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Proximate and Mineral Composition of Freshwater Snails of Tripura, North-East India

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Abstract

Four freshwater snails (*Brotia costula, Bellamya bengalensis, Bellamya dissimilis* and *Pila globosa*) were assessed for proximate and mineral compositions with an aim of establishing their nutritive values. Analysis of muscle tissues showed crude protein levels from 11.18 (*B. dissimilis*) to 15.59% (*P. globosa*), moisture 65.80 (*B. bengalensis*) to 73.80% (*P. globosa*), lipid 0.82 (*B. costula*) to 1.15% (*P. globosa*), ash 3.82 (*P. globosa*) to 8.11% (*Bellamya* spp.) and carbohydrate 5.62 (*P. globosa*) to 11.97% (*Bellamya* spp.). Among the minerals, calcium content varied from 142 (*B. dissimilis*) to 312.50 mg% (*P. globosa*), phosphorus 55.39 (*B. dissimilis*) to 121.17 mg% (*P. globosa*), potassium 118.20 (*B. dissimilis*) to 182.28 mg% (*P. globosa*), magnesium 13.37 (*B. dissimilis*) to 21.43 mg% (*B. bengalensis*), iron 4.03 (*B. dissimilis*) to 68.64 mg% (*P. globosa*), copper 0.41 (*B. dissimilis*) to 0.84 mg% (*P. globosa*), zinc 1.47 (*B. costula*) to 2.17 mg% (*P. globosa*) and manganese 3.13 (*B. costula*) to 5.33 mg% (*P. globosa*). These values were significantly different ($p<0.05$) among the snails. Crude fibre was not detected. Mercury and arsenic were not detected in any of the samples. From this study, it is clear that freshwater snails of Tripura are rich in macro and micro nutrients needed for human body; they are safe from heavy metal contamination, hence recommended for regular consumption.

Keywords: Freshwater snails, minerals, nutrition, proximate

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Introduction

Livestock is the major source of animal protein in the diet of the people. However, these sources are under threat from conditions like drought, diseases, high cost of feed, primitive animal husbandry practices and low productivity of the animals. The situation is more alarming in North-East States of India because of strategic location, geo-ecological fragility, transboundaries and most importantly the socio-economic instabilities of the place which are inherent. The ever increasing growth of human population together with the rising standard of living exerts immense pressure on the existing resources of animal protein and hence low-cost alternative sources of protein is needed.

Snails are a group of molluscs which constitute the largest animal group after arthropods (Yoloye, 1984). Since ancient times, snails are being used as medicines by aboriginal people for curing rheumatism, cardiac diseases, asthma, urticaria, rickets, calcium metabolism, nervousness, giddiness, circulatory disorders, high body temperature, constipation, haemorrhoids and as a source of trace vitamins and minerals (Mahata, 2002). Snail meat helps in restoring virility and vitality, cures hypertension (Oyenuga, 1968). The highly delicious and proteinaceous snail meat is popular in West Africa, France, Italy, Chile, Mexico, Taiwan, Formosa, Philippines, Thailand, Bangladesh etc (Baby et al., 2010; Nargis et al., 2011). There is now a considerable interest in snail farming (Elmislie, 1982).

In India, snails were mostly consumed by the tribes. Saha (1998) reported snail consumption in 29 tribal groups. However, the reports on the nutritive value of freshwater snails are very scant. Hence the present study was undertaken to assess the proximate and mineral compositions as well as heavy metal contaminations of freshwater snails of Tripura.

Materials and Methods

The study was conducted in ICAR Research Complex for NEH Region, Tripura Centre, Lembucherra. Snail species studied were *Brotia costula* (Rafinesque), *Bellamya bengalensis* (Lamarck), *Bellamya dissimilis* (Mueller) and *Pila globosa* (Swainson). They were collected locally from ponds, paddy fields, wetlands and markets. After collection, they were cleaned and measured for wet weight (g), total length (cm), total width (cm), aperture length (cm), aperture width (cm). Edible parts from the shells of each species were removed carefully using a needle and weighed to the nearest 0.1 g in a weighing machine (Shimadzu) and meat content was calculated (Table 1). Flesh samples were analysed for proximate and mineral contents. Moisture, ash and crude fibre were determined by the methods of the Association of Official Analytical Chemists (AOAC, 1990). Nitrogen content was determined by the Micro-Kjeldahl method (Pearson, 1976) and crude protein level was calculated by multiplying the percentage nitrogen with a factor 6.25. Lipid content was determined by acid hydrolysis by refluxing the fresh sample with 3 N hydrochloric acid for 1 h (Neilsen, 2010). Carbohydrate content was determined by calculating the difference between 100% (accepted total value of nutritional status) and the sum of values of moisture, protein, fibre, lipid and ash. Potassium content was determined by flame photometer (Systronics 130) using KCl as standard solution, whereas, phosphorus content was determined by phosphor-vanadomolybdate method using potassium di-hydrogen phosphate as standard solution. Other minerals were determined by atomic absorption spectrophotometer (GBC 932 plus) using the solutions obtained by dry-ashing the samples at 550°C in a muffle furnace (Thermotech, TIC-4000) followed by dissolving the ash in volumetric flasks with distilled water containing few drops of concentrated hydrochloric acid. All samples were tested in triplicate. Data were analysed using the SPSS 11.5 and expressed as mean±SD. One-way ANOVA was performed followed by Duncun post-hoc analysis to compare the means of proximate analysis of different snails at 5% level of significance ($p \leq 0.5$).

Results and Discussion

The morphometric characteristics of freshwater snails used in the study are given in Table 1. The weight of snails varied between 3.172 to 9.06 g. Total length and aperture length varied between 1.14 - 5.38 cm and 0.91 - 2.6 cm, respectively. Meat content was highest for *B. dissimilis* and least for *B. costula.* Proximate compositions of snails are presented in Table 2. Levels of moisture, protein, lipid and ash showed variations among the snails. In *P. globosa*, moisture level was higher ($p \leq 0.05$) compared to *B. dissimilis* and *B. bengalensis*, whereas, protein and lipid levels were significantly higher ($p \leq 0.05$) than other snail species. There were no significant differences ($p \geq 0.05$) in protein and lipid contents among *B. costula*, *B. bengalensis* and *B. dissimilis*. Ash content was higher ($p \leq 0.05$) in *B. dissimilis, B. costula* and *B. bengalensis* compared to *P. globosa,* however, it showed non-significant differences ($p \geq 0.05$) among *B. dissimilis, B. costula* and *B. bengalensis*. Carbohydrate contents in *B. dissimilis* and *B. bengalensis* were higher ($p \leq 0.05$) compared to *P. globosa*, but, it did not differ significantly ($p \geq 0.05$) among *B. dissimilis, B. costula* and *B. bengalensis*. Crude fibres were not detected in any of the species.

Table 1. Morphometry and meat content of four species of freshwater snails.

Morphometry	Species			
	B. costula	*B. bengalensis*	*B. dissimilis*	*P. globosa*
Weight (g)	6.49±2.40	6.97±1.56	3.17±0.71	9.06±2.03
Total length (cm)	5.38±0.78	2.51±0.40	1.14±0.18	3.27±0.52
Total width (cm)	1.61±0.32	1.88±0.21	0.85±0.09	2.45±0.27
Aperture length (cm)	1.23±0.18	2.00±0.18	0.91±0.08	2.60±0.24
Aperture width (cm)	1.10±0.19	1.23±0.16	0.56±0.07	1.61±0.21
Meat content (%)	36.56±6.57	41.99±4.33	48.24±5.45	43.43±10.89

Mineral composition of snails is presented in Table 3. Values of calcium, phosphorus, potassium, magnesium, iron, copper, zinc and manganese varied species of snails. Mercury and arsenic were not detected in any of the samples. Calcium content was higher ($p \leq 0.05$) in *P. globosa* compared to other species. There was no significant difference ($p \geq 0.05$) in calcium level between *B. costula* and *B. bengalensis* however, it was higher ($p \leq 0.05$) compared to *B. dissimilis*. Phosphorus level was higher ($p \leq 0.05$) in *P. globosa* and *B. costula* compared to the rest. Magnesium level was higher ($p \leq 0.05$) in *B. bengalensis* than *B. dissimilis*. Iron level was higher ($p \leq 0.05$) in *P. globosa* compared to other species of snails where it was non-significantly ($p \geq 0.05$) different among them. Copper level was higher ($p \leq 0.05$) in *P. globosa* than *B. bengalensis.* Zinc level was higher ($p \leq 0.05$) in *P. globosa* than *B. costula.*

The present study provided information on proximate and mineral compositions of freshwater snails from Tripura, NE India. All snails were rich in protein and iron and low in fat (Orisawuyi, 1989). Protein content of snails (11.18 to 15.59%) studied were lower than that in freshwater fishes; however, it is comparable with other snails (Babalola & Akinsoyinu, 2009) and livestock (FAO, 2001). The protein contents of the snails are higher than cereals (8 to 12%) (Bender, 1992), therefore, during relative deficiency of essential amino acids (like lysine) in cereals, snails could be ideal supplement. Low content of fibre in snails is due to their swimming activity in water which is more strenuous than

Table 2. Proximate composition of four species of freshwater snails.

Proximate contents (%)	Species			
	B. costula	*B. bengalensis*	*B. dissimilis*	*P. globosa*
Moisture	69.86±3.68^{ab}	65.80±9.49^{a}	67.73±5.48^{a}	73.80±4.87^{b}
Protein	12.91±2.52^{a}	13.14±1.82^{a}	11.18±2.17^{a}	15.59±1.14^{b}
Lipid	0.82±0.16^{a}	0.96±0.14^{a}	0.99±0.20^{a}	1.15±0.17^{b}
Ash	7.28±2.15^{b}	8.11±2.56^{b}	8.15±2.36^{b}	3.82±1.80^{a}
Carbohydrate	9.12±2.81^{ab}	11.97±6.96^{b}	11.46±6.42^{b}	5.62±5.83^{a}
Fibre	ND	ND	ND	ND

ND - not detected. Values in the same row having the same superscripts are not significantly different ($p \geq 0.05$)

Table 3. Mineral composition of four species of freshwater snails.

Mineral (mg%)	Species			
	B. costula	*B. bengalensis*	*B. dissimilis*	*P. globosa*
Calcium	236.07±23.66^{b}	227.13±31.96^{b}	142.50±12.47^{a}	312.50±12.67^{c}
Phosphorus	116.87±9.76^{c}	93.53±1.65^{b}	55.39±8.66^{a}	121.17±10.17^{c}
Potassium	161.87±7.11^{c}	143.80±8.81^{b}	118.20±5.57^{a}	182.28±8.02^{d}
Magnesium	17.93±2.84^{ab}	21.43±0.74^{b}	13.37±2.31^{a}	18.50±4.12^{ab}
Iron	5.07±1.85^{a}	4.81±1.21^{a}	4.03±1.41^{a}	6.86±3.45^{b}
Copper	0.73±0.35^{ab}	0.69±0.19^{a}	0.41±0.04^{ab}	0.84±0.08^{b}
Zinc	1.47±0.31^{a}	1.57±0.21^{ab}	2.07±0.42^{ab}	2.17±0.35^{b}
Manganese	3.13±0.31^{a}	3.17±0.35^{a}	4.27±1.17^{ab}	5.33±1.10^{b}
Mercury	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND

ND - not detected. Values in the same row having the same superscripts are not differed significantly ($p \geq 0.05$)

crawling in the land (Obande et al., 2013). This might be the reason for meat of aquatic snails being tougher than land snails (Eneji et al., 2008). Ash contents of the snails are higher and comparable with the findings of Obande et al. (2013) and Akinusi (1998). It could be due to more absolute mineral accumulation in water body. Moisture and lipid contents of snails are comparable with findings of Babalola & Akinsoyinu (2009) and Fagbuaro et al. (2006). Lipid content of snails is lower than other animals (Judith & Jenny, 1987); extensively used against hypertension and other related ailments in human (Adegbola, 1998). Low levels of lipids could be due to lipid-oriented metabolism during physiological activity like swimming. This could also be related to the location of the environment and origin of snails (Abua, 1995). Carbohydrate contents of the snails are comparable with the finding of Mitra & Mittra (1945). Higher levels of carbohydrate could be due to over-activeness of the snails for reproduction with the approach of monsoon.

All the snail species are rich in both macro and micro elements. Calcium content (142.50-315.50 mg 100 mg^{-1}) is higher than the values of beef (7), liver (6), egg (54) and milk (120) which agrees the findings of Adeyeye (1996) and Fagbuaro et al. (2006). Phosphorus content (55.39-121.17 g 100 g^{-1}) is low compared to beef (156), liver (313), eggs (218) and milk (95) mg 100 g^{-1} (Fox & Cameron, 1980) which however are comparable with Tunisian snail (Zarai et al., 2010) and *Archachatina marginata* (Fagbuaro et al., 2006). Therefore, snails could be ideal supplement for calcium which helps in blood clotting and phosphorus which helps in bone and teeth calcification and in the activity of adenosine polyphosphatase, the key enzyme responsible for energy release in the body (Nair & Mathew, 2000). Potassium levels (118.20-182.28 mg 100 g^{-1}) are higher than findings of Obande et al. (2013) which indicate snail consumption helps in normal functioning of nerves, muscle and heart tissues, sugar metabolism, ion balance and oxygen metabolism in the brain. Magnesium levels (13.37-21.43 mg 100 g^{-1}) agree well with the findings in land snails (Babalola & Akinsoyinu, 2009). Snails are rich in iron (Ajayi et al., 1978). In this study, iron content of snails (4.0-6.8 mg 100 g^{-1}) are higher than the land snails (Babalola & Akinsoyinu, 2009) and favourably comparable with animal products like kidney (6), liver (11.4), fish (2.9), beef (1.9), eggs (2.1) and milk (0.1) (Fox & Cameron, 1980) and earlier findings in snails (Wosu, 2003). Therefore, aquatic snail can be recommended for pregnant women and children to prevent anaemia (Demirezen & Uruc, 2006), particularly in NEH states in India (Arlappa et al., 2011). Additionally, snail sources of iron absorb faster than plant sources due to haeme form (Bender, 1992). Copper contents (0.41 to 0.84 mg 100 g^{-1}) are comparable with the finding of Babalola & Akinsoyinu (2009), whereas zinc (1.47 to 2.17 mg%) with Fagbuaro et al. (2006). Copper is an active component of cytochrome oxidase and tyrosinase which helps in tissue respiration in association with iron. Daily copper requirement in human body is 1-3 mg; therefore, daily consumption of 100 g snail could meet substantial quantity of daily copper requirement (Fox & Cameron 1980). Similarly snails can contribute significantly in zinc nutrition (15-20 mg day^{-1}) (Moitra, 2011). Manganese content (3.13 to 5.33 mg 100 g^{-1}) of snails in this study is higher than those reported by Fagbuaro et al. (2006) which indicates snails could be an alternative to meat and poultry sources of manganese (Fleck, 1976), which is required for bone formation, reproduction and normal functioning of nervous and enzyme systems (Demirezen & Uruc, 2006).

There are variations in proximate and mineral compositions of snails in the present study compared to earlier findings in this line. This could be due to the effect of environment, food, season, biological factors of the snails such as maturation, spawning, size, sex and aestivation, etc. The snail samples were collected from different environments such as ponds, paddy fields and wetlands during May- June. Therefore, there might have been variations in the availability of nutrients for snails in their environment depending on seasonal conditions (Nargis et al., 2012). The size of the snails were recorded in terms of wet weight, total length, total width, aperture length and aperture width for possible correlation. However, variations in composition in relation to age groups, size groups and sex deserves further attention for study.

Heavy metal contamination in snails is a serious concern as they occur at the low trophic levels in the food chains for food and space. Snails can accumulate metals higher than any other group of invertebrates (Zhou, 2008). However, in this study, mercury and arsenic were not detected in any of the samples of snails. This indicates species and sites studied are free from heavy metal contamination, and are safe for human or animal foods.

It can be concluded from the study that freshwater snails of Tripura are rich in protein and minerals.

They are safe from contamination by heavy metals. Hence, they can be recommended for regular consumption particularly by pregnant women and children. Mass awareness is needed to encourage snail farming with fish in the state as this is capable of ensuring nutritional and livelihood security. Snails can be recommended in nutritional studies of the waste to wealth program where plant/crop wastes of no dietary importance to man can be recycled to produce nutritionally desirable products like snail meat. Further freshwater snails meat can be encouraged to be used in feed formulation for domestic and aquatic animals as low-cost alternative sources of nutrients.

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