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Review Article

Snail Farming: An Indian Perspective of a Potential Tool for Food Security

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Abstract

Wise utilization of known food resources could be one major tool to keep parity with the increasing population and nutriment demand. In many parts of India not unlike many other regions of the world consumption of globe snails is widespread. Although snail farming is not at all a novel entrant in the animal husbandry field, it is still far from being widely accepted. Noting the excellent nutritional potential, characterized by high protein and mineral but low fat content of snails and considering the environmental benefits of making use of snails as human food, gastropods must be viewed as a source of nutritional comparable to or even superior to conventional livestock. This paper aims to justify the need to introduce food snails into mainstream farming systems specifically in India and more generally worldwide.

ABBREVIATIONS

SFA: Saturated Fatty Acids; UFA: Unsaturated Fatty Acids; PUFA: Poly-Unsaturated Fatty Acids; WHO: World Health Organization

INTRODUCTION

Worldwide the number of people not receiving sufficient food has reached 795 million, out of which Asia and Pacific share almost 62%. To be more precise India alone is home for the largest number, i.e. 194.6 million undernourished human beings accounting for about 15% of the country's present population [1]. Food security is a basic human right and thus the biggest challenge of the hour for any country is to guarantee that its population is fed. In the light of a still increasing of human population and the consequent pressure on global water and food resources compounded by climate change, the necessity to find solutions to meet the anticipated demands is urgent.

The world food summit in 1996 provided a comprehensive definition of food security stating 'when all people, at all times have physical and economic access to active and healthy life'. Thus the focus has to be on the linkage between food, nutrition and health. At present it seems practical as well as realistic to focus on nutritional security rather than food security, because not only does the amount of food matter but also the quality of nutrients it contains matters. Besides emphasizing the need to increase yield and crop diversification to rejuvenate the green revolution, pilot projects to establish nutri-farms, i.e. focusing on iron rich bajra, protein packed maize, zinc boosted wheat, etc., have also been suggested in order to fill the gap between food available and nutrition needed in India. Livestock keeping is in many cases an integral part of inclusive agriculture that can further augment a farmer's income. To meet the nutritional requirement of the country it makes sense to strengthen the livestock sector, because nutritionally animal protein has a higher value than that of plants on account of its larger quantity of essential amino acids as well as micronutrients like minerals and vitamins. Thus animal-based food stuffs could be used to alleviate the mild to moderate protein malnutrition prevalent throughout the developing world, including India [2]. Nationwide 57 percent of the expenditure in rural areas and 44.4 percent in urban areas goes to the purchase of food [3]. However, due to rising costs of conventional animal protein sources, a general shift from animal protein to plant sources could affect the nutritional state of the country. This scenario justifies the need for alternative cheap and nutritional sources of animal origin. This paper aims to justify the need to introduce food snails into mainstream farming systems and attempts to rationalize the concept of snail farming in the country.

The concept of introducing invertebrate farming systems

Discussions involving livestock are usually restricted to cattle, sheep, pig and poultry etc., while small creatures like insects, shrimps, snails etc. receive much less attention. Although it may not be widely known, but small animals like insects and

snails have indeed found acceptance as food amongst several traditional cultures in India, not to mention the rest of the world [4-6]. Snails, however, are only one class of the phylum Mollusca and if we were to include the other molluscan classes, especially bivalves and cephalopodes, then the importance of these food sources worldwide becomes even more apparent [7-11].

Snails

In terms of species numbers, gastropods represent one of the largest classes in the animal kingdom. The use of freshwater snails as food is a practice in a number of countries, to name but a few Mexico [12], Taiwan [13], Philippines [14] and Thailand [15]. Land snails (apart from the famed 'escargot' in France) are a non-conventional wildlife protein source in Nigeria and some other parts of Africa and are becoming a highly relished delicacy known as 'Congo meat' [16]. In Bangladesh, tribal people like, for instance, the Bawm, Chakma, Rajbangshi, Hajong, Garo, Marma, Monipuri, Murang, Santal, Tachanga, and Tripuri consume snails [13]. Borkakati et al., reported nine edible fresh water snail species in North East India [17]. Freshwater molluscs play a vital role in the economy and tradition of West Bengal in India serving as a food in 81% families belonging to more than 30 castes of general scheduled and tribal people. *Pila globosa, Bellamya bengalensis, Melania tuberculata, Lamellidens marginalis, Anisus convexiusculus, Helix* spp. are among the edible gastropds of the region [13].

Different snail species with vernacular names like 'shamuk', 'jal geri', 'jhinuk' are included in the "secondary food system" of the Lodha tribe of Midnapore district of West Bengal [18]. Members of the Lodha usually consume the species in order to supplement the nutritional need in periods of the year when agricultural products become scarce. Khalua et al. carried out a study on the seasonal variation of proximate nutrients of *Bellamya bengalensis* [19]. Some European countries are certainly not exceptional in this regard and snails are a distinct part of their cuisine. The French word "escargot" refers to a dish of snails, which is very popular especially in France, but available in most other European countries as well. In fact the term "escargot" does not specify any particular species but edible snails generally, although it is often applied just to species of the genus *Helix*. However, snail production in France is limited to about 190 farms and they import individuals from countries like Greece, Turkey, Belgium and Eastern Europe. According to a recent estimate over 6000 tons of snails have been declared to the French Customs during May 2013 to March 2014 [20]. Inhabitants of Greece, Italy, Spain, and Portugal also consume snails regularly. In the USA there is a huge market for French "escargot" and they are imported from a variety of countries.

Snails are very sensitive to their environment. Humidity and temperature are important factors in keeping and growing the animals, but breeding them is another and even more difficult issue. Optimum conditions for matings of *Achatina fulica*, for example, require 22-32^{0}C with relative humidity >86% [21]. Both *Helix* and *A. fulica* are generally well known food snails, but they are non-endemic to India. *A. fulica* established itself in India after accidental introduction in the year 1847 and in fact is now considered the worst snail pest in the tropical and subtropical regions of the country [22]. These snails can be farmed under semi-controlled environmental conditions. However, at present there are no reliable systematic data on any edible molluscs in India, which includes freshwater snails, mussels, land snails and other gastropods like slugs. Seasonal availability, nutritional profiles, and medicinal uses are all aspects that are in dire need of study.

Mussels, clams and oysters

The other classes of the phylum Mollusca that are of economic interest are the bivalvia (i.e., mussels, clams, and oysters) and cephalopoda (squid, cuttle fish, and octopus). Mussels are accepted delicacies in many parts of world and two of the main edible mussels known as *Perna viridis* and *P. indica* are widely distributed along the entire coast of India. It has been reported that *P. viridis* is distributed along the west coast and also in some places like Visakhapatnam, Kakinada and Chennai along the east coast [23]. Both species are exploited for their meat in many places along western and southern coasts of India. Clams, contribute substantially to the total production of molluscs for human consumption as well as for raw material for cement and the lime industry. *Meretrix casta*, *Katelysia opima* and *Paphia laterisulca* are clam species distributed along the western coast of the India. Oysters, despite their wide distribution along the north-west, south-west and to some extent east coast of the country, are very little in demand as food in India and are harvested only through wild collecting and are not farmed as in many other countries. The Central Marine Fisheries Research Institute (CMFRI), however, has developed techniques for culturing the large Indian oyster *Crassotrea madrasensis* and advocated rope culture of mussels, but to our knowledge there is hardly any commercial venture involved in oyster culture for food in India. In the following we shall therefore restrict the discussion to land and freshwater snail farming.

DISCUSSION & CONCLUSION

Nutritional potential of snails

The food situation of the future is dominated by discussions on possible protein deficiencies rather than the availability of carbohydrates and fats. It is therefore protein-rich food items that receive the most attention in attempts to identify alternative food resources. Work published to demonstrate that snail meat can serve as a supplement animal protein source for fish and prawns is scant [24,25]. In India, snails are almost always directly harvested from the wild and this practice can threaten at least some species' continued existence because of overexploitation. Thus, research should focus on methods to farm the most sought-after species.

Snails have been used by humans as food for millennia including prehistoric times [26]. The abundance of land snails in late Pleistocene and early to mid Holocene archeological sites throughout the circum- Mediterranean region indicates that land snails might be part of prehistoric meals [26]. Fernandez-Armesto suggested that land snails were the first domesticated animal [27]. Tools to extract the soft parts of land snails through deliberately punched holes in the shells have been identified from human habitations 12,000 years ago in North Africa [28] and archaeological evidence from a site in northern Alabama

suggested that 2500 years BC the hunter-gatherer population of the New World also consumed molluscs, identifiable through their high contents of strontium [29]. Although there are few data available on the detailed composition and nutritional value of snails, it is known that there are species in both land and freshwater habitats that contain high amounts of protein and little fat. A compilation of the nutrient compositions of 30 edible species of freshwater and land snails is presented in Table (1). The values are on the basis of dry weight. Protein contents of snails are often higher than those known from conventional animal food sources (Figure1).

The poorer sections of a population can often not afford conventional protein-rich products, e.g., common meats, and have to make do with nutritionally inferior food stuffs. Invertebrates like snails, for instance, can serve as an alternative and economic source of protein. The quality of the protein depends on its amino acid composition and snail protein does indeed contain all the essential amino acids required by humans. The diet of South Asians is dominated by wheat, rice or maize, grains in which lysine is a limiting amino acid. Snail meat, however, can be regarded as a good source of lysine [30-32]. Cagiltay et al., suggested about 100g of snail meat can satisfy 30% of the daily essential amino acid requirements of a 75 kg person [30]. The quality of the snail protein in comparison with other animal and plant proteins has

Table 1: Content composition of terrestrial, freshwater and brackish water edible snails.

Species name	Habitat	Moisture	Crude protein	Crude fat	Crude fibre	NFE	Ash	References
Achatina achatina	Land snail	75.28	69.579	8.94	0	12.055	9.426	39
Achatina fulica	Land snail	79.28	48.649	7.77	0	34.99	8.591	39
Archachatina marginata	Land snail	73.67	74.174	9.267	0	6.836	9.723	39
Archachatina marginata ovum	Land snail	80.78	84.43	4.5	0.5	6.57	4	40
Archachatina marginata saturalis	Land snail	80.3	80.95	4	1	9.57	4.5	40
Limicolaria sp.	Land snail	78.64	71.75	3.75	1	15.5	7	40
Lanistes varicus	Fresh water snail	75.8	70	1.75	1.25	19	8	40
Nucella lapillus	Sea snail	73.69	82.25	8.5	1.5	0.75	8	40
Pila ampullaceal	Fresh water snail	76.32	45.059	0.253	0.127	31.25	23.395	41
Lymnaea stagnalis	Pond snail	38.62	41.707	4.48	6.631	41.626	5.556	42
Pila globosa	Fresh water snail	85.5	57.048	5	0.177	20.014	17.924	13
Helix sp.	Land snail	83.2	51.429	3.399	0.021	38.976	6.167	13
Bellamya bengalensis	Fresh water snail	82.1	50.089	5.497	0.198	24.067	20.335	13
Melania tuberculata	Fresh water snail	74.6	48.65	7.059	0.179	29.787	14.5	13
Lamelhidens marginalis	Fresh water bivalve	85.9	45.844	3.596	0.018	35.057	15.489	13
Anisus convexiusculus	Fresh water snail	75.7	53.198	4	0.152	23.84	18.959	13
Archachatina marginata ovum	Land snail	76.56	87.713	5.887	0	0.0299	6.143	16
Archachatina marginata saturalis	Land snail	76.67	87.184	5.272	0	1.586	6.001	16
Achatina achatina	Land snail	77.54	85.797	6.367	0	1.87	5.966	16
Limicolaria sp.	Land snail	78.68	87.523	5.488	0	0.704	6.332	16
Helix aspera	Land snail	82.5	73.543	3.314	0	28.514	6.114	30
Helix aspersa aspersa	Land snail	83.7	65.2	10	--	0		43
Helix aspersa maxima	Land snail	85.8	58	10.85	--	13.8		43
Helix lucorum	Land snail	82.83	65.33	6.53	--			43
Helix pomatia	Land snail	84.65	63.73	5.15	--			43
Achatina achatina	Land snail		82.96	3.96	--	3.26	3.22	44
Achatina marginata	Land snail	80.9	78.75	7.65	--		6.5	45
Achatina achatina	Land snail	83.3	65.65	11.9	--		4	45
Achatina fulica	Land snail	83.3	83.13	8.7	--		8.9	45
Tympanotonus fuscatus var. radula	Brackish water snail	13.45	74.84	1.32	0.74	0.19	9.56	32

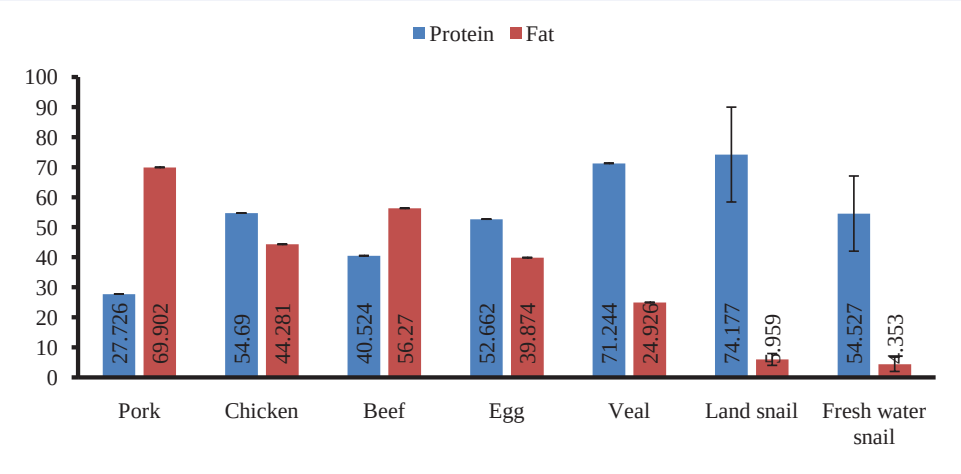

Figure 1 Comparison of protein and fat contents of conventional foods of animal origin and land and freshwater snails.

to be assessed in feeding trials.

The fat content of snails is comparatively lower than that reported for conventional foods of animal origin (Figure 1). The role of fat in the human nutrition is a complex issue and higher amounts of saturated fatty acids (SFA) are not deemed desirable, because of their linkage with atherosclerotic disorders. Polyunsaturated fatty acids (PUFA), on the other hand, are considered desirable, because they have been shown to play protective roles in cases of cardiovascular and inflammatory diseases. Benefits are thought to come from increased intakes of n-3 and n-6 fatty acids in connection with diseases like lupus, diabetes, psoriasis, obesity, Crohn's disease, rheumatoid arthritis, cystic fibrosis etc. A review of the available literature has revealed that snails contain higher amounts of PUFA than SFA [30-33], indicating that, generally, the fat content of snails is superior to that of many conventional meats. A higher ratio of n-3 to n-6 (more n-3 and less n-6) in the human diet is desired as it is thought to improve overall human health and helps to reduce weight, lose intra-abdominal fat, reduce adipocyte size and normalize the heartbeat. The ratio recommended by WHO is 1:5, which fits *Helix aspersa*, *H. pomatia* wild as well as cultured snails [30,31]. However, in clinical trials with fish oils it was revealed that the total amount of fish oil consumed was a more significant determinant of health benefits than the ratio of n-3 to n-6 alone [34]. The intervention study with snail oil is yet to be carried out.

As indicated by several studies, snails are also an excellent source of minerals. Iron needs to be mentioned, because it is often deficient in infants, children, adolescents and women of child bearing age, especially when pregnant. The situation with regard to iron supplies is more critical in developing (including India) than developed countries. Carotenoid content in most of the edible molluscs varies between 10 and 140 µg/100g of the raw edible portion [11] and as a portion of the carotenoids is metabolized in the human body to vitamin A its presence in the molluscan tissue deserves mention.

From the perspective of future demand

India is home to a large number of peoples following different religions and traditions and therefore it is no wonder that there is a huge variety of dietary systems in that country. However, the majority of the population does habitually consume meat, at least from time to time. Although the estimated protein consumption in India stems mostly from plants quite unlike countries like the USA or Australia, economic development in India can be expected to increase the demand for animal-based protein in that country. Moreover, with a population growth projected to reach 1.6 billion by 2050, India should, in addition to conventional sources of animal protein like fish, chicken, pork, beef etc., explore unconventional sources to increase the present protein level intake. At the same time India needs to ensure that the alternative foods are reasonably priced and affordable to the general population. Although snail farming is not a completely novel entrant in the animal husbandry field, it is still far from being widely followed or even accepted. About three decades ago CICFRI (the Central Inland Capture Fisheries Research Institute) formulated a manual of *Achatina fulica* faming [21]. However, in many parts of the country where snail-eating is practiced most of the product is harvested from the wild instead of being farming. There is thus also the potential threat to losing some biodiversity.

Income generation: Apart from the production of meat, snail farming could be a source of earning sizable money by selling the produce directly to sections of the population who eat snails. Of course the infrastructure like store house, processing and/or packaging units and transportation should be taken care of for this purpose. Those farmers who are small land holders and are involved in small capital snail farming could help raising animal protein at least for their own sustenance. Many snail species generally known as agri-horticultural pests could be transformed into proteinaceous food.

Feed efficiency: Since the production of conventional meat requires high amounts of agricultural products like grain to feed livestock, it puts additional pressure on the global food production. Feed is one of the major components required to enhance the efficiency of the production system and this system is facing huge challenges. Livestock production, including feed crop production occupies 70% of the world's agricultural land (30% of the earth's land), requires an enormous amount of freshwater irrigation and consumes 77 million tons of protein to produce 58 million tons of

protein for human consumption annually [35]. More food would be available if people ate the grain instead. Adeyeye reported that the snail's ability to utilize a variety of readily available feeding materials to achieve an appreciable weight gain under intensive management outperforms that of conventional food animals [36]. Among the feed choices for snails, waste products like maize shaft, succulent vegetables, carcasses etc. can be utilized. This indicates that snails are cheap to rear at subsistence and commercial level with high returns on low input. Furthermore, the food conversion efficiency of *A. fulica* is comparatively higher than that reported for conventional livestock. The food conversion ratio of the species was reported 6.1:1 when fed on kitchen refuse, fruit peels etc. and the value was found 5.2:1 when the species was fed purely ash gourd [21]. Not to overlook also is that large amounts of energy and nutrients are used to maintain constant body temperature in the warm-blooded domestic food animals, but that snails being cold- blooded can be expected to be more efficient in transforming plant biomass into animal biomass.

Safety issue*:* One of the major considerable issues is safety. Some cases of angiostrongylus infection have been reported to have possibly occurred in connection with the consumption of raw or undercooked snails [37,38]. The primary route for transmission of human angiostrongyliasis is through ingestion of undercooked, contaminated apple snails, land snails or slugs. The ingested larvae can migrate to the central nervous system and cause neurologic symptoms with meningitis and acute severe headache being the two most common symptoms, while fever, nausea, vomiting, neck pain, neck stiffness, eye sight deterioration may represent additional problems. An especially heavy load of parasites can even be fatal. Thus, processing methods of food snails is important and it is recommended that the gut content of the snails be removed by starvation and by feeding the species with wheat bran and water for some days prior to processing.

CONCLUSION

To face the challenge of future food shortages, snail farming could be of assistance. Herewith we propose the following:

a. Awareness of the nutritional as well as economic benefits of snail farming, involving in particular small land holders or enterprises.

b. Since a number of esteemed research institutions of the country have already developed farming techniques for molluscan species including snails, it is necessary to bring the scientific know-how to the attention of the common people. This can be achieved through pamphlets, lectures, the media like television, radio, internet, etc.

c. Proper supply channels including infrastructural and organizational planning is required. In many parts of the country where people do not consume snails, but the soil and other climate conditions are favorable to snail farming, the latter should be encouraged.

d. Processing units are currently lacking, because of the small demand. However, for large scale production processing of the snails will have to be organized.

e. Mini-livestock should be incorporated into the education system and this could facilitate broadening the acceptability of snails as food as well as increasing the interest in the young in snail farming and snail research perspectives.

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