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EXPLORING THE NUTRITIONAL PROFILE OF A NON-MULBERRY SILK WORM CONSUMED AS FOOD IN ASSAM

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ABSTRACT

The present study aims to investigate the nutritional profile of non-mulberry silk worm *Philosamia ricini,* an edible insect consumed in Assam, India. This research focuses on exploring the proximate composition, mineral and trace element contents. Both the larval and pupal stages were studied. The moisture, crude protein, fat, fibre, total ash and carbohydrates/ Nitrogen Free Extract were determined using standard methods of AOAC while minerals and trace elements were analysed using ICP-OES. Crude protein and crude fat were found to be higher in larval and pupal stages, respectively. Both the larval and pupal stages showed high levels of potassium (K). Findings reveal that *P. ricini* is highly nutritious, with significant levels of crude protein and crude fat. The silkworm also contains considerable amounts of key minerals such as calcium, iron and magnesium, as well as trace elements like zinc and copper. These results highlight the potential of *P. ricini* as a sustainable and nutrient-rich food source.

Key words: Edible, *Philosamia ricini***,** larval, pupal, protein, fat, potential, sustainable, food, minerals, protein, fat, potassium, calcium, iron, magnesium, zinc, copper

In the historical context of human nutrition, insects have significantly served as a vital food source, particularly in developing nations (Bodenheimer, 1951). The practice of including insects in the human diet is known as entomophagy (Evans et al., 2015). Over 1,900 insect species have been documented as food items (Yang et al., 2009). With a growing global population and the escalating demand for food, there is a pressing need to explore alternative protein sources that are environmentally friendly. Insects are a promising option, as they are highly efficient in converting feed into protein, emit fewer greenhouse gases, and require less land and water compared to conventional livestock (Van Huis and Oonincx, 2017). Around 2,000 insect species are consumed in atleast 113 countries (Yen, 2009). Entomophagy, is observed in various parts of India, where it is not only a cultural practice but also a valuable source of nutrition. While the practice is more prominent in certain regions, such as the north eastern states, it has been recorded across the country among different ethnic groups and communities. Approximately 158 insect species are consumed by the people of Arunachal Pradesh (Chakravorty et al., 2011).Additionally, 15 edible insect species were documented among the Mishing tribes in the Dhemaji district of Assam. The Mishing tribe uses edible insects such as *Vespa orientalis*, *Apis cerana indica*, *Samia cynthia ricini*, *Antheraea assamensis*, *Oecophylla smaragdina*, *Odontotermes obesus*, *Eumenes petiolata* and *Schistocerca gregaria* for therapeutic purposes and traditional beliefs (Doley and Kalita, 2012).

Among the Rabhas in Assam, edible insects are not reserved solely for emergencies during food shortages; instead, they are purposefully included as a regular component of the diet throughout the year or when they are in season. The future acceptance of insects as a food source could be enhanced by processing and combining them with other ingredients (Rabha, 2016). Entomophagy has also been observed in the Karbi Anglong district of Assam, reported by Ronghang and Ahmed (2010), which revealed consumption of 32 different species of edible insects. The Eri silk worm and red ants are particularly favoured by the tribes in the Karbi Anglong district. In the Udalguri district of Assam, the Bodo community has been documented consuming 23 species of edible insects from the orders Hemiptera, Coleoptera, Hymenoptera, Orthoptera, Lepidoptera, Isoptera and Odonata (Hazarika and Goyari, 2017). Among these, the giant water bug (*Lethocerus indicus*) and larvae of *Samia ricini* are the most favoured species. This present study focuses on the nutritional assessment through determination of proximate composition and minerals and trace elements of a widely consumed edible insect in Assam, India, aiming to provide valuable insights into their potential as a sustainable protein source. The insect selected for this analysis is chosen based on their cultural significance and widespread consumption in the region.

MATERIALS AND METHODS

The study was designed to determine the proximate composition and mineral and trace elements of *P. ricini*, a widely and popularly consumed edible insect of Assam.Fresh insect samples were collected from local markets of Kamrup (Metro) and brought to the laboratory. The larval and pupal stages of *P. ricini* were chosen for this study. For proximate analysis, the parameters such as moisture, total ash, crude protein, crude fat, crude fibre, Nitrogen-free extract (NFE) were determined using standard methods of AOAC (1990; 1995). Minerals and trace elements, i.e., iron (Fe), copper (Cu), zinc (Zn), sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), manganese (Mn) and phosphorous (P) were analyzed using ICP-OES, where, acid digestion method was used to prepare the samples using hot plate digestion. Total ash was determined by burning the samples in a silica crucible within a muffle furnace. Crude protein was determined by Kjeldahl method, which involves digestion, distillation and titration. The protein content was obtained by multiplying the nitrogen content with the factor 6.25. Crude fat was determined by extracting fats in a Soxhlet apparatus. Crude fibre was analysed using a two-step digestion process involving sulfuric acid followed by sodium hydroxide. Nitrogen-free extract (NFE) is derived by deducting the total value of crude protein, crude fat, crude fibre and ash from 100.

RESULTS AND DISCUSSION

The larval and pupal stages of *P.ricini* have high moisture content (Fig. 1); the larval stage showing a slightly higher value, i.e., 72.27± 0.19 (% of fresh weight), which slightly corroborates with Longvah et al. (2011) with values 71.55± 0.52% (*P. ricini* fed on castor leaves) and 70.90± 0.68% (*P. ricini* fed on tapioca leaves). Both stages have low total ash content, indicating a similar mineral profile. Crude protein content is high in both stages, with a slightly higher value in the larval stage, which corroborates with Ray and Gangopadhyay (2021) with values 62.24± 1.15% (pre-pupa, male) and 61.13± 1.83% (pre-pupa, female). Protein is an essential macronutrient necessary for muscle growth, repair and overall health. The high protein content makes these insects a valuable source

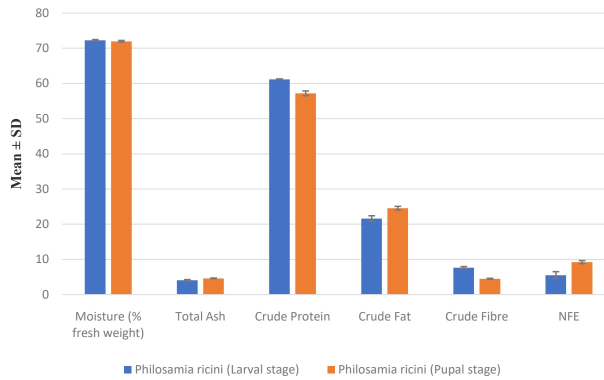

Fig. 1. Proximate analysis (% DM) of two stages of *P. ricini*

of protein, potentially comparable to conventional livestock. The crude fat content is higher in the pupal stage compared to the larval stage, which suggests a richer energy source, which could be beneficial in calorically dense diets. Both larval and pupal stages of *P. ricini* have low crude fibre content, with the larval stage having a slightly higher value. The pupal stage has a higher NFE, indicating a slightly higher carbohydrate content. Choudhury et al. (2020) analyzed proximate composition of pre-pupae of *S. ricini* with values of ash, crude fibre and crude fat content as 4.10± 0.077%, 8.24± 0.382% and 22.23± 0.209%, respectively. Longvah et al. (2011) determined the proximate compositions and mineral contents of pre-pupae and pupal stages grown on tapioca and castor leaves, which showed ash %, fat %, crude fibre % of pre-pupa fed on castor and tapioca leaves with values 4.00± 0.08, 4.10± 0.09; 26.20± 0.32, 26.20± 0.38 and 3.26± 0.07, 3.14± 0.06%, respectively, whereas, pupal stages showed protein %, ash %, fat %, crude fibre % with values 54.6± 0.56, 54.8± 0.61; 3.80± 0.67, 4.20± 0.08; 26.20± 0.35, 25.00± 0.36 and 3.45± 0.06, 3.62± 0.07, respectively.

In the present study, the mineral and trace elements analysis (Fig. 2) showed that both the larval and pupal stages have high levels of potassium (K), with slightly

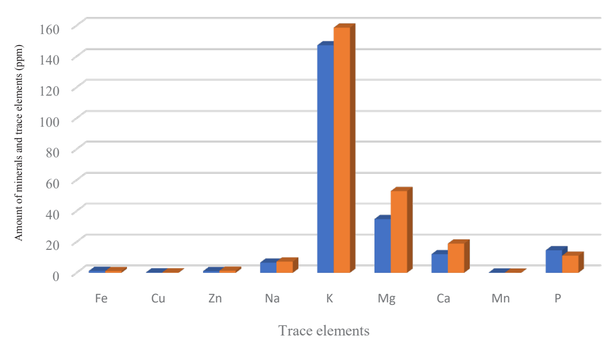

Fig. 2. Minerals and elements of *P. ricini* (Larval and pupal stage; in ppm)

higher concentrations in the pupal stage, with 158.584 ppm. Potassium is essential for maintaining cellular function and fluid balance in the human body (Pohl et al., 2013). There is a significant amount of magnesium (Mg), more so in the pupal stage, with 52.833 ppm. Magnesium plays a vital role in muscle function, nerve signalling, and energy production (Saris et al., 2000). Both larval and pupal stages show considerable amounts of phosphorus (P) slightly higher in the larval stage. Calcium (Ca) is present in moderate amounts, with higher concentrations in the pupal stage, calcium is crucial for bone health and various metabolic processes (Pravina et al., 2013). The present study shows that both the larval and pupal stages have low sodium (Na) levels, which is beneficial as high sodium intake is often linked to hypertension (Grillo et al., 2019). Apart from these, the trace elements Iron (Fe), Copper (Cu), Zinc (Zn), Manganese (Mn) are also present in small amounts. The nutritional profile of *P. ricini* in both larval and pupal stages suggests that these insects could be a valuable food source.

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AUTHOR CONTRIBUTION STATEMENT

Both the authors, DD and DB conceived and designed the study. DD conducted the experiments, analyzed the data and wrote the manuscript. Both authors, DD and DB read and approved the final manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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