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PROXIMATE COMPOSITION OF WILD EDIBLE INSECTS CONSUMED BY THE BODO TRIBE OF ASSAM, INDIA

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Abstract: A study was conducted on twenty species of wild edible insects consumed by the Bodo tribe of Assam of Northeast India to know their nutritive value by following standard methods. Total solids, carbohydrates and calorific values were calculated and estimated from the result of proximate analysis of crude fat, crude protein, moisture and ash content. The results indicated that the wild edible insects contain crude protein ranges between (30.25%-84.56%), crude fat (4.01% - 40.65%), moisture (2.91% - 8.87%), ash (0.48% - 7.93%), carbohydrate (1.58%-47.98%) and total solid (91.13% - 98.6%) on dry weight basis. The study revealed that insects are a rich source of nutrients with highest amount of proteins (84.56%) in *Nephila maculata* and lowest amount (30.25%) in *Ruspoliya Baleyi*. This study suggests that entomophagy is a healthy practice and hence it should be encouraged.

Key words: Bodo tribe; Edible Insects; Entomophagy; Nutritional Value; Proximate

INTRODUCTION

Insects are common food among the Bodo tribe of Assam of Northeast India. Many species of edible insects are found abundantly in the regions dominated by the Bodo tribe so this tribe is engaged in entomophagy since time immemorial. Numerous references about their nutritional value are available in a wide range of scientific disciplines [1]. Many studies conducted around the world have shown that they are a rich source of quality proteins [2]. Many insects are an important source of proteins, carbohydrates and vitamins for humans as well as for domestic animals and they contribute significantly to food security and livelihoods in many developing countries [3]. Documentation of insects with good fatty acid content has been seen in many references [4, 5, 6]. Literature related to entomophagy in Northeast India is rare and therefore reports on the nutritional composition of insects are scanty. Identification and uses of insects in different fields among different tribes of Northeast India are seen in some papers [7, 8, 9, 10]. Most tribes in Northeast India collect wild edible insects for food. The consumption of diverse species of edible insects is also seen among other tribes of this region. This reflects the diversity in wild edible insect species of Northeast India and the need for their documentation.

Scarcity of food resources and malnutrition has become one of the major problems of the world [12, 13]. To compensate this, search for new food resources including identification and development of localized ethnic ones continues. Edible insects being a ready source of many useful and essential nutrients need to be popularized and well exploited to overcome nutrient deficiency. Inadequacy of nutrients from food can be seen in both the populations living in plenty as well as in scarcity of food resources. People living in abundance may suffer from certain nutrient deficiency due to ignorance of adequate food habits which leads them to select deficient diets [14]. Making sure that we consume the standard recommended daily intake level of nutrients is the first step towards keeping healthy physic and mind [15]. This study aims to explore the nutritional benefits of twenty wild edible insects consumed by the Bodo tribe of Assam, India to inform the population about the benefits they provide to human health and thereby to popularize their intake among the other inhabitants.

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MATERIALS AND METHODS

Sample Collection

The samples were collected during seasons of their availability from various wild habitats, fresh water bodies, paddy fields, vegetable gardens, grasslands and local markets of different districts of Assam, inhabited mostly by the Bodos. They were cleaned and the unwanted portions of the body discarded. Help during the sample collection was taken from some local informants who were mostly the local inhabitants of the collection site and were skilled in the collection. Solvents and chemicals used in this study were mostly of the analytical reagent grade and were obtained from Merck Specialties Private Limited, Worli, Mumbai, Thermo Fisher Scientific India Private Limited, Powai, Mumbai and Himedia Laboratories Private Limited, LBS Marg, Mumbai, India.

Killing and preservation

The collected samples were transported to the Department of Biotechnology, Bodoland University. Killing and preservation was done immediately to avoid suffer or starve to death by following standard methods [16]. The species were stored at -20°C for 48hours in a deep freezer for killing. After killing, the samples were divided into 3 parts. One for identification, other for moisture analysis and the remaining to be dried for further nutrient analysis. The

samples for identification was directly placed into pample's fluid, a fixative and transferred to a preservative (70% alcohol). Larvae species were placed to near boiling water to denature their body proteins and prevent decay. They were placed into pample's fluid and transferred to a preservative (70% alcohol). The species were packed in specimen tubes containing preservative (70% alcohol) and submitted to Zoological Survey of India (ZSI), Shillong and Kolkata for identification. The specimens were identified and classified by experts from ZSI, Shillong and Kolkata, India.

Determination of moisture content

3gm of sample was dried in a Universal hot air oven with digital temperature controller for 3 hours at 105°C. The sample was transferred to a dessicator to cool and weighed. The differences in weight represent the loss of moisture and are expressed as a percentage of oven dried sample AOAC (2000) [17].

$$Moisture\ \% = \frac{W1 - W2}{W1} \times 100$$

W1 = Weight (gm) of sample before drying
W2 = Weight (gm) of sample after drying

Determination of total solids

The method described by James (1995) was followed for estimation of total solid [18]. The total solid was estimated by subtracting the moisture percent from 100.

$$Total\ solids\ (\%) = 100 - moisture\ \%$$

Determination of protein content

The crude protein was estimated by using micro kjeldahl method [17]. 1g of sample was taken in a digestion flask and 20mL of concentrated sulphuric acid was added followed by 9.6 g potassium sulphate and 0.4g copper sulphate and heated gently until frothing ceased. The solution was boiled briskly until clear. The solution was allowed to cool and added 60mL of distilled water. Immediately the flask was connected to digestion bulb on condenser with tip of condenser immersed in standard acid and 5-7 drops of mix indicator in receiver. The flask was rotated to mix the content thoroughly and heated until all ammonia was distilled. The receiver was removed and the tip of the condenser washed. The distilled excess standard acid was titrated against standard NaOH solution. The nitrogen percent was calculated by the following formula

$$Nitrogen\ \% = \frac{(Sample\ titre - Blank\ titre) \times Normality\ of\ HCl \times 14 \times 100}{Weight\ of\ sample \times 1000}$$

Protein percentage was estimated by conversion of nitrogen to protein

Protein % = Nitrogen % x 6.25 (conversion factor)

Determination of ash content

The ash content was determined by method of AOAC (2000) [17]. 5 gm of sample was taken in a silica crucible and heated over low Bunsen flame with half covered lid. When fumes were no longer produced, the crucible and lid were placed in a muffle furnace and heated at 550°C overnight. After complete heating the lid was placed on the crucible to prevent loss of fluffy ash and cooled in a dessicator. Weight was taken when the sample turned to gray. Ash percent was calculated out by the following formula-

$$Ash\ (\%) = \frac{Weight\ of\ ash}{Weight\ of\ sample} \times 100$$

Determination of fat content

Determination of fat in the sample was done by the AOAC (2000) method [17]. 3gm of sample was weighed and wrapped in a filter paper. The sample was taken in an extraction thimble and transferred into soxhlet. 250mL of petroleum ether was filled in a bottle and placed on the heating mantle. The sample was heated about 14 hours at a heat rate of 150 drop/min. The solvent was evaporated by using vacuum condenser. The bottle was incubated at 80-90°C until the solvent was completely evaporated and the bottle completely dried. The bottle was transferred to a dessicator with partially covered lid and allowed to cool. The bottle and its dried content were reweighed. The fat% was estimated by the formula-

$$Fat\ (\%) = \frac{Weight\ of\ fat}{Weight\ of\ sample}$$

Determination of carbohydrates

The total carbohydrate was calculated by the arithmetic difference method by subtracting the sum of the weights including ash, protein and lipid from the total solids [18].

$$Total\ carbohydrates\ (\%) = Total\ solids\ (\%) - [\,Protein\ (\%) + Fat\ (\%) + Ash\ (\%)]$$

Determination of Nutritive Value

The method described by FAO (2003) was followed to estimate the total energy value in Kcal/100gm.

$$Nutritive\ value = 4 \times protein\ (\%) + 9 \times fat\ (\%) + 4 \times carbohydrate\ (\%)$$

RESULTS

The scientific name, common name and the developmental stages of consumption of 20 species of edible insects consumed by the Bodo tribe are recorded in Table 1. Among them five species are consumed from order hymenoptera, two from Hemiptera, ten species from Orthoptera and one each from Coleoptera, Isoptera and Araneae.

Table 1: Insects consumed by the Bodo tribe of Assam, India.

S.No.	Order	Family	Scientific Name	English Name	Local Name	Consumption Stage
1.	Hymenoptera	Vespidae	*Vespa affinis continentalis* Bequaert	Vespa bicolor	Handilore bere	Larvae
2.	Hymenoptera	Vespidae	*Polistis (Gyrostoma) olivaceus* (De Geer)	Paper wasps	Jotha bere	Larvae
3.	Hymenoptera	Vespidae	*Parapolybia varia* (Fabricus)	Lesser paper wasps	Mwsou salai Bere	Larvae
4.	Hymenoptera	Formicidae	*Oecophylla smaragdina* (Fabricius)	Weaver ant	Khwjema	Larvae
5.	Hemiptera	Belostomatidae	*Lethocerus indicus* (Lep & Serv)	Giant water bug	Gangjema	Adult
6.	Hemiptera	Nepidae	*Laccotrephes ruber* (Linn)	-	Lanjai gwlao	Adult
7.	Orthoptera	Gryllidae	*Tarbinskiellus portentosus*	Cricket	Khusangra	Adult
8.	Orthoptera	Gryllotalpidae	*Gryllotalpa africana* (Beauvois)	Mole cricket	Sosroma	Adult
9.	Orthoptera	Acrididae	*Eupreponotus inflatus* (Uvrov)	Short horned grasshoppers	Guma nargi	Adult
10.	Orthoptera	Acrididae	*Choroedocus robustus* (Serville)	Short horned grasshoppers	Guma khusep	Adult
11.	Orthoptera	Acrididae	*Chondracris rosea* (De Geer, 1773)	Short horned grasshoppers	Guma nareng	Adult
12.	Orthoptera	Acrididae	*Phlaeoba infumata* (Brunner Von Wallenwyi)	Short horned grasshoppers	Guma daosri jagra	Adult
13.	Orthoptera	Acrididae	*Oxya fuscovittate* (Marschall)	Short horned grasshoppers	Guma daosri jagra	Adult
14.	Orthoptera	Tettigoniidae	*Mecopoda elongate elongate* (Linnaeus)	Long horned grasshoppers	Guma khufri	Adult
15.	Orthoptera	Tettigoniidae	*Ruspolia baileyi*	Nsenene	Guma gwthao	Adult
16.	Orthoptera	Mantidae	*Mantis inornate* (Werner)	Praying mantis	Guma gangu	Adult
17	Coleoptera	Dytiscidae	*Dytiscus marginalis*	Diving beetle	Chingkhouri	Adult
18.	Isoptera	Termitidae	*Macrotermes natalensis*	Termite	Wuri	Adult
19.	Araneae	Nephilidae	*Nephila maculata*	Giant wood spider	Bema raja	Adult
20.	Hymenoptera	pompilidae	*Pompilidae*	Wasps	Hani bere	Larvae

Source: Narzari S and Sarmah J, 2015 [7].

Table 2: Proximate composition (%) of dry matter (g/100g).

S.No.	Scientific Name	Moisture	Total solids	Nitrogen	Protein	Ash	Fat	Carbohydrates	Calorific Value
1	*Vespa affinis continentalis* Bequaert	8.59	91.41	8.02	50.13	2.55	25.33	13.29	483.45
2	*Polistis (Gyrostoma) olivaceus* (De Geer)	8.53	92.47	8.17	51.06	2.60	19.92	17.89	455.08
3	*Parapolybia varia* (Fabricus)	8.87	91.13	8.58	53.63	1.81	15.38	20.31	438.18
4	*Oecophylla smaragdina* (Fabricius)	6.34	93.66	8.34	52.13	5.16	22.72	13.65	467.60
5	*Lethocerus indicus* (Lep & Serv)	5.64	94.36	10.77	67.31	2.81	13.73	10.51	434.84
6	*Laccotrephes ruber* (Linn)	7.34	92.66	7.54	47.13	7.22	10.13	28.18	392.41
7	*Tarbinskiellus portentosus*	6.49	93.51	9.28	58.00	7.93	23.70	3.88	460.82
8	*Gryllotalpa africana* (Beauvois)	6.81	93.19	9.33	58.31	5.83	15.69	13.36	427.89
9	*Eupreponotus inflatus* (Uvrov)	6.80	93.20	12.06	75.38	1.32	11.61	4.89	425.25
10	*Choroedocus robustus* (Serville)	4.22	95.78	10.32	64.50	1.51	15.73	14.04	413.61
11	*Chondracris rosea* (De Geer, 1773)	5.27	94.73	11.02	68.88	2.33	17.52	6.00	457.20
12	*Phlaeoba infumata* (Brunner Von Wallenwyi)	3.47	98.86	11.48	71.75	3.14	10.15	11.49	424.31
13	*Oxya fuscovittate* (Marschall)	3.97	96.03	12.53	78.31	3.81	12.33	1.58	430.33
14	*Mecopoda elongate elongate* (Linnaeus)	6.16	93.14	9.52	59.50	0.56	20.11	13.67	473.67
15	*Ruspolia baileyi*	6.27	93.73	4.84	30.25	0.48	40.65	22.35	580.25
16	*Mantis inornate* (Werner)	6.22	93.78	5.28	33.00	0.51	12.29	47.98	434.53
17	*Dytiscus marginalis*	5.82	94.18	9.44	59.00	2.23	20.74	12.21	434.87
18	*Macrotermes natalensis*	2.91	97.09	6.31	39.44	1.65	18.22	37.78	472.86
19	*Nephila maculata*	1.72	98.28	13.53	84.56	1.02	4.01	8.96	410.17
20	*Pompilidae*	8.31	91.69	8.94	55.88	3.01	25.33	7.47	481.37

In table 2 above, the chemical constitution of each individual insect has been shown. The result of the analysis is recorded on dry weight basis. The highest protein was recorded in *Nephila maculata* (84.56%). Sixteen species have protein content above 50% on dry weight basis. *Ruspoliya baleyi* showed highest percent of fat (40.65%) and lowest percent of protein (30.25%). The highest value of dry matter was observed in *Phlaeoba infumata* (98.66%). The result also indicates that species with the highest protein content has the lowest fat content and species with highest fat content has least protein content. Carbohydrate content was less compared to protein. This data is the average of three determinations and the result obtained showed that edible insects are a rich source of proteins and fats as well.

DISCUSSION

The proximate analysis for wild edible insects has shown that most of the species analyzed are rich sources of many nutrients. Edible insects constitute an important part of daily diet of the Bodos. These insects are highly nutritious even when dried [20]. Malnutrition is basically a problem of calorie deficiency and protein deficiency in many developing countries of the world [21]. Edible insects have the potential to solve this problem if accepted worldwide. The result indicated a fairly high level of fat in most of the insects, the highest being (40.65g/100g), this may be one reason for which insects are preferred food among many communities. High level of fats in foods may be undesirable in the view of a nutritionist, for example saturated fatty acids in food can cause atherosclerotic disorders [22]. To overcome this problem, characterization of lipids in the edible insects becomes necessary so that people get proper information regarding the benefits and ill effects of insect consumption. The protein content interpreted in the data corresponds to the result in many reviews [23, 24, 25]. Species with high protein content mostly showed lesser fat content. Protein quality in any type of food is determined by the content of amino acids. To judge the quality of proteins in insect food the amino acids contents needs to be further analyzed. Carbohydrate content proved to be relatively high when compared to the reported values for meat and fish [26]. High moisture content makes the food susceptibility to microbial growth and enzyme activity [27]. Most species of insects had moisture content above 50% on wet weight basis. The present study has revealed that the wild edible insects consumed by the Bodos of Assam has the potential to provide substantial amounts of proteins and fats to the diets of the consumers. Since the insect food is very popular and widely consumed by different tribes of Northeast India, its consumption can help in alleviating the problem of malnutrition among the low socio economic groups. However, more studies need to be carried out to obtain more information on the nutritional value of these edible insects.

CONCLUSION

The result of the present study showed that most insects consumed by the Bodo tribe are a rich source of good quality proteins and fats. These insects if popularised may constitute a cheaper source of essential diet that is easily available and affordable to all sections of the natives. Attempts should be made to cultivate the highly nutritious species with modern techniques to increase their availability and commercial values.

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