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Macronutrient and mineral content of edible Coleopteran with reference to the Baksa district, India.

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Abstract

Edible insects form a part of human diets from the prehistoric time. The practice of eating insects has associated with rural life and rural communities of Baksa, Assam. Amongst aquatic insects, Coleopterans (beetles) are one of the most successful groups and the largest order in the class Insecta. Coleopterans can be beneficial to human economics by controlling the populations of pests. The biochemical analysis shows that coleopterans are rich in Protein with significant amount of lipid and carbohydrate content. Also all three commonly consumed coleopterans in Baksa, Assam show a good amount of minerals i.e. Mg, Ca, Fe, Zn, Cu, Mn etc.

Keywords : edible, biochemical, coleopterans, minerals, significant.

1. Introduction

Insects play an important role in the creation of a sustainable global food economy as well as food security. Insects are eaten by humans in many countries around the world. Edible insects form a part of human diets from the prehistoric time (Van Huis, 2013). Insects play vital roles in the ecosystems including soil turning and aeration, dung burial, pest control, pollination and wild life nutrition. Besides, ecological services, insects are an important source of protein, fat, carbohydrate and other nutrients. Studies have reported that insects are good sources of proteins and minerals and contribute to the daily requirements of these nutrients in certain developing countries (Ladron de Guevara *et al.* 1995, Bukkens 1997, Ramos-Elorduy *et al.* 1997 , Banjo et al. 2006, Elemo *et al.* 2011). Edible aquatic beetles play an important role in the nutrition and economy of rural people (Ramos-Elorduy, 1997).

Among the edible insects, aquatic insects are one of the most favorable groups among consumers due to their taste and high availability. Amongst aquatic insects, Coleopteran (beetles) are one of the most successful groups and the largest order in the class Insecta. The word “Coleoptera” is from the Greek keleos, meaning “sheath,” and pteron, meaning “wing,” thus “sheathed wing.” Their front pair of wings is hardened into wing-cases, elytra, distinguishing them from most other insects. Scavengers and wood boring beetles OF Coleoptera are useful as decomposers and recyclers of organic nutrients. The order Coleoptera includes more species than any other order, constituting almost 25% of all known life-forms (Banerjee, 2014). Besides food and feed of human and other animals, the predatory species of Coleoptera such as lady beetles are important biological control agents of aphids and scale insects. It is noticed that Coleoptera were most widely consumed in the world (31%) and in the Indo-Malayan region (48%) as in Madagascar (36%), although beetles were less frequently consumed in sub-Saharan Africa (third most widely consumed at 16%).

Edible insects represent an important part of the daily diet of a large number of ethnic tribal people in the Baksa district, Assam. Though eating insects is common practice in the study region of Baksa, Assam but, there is little information about the nutritive value of these edible insects. Therefore, the nutritive values of Coleopteran will inform consumers about the quality of insect intake.

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2. Method and methodology

2.1 Study area

The study area of the present study is 'Baksa Distrct', Assam, India. The latitude and longitude of the study area is 26.6935° N, 91.5984° E. The Baksa district, Assam is one of the 27 districts in Assam of the north- eastern India. The total geographical area of the study area is 2400 square kms. The districtis bounded by Bhutan Hill in the North, Udalguri district in the East, Barpeta, Nalbari and Kamrup district in the South and Chirang district in the West. The climate of the district is sub tropical in nature with warm and humid summer and also followed by cool and dry winter. The winter temperature drops to 10^{0}C and summer temperature goes up to 35^{0}C.

2.2 Collection of aquatic coleoptera

The edible Coleopteran was collected using standard trapping methods from different sites selected on the basis of their specific habitat in Baksa district, Assam. Coleopterans are found in nearly all natural habitats, that is, vegetative foliage, from trees and their bark to flowers, leaves, and underground near roots, even inside plants like galls, tissue, including dead or decaying ones (Wilson, 2010). The most commonly used method for sampling aquatic insects in standing water was hand netting, Besides nets, most of the aquatic insects were trapped through local traditional equipment like Jakoi,Saloni etc. from the different aquatic habitats. Some edible insects were also collected by hand. Kick-net was also used to collect some aquatic insects. Light traps have therefore been widely used in nocturnal insect sampling for a long time. Flying Coleopteran insects got attracted to light and they were collected under the light.

2.3 Bio-chemical analysis of macronutrients

Out of five edible coleopteran, three commonly and most frequencly consumed Coleopteran in the Baksa, Assam were biochemical analysed in sericulture lab, IAAST, Boragoan , Guwahati, Assam. After collection fresh edible Coleopterans were cleaned using clean running water and they were brought to the laboratory in the fresh condition and kept in refrigerator at -20 degree centigrade for further biochemical analysis. Each parameter of biochemical analysis was determined five (5) times and result reported as mean ± SD.

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 total lipid was estimated using chloroform methanol method described by Folch*et al.,*(1957). Estimation of carbohydrate was done by following anthrone method (Sadasivam and Manickam, 2008).

2.4 Biochemical analysis of mineral contents

The mineral elements such as Mg, Zn, Fe, Cu, Ni, Cd, Cr, Pb and Mn were determined by atomic absorption spectroscopy (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. Results and discussion

The five species belonging to Scarabaeidae, : Hydrophilidae , Cerambycidae, Dytiscidae have been recorded in the study area(Table-1). Out of these 05 species,Scarabaeidae family shared with maximum number of 02 species. The maximum number collected species were belonging to family Hydrophilidae and recorded in fresh water environment.

Table-1: Shows the taxonomic distribution by order, family, genus, species with common names and vernacular names

Sl. No.	Scientific name	Order	Family	English name	Vernacular name (bodo)
1	*Hydrophilus olivaceus*	Coleoptera	Hydrophilidae	Water Scavenger	Ankhaouri
2	*Eretes stictus*	Coleoptera	Dytiscidae	Larva of diving bettle	Jujema
3	*Phyllophaga spp.*	Coleoptera	Scarabaeidae	June beetle	Bwarbi
4	*Orycetes rhinoceros*	Coleoptera	Scarabaeidae	Rhinoceros beetle	Jeljer
5	*Plectroderma scalator*	Coleoptera	Cerambycidae	Wood borer	GalaGunjer

Table-2: Shows seasonal availability, mode of eating and edible part of the Coleopteran

Sl. No.	Scientific name	Seasonal availability	Edible part	Mode of eating
1	*Hydrophilus olivaceus*	Whole Year	Larvae and Adult	Fried orCurry
2	*Eretes stictus*	Whole year	larvae	fried
3	*Phyllophaga spp.*	April- June	Adult	fried
4	*Orycetes rhinoceros*	Sept-Feb	Larvae(Grubs)	fried
5	*Plectroderma scalator*	May- August	Larvae	Fried

3.1 Biochemical analysis of edible coleopteran insects

The soluble protein, lipid and carbohydrate contents present inedible insectsis expressed in mg per gm in fresh weight as shown in the following table (Values are represented as ± standard deviation):

Table-3: Protein, lipid and carbohydrate content in different insects in mg/gm. Fresh wet weight (values are mean±SD of three replicates). Means having different superscripts (a,b,c…) differ significantly ($P<0.05$).

Common Name	Protein content (mg)			Lipid content (mg)			Carbohydrate content (mg)		
	Mean		SD	Mean		SD	Mean		SD
Water scavenger	246.00^{j}	±	8.72	62.00^{d}	±	3.61	38.00^{de}	±	2.65
June beetle	244.33^{j}	±	6.66	22.28^{a}	±	2.41	35.67^{de}	±	2.52
Eretis sticticus (larvae)	25.36^{a}	±	1.49	16.30^{a}	±	0.97	45.35^{fg}	±	3.75

This data in the table-3 indicates that all the edible coleopterans are rich in protein content. Except larvae of *Eretis sticticus* other two edible coleopterans showed maximum amount of protein. All the three coleopterans shows considerable amount of lipid and carbohydrate. There is positive correlation between conetent of protein and lipid content in insects.It can be inferred here that when the protein content in any insect incerases then the lipid content in it increases i.e when the content of protein in any insect is more it implies that the content of lipid will also be more. Also it can be inferred that insects are rich in protein and carbohydrate contents together.

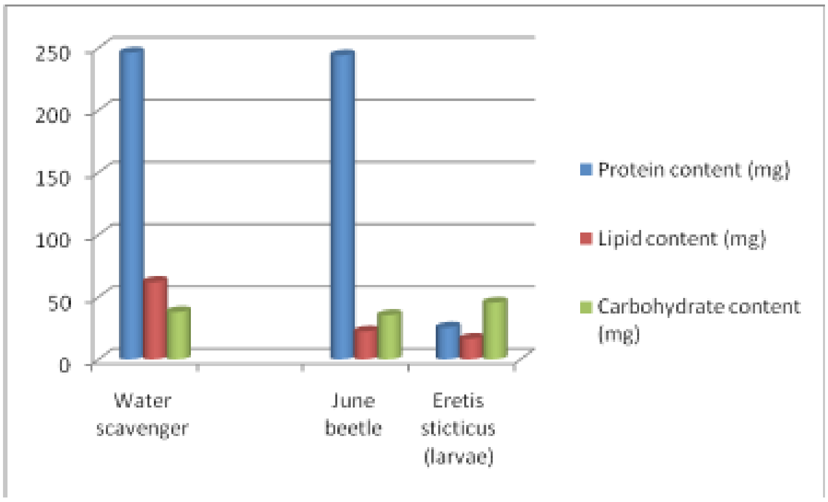

Fig.-1: Multiple bar diagram of macronutrients composition of commonly consumed Coleopterans (mg/gm fresh weight).

The composition of ten minerals was analyzed for three representative edible Coleopterans to assess the nutritive value of edible insects consumed by ethnic tribal people in Baksa, Assam.The Table -4 shows the mineral contents of Ca, Zn, Mg, Fe and trace elements such as Cu, Mn, Ni, Cr, etc. per mg/100g in the edible insects in the study area.

Table-4: Micronutrient contents (mineral composition) of the edible insects found in study area

Name of insects	Fe mg/100g	Mg mg/100g	Cu mg/100g	Ni mg/100g	Cr mg/100g	Zn mg/100g	Cd mg/100g	Pb mg/100g	Mn mg/100g	Ca mg/100g
Hydrophillusolivaceus	15.060	3.531	0.078	3.0100	2.0680	1.6970	0.000	0.000	1.2710	12.570
Phyllophaga spp.	6.078	23.402	0.452	0.087	1.220	3.811	0.081	0.002	9.090	16.221
Eretesstictus(larvae)	8.009	10.445	0.0676	0.564	1.778	5.662	0.023	0.010	2.112	19.886

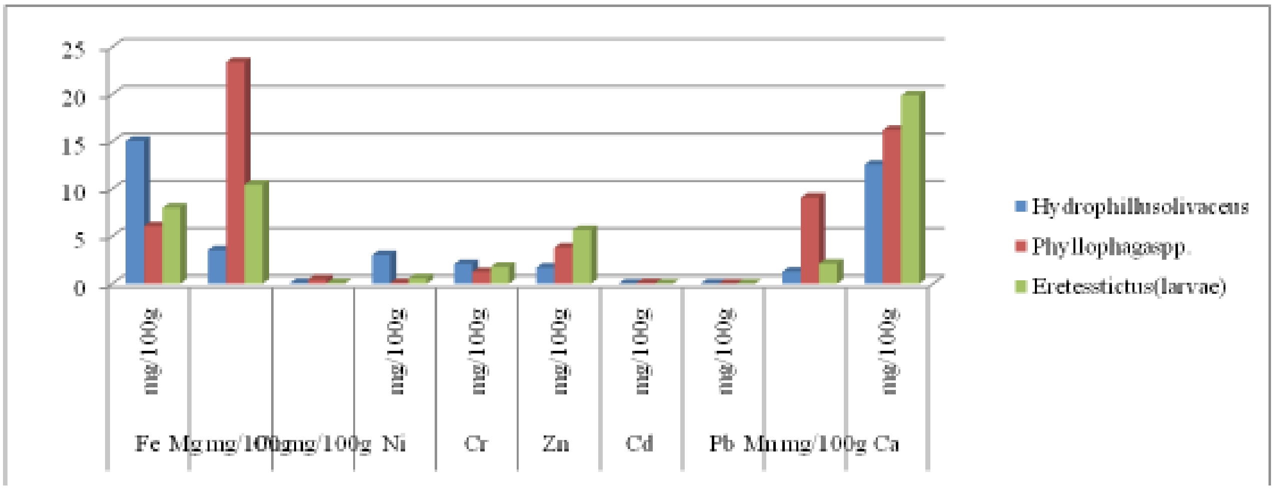

Fig. 2: Graphical Representation of Mineral contents of edible Coleopterans

The present results of macronutrient contents analysis indicate that *Hydrophilus olivaceus* (Water scavenger) have high quantity of protein , a good quantity of lipid and considerable amount of carbohydrate followed by *Phyllophaga spp.*(June beetle), another commonly consumed Coleoptera. It has been reported that insects are good sources of minerals (Verkerk *et al.* 2007). The ash content is indicative of the mineral content; in insects, ash content is 3–8g/100g DW (Verkerk *et al.* 2007). The zinc content of *H. parallela* was 15.4mg/100g DW, which was higher than that of dried silkworm pupae (Longvah *et al.* 2011). Adult *H. parallela* contain high amounts of zinc and iron, which are essential for human health. The iron and zinc contents of *H. parallela* previously reported were 33mg/100g and 17mg/100g DW, respectively. The prior results of edible Coleopterans revealed that adult H. parallela, a coleopteran, is an excellent protein source. The protein content of adult H. parallela was approximately 24%, which is higher than the 16% protein content of silkworm (Longvah *et al.,* 2011). On a dry weight (DW) basis, H. parallela contained 70.57g of protein/100g, which is comparable to the protein content of beef and pork (40–75g of protein/100g DW; Bukkens 1997). Animal protein is superior to plant; therefore, the best protein supplements should include some animal protein (Ssepuuya *et al.,* 2017). Thus, the insects may be a high quality protein ingredient for high standard protein supplement in the food industry. It was also found that the lipid content of larvae (37.87%) was higher than the soybean (14.60%). From the energy point of view, lipids are important because one gram of lipid provides more than 9 kcal of energy when oxidized in the body. Lipids are structural components of all tissues and indispensable in cell membranes structure and cell organelles (FAO, 2010; Drin, 2014 and Prinz, 2014). The fat content of pupae and larvae of edible Coleoptera is higher than the adult insect. The prior results of edible Coleopterans revealed that adult H. parallela, a coleopteran, is an excellent protein source. The protein content of adult H. parallela was approximately 24%, which is higher than the 16% protein content of silkworm (Longvah *et al.,* 2011). On a dry weight (DW) basis, H. parallela contained 70.57g of protein/ 100g, which is comparable to the protein content of beef and pork (40–75g of protein/100g DW; Bukkens 1997). Beetles contain a high iron content (28mg/ 100g DW), higher than that of silkworm prepupae and pupae (24mg/100g; Longvah *et al.* 2011). Adult H. parallela contain high amounts of zinc and iron, which are essential for human health. The iron and zinc contents of H. parallela previously reported were 33mg/100g and 17mg/100g DW, respectively.

4. Conclusion

It was found that the Coleopteran insects consumed were rich in protein, carbohydrate and lipid content and they might be future alternative source of high quality nutrient diet. The consumption of insects by humans is called Entomophagy. Entomophagy depends upon insect palatability. Edible insects are natural renewable resource that provides food and economical security to many ethnic groups in Assam. Entomophagy is common in Africa, Asia and South America, and more than 2 billion people world-wide reporting to have eaten some 2000 different insect species. The high cost of animal protein, which is beyond the reach of the poor, has greatly encouraged entomophagy. The results of this study confirm the fact that insects are indeed a good source of protein and mineral content. The consumption of insects therefore, should be encouraged. Insects are traditional foods in most cultures and also play an important role in human nutrition therapeutic use.

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