus *Ormocarpum* P. Beauv (family Fabaceae-Papilionoideae) consists of approximately 25 species with approximately 17 species distributed along the tropical regions in Africa.[1,2] Several medicinal plants in this genus such as *Ormocarpum kirkii* S. moore, *Ormorcarpum keninse* Gilllet, *Ormocarpum trichocarpum* (Taub.) Engl, *Ormocarpum cochinchinense* (Lour.)Merr) *Ormocarpum sennoides* and *Ormocarpum sennoides* subspecies *Zanzibaricum* have been widely used for the treatment of headaches, oedema, wound, cellulitis and abscess, fever, stomach pains, hernia, rheumatism, diarrhea, gastrointestinal problems, sexually transmitted infections among others.[1,3-5] This is attributed to the fact that plants in this genus are rich in phytochemicals such as biflavanoids, isoflavanoids, triterpenoids, phytosterols, flavonoids, ester of ferullic acid and coumarins.[6] Pharmacological properties such as antiplasmodial, cytotoxicity, anti-oxidant, antimalarial and antimicrobial activities have also been reported in *Ormorcarpum* species.

Due to their extensive pharmacological properties, diverse chemical constituents and great resources, *Ormocarpum* species have a broad application prospects and may act as a great source of novel antimicrobials. However, there is no available systemic reviews on phytochemistry, toxicology and pharmacological properties of the species in this genus linking the traditional uses and their role in modern medicine applications. This review therefore, aims to provide a great foundation for future development and studies of the medicinal plant species from this genus.

Relationship between Traditional uses and Mordern Pharmacological Properties

Several *Ormocarpum* species have been traditionally used for the treatment of various medical conditions. For instance among the Kamba communities in Eastern Kenya, the powdered leaves ointment mixture of *Ormorcarpum Kirkii* S. Moore synonym *O. bibracteatum* Sensu *auct* (common name "Carterpillar bush") is used in the topical treatment of ringworms. The antifungal property of this species has been reported.[7] In some cases of severe headache, dry leaves paste applied on the head gives relief while decoction of the leaves assists in treatment of oedema[3] and malaria.[3,8] The roots crude extracts showed activity (IC_{50} of 15.6–31.2 lg/ml) against *Plasmodium falciparum*.[8] In addition, the reports of the isolation of antiplasmodial biflavanoids and flavonoids provide a great linkage between the traditional and the modern pharmacological studies.[9,10] In some part of East Africa, this medicinal plant is used for the topical treatment of cuts and wounds.[11] The aerial parts of this medicinal plant showed antibacterial activity (MIC 31.25 µg/mL) against methicillin resistant *Staphylococcus aureus,* one of the major bacterial species that infect wounds and cuts when not properly managed.[12] The roots and leaves of this medicinal plant is of great importance in the topical treatment of cellulites and abscess. Further, the root decoction has proven to be essential in the management of fever.[4] The ethno medicinal importance of this species in the treatment of stomach pain, rheumatism, hernia, headache and diarrhea has also been reported.[13,14]

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The leaves of *Ormocarpum trichocarpum* (Taub.) Engl. mixed with fat is used in the treatment of ringworms and ulcers. The stem bark is boiled and decoction taken to stop bleeding during pregnancy or miscarriage. The crushed leaf infusion, used in the treatment of diarrhea, sexually transmitted diseases, stroke, bilhaziasis, paralysis and tuberculosis.[5,15] The antibacterial ethnobotanical use of this medicinal plant has been has been studied and reported[16] whereby the extracts from the leaves, roots and stem bark displayed a broad-spectrum antibacterial and antifungal activity. In another study the antibacterial and antiplasmodial biflavanoids were isolated, which further justified the medicinal importance of this plant.[17]

Ormorcarpum sennoides (wild) DC species, contains two main specific taxa; *Ormorcarpum sennoides* subsp. *Zanzibaricum* Brenan and J.B. Gillett, found in the coastal regions of Tanzania, Kenya and Zanzibar and *O. sennoides* subsp. *hispidum* (Willd.) Brenan and J. Leonard found mainly in Sri-Lanka and India. Traditionally, this medicinal plant has been used in prenatal care, treatment of convulsion, burns, sexually transmitted diseases as well as other infections that affect children.[18] Its importance in the treatment of bone fracture gas has also been reported. The powdered leaf mixed with milk or honey is consumed orally and the paste topically applied on the site of fracture.[19] This property is attributed to the presence of flavonoids and phenols that have been seen to possess great osteogenic and antioxidant activities.[1,20]

Ormocarpum cochinchinense (Lour.)Merr) is distributed within the tropics in Southern Africa, South Asia, Madagascar, islands of the Pacific Ocean and Northern Australia.[21,22] In India, the roots are traditionally used in the treatment of lumbago. This is due to its stimulant and tonic property.[23] The leaves of *Ormocarpum cochinchinense* are also a part of a formulation used in setting bone fractures as well as in reduction of nervous pain.[24] The root bark is also used to make oil formulation used in paralysis treatment.[25] *Ormorcarpum keninse* Gillet is reported to be used in the treatment of human worms in Tharaka county- Kenya.[26] To date, the traditional uses of the *Ormocarpum cochinchinense* (Lour.) Merr) and *Ormorcarpum keninse* Gillet have not been scientifically proven through the analysis of their phytochemicals.

Phytochemistry of the genus *Ormocarpum*

Various plant parts of different species of (*Ormocarpum kirkii* S. Moore (Figure 1),[27] *Ormocarpum sennoides* (Willd.) DC. (Figure 2)[27] and *Ormocarpum trichocarpum* (Taub.) Engl (Figure 3)[27] have been chemical investigated leading to the characterization of various secondary metabolites.[1,6,10,17] The secondary metabolites in this genus have been categorized into biflavonoids, flavonoids, coumarins, isoflavones, bisdihydrocoumarins, triterpenoids, phytosterols, flavonoids and ester of ferullic acid.[1,6,10,17] To the best of our knowledge, *Ormocarpum cochinchinense* (Lour.)Merr) (Figure 4)[27] and *Ormorcarpum keninse* Gillet have not been chemically investigated.

Figure 1: *Ormorcapum kikii* S. Moore

Figure 3: *Ormocarpum trichocarpum* (Taub.) Engl

Figure 2: *Ormorcapum sennoides* (Willd.) DC

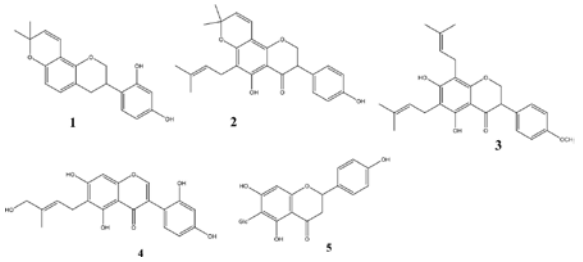
Figure 4: *Ormocarpum cochinchinense* (Lour.) Merr

Pictures of *Ormocarpum* species

Classes of Secondary Metabolites Common to the Genus *Ormorcapum*

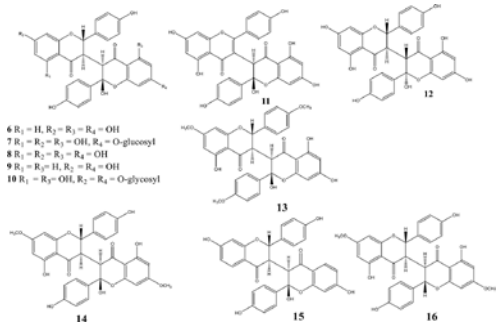
Flavonoids

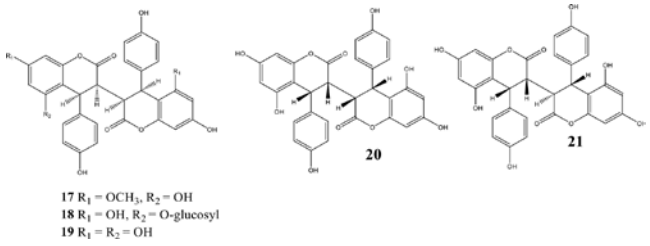
Flavonoids are bioactive secondary metabolites that are found mostly in fruits and vegetables.[28] Regular intake of flavonoid rich foodstuff has been linked to low risks of chronic diseases such as cardiovascular diseases and cancer.[29] Flavanones, flavones, flavonols, flavan-3-ols, anthocyanins and isoflavones are subclasses of flavonoids because of their chemical structure.[30] Isoflavones are a subgroup of flavonoids and are similar to estrogens in terms of properties. They are diphenolic structures with the ability to bind alpha and beta estrogen receptor.[31] Studies have shown that plants in the genus *Ormocarpum* possess flavonoids and isoflavones among other classes of metabolites. An isoflavan; glabridin (1) was isolated from *O. sennoides* (Willd.) DC subsp. *Zanzibaricum*.[1] Isoflavones: osajin (2), 5,7-dihydroxy-4'- methoxy-6,8-diprenylisoflavone (3) from *Ormocarpum kirkii* S. Moore stem bark and root.[6] 4"-Hydroxydiphysolone (4) and isovitexin (5) from *Ormocarpum kirkii* S. Moore root.[10]



Biflavonoids

Biflavonoids belong to a subclass of the plant flavonoids family and are limited to several species in the plant kingdom. This class of compounds are reported for their pharmacological properties including anti-inflammatory, antioxidant, inhibitory activity against phospholipase A2 (PLA2) and antiprotozoal activity.[32,33] A number of biflavonoids have been isolated from various species in *Ormocarpum*. Liquiritigeninyl-(I-3,II-3)-naringenin (6), 7-O-β-D-glucopyranosylchamaejasmin (7), (+)-chamaejasmin (8), (I-3,II-3)-biliquiritigenin (9), ormocarpin (10) apigeninyl-(I-3,II-3)-naringenin (11) and isochamaejasmin (12) isolated from *Ormocarpum kirkii* S. Moore.[10] trime-chamaejasmin (13), (+)- chamaejasmin (8), (+)-liquiritigeninyl-(I-3,II-3)-naringenin) (6) isolated from roots of *Ormocarpum sennoides* (Willd.) DC subsp. *Zanzibaricum*.[1] (+)- chamaejasmin (8), 7,7″-di-O-methylchamaejasmin (14) and campylospermone A (15) isolated from *Ormocarpum kirkii* S. Moore.[6] (+)- chamaejasmin (8), 7,7″-di-O-methylchamaejasmin (14) and 7,7″-di-O-methylisochamaejasmin (16) isolated from *Ormocarpum trichocarpum* (Taub.) Engl.[17]

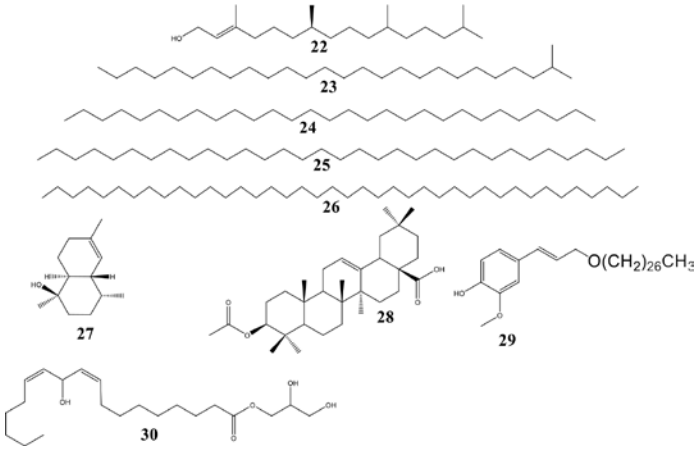




Coumarins

Coumarin compounds represent an important type of naturally occurring and synthetic oxygen-containing heterocycles.[34,35] The pharmacological properties of coumarins such as bacteriostatic and anti-tumor activity are some of the reasons for the great interest in coumarins.[36] In the genus *Ormocarpum*, bisdihydrocoumarins have been reported as well as their biological properties. 5,5" di-O-methyldiphysin (17), 7-O-β-D-glucopyranosyldiphysin (18) and Diphysin (19) from *Ormocarpum kirkii*.[10] Diphysin (19) isolated from *O. sennoides* subsp. *zanzibaricum*[1] and *Ormocarpum kirkii*.[6] (-)-diphysin (20), 3″-epidiphysin (21) isolated from *Ormocarpum trichocarpum*.[17]

Other class of compounds that have been isolated from the genus *Ormocarpum* include; Diterpenoid; phytol 22, aliphatic hydrocarbons; 2-methylhexacosane 23, nonacosane 24, dotriacontane 25, tetracontane 26, sesquiterpenoid; t-cadinol 27,[16] from *O. trichocarpum*, triterpenoid; 3-*O*-acetyloleanoic acid 28, from *O. sennoides* subsp. *zanzibaricum*[1] Erythrinasinate 29 from *O. kirkii*[6] and an oxylipin 9Z,12Z-2,3dihydroxypropyl-11-hydroxyoctadeca-9,12-dienoate (30) from *O. kirkii*.[7]



CONCLUSION

This review is a summary of the phytoconstituents of the plants of the genus *Ormocarpum*, their pharmacological properties as well as the ethno medicinal uses. The phytochemical and pharmacological studies of plants in this genus have validated their traditional uses. The isolated extracts and compounds have been subjected to various pharmacological studies confirming their antibacterial activity, cytotoxicity activity, antifungal activity, antiplasmodial activity, antimalarial activity and antioxidant activity. Whereas this genus comprises of approximately 25 species, only a few species have been chemically investigated. The authors conclude that, plants in the genus *Ormocarpum* play an important role in the medicinal world. Thus, further studies should be carried out with the intention of documentation of the ethno medicinal uses, isolation of compounds and validation of the pharmacological activities.

Pharmacological investigation of the genus *Ormorcapum*.

Pharmacological properties	Ormorcapum species	Part used	Activity	Reference
Antiplasmodial activity	*Ormocarpum kirkii* S. Moore	Root	Crude extract of the root of *Ormocarpum kirkii* showed an IC_{50} of 15.6–31.2 µg/ml against *Plasmodium falciparum*.	[1]
Antifungal activity	*Ormocarpum kirkii* S. Moore	Bark	Ethanol bark extract showed inhibitory activity against resistant *Saccharomyces cerevisiae*	[7]
Cytotoxicity	*Ormocarpum kirkii* S. Moore	Stem Bark	Pure compounds displayed IC_{50} values below 20 µM towards CCRF-CEM and CEM/ADR5000 leukemia cells	[6]
Antibacterial activity	*Ormocarpum kirkii* S. Moore	Stem Bark	showed antibacterial activity against selected bacterial strains both gram positive and gram negative MRSA, *B. cereus E. coli, P. aeruginosa*	[6]
Antimalarial activity	*Ormocarpum kirkii* S. Moore	Roots	Showed antimalarial activity against *Plasmodium falciparum*	[8]
Antioxidant	*Ormocarpum cochinchinense* (Lour.)Merr)	Leaf	Fractions collected from column showed good antioxidant property up to a level of 73.4%	[37]
Antibacterial activity	*Ormocarpum cochinchinense* (Lour.)Merr)	Leaf	Acetone extract showed good activity against *E. coli*, *K. pneumonia*. The methanol extract showed activity against MRSA and *E. coli*	[38]
Antioxidant	*Ormocarpum sennoides* (Willd.) DC	Leaf	Ethanol extract showed high antioxidant activity in the range 1.2431 µl to 3.4939 µl	[20]
Antimicrobial	*Ormocarpum trichocarpum* (Taub.) Engl	Stem root	Stem aqueous extract and root ethyl acetate extract exhibited antimicrobial activity against all tested microbes with MIC range of 0.781-3.125 mg/mL and 0.097-0.781mg/mL respectively	[16]
Antiplasmodial Activity	*Ormocarpum trichocarpum* (Taub.) Engl		Compounds showed activity against malaria parasite *P. falciparum* strain D10 with negligible or no toxicity.	[17]
Antibacterial activity	*Ormocarpum trichocarpum* (Taub.) Engl		Compounds displayed activity against both gram positive and gram-negative bacteria	[17]

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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