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Research article

Protein composition of Oecophylla smaragdina (Hymenoptera: Formicidae) based on altitudinal variation from Arunachal Pradesh, India.

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Abstract: The crude protein content of weaver ant- Oecophylla smaragdina (Hymenoptera: Formicidae), used as food among some tribal from different places of Arunachal Pradesh was analyzed. The amount of crude protein found in both the adult and larva of O.smaragdina from different attitudes was quite appreciable. In both adult and larva, the highest amount was found in Namsai (Adult- 57.05%; Larva- 52.99%) followed by the lowest in Changlang (Ault- 52.99%; Larva-43.49%). Compared with conventional animal meats and easily available foods we found that this insect can be an alternative source of nutrition as they contain a comparable or higher amount of protein. Farming of this insect will be a great substitute for food for the local people of remote villages.

Keywords: Entomophagy, Food source, Namsai, Oecophylla smaragdina, Protein,

Introduction

Insect as sources of Food:

The practice of eating insects as food (entomophagy) is an age-old practice of humankind. Entomophagy emphasizes a commitment to mitigate the shortage of nutrition which is fundamental to health around the world. According to Bodenheimer (1951), insects played an important part in the history of human nutrition in Africa, Asia, and Latin America. Insects ensure high potentiality to supply abundant macronutrients, micronutrients, and health-enhancing properties (Meyer Rochow, 2010, Chakravorty et al., 2011) that are enormously beneficial for health, especially for the poor and hungry people of tropical countries. Since the world's recent food crisis, international attention has been focused on the exploration of non-conventional food resources including insects. The priority of insects in this regard of proposing as an alternative sustainable food resource is already being reflected in several activities of the Food and Agriculture Organization (FAO) of the United Nation. With the rapid dwindling of natural forests and the explosion of the human population, the world (especially developing and underdeveloped countries) faces major problems of malnutrition. In a recent report by FAO (2009), it was estimated that 15% of the world's population is still undernourished. Therefore, it is agreed that there is a demand for alternatives food sources from surrounding biodiversity for the energy and nutritional needs of populations. The increasing pressure on macro-livestock farming and diversion of crops for

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other commercial activities bring food insecurity and less sustainability than ever before. Insects being of higher nutritive value than other conventional food resources can meet the global demand by their abundant nutrient supply as an alternative food provided its nutritional potential be proportionately tapped. In relevance to it, insects as an alternative sustainable food source have been studied by Ramos-Elorduy, 1997b; Paoletti *et al.*, 2000; Verkerk *et al.*, 2007; Meyer-Rochow 2010; Mitsuhashi 2010 and altogether of at least 1,900 species of edible insects are consumed worldwide (Mitsuhashi, 2008).

Local people and weaver ant in Arunachal Pradesh

Oecophylla smaragdina (Order- Hymenoptera, Family-Formicidae, common name- weaver ant. Local Name-Rukkung) has been known to consume throughout the year by people living in foothills and plain areas in Arunachal Pradesh (Chakravorty *et al.*, 2010), Assam, and other parts of India. In the immature stages egg, larvae, pupae, and little amount of adults are consumed in form of chutney, paste, frying with oil, as a part of the diet after mixing with other ingredients. In spite of the ferociousness of weaver ant, people prefer it for local consumption. The weaver ant is found throughout the year, so it is feasible to consume in all seasons. The detailed scientific study on the nutritional composition of this highly edible ant is an essential requirement and therefore, needs proper attention. In this regard, the work has been undertaken to study comparative aspects on the nutritional potential of *Oecophylla* species from different altitudes from Arunachal Pradesh.

MATERIALS AND METHODS

Sample Collection (Table 1)

Oecophylla smaragdina were collected from the different types of trees mostly from Rajiv Gandhi University campus, Rono hills, Papum-pare district of Arunachal Pradesh in different seasons of the year. For study based on altitude study the samples from other districts (Namsai, East Siang, Changlang) were collected during the same month (mostly during spring seasons) of the year for three years period consecutively. The weaver ants were collected from vegetation along the roadside and inside the dense jungle. The whole nest was collected because both the larva and adult were found on the nest. The young (larva and pupa) and an adult were manually separated. As soon as the collection was done, the samples were immediately taken back to the Biochemical Nutrition Laboratory, Rajiv Gandhi University in chilled freeze- boxes to avoid decay. Weaver ant was selected for the present study because it was reported most preferred by a previous study in my laboratory (Chakravorty *et al.*, 2011a; Chakravorty *et al.*, 2013), and also it is available all year round.

Table1: Sample collection sites showing coordinates and altitude (in feet).

Location/Districts	Coordinates		Altitude(in feet)
Papum-Pare	27°09′11.80"N	93°46′01.16"E	836
East Siang	28°03′42.96"N	95°19′33.47"E	605
Namsai	27°39′54.98"N	95°51′55.74"E	485
Changlang	27°07′52.07"N	95°44′04.03"E	1213

Sample Preparation:

The sampled insect, after they were brought to the laboratory, were thoroughly washed and then bottled dried. The dried samples were later oven-dried (500 C to 600 C), and for further analysis, they were ground to powder and stored in deep freeze (-200 C, NSW 152-L, Narang Scientific Works Pvt. Ltd., India). Care was taken to complete all the analyses within a month after collection. Analytical grade chemicals and solvents were used for the study and also meticulously clean glassware was used.

Crude Protein Analysis:

The standard procedure of AOAC (1990) was followed to estimate crude protein content. Nitrogen was determined by a micro-Kjeldahl method where the sample was digested with concentrated sulfuric acid (H_2SO_4) at 400^0 C for 2 hours (Kel Plus KES-04L, Pelican Equipments Pvt. Ltd., India) followed by distillation (Kel Plus Distyl-EM, Pelican Equipments Pvt. Ltd., India) and titration with 0.1 N Hydrochloric acid (HCl) and the total protein content was calculated as the amount of total N determined multiplying by the specific nitrogen-to-protein conversion factor of 6.25. Nitrogen content was calculated as follows:

$$\text{\% of nitrogen} = \frac{[14.01 \times (S - B) \times 0.1 \times 100]}{[W \times 1000]}$$

Where, S= 0.1N HCl required for titration of sample (mL)

B= 0.1N HCl required for titration of blank (mL)

W= weight of sample (g)

Result:

As shown in Table 2 the crude protein found in both the adult and larva of *O.smaragdina* from different attitudes is given. In the adult, the highest amount was found in Namsai (57.05%) followed by East Siang (56.81%), Papum Pare (55.15%), and the lowest in Changlang (52.99%). And in the larva also, it was highest in Namsai(47.91%), followed by Papum Pare (45.02%), East Siang (44.06), and lowest in Changlang (43.49%).

Table 2: Crude protein content (% of DM) of *O.smaragdina* from different altitudinal regions (Papum Pare, East Siang, Namsai and Changlang) (Mean ± SD)

Altitudinal region	**Crude Protein Content(%)**	
	Adult	Larva
Papum Pare	55.143 ±1.821	44.813 ± 2.036
East Siang	56.801 ± 1.602	45.013 ± 1.809
Namsai	57.037 ± 2.589	47.912 ± 2.899
Changlang	52.982 ± 1.633	43.482 ± 1.991

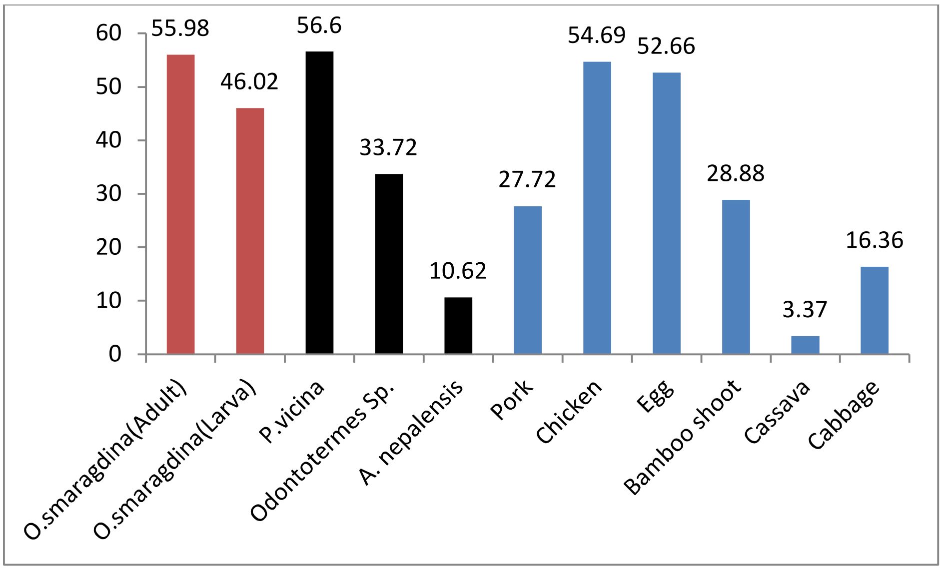

Fig 1: Comparison of protein content (%) of *O. smaragdina*(Adult and Larva) with other insects (Source: Shen et al, 2006, Chakravorty et al, 2011, 2016) and conventional food sources of both animal and plant origin obtained from USDA database: www.ndb.nal.usda.gov.

Discussion:

Proteins are the building block of life. It is made up of amino acids monomers and the basis of many important biomolecules such as enzymes, hormones, and hemoglobin. It is also an important component of cells of the immune system- antibodies as it sustains the immunity function of the body. Protein contributes to producing nitrogen for the maintenance and regulation of acid and alkali balance. It helps in the transformation of genetic information and transportation of important materials in the human body. As a nutritive element that produces heat, protein can supply energy. The common sources of protein are meat, poultry, egg fish, beans peas, etc. As per the report of Ramos-Elorduy and Pino, 1989; Mitsuhashi, 1992; DeFoliart, 1992; Yang, 1998; Banjo *et al.*, 2006 after assessment of nutrients content many edible insects are found to be rich in protein ranging from 20 to 70%.

This study revealed that, weaver ant (*O. smaragdina)*, in general, are rich in protein, though the values slightly vary from place to place. It was noted that the protein contents of the weaver ant (both adult and larva) fall in the range of reported protein values within and between other species of insects (Figure 1). It is very important to mention that protein values were found to vary from as low as about 6.25% to 27% to a high of about 65.62% to 81.69% for many studied species of insects belonging to the order Hemiptera, orthoptera, Hymenoptera, Isoptera and Coleoptera respectively which has been analyzed and described from all over of the world (de Conconi *et al.*, 1984; Banjo *et al.*, 2006; Bhulaidok*et al.*, 2010; Blasquez *et al.*, 2012). These variations in the protein content or nutrient content, in general, may partly be due to disparity in feeding habits, the difference in seasonal occurrence, dissimilarity of growth stages, and their adaptation in varied geographical locations. Bhulaidok *et al.* (2010) reported a significant difference in protein content of the same species of Chinese black ant *P. Vicinia* collected from two different geographical locations. The protein content of grasshopper *Zonoceros variegates* adult was reported to be 26.8% (Banjo *et al.*, 2006) whereas Adedire and Aiyesanmi (1999) reported for the same species to be at the value 50.39% and 53.1% for larva and adult respectively.

From the report of Dufour, 1987; de Conconi *et al.,* 1984; *cf.* Rastogi, 2011 the protein content, 45% in larva and 55% in adult of weaver ant were higher than the reported value of other ant species like *Atta sexdens*, *A. cephalotes*, *Liometopum apiculatum*, adult and reproductive stage of *L. luctuosum* and from the report of Ekpo *et al.*, 2009; Ramos-Elorduy, 1998 the protein content was equivalent to some coleopteran species like palm weevil *Rhynchophorus phoenicis* larvae, rhinoceros beetle *Oryctes rhinoceros* and June beetle. The crude protein content of weaver ant adult and larva were comparable to the protein content of reported witjuti grub (Meyer-Rochow, 1976) and many of the species mentioned by Bukkens, 2005 and other thirteen edible insects analyzed by Banjo *et al.* (2006), but the weaver ant (larva and adult) protein content was found to be much higher than that of the protein content in commonly used cow milk (whole 3.22g/100g) or soy milk (3.27g/100g) (data obtained from USDA database).

Banjo *et al.* (2006) reported the respective value-18.9%, 25.7%, and 20.2% for caterpillar *Anaphe* sp., *A. venata,* and *Cirinaforda* respectively; 20.4% and 22.1% for termite *Macrotermes bellicosus* and *M. notalensis* respectively and 21% for commonly cultured honey bee *Apis mellifera*. Compared to conventional food of animal and plant origin, the protein content of weaver ant (adult and larva) is within the range of chicken beef, pork egg, bamboo shoot soybean and mung beans, etc.(*cf.* Fig. 2). The majority of the Indian population is below the poverty line, hence they do not fully meet the nutrition requirements on daily basis. The recommended dietary allowances (RDA) of protein for Indian men are 60 g/day and that of women are 55g/day, however, there is a slight increase of protein demand for a pregnant and lactating woman which goes up to 82.2g/day and 77.9g/day respectively. For children under growing stages (age group of 16-17 years), the RDA of protein for boys and girls is 61.5g/day and 55.5g per day respectively, (ICMR, 2009). Therefore, consumption of 100g of the tested weaver ant on daily basis can meet up to about 108.37% for men. Protein is the main component of nutrients. In a rural area where the conventional protein sources are either not easily available or not affordable the cost, the consumption of insects (say weaver ant) can be a promising source of protein for mitigation of protein-energy malnutrition thereby preventing a susceptible disease that may occur out of under-nutrition.

Conclusion:

Regular intake of *O. smaragdina,* be it adult or the larva from any places and seasons is recommendable as a source of nutrient and encouraged to solve and mitigate the nutritional deficiency which leads to malnutrition among many least privileged parts of the Arunachal Pradesh and the world in general.

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