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Termites (*Microtermes Obesi*: Termitidae) and Their Nutritional Role with Special Reference to Assam

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Abstract: ***Termites are usually the most dominant arthropods in tropical forest habitat. Microtermes obesi (termite) is a small species of termite of the genus Microtermes. It is native to India, Sri Lanka, Pakistan and Vietnam. It is a major pest of wheat and minor pest of sugarcane. Termites are usually roasted and eaten as food, mostly during the rainy season. Termites (Order: Isoptera) considered as serious pests of agricultural, horticultural and plantation crops including forest trees. The habit of eating termites and its eggs among the ethnic tribes in Assam minimises the use of pesticides on crops to kill termites and its eggs and larvae. Bio-chemical composition showed that various forms of Microtermes obesi contain protein, lipid and considerable amount of carbohydrate. These species of termite 'Microtermes obesi' have high amount of indispensible mineral elements. The protein content of the worker termites was higher than those of larvae, Queen and workers. Calcium is the highest amount of mineral element found in workers of termites. The queen, solders and larvae of termites have also large amount of calcium. Meanwhile, all the forms of termites found more amounts of important mineral contents such as magnesium, zinc and iron.***

Keywords: Arthropods, Calcium, Indispensible, Isoptera, Larvae, Microtermes, Native

1. Introduction

Insects are used as a traditional food in many parts of the world and are highly nutritious especially rich in proteins. The ethnic people of India also consume insects as food. A review on the practices of entomophagy in India revealed that about 255 species of insects are taken as food by different tribes of India. The practice of entomophagy is quite common among the ethnic people of North East India particularly among the tribes of Arunachal Pradesh, Assam, Manipur and Nagaland and to a lesser extent by the tribes of Meghalaya and Mizoram (Chakravorty, J. ,2014).Termites are a group of eusocial insects found on all continents except Antarctica (Govorushko, 2018). A total of 3,106 species of termites have been described so far by different workers worldwide under 12 families (Krishna et al., 2013). There are about 435 species of termites in Asia (Krishna et al., 2013). Among all the known species of termites, 300 are considered to be pests (Kumari et al., 2013). 43 termite species are used as food by humans or are fed to livestock (de Figueirêdo, R. E. C. R.,et al, 2015).These insects are particularly important in impoverished countries where malnutrition is common, as the protein from termites can help improve the human diet. Termites are consumed in many regions globally, but this practice has only become popular in developed nations in recent years (de Figueirêdo, R. E. C. R.,et al, 2015). Termites are consumed by people in many different cultures around the world. In many parts of Africa, the alates are an important factor in the diets of native populations (Nyakupfuka, A., 2013). Termites are typically eaten when livestock is lean and tribal crops have not yet developed or produced any food, or if food stocks from a previous growing season are limited (Nyakupfuka, A., 2013).

Insects have played an important role in the history of human nutrition. Termites are good sources of protein, fat content and many important minerals and vitamins (Banjo et al., 2006). Ants and termites are used as food for non-human primates such as wild chimpanzees, Japanese monkeys and baboons (Suzuki, 1966). Termites are eaten in several parts of Nigeria and it is also used for rituals and medicinal purposes. In India termites and even its termitaria have medicinal usages (Ntukuyoh, et al, 2012) as termites based medicinal companies are established. In East Africa, termite mounds are considered so important that they are owned by individual and form part of his inheritance when he dies (Bristowo, 1953). In addition to their ecological importance, termites are a source of medicinal and food resources to various human populations in various locations of the world , showing their potential for being used as an alternative protein source in human or livestock diets , as well as a source for new medicines. Termites are the most dominant arthropod decomposers in the tropical forests and show high diversity and abundance. The areas of higher altitudes and extreme temperatures have restricted the distribution of termite fauna in India. The species richness is more in the north-eastern regions, compared to rest of India.

Termites cause extensive damage to agricultural and horticultural crops, books and papers, wooden material, buildings and stored products containing cellulose (Rasmi and Sundararaj, 2012). Globally, the estimated loss due to termite damage is about 50 billion US$ annually (Subekti et al. 2015). Pardeshi et al. 2010) observed that *Odontotermes obesus* acted as pest to all crops irrespective of the plant stages. Microtermes obesi is a serious pest of sugarcane (58%) particularly at seedling stage as well as wheat (37%) and cotton (6%) (Paul et al.2018).digging deep trenches around the tree nurseries help to protect the saplings from workers of *Macrotermes sp*. which will not be able to construct galleries (Beeson, 1941). The species of insects play both negative and positive roles in the lives of humans or other lives. They may destroy our crops as pests and

transmit diseases to man as vectors and some insects might be harmful to crops and other vegetables. Termites are primary consumers; they promote the mineralization of nutrients rich in cellulose (Cunha and Orlando 2011). They are most dominant arthropod decomposers in the tropical forests (Collins 1983) and show high diversity and abundance (Bignell and Eggleton 2000).

Park and Shin (2005) observed that garlic oil was more toxic against Japanese termites. Doolittle et al (2007) reported that the number microbes present in the hind gut of *C. formosanus was reduced by treatment of neem extracts, capsaicin and gleditchia.*neem extracts significantly reduce the population of termites leading to 100% mortality among termites. Verma(2006) studied termiticidal effect of 5 % chloroform extract of Lantana camara var aculeate L. leaves. Similarly Ganapaty et al (2004) isolated plumbagin sodiospyrin and microphyllone from the roots of Diospyros sylvatica L. and found them to be toxic against *O. obesus.* Thus the continued interest in search of greener pesticide led to the evaluation of different plants products all over the world. Workers around the globe are reporting activities of new compounds isolated from various plant parts.

Chemical insecticides are banned in most of the countries due to their long persistence in soil. In India, the most commonly used insecticide of termite management is chloropyrifos. This pesticide is really harmful to human and other living beings. The habit of eating insects can minimize the pesticidal problems and can make cleanliness of environment.

2. Materials and Methods

2.1 Study Area

The state of **Assam** is comprised of three physical divisions, namely, the Brahmaputra Valley, the Barak Valley and the Hill ranges. The total geographical area of the study area is 78, 438 square kilometres. Assam is bounded by Bhutan and Arunachal Pradesh to the north; Nagaland and Manipur to the east; Meghalaya, Tripura, Mizoram and Bangladesh to the south; and West Bengal to the west.

The study area is extending from 89° 42′ E to 96° E longitude and 24° 8′ N to 28° 2′ N latitude. Assam is a temperate region and experiences heavy rainfall and humidity. Winter lasts from late October to late February. The minimum temperature is 6 to 8 degrees Celsius (43–46 °F) and the maximum temperature is 35 to 38 degrees Celsius (95–100 °F).

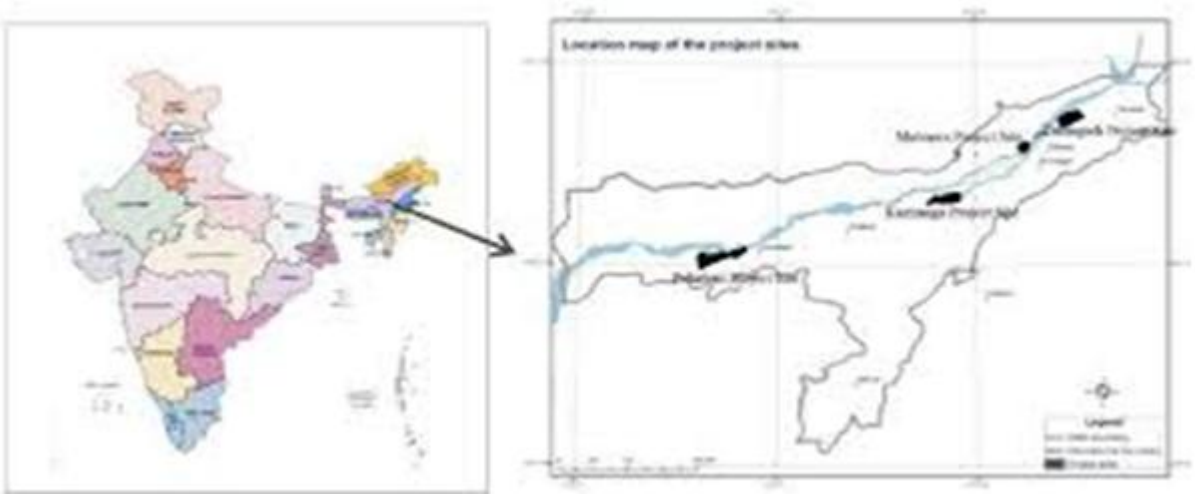

Figure 1: Map of study area (Assam), India

2.2 Sampling

The different stages of termites of the species *Microtermes obesi* were collected by digging soil with the help of spade. When they came out, then they were brushed off into plastic containers. Some termite samples were collected by water traps, digging and handpicked. The collected specimen was identified with valid taxonomic key by entomology specialists, Department of Zoology, Barama College, Barama, Assam. . The adult termite samples (worker termites) and a few larvae were properly labeled and placed in refrigerator for bio- chemical analysis.

2.3 Bio-chemical Analysis

The both adult forms such as winter, soldier, queen and larvae of termite sample were chemically analyzed according to official methods of analysis recommended by the Association of Official and Analytical Chemist (AOAC, 1990). The soluble protein, lipid and carbohydrate contents present inedible insectsis expressed in mg per gm in fresh weight. The protein content of the edible insects were estimated following the method of Lowry *et al*., (1951) method using bovine serum albumin as a standard protein. The carbohydrate was done by following anthrone method (Sadasivam and Manickam, 2008). The total lipid was estimated using chloroform-methanol method described by Folch *et al*., (1957). The result of macronutrient content has been expressed as mg /100gm of fresh weight tissue material.

The mineral elements were also determined by using a Perkin Elmer 3280 Atomic Absorption Spectrophotometer (AAS). All the value of the micronutrients of the sample was recorded in ppm (parts per million) and calculated. The

calculated values in AAS were converted into mg/100 g sample using the following formula.

µg/gm of sample= (AAS reading x volume taken)/wt. of sample

(i.e. 1 ppm = 0.001 mg/g)

3. Result and Discussion

On biochemical analysis, following macronutrients were found in the four forms of *Microtermes obesi* which are tabulated in the table-1.

Table 1: Macronutrient contents of *Microtermes obesi* (in mg/100g fresh weight)

Sample	Protein content (mg)			Lipid content (mg)			Carbohydrate content (mg)		
	Mean		SD	Mean		SD	Mean		SD
Microtermes obesi (worker)	216.33 ^{hi}	±	2.52	133.00 ^{f}	±	7.21	29.00 ^{c}	±	3.61
Microtermes obesi (soldier)	145.67 ^{cd}	±	7.09	186.33 ^{g}	±	7.64	45.35 ^{fg}	±	5.78
Microtermes obesi(queen)	169.00 ^{e}	±	7.94	65.00 ^{de}	±	4.36	58.00 ^{ij}	±	3.46
Microtermes obesi (larvae)	198.00 ^{fg}	±	8.54	69.00 ^{de}	±	4.36	53.00 ^{hi}	±	2.65

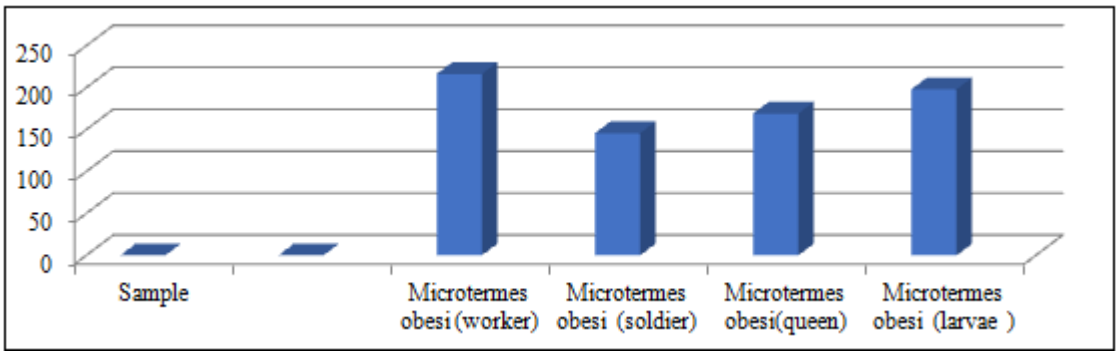

Figure 2: Bar diagram of Protein (mg/100g)

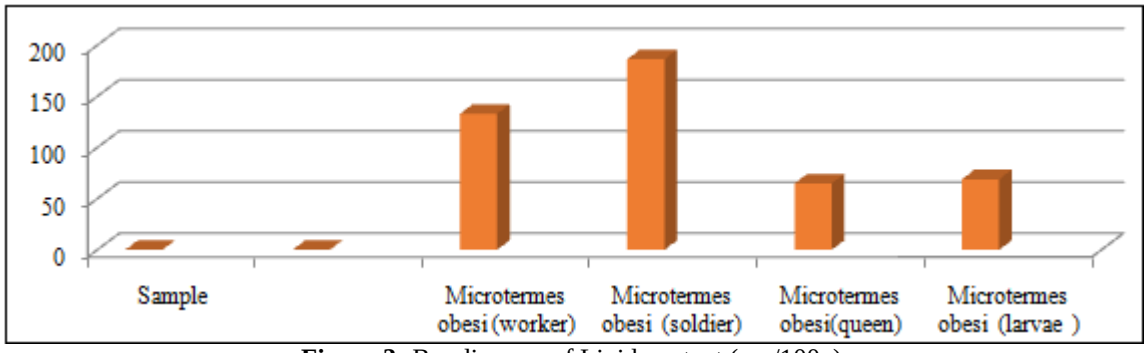

Figure 3: Bar diagram of Lipid content (mg/100g)

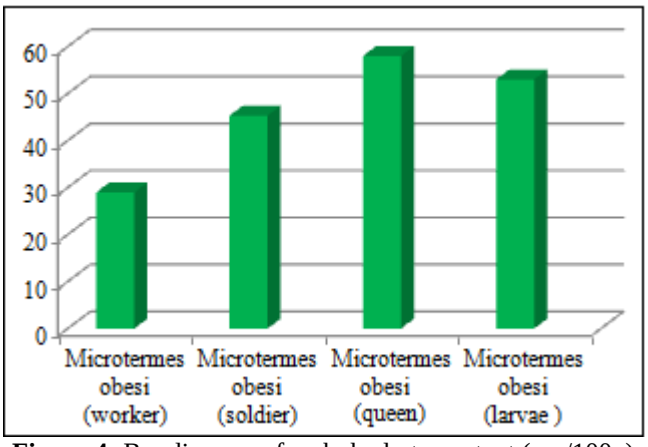

Figure 4: Bar diagram of carbohydrate content (mg/100g)

Table-2 shows some important mineral content in mg/100g fresh weight using a Perkin Elmer 3280 Atomic Absorption Spectrophotometer.

Table 2: The values of mineral elements in mg/100g fresh weight amount

Name of insects	Cu mg/100g	Fe mg/100g	Ni mg/100g	Cr mg/100g	Zn mg/100g	Cd mg/100g	Pb mg/100g	Mn mg/100g	Ca mg/100g	Mg mg/100g
Microtermes obesi (Worker)	0.217	9.582	0.100	0.106	14.113	0.002	0.000	0.304	69.520	5.905
Microtermes obesi (soldier)	0.870	13.924	0.009	1.228	14.568	0.132	0.000	1.922	22.223	13.432
Microtermes obesi(queen)	0.837	12.935	0.022	0.028	12.675	0.000	0.002	1.428	28.337	16.505
Microtermes obesi(larvae)	0.078	16.060	3.0100	2.0680	1.6970	0.000	0.000	1.2710	21.570	3.531

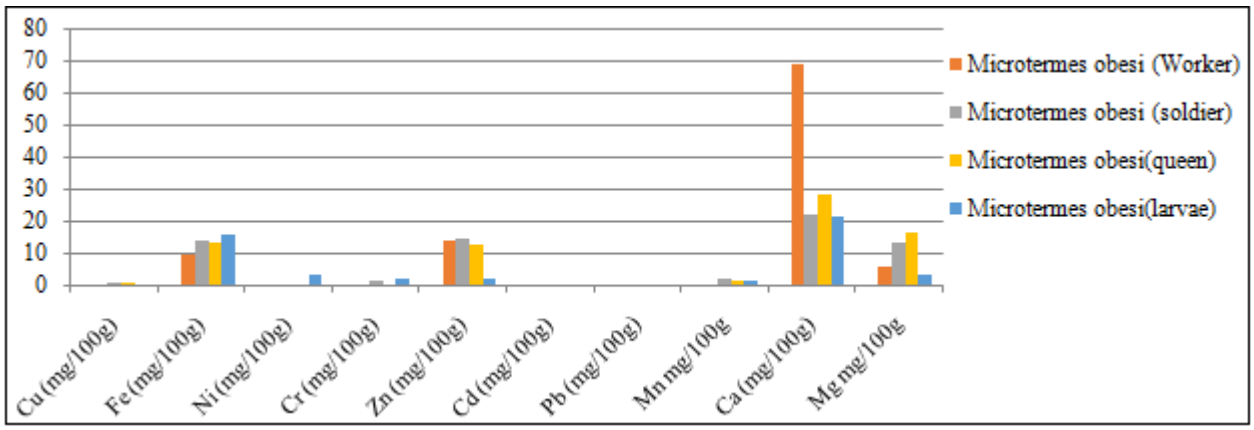

Figure 5: Mineral content (mg/100g) of diierent stages in *Microtermes obesi*.

All the stages of *Microtermes obesi*, was found to infest seedling and maturing stages. Sugarcane provides maximum shade and is more susceptible to termite attack. Shade provided by sugarcane plantation, high sugar content and faster growth rate are some of the major reasons for the preference of this crop by a wide variety of termites. *Microtermes obesi* damages both young and maturing stage wheat plants. *Micrtermes obesi* damages cotton crops. *M. obesi* destroys the entire crops at maturing stage by making tunnel through their roots. Termites are eaten in several parts of Nigeria and it is also used for rituals and medicinal purposes. In India termites and even its 'termitaria' have medicinal usages (Angady, 2007) as termites based medicinal companies are established.

The proximate composition showed that crude protein content of the soldiers was higher than those of workers and Queen. The highest mineral element was sodium in queen, while the least mineral was manganese in the soldiers of termites (Ntukuyoh, A. I. et.al, 2012). The termites were rich in vitamins A and C. Workers termites had the highest vitamin C content, while Queen termites had the highest vitamin A content (tukuyoh, A. I. et.al, 2012). The present biochemical estimation of termites in Assam, India shows highest protein content (21.633 mg/ml). The *Microtermes obesi* (soldier) shows highest amount of lipid content18.633 mg/ml compared to larvae of *Microtermes obesi*.

The solders of Syntermes constitute a food source of great nutritional value: high in proteins and essential amino acids such as trytophan, which is generally limiting in the food insects. Abundant are minerals such as iron and calcium together with micronutrients. Researchers have suggested that termites are suitable for human consumption as they are high in protein and can be used to convert inedible waste to consumable products for humans (Katayama, N. et.al., 2008).Termites can be beneficial to agriculture, such as by boosting crop yields and enriching the soil. Termites and ants can re-colonise untilled land that contains crop stubble, which colonies use for nourishment when they establish their nests. The presence of nests in fields enables larger amounts of rainwater to soak into the ground and increases the amount of nitrogen in the soil, both essential for the growth of crops (Evans, T.A. et al, 2011). The protein contents of *Microtermes obesi are* more in larve than soldiers and queens of Microtermes.The larvae of *Microtermes obesi* are more iron than soldiers, workers and queens. The workers of termites possess more calcium compared to queen, soldier and larvae respectively. However , it is experimentally found that termites (Microtermes obesi) are rich in calcium, magnesium and iron compared to many livestocks.

4. Conclusion

The present study reveals that termites (*Microtermes obesi*) have high macronutrients and essential mineral contents. The result of this study confirms the fact that termites are indeed a good source of protein, lipid and moderate amount of carbohydrate contents. In addition to it, termites and their larvae are very rich in some essential mineral contents needed for human and other animals. As it is easily available in rural areas in Assam, so the consumption of termites should be encouraged considering their pesticidal causes on crops, other vegetable and domestic materials.

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