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Nutritional and Medicinal Value of Asian Weaver Ant, *Oecophylla smaragdina*: A Review

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Abstract: The Asian weaver ant, *Oecophylla smaragdina* is known for its nutritional and medicinal value. This ant belongs to the family Formicidae and commonly found in Asia and Australia. It is a social insect whose colony consist of drone, queen and workers. The worker ants and the eggs are often used as food by different communities and for therapeutic purposes. It has been regarded that by consuming this insect can reduce the malnutrition diseases as it contains abundant number of nutrients (minerals and vitamins) and a number of bioactive compounds (flavonoids, phenolics). Different tribal people consume it by preparing different dishes (chutney, fries, baked ant eggs) and some used to take it in raw form also. Different study reported that the weaver ant is also having different therapeutic properties like anti-arthritic, anti-oxidant, anti- malarial and ant-microbial property.

Keywords: Asian weaver ant, *Oecophylla smaragdina*, Malnutrition, Therapeutic, Bioactive compounds, Nutrients, Anti-malarial

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Introduction

Human beings are the most advanced and powerful creatures on earth which have the capability to rule over other creatures present on this earth. There is no any other biological species present that have more power than humans. Like other creatures human also need their basic necessities. Healthy food is one of the basic necessity that one needs to survive. A healthy diet includes foods that have both the nutritional and medicinal properties. One such food is edible

insects. Edible insects have been proposed as a store house of proteins, amino acids, carbohydrates specially chitin, fibre, fatty acids and micronutrients (Zielinski and Pankiewicz, 2023). The term entomophagy is used to refer to humans that consumes insects as food. Over 1900 species of insects belonging to different orders have been recorded worldwide to be part of human diet (Bernard and Womeni, 2017). It has been suggested that edible insects are the best source of

protein comprising between 30% and 50% of total dry matter (Dobermann *et al.*, 2017) and it could be the most favourable substitute of animal protein and cereal protein also as its amino acid composition are so good (Siddaraju and Negi, 2022). Due to its environment friendly nature, rapid growth rate, less requirement of food and water for survival it is most important for both nutritional and medicinal properties. Entomophagy has demonstrated for having interesting impact on the human health (Tuhumury, 2021). Over 303 species of edible insects are consumed by the tribal communities in 10 states of India (Meenakshi, 2019). One such edible insect which have both the nutritional and health benefits is red weaver ant, *Oecophylla smaragdina*. It belongs to the family Formicidae. It is used as a folk remedy for the treatment of different diseases as it contains a number of potent bioactive compounds (Table 1). Along with the therapeutic effects, it also have enormous nutritional benefits. Especially the eggs of the weaver ant is having a good nutritional value which contribute for the improvement of human health (Punchongmart *et al.*, 2014). Weaver ant eggs and larva are consumed by different tribal people to cure the health problems. The Khasi and Hrangkhols tribes of Dima Hasao district consume the eggs to get rid of cough and cold and it has also been regarded as a beneficial insect to treat the malaria disease (Sabina *et al.*, 2017). The method of preparation varies among different tribes, some used to fried in mustard oil, some baked the eggs and larva by wrapping it with banana leaves whereas Some used to make chutney of the adult ants along with chilli, vegetables, dry fish (Sabina *et al.*, 2017; Jena *et al.*, 2020).

Along with its nutritional and medicinal value, this ant has also got ecological significance mainly as a biocontrol agent (Mele, 2008). It has been revealed that the weaver ant is a potent biocontrol agent which has the ability to reduce pest damage, thus enhance the crop yield around the world (Offenberg, 2015; Thurman *et al.*, 2019). Moreover it has been observed that weaver ants also act as a bioindicator of rainfall and it has been revealed

that number of nest is directly proportional to rainfall (Bagchi, 2015).

Systematic position and Taxonomical description:

Oecophylla smaragdina, red weaver ants are insects belonging to order Hymenoptera and family Formicidae (Fabricius, 1775; Smith, 1860). It is a social ant whose colony consist of prolific and non-prolific castes. The drone (male) and queen (female) belongs to the prolific caste whereas the workers belongs to the non-prolific caste (Barsagade *et al.*, 2020).

It has been reported that red weaver ant workers show a clear size differences which can be distributed into two groups. These groups of workers show division of labour regarding maintaining the colony. The bigger ones are known as major workers which are 8-10 mm in length approximately and the smaller ones are known as minor workers which are half the length of the major workers i.e. 4-5 mm (Weber, 1946; Wilson and Taylor, 1964). Major workers perform different roles like -- to guard the colony to keep safe by resisting attack, forage, defend and overall maintain the colony. The minor workers resides within the nest and takes care of the broods (Holldobler and Wilson, 1983).

The adults of this weaver ant vary in color from reddish to brown. The larvae are transparent, whitish creamy in colour (look like maggots). The adult ants have segmented antennae with 2 segmented clubs. Their eyes are comparatively much larger than other species of ants . The adults bites to defend themselves and secretes a chemical from their abdomen which gives a painful sensation. They do not possess stingers (Sabina *et al.*, 2017).

Distribution:

The weaver ant is widely distributed in tropical Asia and Australia and the Western Pacific (Latreille, 1802). They are regarded as an important part of an ecosystem providing ecosystem services to tropical tree crops by controlling huge diversity of natural pest (Thurman *et al.*, 2019). They have the potentiality

to construct their nest in a creative manner with hundreds of fresh leaves weaving together and glued them using silk (Bharti and Silla, 2011). The interesting fact about the weaver ant is that the larva only produce and secretes silk. So to weave a nest the worker ants holds the larva in their jaw and glued the leaves to construct the same (Sabina *et al.*, 2017). It has been revealed that certain environmental factors such as temperature and wind intensity affects the arrangement of the nest along with the morphology of tree and leaf (Castelino and Roopavathy, 2018).

Nutritional analysis:

Weaver ant adult, the larva or the egg are the source of different nutrients and bioactive compounds. Specially they are regarded as the store house of proteins, where the value of protein vary slightly from place to place (Megu *et al.*, 2019). It has been reported that protein content of adult and larval form was found to be much higher than that of the protein content in cow milk or soy milk (data obtained from USDA database). Megu *et al.* (2019) reported the crude protein content of *O. smaragdina* from different altitudinal region, in adult the highest amount is found to be 57.05% and lowest is 52.99%. In larva, the highest amount of crude protein content is 47.91% and lowest is 43.49%. It has also been estimated that by consuming 100 g of weaver ant on a daily basis will be a promising source for protein, which can be up to 108.37% for men. Thereby it can prevent from protein malnutrition diseases (Megu *et al.*, 2018). Another result documented that the larva and pupa of weaver ants are a potential source of peptides which have shown to possess biological activities. It has also been revealed that the protein and lipid content of the mixed pupa and larva of weaver ant is about 53% and 13%, respectively (Pattarayingsakul *et al.*, 2017). Another study reported that 100 g of weaver eggs contain nutrients parameters like moisture 77.7%, total solid 22.3%, ash 1.3%, fatty acid 3.1%, calcium 0.0031%, potassium 0.002%, iron 0.0033% and 0.0023% of zinc (Punchongmart *et al.*, 2014). For instance, weaver

ant larva and eggs provide around 7 g of proteins per 100 g of the body weight. The mineral, protein and fat content of weaver ant has also been reported where all minerals are in mg/100 g dry matter. The data provided are- calcium 63.85, potassium 749, magnesium 96.05, phosphorus 726.5, sodium 225, iron 65.4, zinc 13.5, manganese 7.68 and copper 1.52. Along with this protein and fat content is documented as 53.46% and 13.46% respectively (Rumpold and Schluter, 2013).

The weaver ant is also reported to be a good source of bioactive compounds which have different ethnoentomological values for human health. An evident shows that both the adult and brood of the ant contains some of the bioactive compounds such as flavonoids and phenolics for which this ant is regarded to serve as the dietary supplements for handling oxidative stress (Raza *et al.*, 2022). In an analytical study of gland extracts of three types of workers showed the presence of abundant compounds which are having different pharmacological effects. Compounds like alkanes, alkenes, aldehydes, ketones, esters and their derivatives are reported to have anti-bacterial, anti-fungal, anti-feedant and insect repellent activities (Senthikumar *et al.*, 2012). Phenolic compounds, esters, alkanes, aldehydes, alkenes and ketones are reported of having anti-inflammatory, anti-arthritic, anti-diabetic, anti-ulcer, hypolipidemic, anti-atherosclerotic, anti-HIV and cytotoxic activities (Safayhi and Sailer, 1997).

Vadakkepurakkal *et al.* (2015) reported that in the forest of Wayanadu and Kasaragod districts of Kerala, India, the tribal people used the weaver ant as food (use the crushed body of worker ants to make sauce) and medicine. It has been reported that the adult worker ants are rich in formic acid whereas the brood of the weaver ant has no traces of formic acid but they possess all the essential amino acid (tryptophan, leucine, threonine, methionine and lysine in high amount) and high content of carbohydrate. Moreover, the brood of the weaver ant are also rich in retinol, tocopherol, ascorbic acid, thiamine, niacin and riboflavin.

Among the minerals sodium, phosphorus, calcium and magnesium are found in higher concentration. This tribes used medicated oil prepared from crushed worker ant to treat joint pain, inflammation of joints and for different skin infections. Whole body worker ant is also reported to have anti-oxidant and anti-arthritis property. The abdominal gland secretion shows the anti-microbial activity against six bacterial and fungal strain. GC-MS analysis of abdominal glands revealed the presence of 39 chemical compounds having pharmacological activities.

Traditional value of Oecophyla smaragdina:

Oecophyla smaragdina is used as a potent insect to treat different ailments. It can be regarded as traditional healer for different diseases like common cold, cough, jaundice etc. Different study has revealed the traditional use and ethno-entomological value of red ant. The mode of preparation is different to treat different diseases.

Jena *et al.* (2020) conducted a study among the different tribes of Mayurbhanj district of Odisha, India and reported about the different mode of preparation of weaver ant. The whole body and legs are crushed and make aqueous form which is then feed to children and adults to treat common cold and cough. Some local tribes crushed the freshly collected ants and allow it to inhale for several times. It has been also reported that the red ant is known to be as an acidizing agent by some tribes of Mayurbhanj district and also regarded to be a good appetizer. The brood of the red ant are crushed and make aqueous extract which is then consumed stop the tendency of vomiting. An interesting fact has been revealed by the people of Rairangpur area that they used to use hundreds of soldier ant to treat the jaundice disease in which the soldier ants are placed in the skin surface of the patient and allowed them to bite the patient. This comes out to be an effective medicine for jaundice and results can be seen within a week.

Raza *et al.* (2022) regarded weaver ant to be a potential source of antioxidant. In a study, by

using different standards methods it has been revealed that the brood content and the adult weaver ant contains some important bioactive compounds like flavonoids, phenolics which play important role against different disease caused by oxidative stress. It has been reported that weaver adult ants have higher content of flavonoids than its brood but the brood of weaver ant contains more amount of phenolics as compared to weaver ant adult. It has been advocated that the weaver ant can be recommended as a natural antioxidant which have the potentiality to provide protection against oxidation by interfering in enzyme activity. It has been reported that mostly the weaver ants are consumed in the raw or fresh form by different local tribes. Therefore it is evident that compounds responsible for antioxidant capacity are consumed without any loss of its activity.

It has also been revealed that tribal people prepare a medicinal oil from the weaver ant. The weaver ants are dipped in mustard oil and are stored for about 40 days. After that this oil is used as baby oil and can be applied externally to cure rheumatism, gout, ringworm and other different skin diseases (Oudhia, 2002). The tribes of Mayurbhanj have been found to consume weaver ant in the form of soup or chutney, popularly known as Kai chutney to get rid of different diseases like flu, common cold, whooping cough. It has also been found that after consumption of the weaver ant for a weeks enhances the vision and eyesight naturally (Sabina *et al.*, 2017).

Therapeutic use:

(i) *Anti-arthritis property:* Vidhu and Evans (2015) reported that the abdominal gland extract of the weaver ant possess significant anti-inflammatory potential. It has been revealed that ethanolic extract of the weaver ant contains some of the potent bioactive compounds one of which is 7,10-octadecadienoic acid methylester, which is reported to exhibit anti-arthritis property (Balamurugan and Nataranjan, 2018; Lee *et al.*, 2018; Zayed *et al.*, 2019). This compound is also reported to have inhibitory activity against the inflammatory cytokines like tumour necrosis

Table 1: Bioactive compounds present in weaver ant and their use for treatment

Species name	Bioactive compounds/nutrients	Parts used	Preparation	For treatment	Reference
<i>Oecophylla smaragdina</i> (weaver ant)	—	egg	Aqueous extract of egg is feed to baby	Common cold	Jena <i>et al.</i> (2020)
	—	egg	Crushed egg is inhaled	Cold and cough	Jena <i>et al.</i> (2020)
	—	Whole body of worker ant	Aqueous solution is prepared	Vomiting, whooping cough, enteric gas problem.	Jena <i>et al.</i> (2020)
	—	Whole body	The whole body along with the eggs are crushed with chilli, salt and make a paste called chutney	Increases hungriness	Jena <i>et al.</i> (2020)
	Formic acid	Eggs	Fried or baked	Fight against bacteria in human digestive system	Jena <i>et al.</i> (2020)
	Zinc, calcium, proteins	Whole body	Chutney	Boost up immune system	Jena <i>et al.</i> (2020)
	Zinc, selenium	Whole body	Fried in mustard oil	Infection	Jena <i>et al.</i> (2020)
	Polyphenols	Whole body	Fried	Anti-inflammatory properties that alleviate conditions like arthritis asthma	
	Zinc, tryptophan	Whole body	Baked or fried	Help to improve mood and reduce symptoms of depressions and anxiety	
	7,10-octadecadienoic acid methylester	Whole body	Ethanollic extract	Anti-arthritic property	Balamurugan and Nataranjan (2018), Lee <i>et al.</i> (2018), Zayed <i>et al.</i> (2019)
	2,5-dipropyl decahydroquinoline, 1-butamine, 3-methyl-N-(3-methyl butylidene) dodecanoic acid and n-nonadecanoic acid	Whole body	Ethanollic extract	Anti-microbial property	Sarova <i>et al.</i> (2011)
	2,4-DTBP	venom	GC-MS analysis	Anti-malarial property	Das <i>et al.</i> (2019)
	Dodecanoic acid	Whole body	Ethanolica extract	Anti-oxidant property	Balak (2015), Nataranjan <i>et al.</i> (2019)

factor-alpha (TNF- α), interleukin-6 (IL-6), inducible nitric oxide synthase (iNOS) and cyclooxygenase 2 (COX-2) (Xia *et al.*, 2018).

(ii) Anti – microbial property: A study reported that the abdominal extract of weaver ant is having anti-bacterial and anti-fungal activity against different variety of microorganisms like *E. coli*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus niger*, *Klebsiella pneumonia* (Vidhu and Evans, 2015). Ethanolic extract of weaver ant contains compounds that possess potential anti-microbial activity such as 2,5-dipropyl decahydroquinoline, 1-butamine, 3-methyl-N-(3-methyl butylidene) dodecanoic acid and n-nonadecanol (Sarova *et al.*, 2011). Some studies revealed that both tissue and protein extracts of the weaver ant larvae produce some biomolecules which act as a potent bio-facilitator for developing silver nanoparticles (AgNPs) which have potential activity against microbes like *E. coli* and *S. aureus*, thus can be used as an effective anti-bacterial agent (Khamhaengpol and Siri, 2016).

(iii) Anti-malarial property: A study has been made using GC-MS (Gas chromatography mass spectrometry) analysis of weaver ant venom and reported the presence of a potent neurotoxin 2,4-bis (1,1 dimethyl) phenol or 2,4 –DTBP (Das *et al.*, 2019). This potent bioactive compound is reported for having anti-malarial activity which have the potentiality for inhibiting nAChRs (Neuronal nicotinic acetylcholine receptors) of muscles of humans (Gisselman *et al.*, 2018).

(iv) Anti-oxidant property: The gas chromatography-mass spectrometry analysis (GC-MS) of ethanolic extract of weaver ant has revealed the presence of dodecanoic acid which is known for its antioxidant, anti-bacterial, anti-viral and hypocholesterolemic activities along with fumaric acid, 2-dimethylaminoethyl heptyl ester, that is used in the treatment of psoriasis (Balak, 2015; Nataranjan *et al.*, 2019).

Conclusion

Weaver ant is a good choice food having both nutritional and medicinal properties. Among the

different tribes, it is very much popular due to its medicinal value. Traditionally, it is used to treat different ailments by taking it orally and some used to prepare oil to treat joint pain, inflammation etc. This ant species is thus help the traditional healers in making different medicated substances for different diseases. There is not much information available regarding its nutritional value of weaver ant and its brood or eggs. However more nutritional as well as medicinal information is required so that it can be used as a good supply of nutrients which can benefit the mankind to a great extent.

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