

Assessment of the Consumer's Knowledge on Underutilized Freshwater Gastropod from North-East India – A High Value Food

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ABSTRACT

Gastropod resources are vastly underutilized and have the potential to significantly contribute to global food security, nutritional security and national economic growth. Gastropods, particularly edible snails, are important fisheries resources in many parts of the world, primarily for food and shells. The purpose of this research was to assess the current use of edible gastropod resources and the potential for value addition in North-East India's freshwater gastropod fisheries. Surveys of a representative selection of snail consumers were conducted in five north-eastern Indian states. In addition, key informant interviews with government representatives from Manipur were also surveyed. This research revealed that majority of the snail consumers in the five north-eastern states of India range in age from 18 to 25 years, with a female predominance. *Filopaludina bengalensis* was the most preferred species among respondents for consumption. The majority respondent's knowledge on the traditional medicinal uses and health benefits of snails included use in treatment of chicken pox and measles. Pickling snail meat was the most popular method of value addition suggested by respondents. The survey revealed that no data from the Government Fisheries Department on total gastropod harvest were available. However, the Government respondents suggested that there was still potential for value adding the snail's fisheries in Manipur. This research has shown that there is huge potential to further value add the snail meat which are considered healthy, nutritionally rich with high vitamins and minerals, particularly high calcium. This could improve the health of larger populations, generate income and employment, and promote the region's socio-economic development.

Key words: Gastropods, fisheries, survey, consumers, value add, snails

INTRODUCTION

Our agricultural industry is almost at its peak and aquaculture is currently increasing with much potential for increased production, but undernourishment and starvation are still common in many parts of the world. The global population is anticipated to reach 9.7 billion by 2050, but world food production might be unable to produce sufficient food to meet the demand of this growing population. Globally 828 million people were unable to meet their dietary energy requirements during 2021 and suffered from chronic hunger (WHO, 2022). To attain food security, indigenous and other underutilized food sources such as mollusc resources should be further developed for incorporation into modern food production systems.

Molluscs are the second largest animal phylum on the planet, after arthropods. Fresh water molluscs, such as snails, are regarded as an important source of food for humans (Pissia *et al.*, 2021). Molluscan bioactive compounds have the potential to be used in therapeutics and pharmaceutical development. Aside from therapeutic and pharmaceutical products, molluscs provide important nutraceuticals or natural health products (Radis-Baptista, 2022). Molluscs are also known for having high protein content, essential amino acids and a low fat content (Moniruzzaman *et al.*, 2021). Gastropods mainly the snails have been consumed as food as well as medicine by various ethnic group of the north-east Indian states (Baghele *et al.*, 2023; Imsong and Murali, 2023). Some of the common edible freshwater

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snails of north-east India include *Pila globosa*, *P. olea* (Ampullariidae), *Filopaludina bengalensis*, *Angulyagra oxytropis*, *Cipangopaludina lecythis* (Viviparidae), *Paludomus blanfordiana*, *P. crassa*, *P. pustulosa* (Paludomidae) and *Brotia costula* (Pachychilidae; Jadhav *et al.*, 2020). The underutilized gastropods resources can make an important contribution to global food security, nutritional security and the economic growth of nations. It can serve as an important source of nutrients in many people diet as it also serves as delicacy in north-east India, with high protein content and essential amino acids (Ghosh *et al.*, 2017; Bar, 2020; Baghele *et al.*, 2023). The gastropods shells, meat and opercula were used in traditional medicine and perfumery (Nongmaithem *et al.*, 2017, 2018; Ngangbam *et al.*, 2019). However, very few studies (Debnath *et al.*, 2016) have been conducted on the preliminary proximate composition profile of gastropod resources of north-east India. Freshwater gastropods were also used in traditional medicine to fasten the chicken pox recovery and the ashes of burnt shells were used for wound healing (personal first hand information). However, the uses of freshwater gastropod for treating various medicinal conditions are not scientifically substantiated till date and the studies of bioactive compounds are very limited. In order to bridge the growing future demand and diminishing supply of food, there is in need to assess the potential for functional food development from underutilized nutritious food.

It is important to assess the consumer preference of the snail consuming communities as delicacy to understand the factors influencing their perception of snails consumption. Understanding the consumer preference would also help the snail collectors and sellers (fresh or cooked) to enhance their livelihood. The age, gender, level of education and annual income of the people consuming snail can provide the market segments of the snail consuming populations. The purpose of this study was to evaluate the current use of edible gastropod resources and the potential for value addition in North-East India's gastropod fisheries. The snail consumers in the north-east region of India were interviewed to assess the current use of edible gastropod resources and and the potential to value-add

the resource for export markets, as well as their local dependence on the snail fishery for supporting their livelihoods. A separate survey of the government regulatory body representatives in Manipur was also carried out to obtain information on government regulations and their perspective on the potential to value-add the snail's meat for consumption. Overall this study contributes to a broader and deeper understanding of how important shellfish species could be better utilized.

MATERIALS AND METHODS

Survey was undertaken during the month of March to September, 2023 for the consumers on their perception on selected commonly edible gastropod snail species of the different states of north-east India. Survey was initiated by setting and designing different set of survey questions for surveying the snail's consumers and State Fisheries Dept. of north-east India. Snail consuming states of north-east India, namely, Manipur, Nagaland, Assam, Arunachal Pradesh and Tripura (Fig. 1) were selected for undertaking the snail's consumer's surveys and Manipur govt. state fisheries department was selected as state fisheries dept. The survey questionnaire for snail consumers and the government fisheries department was distributed. Participants who agreed to participate were asked to complete the survey. No further surveys were conducted for those who did not wish to participate.

Snail consumers were randomly interviewed at each of these locations. Two levels of investigation were carried out: (1) A total of 500 snail consumers (300 Manipur, 50 each from Nagaland, Assam, Arunachal Pradesh and Tripura), and (2) State fisheries dept., Manipur were interviewed (Table 1; Fig. 1). All these surveys were conducted using verbal interviews and through telephone in the local language, with the assistance of an interpreter.

The survey questionnaire for snail consumers and Govt. Fisheries Dept. were designed to obtain a variety of information, including (1) potential interest and scope for value-add the snail's meat for consumption, (2) information about the health benefits of eating the snails, (3) information about the traditional medicinal uses of snails and (4) snail species which are

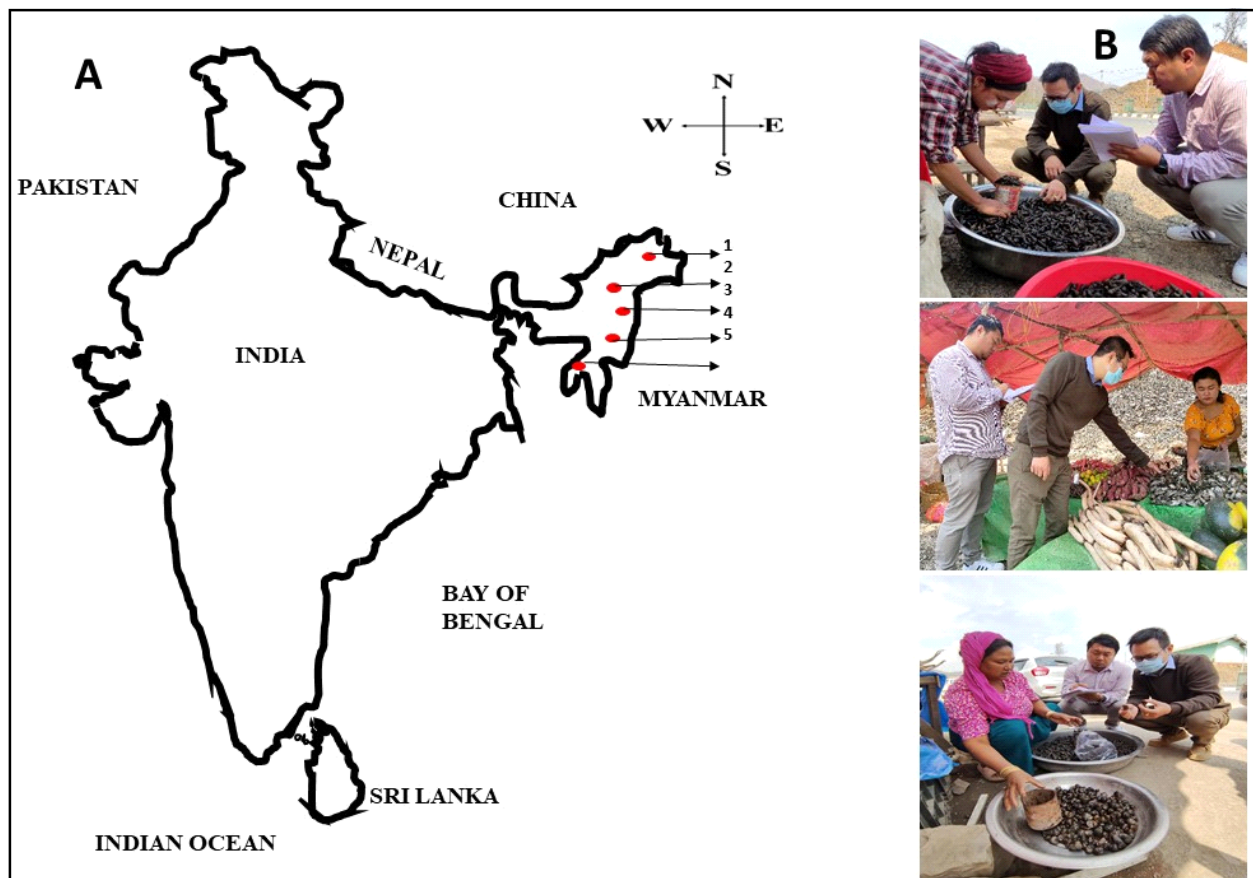


Fig. 1. A. The five states of North-East region of India illustrating the survey (red dot indicates the survey states, 1-Arunachal Pradesh, 2-Assam, 3-Nagaland, 4-Manipur and 5-Tripura). B. Snail consumers and seller's interview.

Table 1. List of the five north-east states/districts and number of respondents used in the survey

State	District	Number of respondents
Manipur	Imphal West	66
Manipur	Imphal East	61
Manipur	Kakching	38
Manipur	Bishnupur	51
Manipur	Ukhrul	6
Manipur	Thoubal	53
Manipur	Noney	15
Manipur	Senapati	10
Nagaland	Makokchung	10
Nagaland	Kohima	14
Nagaland	Wokha	10
Nagaland	Chumoukedima	8
Nagaland	Phek	8
Tripura	West Tripura	37
Tripura	Khowai	8
Tripura	Gomati	5
Arunachal Pradesh	East Siang	12
Arunachal Pradesh	Lower Subansiri	8
Arunachal Pradesh	Papum Pare	24
Arunachal Pradesh	Itanagar	6
Assam	Karimganj	21
Assam	Cachar	11
Assam	Tinsukia	7
Assam	Sonitpur	7
Assam	Kamrup Metropolitan	4
Total respondents		500

most commonly consumed in the area. The survey provided scientific names and images of the main species of snails, which are commonly consumed in these north-eastern states. In the second part of this knowledge elicitation process, a different set of survey questions were designed for state government. Staffs that are in charge of the state fisheries department were contacted personally. Information such as data of the total harvest of edible snail species, funding scheme from the Fisheries dept. for snail's culture, potential for value adding the snail's fisheries, suggestions from fisheries department for promoting value-addition of the snail's meat were included. These responses were used to assess the government perspective on the current use of edible gastropod resources and the potential for value adding the gastropods fisheries of north-east India including any likely restrictions or predicted impediments. Both groups provided demographic and socio-economic information and insights into their

level of knowledge about snail as a food and value add. The data analysis of the surveys included both qualitative and quantitative assessment. Descriptive statistics of the data included number of response rates and frequency distributions of yes/no answers. Participants own comments and suggestions on the survey were classified and the matic frequencies identified for interpretation.

RESULTS AND DISCUSSION

This research investigated the current use of gastropod resources and the potential for value adding the gastropods fisheries of north-east India. The surveys conducted provide novel insights into the present scenario of snail consumption, health benefits, traditional medicinal use and value add of the snail meat. The total number of respondents to this survey conducted in the north-eastern states of India was 500 individuals. It consisted of 300 individuals from Manipur alone; and remaining 50 individuals each from Nagaland, Assam, Arunachal Pradesh and Tripura of India. The majority of the snail consumers (60.8%) in the five north-eastern states of India ranged in age from 18 to 25 years, followed by

age range from 25 to 50 years with 32.8% and age more than 50 years standing at 6.4% (Fig. 2 A). Out of 500 respondents, 51.8% were female and 48.2% were male (Fig. 2 B). Majority respondents of 59.2% of the snail consumers, were predominantly graduate (G) or higher, as shown in Fig. 2 C. A higher rate of snail consumers (27%) were from high school (HS; up to grade 12), followed by secondary education (S; up to grade 10) with 11.6 and 2.2% of primary education (PE; up to grade 5; Fig. 2 C). This research found that majority of the snail consumers (60.8%) in the five north-eastern states of India ranged in age from 18 to 25 years. This could be due to a greater awareness of the health benefits of snails among younger generations, who had greater access to popular food bloggers around the world. More than half of the respondents were women. Interestingly, it was reported that majority of the women were also involved in the snail harvest and selling. Several studies also indicated that women were actively involved in fisheries and aquaculture related activities however, their contribution to the fisheries related sector had been overlooked, under-estimated and under-valued (Lekshmi *et al.*, 2022). Women work force also contributed

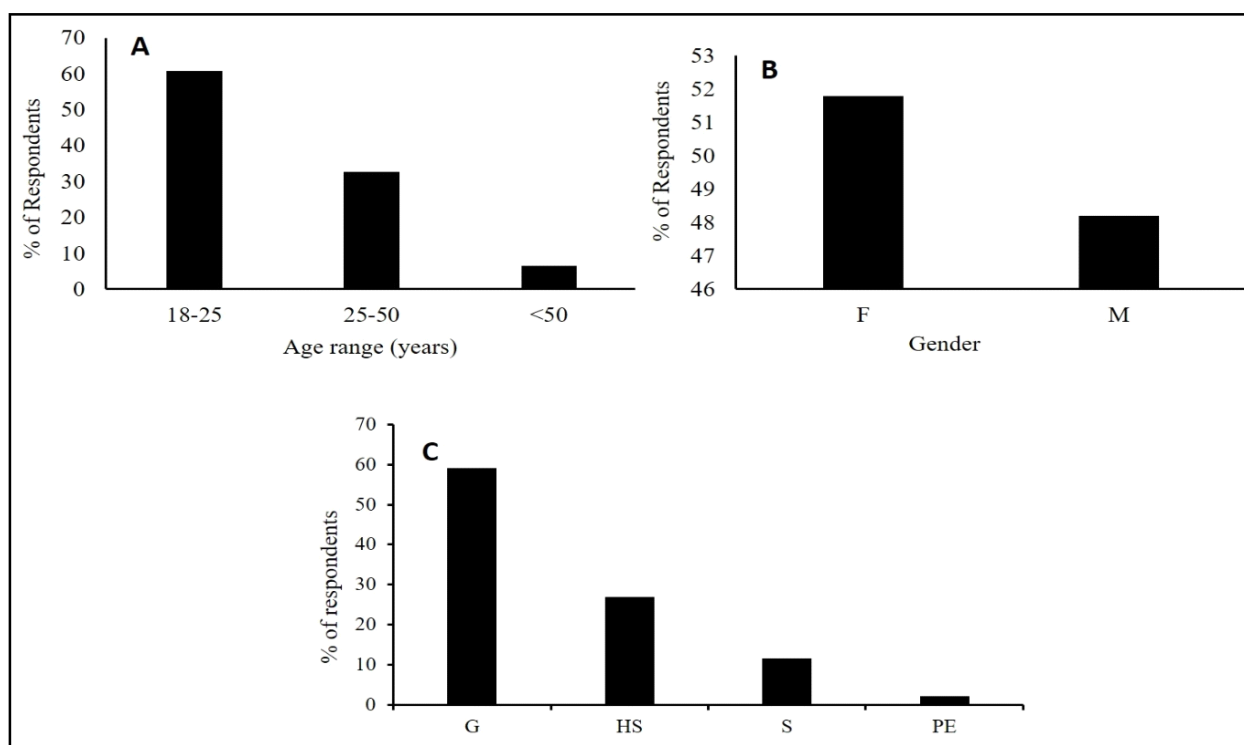


Fig. 2. A. Age distribution, B. Gender distribution and C. Level of education of snail's consumers in five north-eastern states of India (Manipur, Nagaland, Assam, Arunachal Pradesh and Tripura).

substantially to improve the fisheries economies worldwide (Frangoudes *et al.*, 2019). The annual income for the majority (48.8%) of the snail consumers was less than Rs. 50,000 per annum (Fig. 3), whereas 23.2% of the snail consumer's annual income was in the range of one lakh to less than three lakh per annum. Around 14.6% were in the lower income range of Rs. 50,000 to less than one lakh per annum, 3% of the snail consumers were in the annual income range of three lakh or more and 10.4% of the snail consumers with no income (Fig. 3). The level of annual income reported by the snail consumers in this research indicated that, according to the Government of India income classes (Press Information Bureau India, 2015), they belonged to the category of Other Backward Class (OBC).

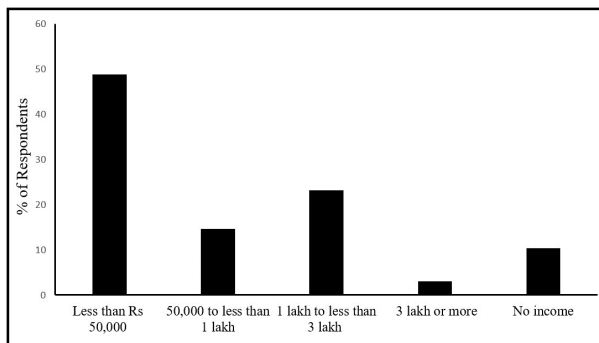


Fig. 3. Average yearly income of snail's consumers in five north-eastern states of India (Manipur, Nagaland, Assam, Arunachal Pradesh and Tripura).

Majority respondents of 53.8% (269 out of 500 respondents) had no prior idea and did not use shells and opercula for any human or livestock purpose, however, 46.2% (231 respondents) used snail's shells and opercula mainly as feed for livestock and ornamental purpose. 28.8% of the snail consumers in five (Manipur, Nagaland, Assam, Arunachal Pradesh and Tripura) north-eastern states of India

consumed all the snail species (*Filopaludina bengalensis*, *Brotia costula*, *Melanoides tuberculata*, *Thiara tuberculata* and *Cipangopaludina lecythis*), listed in the survey questionnaire. However, 46.4% of the consumers consumed either single species or a combination of two to three snail species but not all the species. Interestingly, 5% of the snail consumers participated in the survey consumed other types of snail species, not listed in the survey questionnaire (Fig. 4). 19.8% among the respondents did not consume snails due to reasons such as religion, bad smell, bad taste and allergy. Selected short quotations from the respondent's descriptions are provided in Table 2. These comments show that people think snails are a healthy food, and readily compare their taste and cooking methods to other sources of meat. Around 313 respondents consumed snail almost on monthly basis, whereas 36 respondents consumed on a weekly basis. This research showed that most of the respondents consumed snail by simply boiling and fried with spices and vegetables or meats. This study revealed that many of the respondents of 46.2% used snail's shells and opercula mainly as feed for livestock and ornamental purpose. Studies

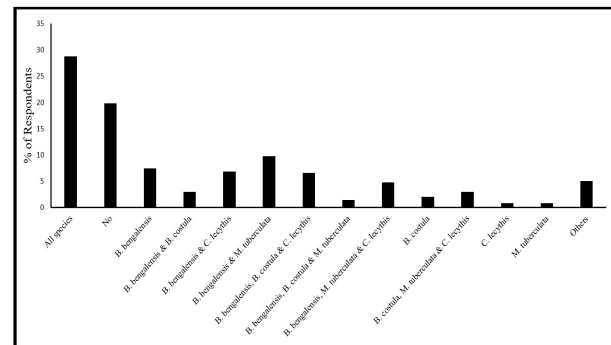


Fig. 4. Snail species-wise consumption in five north-eastern states of India (Manipur, Nagaland, Assam, Arunachal Pradesh and Tripura).

Table 2. Selected responses from the snail's consumers, to open ended questions asking them to describe snail's meat for consumption

Snail meat	Respondent response quotation
Healthy food	Especially from the older generation or elders. Snails meat must be healthy food because of high protein, high content of vitamins and minerals.
Way of cooking	Boiled and fried snails flesh with spices was very tasty. Boiled and fried snails flesh with spices and vegetable or meat were very tasty. Whole flesh, except shells is eaten but viscera are discarded or used for poultry feed by few consumers. Boiled and mixed with flour and fried.
Taste description	Boil snail flesh taste like soft texture meat with fishy smell Fried and spicy flesh taste like rubbery and chewy Taste of flesh depends on the way they cook.

have shown the use of shells and opercula of snails for livestock feed and ornamental purpose (Heuze and Tran, 2017; Khamis, 2022; Jadhav *et al.*, 2023). It was also revealed during the survey that majority of the respondents consumed *Filopaludina bengalensis*, *Brotia costula*, *Melanoides tuberculata/Thiara tuberculata* and *Cipangopaludina lecythis*. Interestingly, it was observed that *F. bengalensis* was the most preferred species for consumption among the respondents. This might be due to their good taste and easily availability and traditional medicinal value. Jadhav *et al.* (2023) reported that *F. bengalensis* was the most widely consumed species in the north-east India. Among the respondents that did not consume snails, the main reasons were religion, bad smell, bad taste and allergy. Majority 75.8% (379) of the respondents were not aware about the traditional medicinal uses of snails, whereas 24.2% (121) of the respondents had the prior knowledge of traditional medicinal uses and health benefits of snails such as use in treatment of chicken pox, treatment of measles, skin treatment, anti-aging treatment and joint pain and knee pain treatment. Out of the 500 respondents, 71.2% (356) of the respondents had no information or idea about the health benefits of eating the snails. 28.8% (144) of the respondents were well aware of the health benefits of eating the snails. The health benefits of eating the snail as identified by the consumer included good for stomach and eyes, rich source of calcium, protein, fiber, vitamins and minerals. The majority of the snail consumers 429 of 500 (85.8%) in the five north-eastern states of India had no idea on how to value-add the snail's meat for consumption. Only 14.2% respondents had proper knowledge of value-adding the snail's meat for consumption. Pickling of snail's meat was the most common methods suggested for value add by the respondents. Around 24.2% of the respondents had the prior knowledge of traditional medicinal uses and health benefits of snails. Snails had been traditionally used in the treatment of various human ailments such as treating asthma, arteriosclerosis, constipation, poor eyesight, small pox, treatment of chicken pox, treatment of measles, treatment of pain, burns, wound healing, treatment of dermatological disorders and anti-inflammatory, anti-microbial, anti-

oxidative, anti-fungal and anti-cancer properties (Nongmaithem *et al.*, 2017; Bar, 2020; Jadhav *et al.*, 2023). This study also revealed that the respondents were aware of the fact that the snails were rich in mineral mainly calcium. Snails were known to have high calcium content and could be a suitable supplement for calcium, which helps in blood clotting, calcification of bone and teeth (Darwin and Padmavathi, 2018; Baghele *et al.*, 2021). During the survey, it was observed that the price of snails in Manipur increased up to threefold in the last five to six years after it was discovered that "snails are high in calcium content" (Personal communication).

A separate survey of the government regulatory body representatives in Manipur was also carried out to obtain information on government regulations and their perspective on the potential for value adding the gastropods fisheries and to assess the current use of gastropod resources of Manipur. To date there have been no government fisheries department data on the total harvest of edible snail species in Manipur. Most of the respondents from government departments indicated there was limited scope for funding scheme from the fisheries department for snail culture like those funding scheme available for finfish culture. There was no initiative from the fisheries department for conducting training for the farmers to encourage snail culture alongside the finfish and also no information available on the farmers showing interest for large scale culture of snails. However, the government officials suggested that there was potential for value adding the snail's fisheries in Manipur, which will eventually enhance the livelihood of the shell fishers.

To ensure future sustainability of the snail values add, a hatchery should be established, to reseed the natural populations with juveniles or farm the snails in aquaculture. The life cycle of Indian marine gastropod *Chicoreus* spp. and *Lambis* spp. have been closed in India (Jagadis *et al.*, 2016), confirming the possibility of producing these snails by culture. Aquaculture of snails is now underway at the commercial scale for species in Thailand and there is huge potential for snail's aquaculture in India (Panda *et al.*, 2021). Assistance from the government for local aquaculture of snails could be helpful to diversify employment

opportunities and minimise the difficulties faced by the shell collectors.

The current survey provided further indication that snails are generally healthy, nutritionally rich with high vitamins and mineral mainly high calcium content and in traditional medicinal use for treating various medical ailments. Snails are known to be traditionally used by many people in medicine since antiquity and as a means of food. Understanding their important characteristics, there is high potential to value add the snail's meat for consumption and subsequently identify the components necessary for their marketability and promotion that could give it considerable economic value in the future. All the respondents (100%) expressed interest in value addition, like canning or pickling of meats, but the main constraints were identified as finance, due to lack of capital and lack of knowledge about health benefits and possible markets. Overall, the awareness of the food value will help to propagate future direction for aquaculture research and the life cycle study of the freshwater gastropod resources for sustainable production. This could improve the health of the larger populations, generate income and employment, and promote socio-economic development of the region.

CONCLUSION

Overall, this study provided a preliminary assessment of the current use of gastropod resources, as well as the possibilities and potential for value addition in north-eastern India's gastropod fisheries. This research showed that freshwater snail had the potential to further develop the potential for value adding the gastropods fisheries of north-east India with a better-organized marketing structure and potential aquaculture. The survey data on traditional medicinal use of some snail species by consumers in the treatment of chicken pox and measles, as well as nutritionally rich sources with health benefits, was very interesting. The uses of freshwater gastropod for treating various medicinal conditions were not scientifically substantiated till date and the studies of bioactive compounds were very limited, hence, future studies on the scientific substantiation of the bioactive compounds in freshwater gastropod and understanding its biosynthetic origin through the application of omics approach need to be undertaken.

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