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Determination of some essential minerals in selected edible insects

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The essential minerals, Cu, Fe, Mg, Co, Zn, Na and K were determined in selected edible insects (Locust, Cricket, Grasshoppers and Termite) using standard analytical method. The result obtained from the study shows that Cu content ranged from 85.5 ± 3.40 mg/kg; Fe from 390.025 ± 31.61 mg/kg; Mg from 1534.84 ± 85.01 mg/kg; Co from 4.35 ± 0.28 mg/kg; Zn from 208.11 ± 63.90 mg/kg; Na from 223.25 ± 14.32 mg/kg and K from 325.69 ± 7.16 mg/kg respectively. The statistical analysis shows that Cu, Co, Na and K content in the studied insects were significantly different except for Fe, Mg and Zn which shows no significant difference at P ≥ 0.05. From the high essential minerals content obtained from this study, these insects could harnessed as alternative source of these minerals in order to help compliment the nutritional needs of an individual.

Key words: Minerals, edible, insects, locust, grasshoppers, termites.

INTRODUCTION

Insects are the most successful prolific group of organism in the animal kingdom, constituting of about 76% of known species of surviving animal (Yoloye, 2010). It is well-know that insects are an attractive and important natural source of food for many kinds of vertebrae animals, including birds, lizards, snakes, amphibians (toads, frogs, salamanders), insectivore and other mammals (Banjo et al., 2010). Insects have played an important part in the history of human nutrition in Africa, Colombia, Venezuela, Asia and Latin America (Ruddle, 2006; Chavunduka, 2010). They were equally important resources for Indians of North America, who like other indigenous groups, expended much effort in harvesting them (Finke et al., 2008). The aversion to insects as human food among Europeans is nothing more than custom and prejudices as rightly asserted by Kent (2002). Hundreds of species have been used as human food. Some of the more important groups include grasshopper, termites, caterpillars and beetle grubs. Insects are being market and consumed in Western and Delta region of Nigeria and road side-hawking are visible (Banjo et al., 2006; Ifie and Emeruwa, 2011).

The high consumption of insects as food can be attributed to their high nutrient content like protein (Yoloye, 2010), fats (Quin, 2005), vitamins and minerals (Akindele et al., 2009; Kodondi et al., 2010; Oliveira et al*.,* 2007; Ledger, 2010). Also, consumption of insects as food reduces serum cholesterol and serves as haemostatic agent of tissue repairs and for accelerating the healing of wounds due to its chitin content (DeFoliart, 2007; Goodman, 2011). Other researchers in their review of different edible insects also reported the presence of various nutrient, micronutrients, proteins and vitamins in various edible insects and caution on the need to develop proper processing and decontamination method for the removal of the toxic, and pathogens and other

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Table 1. Essential mineral content in selected edible insects (mg/kg).

Parameter	Locu	Cricket	Termites	Grasshoppers
Cu	99.04 ± 6.06[a]	69.05 ± 0.70[b]	77.77 ± 9.86[b]	73.02 ± 0.74[b]
Fe	574.75 ± 30.75[a]	519.00 ± 44.5[ab]	205.30 ± 32.45[c]	349.27 ± 123.21[bc]
Mg	1484.17 ± 98.74[a]	1538.77 ± 27.47[ab]	1400.17 ± 144.78[b]	1669.50 ± 25.24[a]
Co	8.55 ± 0.56[a]	2.07 ± 0.70[c]	0.15 ± 0.00[d]	5.45 ± 0.21[b]
Zn	160.37 ± 4.84[b]	256.55 ± 28.70[a]	159.3 ± 6.29[b]	256.92 ± 121.51[a]
Na	290.25 ± 7.42[a]	156.25 ± 5.30[c]	287.5 ± 21.21[a]	243.25 ± 9.54[b]
K	480.12 ± 7.24[a]	282.80 ± 17.88[c]	317.5 ± 10.60[b]	225.25 ± 7.07[d]

Values are mean duplicate determinations. Data with the same superscript along the same row are significantly different at P ≥ 0.05.

antinutritional factors present in these insects if the consumer is to optimize the nutrient content of these insects (Birgit and Oliver, 2013).

Contamination of food products by heavy metals is becoming an unavoidable problem these days. Air, soil, and water pollution are contributing to the presence of harmful elements, such as Cadmium, Lead, Mercury, and Arsenic in foodstuffs. Most of these food stuffs are being consumed directly or indirectly by insects. The occurrences of heavy metals-enriched ecosystem components have impaired health of the population by the ingestion of foods contaminated by these harmful elements. The toxicity of heavy metals to man is mainly caused by their persistence in the environment and hinged strongly upon the chemical form in which they are ingested (Gorham, 2007).

Considering the high consumption rate of insects and their nutritional contribution to the growth and development of man and coupled with the fact that these insects migrate from one location to another and could be susceptible to heavy metal contamination through their feeding habits, there is therefore the need to constantly investigate the essential mineral content of some of these edible insects in order to ascertain if they are within the tolerable limit that will meet the nutritional needs of the consumer without causing any negative health effect.

MATERIALS AND METHODS

Sampling area and sample collection

Four types of edible insects, cricket (*Gymnogryllus lucens*), grasshopper (*Zonocerus variegatus*), termite (*Macrotermes bellicosus*) and locust (*Schisocerca gregaria*) were collected randomly from Gbaiko village, Kagara area and Gidan Kwano village of Niger State using an entomological net and some were handpicked. Insects of similar species were mixed together and sun- dried.

Sample pretreatment

All glass wares were carefully soaked with a solution of 10% nitric acid for 48 h and rinsed with deionized water. The samples were sun dried for one week to reduce the moisture content. The insects were dewinged before they were ground into powder with laboratory porcelain mortar and pestle. Each ground sample was stored in well- labeled air-tight glass containers and stored in an oven prior to digestion.

Digestion of sample

2.00 g of the sample was placed in a digestion tube and was predigested with 10 ml concentrated HNO_3 at 135°C until the liquor was clear. This was followed by the addition of 10 cm^3 HNO_3, 1 cm^3 $HClO_4$ and 2 cm^3 H_2O_2 and the heating continued at a temperature 0f 250°C for 1 h until the liquor became colourless. The digest was then slowly evaporated to near dryness (avoiding prolonged baking), cooled and dissolved in 1 m HNO_3. The digest was subsequently filtered through a Whatman No. 1 filter paper into a 100 ml volumetric flask and made up to volume with distilled water and stored for AAS analysis.

Elemental analysis

The elemental analysis of the samples were, performed using Atomic Absorption Spectrometer (Hitachi Z-8100, Japan) at the Central Laboratory for Research and Development, University Of Ibadan, Oyo State, Nigeria while Flame photometer (JENWAY PFP 7) was used to determine the K and Na content at the Department of Chemistry Laboratory, Federal University of Technology, Minna, Niger state.

Statistical analysis

The results obtained from the study were subjected to SPSS 15.00 statistical analysis using one way ANOVA and Duncan's multi range comparison test at 95% confident level.

RESULTS AND DISCUSSION

The result of essential minerals obtained from the selected edible insects studied using one way ANOVA and Duncan's multi range comparison test at 95% confident level are shown in Table 1. From the result in Table 1, the concentration of Cu in all the samples range between 69.5 ± 0.70 to 99.04 ± 6.06 mg/kg with locust having the highest concentration and cricket the least.

The finding from this study is comparable with that reported by Banjo et al. (2010), of between 73.72 to 99.04 mg/kg Cu in their analysed edible insects. But is at variance with that reported by Defoliart of between 100 to 120 mg/kg in other edible insects used as human food and as animal feeds (Defoliart, 2007). This variation can be attributed to ecological factors and variation in species.

The Iron content in the studied edible insects ranged between 205.30 ± 32.45 to 574.75 ± 30.75 mg/kg. These concentrations are lower than that reported by Bodenheimer (2005), of between 320 to 747 mg/kg. This variation could also be as a result of their feeding habits. Locust has the highest Fe value while termites the least Fe concentration. According to World Health Organization, Fe plays an important role as a heme molecule in red blood cells as it permits oxygen transport (WHO, 2006), but excessive Fe intake can also be a serious problem enhancing free radical activity in the body or damaging the liver (Ekop et al., 2010).

The magnesium concentration in the analysed edible insects ranged from 1400.17 ± 14.78 to 1669.50 ± 25.24 mg/kg, with termites having the least concentration of 1400.17 ± 14.78 mg/kg and locusts the highest 1669.50 ± 25.24 mg/kg. The need for magnesium in our diet is very important since Type 2 diabetes have been reported to be associated with low magnesium content in the body (WHO, 2005). These insects would be a better source and cheap means of obtaining this vital mineral from the food chain. It have also been reported that moderate magnesium supplements can help people with heart disease and osteoporosis, since excessive use of it can be toxic (Adeyemo et al., 2001). Generally, the Mg levels in all the samples showed no significant difference at $P \geq 0.05$ (Table 1).

The concentration of Co in the samples ranged between 0.15 ± 0.00 to 8.55 ± 0.56 mg/kg with locust, having the highest concentration of 8.55 ± 0.56 mg/kg and termites the least of 0.15 ± 0.00 mg/kg. The level of Co in all the samples was generally lower than that reported by Muyay (2009), of between 12.75 to 15 mg/kg in edible insects in Mexico. The differences are due to the geographical location and their feeding habits. Concentration of Zinc in the studied edible insects were; locusts 160.37 ± 4.84 mg/kg, cricket 256.55 ± 28.70 mg/kg, termites 159.30 ± 6.29 mg/kg and grasshoppers 256.92 ± 21.51 mg/kg respectively. This could be used to compliment the daily dietary Zinc need of 15 mg/day of an adult of 60 kg body weight (WHO, 2005). The concentration of Zinc does not show significant difference between the analysed edible insects at $P \geq 0.05$.

Considering the importance of sodium in human metabolism, Food and Agricultural Organization (FAO) has recommended a daily dietary allowance of 2400 mg of sodium per day (FAO, 2010). From the result of this study, sodium has a concentration of 290.25 ± 7.42 mg/kg in locust, 156.25 ± 5.30 mg/kg in cricket, 287.50 ± 12.21 g/kg in termites and 243.25 ± 9.54mg/kg in grasshoppers. These concentrations are lower than that reported by Banjo et al. (2010), of 1500 mg/kg in some edible insects. This variation can be attributed to differences in geographical locations as well as inter-elemental interactions (Quin, 2005).

Potassium levels for locust and termite species were 480.14 ± 7.24 mg/kg and 17.50 ± 10.60 mg/kg respectively. These values are significantly difference at $P \leq 0.05$. Those of the two, cricket and grasshopper species were 282.80 ± 17.88 mg/kg and 225.25 ± 7.07 mg/kg respectively. The result is very low compared with that reported by Chen et al. (2008), of 500 mg/kg. The variation could be attributed to the sampling location and the feeding habits of these insects. The recommended dietary allowance for K is 2,000 mg per day for the average adult (WHO, 2010). Generally, considering the high essential minerals content in the studied edible insects, they sourced and consumed in order to help compliment the deficiency of the nutritional needs of an individual.

Generally, the one way Anova and Duncan multi range comparative test, shows that edible insects, locust had the highest concentrations of most of the essential minerals analysed at $P \leq 0.05$ and at 95% confidence level and termites the least with variations between the other two insects. This goes to suggest that any consumer intending to source for these essential minerals in order to compliment his/her nutrient needs from these insects should concentrate more on locust.

Conclusion

Based on the findings it can be concluded that considering the high mineral content of these edible insects studied, their low cost and availability, that they can be harnessed and included in our diet in order to help compliment the deficiency of these minerals from other food sources.

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