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Quantitative Analysis of Mineral Content of Six Edible terrestrial Insects Commonly Consumed by ethnic people in Baksa District, Assam, India.

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Abstract

Edible insects are economically and environmentally preferable species which are rich in macro nutrients and micronutrients that benefit human health. They are rich in protein and fat and provide ample quantities of minerals. Minerals are inorganic nutrients, usually required in small amounts from less than 1 to 2500 mg per day. The mineral element analysis of six edible insects was carried out using the Atomic Absorption Spectrophotometer (AAS). Following acid digestion the larva sample was analyzed for Calcium (Ca), Sodium (Na), Iron (Fe) and potassium (K), respectively. We find a elemental variation in studied insects. The content of calcium in insects is the highest compare to all other minerals. Calcium content is the highest in cricket compare to other insects. The mineral content of commonly eaten insects were analyzed to inform consumers among indigenous populations in Baksa, Assam,India.about the micro-nutritional quality of the insects.

Keywords: Edible insects, indigenous, mineral content, micronutrients. Variation

1. Introduction

Insects are the only winged invertebrates, cold-blooded which within the arthropod group that have a chitinous exoskeleton, a three-part body (i.e. head, thorax and abdomen), three pairs of disjointed legs, compound eyes and a pair of antennae. Insects have been used as a part of human diet among many indigenous people in Assam, as well as other states in N.E.India from long before.

Insects are unlikely to compete with conventional animal products such as beef and pork, but as a side dish, snack or delicacy—the way they are typically consumed by indigenous populations—they should be given due importance. Given their high nutritional value, efforts should be made to retain the tradition of entomophagy where it is still alive. Unfortunately, availability of several insects may be in decline because of destruction of insect host trees/plants (e.g., Ashiru 1988, McGregor 1995). The Baksa district which is mostly inhabited by tribal communities has a distinct identity, culture, and food habits. Most of the tribal communities in Baksa as well as other states in North Eastern India prefer pre pupal stage of Eri pupa for consumption. The indegeneous tribal people in the Baksa mainly Boro and Rabha people eat beetles (Coleoptera), caterpillars (Lepidoptera) and bees, wasps and ants (Hymenoptera) grasshoppers, locusts and crickets (Orthoptera) cicadas, leafhoppers, planthoppers, scale insects and true bugs (Hemiptera) termites (Isoptera) dragonflies (Odonata) etc.Grasshopper and field cricket are simply fried with salt, chilly spices and mustard oil and consumed directly. Hence, the edible insect can be comparable with other conventional food products by integrating scientific cultivation and validation to the traditional wisdom for livelihood development of the tribal's. Much attention has been paid to edibleinsects as a future food source to combat the food crisis as they are rich in protein, minerals, and vitamins (Nowak, Persijn, Rittenschober, & Charrondiere, 2016). Micronutrients (minerals and vitamins) play an important role in the nutritional value of food. The edible insects appear a good source of

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iron (Fe). For comparison, beef has an iron content of about 6 mg/100 g dry weight (2.1 mg/100 g fresh weight), while the iron content of most food insects lies well above this value (INN1989). No data are available whether this iron is readily available. The calcium content of food insects is certainly higher than that of conventional meats, although lower than that of whole milk (920 mg/100 g dry weight or 120 mg/100 g fresh weight) (INN 1989). In a study in Kenya, crickets and termites proved to have a high iron and zinc content. Assuming a bio-availability of 10 %, 10 g crickets would cover 114 % of the recommended nutrient intake for iron for adult males and 53 % for adult females; these figures for zinc are 36 and 51 % (DL Christensen , FO Orech , MN Mungai et al. ,2006). Oliveira and others (1976) found the Angolan caterpillar, *Usta terpsichore* (Saturnidae) to be a rich source of iron, copper, zinc, thiamine (vitamin B1), and riboflavin (B2).Total mineral content of 1.25/100 g in eri pre pupae was comparable to that of other insect larvae, such as Mopane worm (Dreyer & Wehmeyer, 1982). The eri silkworm prepupae and pupae appear to be a good source of phosphorus, calcium and magnesium. Iron content of 24 mg/100 g in eri silkworm prepupae and pupae, on a dry weight basis, was lower than the 40 mg/ 100 g reported in Antherea pernyi (Zhou & Han, 2006a). The phosphorus content of eri silkworm prepupae and pupae was 570– 585 mg/100 g on a dry weight basis which was slightly higher than the 474 mg/100 g reported by Rao (1994) in spent silkworm pupae. The high zinc content of 7.24 mg/100 g in dried eri pupae is of significance, especially considering the importance of this trace element in health and nutrition. Many attempts have been made to make nutritious food supplements available to the population, using staple foods to ensure nutritional security. All the edible insects consumed by tribal people in Baksa District contain adequate amount of minerals, which helps as proper body functions and body building elements of our body. Hence, edible insects constitute an important part of the daily diet for most tribal people of the Baksa District of Assam, India

2. Materials and methods

2.1. Study area

This research was carried out in the Baksa district, Assam, India at fourteen villages under different blocks. Baksa in Assam, India

2.2. Sample preparation

Insect sampling was done during July 12 to November, 2013 from fourteen villages in Baksa district, Assam. The insect sampling was carried out in the early hours of the day as insects are active and easily observed at early sun rise. In order to conduct mineral content analysis some edible insects found in different markets in Baksa were collected . Then, 2 g of specimen were put into 50 ml flask for digestion and digestion was conducted on a hot plate at 250°C until there was no light brown colored smoke after adding nitric acid . After drying samples were subjected to the acid digestion method according to AOAC (1984).

Acid digestion method

1 gm of dried sample were taken and placed in a small beaker. Then 10 ml of concentrated nitric acid (HNO_3) is added and allowed to stand for overnight. Heated and cooled down; 3 ml of 70% perchloric acid ($HClO_4$) was added. Now again heated and allowed to evaporate to a small volume. Then sample is transferred to 50ml flask and dilute to volume with distilled water. Now the elements were detected in a Perkin Elmer 3280 Atomic Absorption Spectrophotometer (AAS). And all the value of the micronutrients of the sample found in ppm (parts per million) and calculated using the formula.

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

Principle of Atomic Absorption Spectroscopy (AAS)

The technique makes use of absorption spectrometry to assess the concentration of an analyte in a sample. It requires standards with known analyte content to establish the relation between the measured absorbance and the analyte concentration and relies therefore on Beer-Lambert Law. In short, the electrons of the atoms in the atomizer can be promoted to higher orbital (excited state) for a short period of time (nanoseconds) by absorbing a defined quantity of energy (radiation of a given wavelength). This amount of energy, i.e., wavelength, is specific to a particular electron transition in a particular electron transition in a particular element. In general, each wavelength corresponds to only one element, and the width of an absorption line is only of the order of a few picometers (pm), which gives the technique its elemental selectivity. The radiation flux without a sample and with a sample in the atomizer is measured using a detector, and the ratio between the two values (the absorbance) is converted to analyte concentration or mass using Beer-Lambert Law.

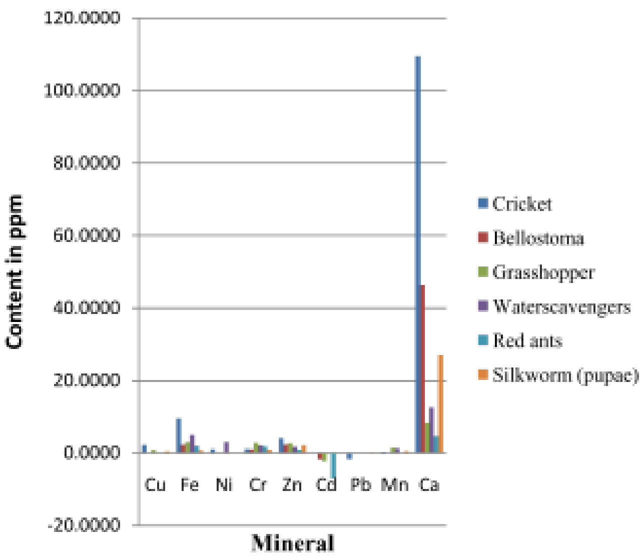
3. Results and discussion

Mineral content on six edible insects consumed by ethnic tribal people in Baksa is shown in Table-1. These edible insects are high in calcium, zinc, iron and potassium and rich in magnesium. The contents of calcium, zinc, iron and potassium, magnesium per ppm are as shown in the following table-1

Table-1: six edible insects consumed by ethnic tribal people in Baksa

Name of insects	Cuppm	Feppm	Nippm	Crppm	Znppm	Cdppm	Pbppm	Mnppm	Cappm
Cricket	2.1780	9.5820	1.0090	1.0680	4.1110	0.0190	-1.7410	0.3040	109.5000
Bellostoma	0.1147	2.2970	0.0020	0.9800	2.3210	-1.7710	-0.0690	0.0500	46.3380
Grasshopper	0.8370	2.9350	0.2200	2.8250	2.6750	-2.3000	-0.1290	1.4280	8.3370
Waterscavengers	0.0780	5.0600	3.0100	2.0680	1.6970	-0.1300	-0.0790	1.2710	12.5700
Red ants	0.0015	1.9510	0.2100	1.7900	0.8590	-7.0000	-0.1190	0.1220	4.6890
Silkworm (pupae)	0.4600	0.7000	0.1200	0.8400	2.1000	-0.0110	-0.2300	0.5600	27.0000
Total	3.6692	22.5250	4.5710	9.5710	13.7630	-11.1930	-2.3670	3.7350	208.4340
Mean	0.6115	3.7542	0.7618	1.5952	2.2938	-1.8655	-0.3945	0.6225	34.7390
Variance	0.5719	8.5071	1.4692	0.5197	0.9834	8.5698	0.3668	0.2922	1312.5281

Minerals are indispensible inorganic elements because the body is not able to synthesize them. Minerals have an impressive varieties of metabolic functions as they build, activate, regulate and control many chemicals e.g. iron in hemoglobin, zinc in insulin. Minerals are needed for the proper composition of body fluids, including blood, and for the proper composition of tissues, bone, teeth, muscles and nerves. Minerals also play a significant role in maintaining healthy nerve function, the regulation of muscle tone, and supporting a healthy cardiovascular system. Like vitamins, minerals also function as coenzymes that allow the body to perform its biochemical functions including: energy production, growth, healing, proper utilization of vitamins and other nutrients.Nutritionally, minerals are generally subdivided into two groups, macro minerals and trace minerals (micro minerals). The macro minerals include calcium, magnesium, potassium, phosphorus and sodium. These are the minerals that are required in large amounts in the body. Trace or micro minerals, on the other hand, are those minerals that are required only in minute quantities in the body. These include zinc, copper, chromium, selenium, molybdenum, manganese, iodine, iron, boron, silicon, and vanadium. Though only required in small quantities, they are, nevertheless, essential for good health. Edible insects are high in calcium, zinc, iron and potassium and rich in magnesium.Table 1 shows details of mineral composition analysis six commonly eaten edible insects eaten by tribal people in Baksa district, Assam.



From the above multiple bar diagram the following are observed

(i) The content of calcium in insects is the highest compare to all other minerals.

(ii) Calcium content is the highest in cricket compare to other insects.

1. Alltogether 36 possible pairwise coefficients of correlation between the minerals were calculated by using the formula of Pearson's coefficient of correlation, which is given by

$$\mathrm{corr}(X,Y) = \frac{\mathrm{Cov}(X,Y)}{\sqrt{\mathrm{Var}(X)\mathrm{Var}(Y)}} \text{ where}$$

$$\mathrm{Cov}(X,Y) = \frac{1}{n}\sum (X-\bar{X})(Y-\bar{Y})$$

with n being the pairs of observations (X,Y).

All the calculated values are being summarized in the following table:

Serial No	Correlation between	Values	Probable error (PE)	6 × PE	Remark
1	**Cu, Fe**	**0.7960**	**0.1009**	**0.6053**	**Significant**
2	Cu, Ni	-0.0257	0.2752	1.6511	Not significant
3	Cu, Cr	-0.1557	0.2687	1.6121	Not significant
4	**Cu, Zn**	**0.9205**	**0.0420**	**0.2521**	**Significant**
5	Cu, cd	0.4225	0.2262	1.3573	Not significant
6	Cu, Pb	-0.9380	0.0331	0.1986	Not significant
7	Cu, Mn	-0.0261	0.2752	1.6511	Not significant
8	**Cu, Ca**	**0.8318**	**0.0849**	**0.5092**	**Significant**
9	Fe, Ni	0.4802	0.2119	1.2712	Not significant
10	Fe, Cr	-0.0494	0.2747	1.6482	Not significant
11	Fe, Zn	0.7282	0.1293	0.7760	Not significant
12	Fe, Cd	0.3949	0.2324	1.3945	Not significant
13	Fe, Pb	-0.8628	0.0704	0.4223	Not significant
14	Fe, Mn	0.0273	0.2752	1.6509	Not significant
15	**Fe, Ca**	**0.7717**	**0.1114**	**0.6682**	**Significant**
16	Ni, Cr	0.2477	0.2585	1.5508	Not significant
17	Ni, Zn	-0.0324	0.2751	1.6504	Not significant
18	Ni, Cd	0.3944	0.2325	1.3952	Not significant
19	Ni, Pb	-0.0710	0.2740	1.6438	Not significant
20	Ni, Mn	0.4942	0.2081	1.2486	Not significant
21	Ni, Ca	-0.0188	0.2753	1.6516	Not significant
22	Cr, Zn	-0.2189	0.2622	1.5730	Not significant
23	Cr, Cd	-0.3023	0.2502	1.5012	Not significant
24	Cr, Pb	0.3567	0.2403	1.4420	Not significant
25	**Cr, Mn**	**0.7705**	**0.1119**	**0.6714**	**Significant**
26	Cr, Ca	-0.5823	0.1820	1.0920	Not significant
27	Zn,Cd	0.6286	0.1666	0.9993	Not significant
28	Zn,Pb	-0.8209	0.0898	0.5388	Not significant
29	Zn,Mn	0.0174	0.2753	1.6517	Not significant
30	**Zn,Ca**	**0.8533**	**0.0748**	**0.4491**	**Significant**
31	Cd, Pb	-0.3557	0.2405	1.4432	Not significant
32	Cd, Mn	0.3216	0.2469	1.4813	Not significant
33	Cd, Ca	0.3216	0.2469	1.4813	Not significant
34	Pb, Mn	0.2616	0.2565	1.5391	Not significant
35	Pb, Ca	-0.9167	0.0439	0.2637	Not significant
36	Mn, Ca	-0.4304	0.2244	1.3461	Not significant

The probable errors of the coefficients of correlation (PE) as shown in the above table are being calculated by using the following formula:

PE = $0.6745 \times \frac{(1-r^2)}{\sqrt{n}}$ where n = number of pairs of observations, r = coefficient of correlation.

It is to be noted that, PE is generally used for interpreting the coefficient of correlation r, whether it is significant or not.

(i) If r < 6 × PE, then r is not significant.

(ii) If r e" 6 × PE, then r is significant.

From the above table, the coefficients of correlation between Cu & Fe, Cu & Zn, Cu & Ca, Fe & Ca and Cr & Mn are found to be significant i.e. there are significant linear relationships between these pairs of minerals.

4. Conclusion

Minerals are indispensible inorganic elements because the body is not able to synthesize them. Minerals have an impressive varieties of metabolic functions as they build, activate, regulate and control many chemicals e.g. iron in hemoglobin, zinc in insulin. These consumers have traditionally been using edible insects in their culture from the time immemorial. Since edible insects are used as food, it is important to measure their trace nutrient content. These results show that the six insect samples were good sources of minerals \which are essential for proper functioning of the body. Therefore, nine minerals were analyzed for six representative edible insects to assess the nutritive value of edible insects consumed in the tribal people in Baksa district, Assam. The present study focuses essentiality of edible insects as an important elemental constituents besides being the macronutrient value especially protein content.

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