Nutritional aspects of edible insect, *Coridius sp.* (Hemiptera: Dinidoridae) of Manipur

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Summary

The nutritional and antinutritional aspects of *Coridius sp.* revealed high protein (36.5%), lipids (38.7 %) and fibre (8.7 %) content. The total energy of available carbohydrates, protein, and fat was provided about 494.4 kcal/100 g of energy. Out of the micro-nutrient compositions, iron, potassium and calcium are the most prominent minerals observed in the edible bug which can be used as supplementary food to human diets. IC_{50} % of 0.363 mg/ml indicates higher than the standard value of ascorbic acid. Low values of antinutritional elements like phenol (25.3 mg/g) and tannin (31.2 mg/g) content showed non-toxic. The insect is found to sell in large quantities in the local market of Manipur. The edible insects provide economic support, nutritive values, food security and environmental management.

JAE 2022, Vol 14
Received: 22 Oct. 2022
Accepted: 10 Nov. 2022
Published: 30 Nov. 2022
https://doi.org/10.53911/JAE.2022.14223

Associate Editor: Dr. Manoj Kumar Jat

Keywords: Nutritional, anti-nutritional, protein, lipid, fibre, human diets

INTRODUCTION

Entomophagy is the practice of eating insects, and humans have followed the inclusion of edible insects in the diet for many years as a food that provides nutritional food security, family livelihood to the tribal populations and a great source to supplement food items that would meet the people's present and future need. Edible insects are preferred by tribal communities as eggs, nymphs, larvae, pupa and adult insects, and eaten as fried, cooked, roasted or even consumed raw repeatedly. The people of North-east India consider edible insects as delicious and nutritious food rich in protein, fat, vitamins, fibre and minerals. The practice of eating insects (Entomophagy) is prevalent worldwide, most developing countries like Asia and Africa, with approximately 2.5 billion population belonging to the indigenous group of people, had considered edible insects as a highly prioritized alternative food and part of their diet.[12] Due to recent global food crises, attention has been given internationally to exploring biodiversity contribution and ensuring food security. Generally, edible insects represent significant biological resources, not only proteins and fats benefit gained but also significant levels of essential nutrients comparable to or superior to that of meat and the high cost of animal protein, which is beyond the reach of the poor, has greatly encouraged entomophagy.[19, 17] Nutritional and toxicological studies on the insect provide a scientific basis for the comprehensive utilization of insects and possibly their application as a food source and in therapeutic approaches. Beef, pork, chicken, egg, fish and mushrooms are mostly studied for their nutritional values which revealed that most of the insects have higher nutrient contents than beef, pork, chicken, egg, fish and mushrooms, clearly justifying the traditional perceptions of higher nutritional quality in insects. In Manipur, North-East India, the region is inhibited by diverse ethnic communities where entomophagy practised is one of their inseparable food cultures with its highly appreciated delicacy. The study was designed to evaluate the nutritive content including minerals and antioxidant activity of one of the most widely accepted edible insects *Coridius sp.* (Hemiptera: Dinidoridae) of Manipur.

Materials and Methods

Specimens of *Coridius sp.* were collected from the local market, Ukhrul District, Manipur, collected at the adult stage which is the ideal consumption stage (Figure 1). The specimen was taken to the Laboratory Dept. of Entomology, College of Agriculture, CAU, Imphal. In the laboratory, the sampled insect was washed thoroughly in distilled water, then oven-dried (50°C), ground to a powder and prepared as dry matter (DM) for further analyses. All the solvents and chemicals used in the study were of analytical grade. Using the techniques recommended by the Association of Official Analytical Chemists (AOAC

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1990),[3] the analyses were performed for proximate compositions, *i.e.*, moisture content, crude protein, carbohydrate, crude fat, crude fibre and ash content.

Moisture percentage was calculated by drying the sample in an oven at 100 °C for 2 h. The dried sample was put into desiccators and allowed to cool and reweighed. The process was repeated until a constant weight was obtained. Crude protein was determined by the Kjeldahl method and total protein content was calculated as the amount of total N determined multiplied by a nitrogen-to-protein conversion factor of 6.25. Fat percentage was calculated by drying fats after extraction in a Soxhlet using Diethyl ether. Ash percentage was calculated by combusting the samples in a silica crucible placed in a muffle furnace. The crude fibre was determined through double digestions, first with sulphuric acid and then with sodium hydroxide. Carbohydrate content was determined by the Anthrone method[9] by taking glucose as standard.100 mg of insect sample was hydrolysed by keeping it in a boiling water bath for 3h with 5ml of 2.5ml of 2.5N HCl and cool to room temperature. It was neutralized with sodium carbonate until the effervescence ceases. Further, the content was centrifuged and the supernatant was used to estimate carbohydrates. The supernatant was allowed to react with anthrone reagent to form a dark green colour solution for which optical density was read at 630nm. The calorific value (kcal/100 g) was computed by multiplying the factors for carbohydrate and protein by 4 each and that of fat by 9 and then taking the sum of the products. All of the analyses were performed in triplicate and expressed as mean ± standard deviation.

Figure 1: Women selling edible bug, *Coridius sp.* in local market of Ukhrul, Manipur

Minerals elements such as calcium (Ca), sodium (Na), potassium (K), magnesium (Mg), phosphorus (P), iron (Fe), zinc (Z)n, copper (Cu) and manganese (Mn) were estimated using atomic absorption spectrophotometer

(AAS) after dry-ashing the samples and acid dilution.[3] The ash was digested with HCl made up to 100 mL and filtered before the mineral elements were determined by atomic absorption spectrophotometer.

The antioxidant potential of the methanol extract was determined based on the scavenging activity of stable 1,1-diphenyl-2- picryl hydroxyl (DPPH) free radicals.[23] Ascorbic acid was used as the standard, and the absorbance was measured at 517 nm. The IC_{50} value denotes the sample concentration required to scavenge 50% of the DPPH free radicals.

The Total Phenol Content (TPC) of the methanol extract of the samples was estimated by following the Folin-Ciocalteu method,[13] measuring the absorbance spectrophotometrically at 650 nm (Thermo Fisher Scientific, Multiskan Go) after 30 min incubation at room temperature and in the dark. TPC of the extract will be estimated by adding 1ml of freshly prepared Folin-Ciocalteu reagent (Sigma-Aldrich, USA) in the ratio (1:9), 1ml of 10% sodium carbonate (Merck) and 7ml Millipore water (Elix Technology, Merck), all together in the ratio of 1:1:1:7. The concentration of TPC in the extracts was determined and expressed as mg gallic acid (Sigma-Aldrich, USA) equivalent (mg GAE/100g DM) using an equation obtained from the standard gallic acid graph.

Tannin content was determined by the qualitative method using tannic acid as a standard solution.[10] A finely-ground sample (0.2 g) was soaked in 10 ml of 70% acetone for 15 minutes in ice water. To the filtrate, 0.5 ml of Lower reagent and 2.5 mL of 20% sodium carbonate were added and incubated for 40 minutes. Absorbance was measured at 700 nm.

Statistical Analysis

All the data obtained for the proximate contents, fatty acids, minerals and antioxidant activities will be evaluated by using one-way ANOVA (Analyses of Variance. P values < 0.05 will be regarded as “significant” and P values < 0.01 as “very significant”. The experimental result of the insect sample will be performed in triplicate and given as Mean ± Standard Error (SE).

Results and Discussion

The proximate composition of *Coridius sp.* such as moisture, crude protein, carbohydrate, lipid, ash, fibre, and energy was analyzed and the results are presented in Table 1. A moisture content of 9.5 % was found in *Coridius sp.* which is lower as compared to the moisture content of all edible insects reported by Banjo et al. (2006)[4] and Shantibala et al. (2014)[24] which would be a great advantage for its storage as low moisture content indicates good shelf-life characteristics. The protein content was found to be 36.5% which is shown to be a good source of protein. The protein content (%) exhibited by the insects was significantly higher than in conventional animal meats, and therefore insects may offer an affordable source of protein to counteract protein malnutrition.[14] The lipid content was observed to be 38.73 % lower as compared to the fat content (60.42%) of the Bamboo insect, *Chilo fuscidentalis* by Ying & Xiao-ming (2000).[27] The fat content of edible bugs was higher than edible insects reported by Ying *et al.* 2001 found between 10 and 50%. The energy available in carbohydrates, protein, and fat was also analyzed. A total of about 494.4 kcal/100 g of calorific value was reflected in the studied insect sample contributing high energy value in the diet. The gross energy value given by these edible insects depends on the amount of protein, fat, and carbohydrate contents in the insect. In the study, the larval crude fibre and ash content were found to be 8.70 % and 2.9 % respectively which is lower than edible aquatic insects reported by Shantibala et al. (2014).[24] The crude fibre content of the insect in this study was quite high, compared to other edible insects reported by Adeduntan 2005,[1] Mbah & Elekima 2007.[18] The high crude fibre content in the insects could be due to the chitin normally found in insects.[2] Chitin is a structural nitrogen-based carbohydrate found in the exoskeleton of insects, which may have ‘anti-nutrient’ properties due to potential negative effects on protein digestibility.[5] A study comparing dried honey bees and honey bee protein concluded that the removal of chitin improved the quality of the insect protein as measured through protein digestibility, amino acid content, protein efficiency ratio and net protein utilisation.[20] On the other way, chitin is notably high in fibre, and chitin extracts from the exoskeletons of shellfish have been approved by relevant authorities and are readily used in Japan as a source of fibre in cereals.[8] Although chitin is usually considered to be indigestible by humans,[6] chitinolytic enzymes, produced by bacteria from human gastrointestinal tracts, have recently been found, suggesting that chitin and chitosan can be digested.[21, 22] Moreover, the high crude fibre content can be used to complement animal roughages in addition to other uses mentioned earlier.[18]

Table 1: Proximate composition of *Coridius sp.*

Components	Average composition
Moisture %	9.5 ±0.21
Protein %	36.5 ±0.95
Lipid %	38.73 ±0.24
Carbohydrates %	0.06 ± 0.00
Calorific value (kcal/100g)	494.4 ± 12.37
Fibre %	8.70 ± 0.15
Ash %	2.9 ± 0.08

Results are in means of triplicate determinations ± SE

Mineral profile: Among the mineral compositions, calcium and iron were the most prominent in *Coridius sp.* followed by potassium, sodium, phosphorus, magnesium, manganese, zinc and copper shown in Table 2. Mineral content, as well as exceptional nutrient values in insects, are several times higher than most of the traditional foods we consumed.[19] Mineral deficiency mainly leads to major primary health issues. This species could supplement a good amount of micronutrients with a surplus amount of Ca, K, Na and Fe for human consumption. The level of minerals present in edible insects indicates that insects are good sources of minerals for the human body.[15] Because sodium is both an electrolyte and mineral, it helps to maintain the amount of fluid inside and outside the body's cells and the electrolyte balance in the body. The mineral content of *Coridius sp.* is provided with a contribution to per cent RDA (Recommended Dietary Allowance) requirements as well as the mineral content of some conventional foods. The per cent fulfilment of recommended intake for macro elements was found to be lower than for microelements. Calcium (232.7mg/100g) could supplement about 23.27% in both male and female adults whereas magnesium with the least content (42.8mg/100g) among micronutrients could fulfil 9.73% and 11.57% in males and females respectively. But the species could supply an adequate amount of microelement with the highest iron content (373.6mg/100g) from all the studied edible insects and conventional food also. The percentage of recommended intake contributed by microelement content in insects exceeded the requirement in both male and female adults. The species is a potential source of micronutrients and can supply an adequate amount for nutrition and health through consumers' diets.

Table 2: Recommended intakes of essential minerals of humans per day compared with *Coridius sp.* (Mean ± SE)

Minerals	Intake recommended (mg/day)		*Coridius sp.* (mg/100g dry weight)	Per cent fulfilment of recommended intake	
	Male	Female		Males	Females
Calcium	1000	1000	232.7 ± 3.27	23.27	23.27
Sodium	2000	2000	142.5 ± 1.12	7.13	7.13
Potassium	3500	3500	200.1 ± 0.95	5.72	5.72
Magnesium	440	370	42.8 ± 0.17	9.73	11.57
Phosphorus	1000	1000	48.4 ± 1.04	4.84	4.84
Zinc	17	13	13.3 ± 0.20	78.24	78.24
Iron	19	29	373.6 ± 8.95	1966.32	1288.28
Copper	2	2	2.3 ± 0.03	115	115
Manganese	4	4	25.9 ± 0.29	647.5	647.5

Results are in means of triplicate determinations ± SE.

Anti-nutritional factor: The total phenolic and tannin content of the methanol extract of the selected insect *Coridius sp.* was found to be 25.3 mg GAE/g DM and 31.2 mg TAE/100g DM respectively which is shown in Table 3. Chakravorty et al. 2016[7] reported tannin content for *Oecophylla smaragdina* and for *Odontotermes* sp. as 615.0 mg/100 g and 496.67 mg/100 respectively, values much lower than some common foods of plant origin. The polyphenolic compound is considered one of the most effective antioxidant constituents in plant food and grains.[26] Tannin forms insoluble complexes with protein, thereby reducing protein absorption due to phenolic hydroxyl groups that produce unstable radicals.[11] With the increasing utilization of antioxidant properties in the food industry for health benefits very less information is reported on phenolic content and its compounds for edible insects. Suh et al. (2010)[25] found many phytochemical constituents from extracts of Coleopteran larva (*Allomyrina dichotoma*) as well as the adult edible beetle, *Holotrichia parallela* was found with phenolic compounds and proposed that catechin with protein synergistic antioxidant activity.[16]

Table 3: The anti-nutritional factor of *Coridius sp.*

Insect species	Total Phenol content (mg GAE/g DM)	Total Tannin content (mg TAE/g DM)	DPPH radical scavenging activity (IC_{50} values)
Coridius sp.	25.3 ± 0.36	31.2 ± 0.54	0.363 ± 0.96

Results are in means of triplicate determinations ± SE.

The antioxidant property DPPH (2,2-diphenylpicrylhydrazyl) free radical scavenging assay of methanol extract compared with standard ascorbic acid was analyzed. The IC_{50} value of the insect was found to be 0.363mg/ml which is greater than the standard value (0.123mg/ml) and lesser than *Crocothemis servilia* (880 µg/mL) showing scavenging activity ranging from 110 to 880 µg/ml, with highest and lowest in *Cybister tripunctatus* (110µg/mL) and *Crocothemis servilia* (880 µg/mL) reported by Shantibala et al. (2014).[24] The species with a lesser IC_{50}% value had stronger antioxidant properties.

Acknowledgement

The research was supported and funded by the NMHS Project entitled "Systematic Inventorization, Use Profiles and Molecular cataloguing for the sustainable management of Edible Insects resources for boost the livelihood security of local people of the Himalayan range of Manipur, North East India. The authors are thankful to the Department of Entomology, College of Agriculture, CAU, Imphal for allowing them to avail the laboratory facilities.

Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

References

1 Adeduntan SA. 2005. Nutritional and antinutritional characteristics of some insects foraging in Akure forest reserve Ondo state, Nigeria. *Journal of Food Technology*, 3: 563–567.

2 Akinnawo O & Ketiku AO. 2000. Chemical composition and fatty acid profile of edible larva of *Cirina forda* (westwood). *African Journal of Biomedical Research*,3: 93– 96.

3 AOAC. 1990. Official methods of Analysis (15th Ed.) *Association of Official Analytical Chemists*. Washington DC, USA.

4 Banjo AD, Lawal OA & Songonuga EA. 2006. The nutritional value of fourteen species of edible insects in southwestern Nigeria. *African Journal of Biotechnology*, 5: 298–301.

5 Belluco S, Losasso C, Maggioletti M, Alonzi, CC, PaolettiMG, & Ricci A. 2013. Edible insects in a food safety and nutritional perspective: A critical review. *Comprehensive Reviews in Food Science and Food Safety*, 12(3): 296–313.

6 Bukkens SGF. 1997. *Ecology of Food and Nutrition*, 36:287-319.

7 Chakravorty J, Ghosh S, Megu K, Jung C & Meyer-Rochow VB. 2016. Nutritional and anti-nutritional composition of *Oecophylla smaragdina* (Hymenoptera: Formicidae) and *Odontotermes sp.* (Isoptera: Termitidae): Two preferred edible insects of Arunachal Pradesh, India. *Journal of Asia-Pacific Entomology*, 19: 711–720.

8 DeFoliart GR. 1992. Insects as human food: gene DeFoliart discusses some nutritional and economic aspects. *Crop Protection*, 11(5):395–9.

9 Dubois M, Gilles KA, Hamilton JK, Rebers PA & SmithF. 1956. Colourimetric method for determination of sugars and related substances. *Analytical Chemistry*, 28: 350–356.

10 Enujiugha VN & Ayodele-Oni. 2003. Evaluation of nutrients and some antinutrients in lesser-known underutilized oil seeds. *International Journal of Food Science and Technology*, 38: 525–528.

11 Feeney PP. 1969. Inhibitory effect of oak leaf tannin on the hydrolysis of protein by trypsin. *Phytochemistry*, 8: 2119–2126.

12 Haldhar SM, Thangjam R, Kadam V, Jakhar BL, Loganathan R, Singh KI, Rolania K, Singh S, Dhaka SR & Singh KM. 2021. A review on Entomophagy: Natural food insects for ethnic and tribal communities of North-East India. *Journal of Environmental Biology*, 42: 1425-1432.

13 Harborne JB. 1973. Phytochemical Methods, *Chapman and Hall, Ltd., London*, pp. 49-188.

14 Kariuki PW. 1991. Malnutrition and gender relations in Western Kenya. *Health Transition Review*,1(2):171-87.

15 Kinyuru JN, Kenji GM, Muhoho SN & Ayieko M. 2010. Nutritional potential of longhorn grasshopper (*Ruspolia differens*) consumed in Siaya district, Kenya. *Journal of Agricultural Science and Technology*, 12: 32–46.

16 Liu S, Sun J, Yu L, Zhang C, Bi J, Zhu F, Qu M & Yang Q. 2012. Antioxidant activity and phenolic compounds of *Holotrichia parallela* Motschulsky extracts. *Food chemistry*, 134:1885-1891.

17 Loganathan R & Haldhar SM. 2020. Utilization of edible insect as food in Northeast India. *Indian Entomologist*, 1 (2): 25-31.

18 Mbah CE & Elekima GOV. 2007. Nutrient composition of some terrestrial insects in Ahmadu Bello University. *Science World Journal*, 2 (2): 17–21.

19 Narzari S & Sarmah J. 2017. Nutritional aspects of an aquatic edible insect *Sympetrum sp.* (Odonata: Libellulidae) of Assam, northeast India. *International Journal of Food Science and Nutrition*, 2(4):38-42.

20 Ozimek L, Sauer WC, Kozikowski V, Ryan JK, Jorgensen H & Jelen P. 1985. Nutritive value of protein extracted from honey bees. *Journal of Food Science*, 50:1327–1332.

21 Paoletti MG, Norberto L, Damini R & Musumeci S. 2007. Human gastric juice contains chitinase that can

degrade chitin. *Annals of Nutrition and Metabolism*, 51(3):244–51.

22 Rumpold BA & Schluter OK. 2013. Potential and challenges of insects as an innovative source for food and feed production. *Innovative Food Science & Emerging Technology*, 17:1–11.

23 Sanchez-Moreno C, Larrauri JA and Saura Calixto F. 1998. A procedure to measure the antiradical efficiency of polyphenols. *Journal of the Food Science and Agriculture*, 76: 270–276.

24 Shantibala T, Lokeshwari RK & Debaraj H. 2014. Nutritional and antinutritional composition of the five species of aquatic edible insects consumed in Manipur, India. *Journal of Insect Science* 14:14. Available Online: http://www.Insectscience.org/14.14

25 Suh HJ, Kim SR, Lee KS, Park S & Kang SC. 2010. Antioxidant activity of various solvent extracts from *Allomyrina dichotoma* (Arthropoda: Insecta) larvae. *Journal of Photochemistry and Photobiology B: Biology*, 99:67-73.

26 Velioglu YS, Mazza G, Gao L & Oomal BD. 1998. Antioxidant activity and total phenolics in selected fruits, vegetables and grain products. *Journal of Agricultural and Food Chemistry*, 46(10): 4113 – 4117.

27 Ying F & Xiao-ming C. 2000. The Nutritional Elements Analysis of bamboo insect and review on its development and utilization value. *Forest Research*, 13(2): 188 - 191.

Preferred citation: Sheileja T, Singh KM, Shantibala T, Haldhar SM & Singh KI. 2022. Nutritional aspects of edible insect, *Coridius sp.* (Hemiptera: Dinidoridae) of Manipur. *Journal of Agriculture and Ecology*, 14: 158-163; http://doi.org/10.53911/JAE.2022.14223