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Proximate Composition of Some Traditionally Fermented Small Indigenous Fish Species of Assam

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ABSTRACT

Fish are widely recognized as a preferable source of protein and other essential nutrients for maintaining a healthy body, making it one of the most crucial animal protein sources. In this study, eight small indigenous fish species (SIS) were collected from various sites within the study area and "namsing", a fermented fish product by mising the Mising tribe, was prepared to estimate their proximate composition using the techniques outlined by the Association of Official Analytical Chemists. The protein content of *Amblypharyngodon mola*, *Puntius sophore*, *Mystus vittatus*, *Barilius barila*, *Gudusia chapra*, *Macrognathus aral*, *Anabas testudineus*, and *Nandus nandus* ranged from 51.06±0.68 to 60.47±1.22g/ 100g. Lipid content was the highest in *Barilius barila* (22.0±0.66 g/100g) and the lowest in *Nandus nandus* (11.01±0.24g/ 100g). Ash content ranged from 9.61±0.41% in *Anabas testudineus* to 19.87±0.40% in *Puntius sophore*. Moisture content varied from 7.96±0.86g/ 100g in *Nandus nandus* to 12.38±0.41g/ 100g in *Barilius barila*. This study concludes that traditionally fermented fish i,e., "naming" is a rich source of essential nutrients, making it an effective food for combating malnutrition and preventing various health issues.

INTRODUCTION

Fish are a vital role in ensuring food security and reducing poverty in both rural and urban regions. They are regarded as one of the most significant sources of high-quality animal protein in the diet, containing essential amino acids for human growth and maintenance **(Sarma *et al.*, 2014)**. Additionally, they are recognized to be a great source of easily digestible animal protein and are safer and healthier than other protein sources like goat and chicken meat **(Ogundiran *et al*., 2014)**. Unsaturated fatty acids, fat-soluble vitamins, and fats are vital sources of energy **(Sarma *et al.*, 2013)**. Researchers have studied the proximate analysis of almost all fish or fish-related foods. However, minor discrepancies in nutritional composition exist due to their feeding habits, age, sex, season, temperature, adaptation, and hatching **(Pal *et al.*, 2018)**. Further reports and analyses state that fish provide protein of a superior quality with all the essential amino acids, as well as elemental sources of dietary vitamins and minerals, including zinc (marine fish), iron, calcium, phosphorus, iodine, selenium, vitamin A, D, E, several B vitamins (B3, B6, and B12), important amounts of PUFAs and various other micronutrients **(Singh & Ranjan, 2016; Suleria *et al*., 2016; Marques *et al*., 2019; Mamun *et al.*, 2024)**. Because of their high amount of polyunsaturated fatty acids, particularly the ω-3 fatty acids docosahexaenoic acid (C22:6) and eicosapentaenoic acid (C20:5), there has been a recent surge in interest in the intake of fish globally **(Alam *et al*., 2016; Julmohammad *et al.*, 2025)**. Since the human body is unable to synthesize these two fatty acids, they must be supplied from diet. Additionally, eating fish has been linked to several health advantages because long-chain polyunsaturated fatty acids have drawn more attention due to their ability to prevent coronary artery disease, enhance retinal and brain development, lower the risk of breast cancer, rheumatoid arthritis, multiple sclerosis, asthma, psoriasis, inflammatory bowel disease, and regulate prostaglandin synthesis **(Simopoulos, 2002; Dhaneesh *et al*., 2012)**.

Traditionally fermented products made from small indigenous fish species (SIS) have significant potential to contribute to several Sustainable Development Goals (SDGs). These nutrient-dense foods enhance food and nutritional security, particularly in rural and marginalized communities, thereby supporting SDG 2 (Zero Hunger). Rich in high-quality proteins, essential fatty acids, and vital micronutrients such as calcium and iron, they also help combat malnutrition and undernutrition, contributing to SDG 3 (Good Health and Well-being). Furthermore, the natural fermentation process serves as a low-energy, traditional method of food preservation, reducing dependency on refrigeration and other energy-intensive storage systems. This supports SDG 12 (Responsible Consumption and Production) by promoting sustainable consumption and minimizing food waste **(Bavinck *et al*., 2023; Islam *et al*., 2023)**.

Fermentation is a cost-effective and time-tested food preservation process that involves various probiotic microorganisms. It transforms bioactive and volatile chemicals into edible forms with enhanced flavors and fragrances. Fermented food products have been consumed since ancient times, with distinct tastes, textures, appearances, and functions compared to unprocessed components. Fermented rations were purposely made for nutrition research centuries ago **(Nath *et al*., 2024)**.

Fermented fish, a delicacy in global cuisines, varies based on processing type and local preferences. In South and Southeast Asia, they are often served as rice condiments **(Narzary *et al*., 2021)**. The cuisine of northeastern India closely resembles that of Southeast Asian nations, with fish being the primary source of animal protein for about 98% of the population, often consumed with rice. The region is home to diverse communities with unique traditions and dietary practices, including specialized knowledge and techniques for preparing fermented fish products. Although different vernacular names know these products, they share similar tastes and culinary methods. The basic processing principles remain the same, with slight variations in techniques, and both fresh and preserved fish can be used **(Nath *et al*., 2024; Thaosen & Sarma, 2024)**. In Northeast India, people's social and economic well-being has long been linked to fish and fish products. The population of this area is diverse, consisting of over 100 tribes and settlements, each of which has spent many generations developing its own unique ethnic cuisine. Since ancient times, the people of several Northeast Indian states have prepared fish-based traditional ethnic products using their unique techniques. These goods are made either by combining the processes of drying, smoking, and fermentation, or by using the methods of drying, smoking, and fermentation alone **(Muzaddadi *et al*., 2013)**. The Mising tribe's traditionally prepared smoke-dried fermented fish paste, “namsing”, has not yet had its full scientific potential investigated, despite records of other fermented fish items from the area. Among the Assamese Mising people, namsing is a beloved delicacy with significant meaning and appeal. This study focused on the nutritional profiling of namsing, a traditional dish prepared using a single plant species—banana stem—as an ingredient. Despite the widespread use of various plant ingredients in the preparation of namsing, the specific nutritional composition of the dish made solely with banana stems has not yet been explored by researchers. This research aimed to fill that gap by providing a detailed analysis of the banana stem-based namsing, offering valuable insights into its nutritional properties.

MATERIALS AND METHODS

Sample collection and preparation of namsing

Namsing is a traditionally prepared fermented fish paste made by the Mising community in Assam, India. For the preparation of naming, eight small indigenous fish species (SIS), namely *Amblypharyngodon mola*, *Puntius sophore*, *Mystus vittatus*, *Barilius barila*, *Gudusia chapra*, *Macrognathus aral*, *Anabas testudineus*, and *Nandus nandus*, were properly collected from a variety of fish markets in Biswanath district, Assam, between October and January 2024. Approximately, 1kg of each species was obtained using ice boxes to maintain freshness. The fish were promptly cleaned using running water from the tap, and their digestive tracts were carefully removed. The fish were placed in bamboo sieves known as “saloni” and were allowed to be sundried for 2 to 3 days, as per the intensity of sunlight after that partially dry fish were smoked over a fireplace until the sample became hard. Care was taken to prevent contamination from dirt, mosquitoes, and other pests during sun-drying. At the same time, the soft inner core of the "Athia Kol" stem (*Musa balbisiana Colla*), which is the edible part, was sliced into small pieces using a knife and sun-dried for 2 to 3 hours. Following adequate smoking and drying, the fish were mixed in a 4:1 weight ratio with semi-dried banana stem. After that, the mixture was ground into a coarse paste using a traditional wooden grinder known as “Dekhi”. The ground material was firmly packed into a hollow, immature bamboo tube with a single internode for the subsequent sealing. The main sealing material was a clean, dry rice straw, which was packed securely with air to leave 5/6 inches of headspace inside the bamboo tube. The bamboo tube was then sealed with clay to prevent the entry of insects and air. The bamboo tubes were left over the fireplace for at least 2/3 months to ferment (Fig. 1).

Proximate analysis

The hot air oven method measured moisture content **(AOAC, 1990)**. Total lipid was extracted using the method of **Singh *et al.* (1990)**. According to the modified micro-kjedahl method, the calculation of total protein was performed by multiplying the values of total nitrogen by 6.25 (conversion factor) **(AOAC, 1990)**. The ash content was also determined using the **AOAC (1990)** method.

Statistical analysis of results

The results were derived by averaging three evaluations and were expressed as the mean ± standard deviation.

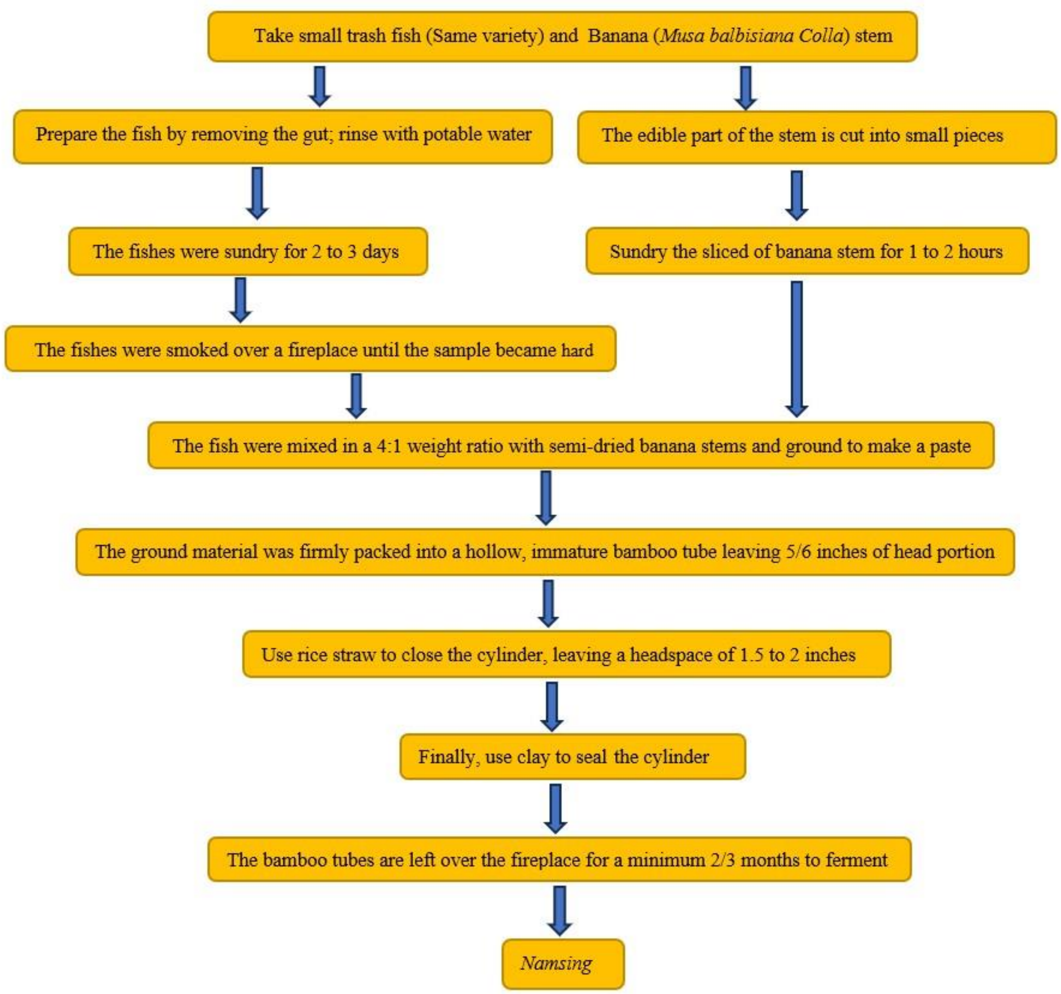

Figure 1: Flowchart of preparation of *Namsing*

RESULTS AND DISCUSSION

Among the Mising community of Assam, namsing is a common fermented fish product added to cooked vegetables to improve their flavor or eaten as an appetizer with rice. Though the product's name is the same, namsing can be prepared using different ingredients **(Chowdhury *et al.,* 2018)**. In this study, the edible portion of the banana (*Musa balbisiana Colla*) stem was used as an ingredient. Namsing was prepared for each fish variety following the same procedure. Fig. (2) shows the bar diagram of the proximate composition of namsing prepared by different small Indigenous fish species (SIS). Some photographs of namsing preparation are shown in Fig. (3A-H). The proximate composition was analyzed after two months of fermentation.

The protein content ranged from 51.06±0.68 to 60.47±1.22g/ 100g among the examined species (Table 1). The lowest protein content recorded was in namsing prepared by *Gudusia chapra* (51.06±0.68g/ 100g) whereas the highest was in *Macrognathus aral* (60.47±1.22g/ 100g). The protein content of namsing prepared by *Amblypharyngodon mola*, *Puntius sophore*, *Mystus vittatus*, *Barilius barila*, *Gudusia chapra*, *Macrognathus aral*, *Anabas testudineus*, and *Nandus nandus* were found to be 54±0.59, 53.48±1.4, 58.21±0.2, 56.23±0.43, 51.06±0.68, 60.47±1.22, 55.39±0.46 and 53.19±0.67g/ 100g respectively. Fresh fish typically contain 15-22g/ 100g of protein. However, the higher protein content can be attributed to microbial creation of proteins from intermediate products of metabolism during the life cycle. The protein content of napham (traditionally fermented fish paste by the Bodo tribe, Assam) was 63.65 ± 0.83g/ 100g, which is higher than the protein content recorded in this study **(Nath *et al*., 2024)**. **Majumdar *et al.* (2015)** reported that the protein content of hentaak, a fermented fish paste from Manipur, India, was 37.63 ± 0.89g/ 100g, which is comparatively lower than that determined in this study. The fact that this study presented results on a dry-matter basis or the varying maturation durations were two possible reasons for this difference.

The lipid content varied from 11.01±0.24 to 22.0±0.66g/ 100g (Table 1). The lowest lipid content (11.01±0.24g/ 100g) was found in *Nandus nandus* whereas the highest (22.0±0.66g/ 100g) was in *Barilius barila*. The lipid content of *Amblypharyngodon mola*, *Puntius sophore*, *Mystus vittatus*, *Barilius barila*, *Gudusia chapra*, *Macrognathus aral*, *Anabas testudineus*, and *Nandus nandus* were 18.26±0.14, 13.13±0.49, 16.22±0.45, 22.0±0.66, 15.21±0.16, 14.37±0.55, 19.68±0.57 and 11.01±0.24g/ 100g, respectively.

Ash content varied among the examined species (Table 1). The lowest ash content (9.61±0.41g/ 100g) was recorded in *Anabas testudineus*, whereas the highest ash content (19.87±0.40g/ 100g) was in *Puntius sophore*. The ash content of *Amblypharyngodon* *mola*, *Puntius sophore*, *Mystus vittatus*, *Barilius barila*, *Gudusia chapra*, *Macrognathus aral*, *Anabas testudineus,* and *Nandus nandus* were found to be 13.81±0.6, 19.87±0.40, 14.13±0.23, 10.08±0.19, 14.33±0.35, 16.83±0.76, 9.61±0.41 and 18.97±0.37g/ 100g, respectively.

The moisture content, in the present study, varied among the examined species (Table 1). The lowest moisture content (7.96±0.86g/ 100g) was recorded in *Barilius barila*, whereas the highest (12.38±0.41g/ 100g) was in *Nandus nandus.* The moisture content of *Amblypharyngodon mola*, *Puntius sophore*, *Mystus vittatus*, *Barilius barila*, *Gudusia chapra*, *Macrognathus aral*, *Anabas testudineus,* and *Nandus nandus* were found to be 11.5±0.44, 10.7±0.31, 11.56±0.67, 7.96±0.86, 10.42±0.51, 10.99±0.64, 10.29±0.26 and 12.38±0.41, respectively. Generally, fresh fish contain 65 to 82g/ 100g moisture **(Pegu *et al*., 2023)**. The usage of sundried fish in the preparation of namsing may be the cause of the low moisture content, or it may be related to the fat content of the fish. Namsing has a higher moisture content (10.1%) than other dry fish produced using different methods; *Channa punctatus* had the lowest moisture content (2.55%) among dry fish, while *Puntius sophore* had the highest percentage of moisture (7.45%) **(Baruah *et al*., 2021)**.

The proximate composition of the understudied small indigenous fish species are significantly different from those reported by **Nath *et al.* (2024)**, who reported that the moisture, protein, fat, and ash contents in Napham, a fermented fish paste traditionally prepared by the Bodo tribe of Assam were 3.52 ± 0.37, 13.95 ± 0.02, 63.65 ± 0.83, and 12.12 ± 0.15g/ 100 g, respectively. These results also differ to some extent from the findings of **Majumdar *et al.* (2015)**, who reported that the moisture, protein, and fat contents in hentaak, a fermented fish paste from Manipur, were 35.0 ± 1.04g/ 100 g moisture, 37.63 ± 0.89g/ 100g protein, and 9.91 ± 0.17g/ 100g fat. This variation may be attributed to the fact that these results were presented on a dry-matter basis and used banana stem as main ingredient after fish, or it could be due to differences in the maturation periods of the fish species used in the study.

Beyond their nutritional value, fermented SIS products offer significant socio-economic and cultural benefits. Their production, processing, and marketing provide livelihood opportunities for small-scale fishers, women, and local entrepreneurs, aligning with SDG 8 (Decent Work and Economic Growth). Additionally, the continuation of traditional fermentation practices contributes to the preservation of cultural identity and indigenous knowledge systems, aligning with SDG 11 (Sustainable Cities and Communities). Thus, fermented SIS products not only represent a sustainable and health-promoting food source but also serve as a vehicle for empowering communities and preserving cultural heritage, aligning holistically with global development goals**.** **(Bavinck *et al*., 2023; FAO, 2023)**.

Table 1. Proximate composition of *namsing*, prepared from eight small indigenous fish species in Assam

Sl. No.	Species name	Moisture (g/100g)	Protein (g/100g)	Lipid (g/100g)	Ash (g/100g)
1	*Amblypharyngodon mola* (Hamilton, 1822)	11.5±0.44	54±0.59	18.26±0.14	13.81±0.6
2	*Puntius sophore* (Hamilton, 1822)	10.7±0.31	53.48±1.41	13.13±0.49	19.87±0.40
3	*Mystus vittatus* (Bloch, 1794)	11.56±0.67	58.21±0.2	16.22±0.45	14.13±0.23
4	*Barilius barila* (Hamilton, 1822)	7.96±0.86	56.23±0.43	22.0±0.66	10.08±0.19
5	*Gudusia chapra* (Hamilton, 1822)	10.42±0.51	51.06±0.68	15.21±0.16	14.33±0.35
6	*Macrognathus aral* (Bloch & Schneider, 1801)	10.99±0.64	60.47±1.22	14.37±0.55	16.83±0.76
7	*Anabas testudineus* (Bloch, 1794)	10.29±0.26	55.39±0.46	19.68±0.57	9.61±0.41
8	*Nandus nandus* (Hamilton, 1822)	12.38±0.41	53.19±0.67	11.01±0.24	18.97±0.37

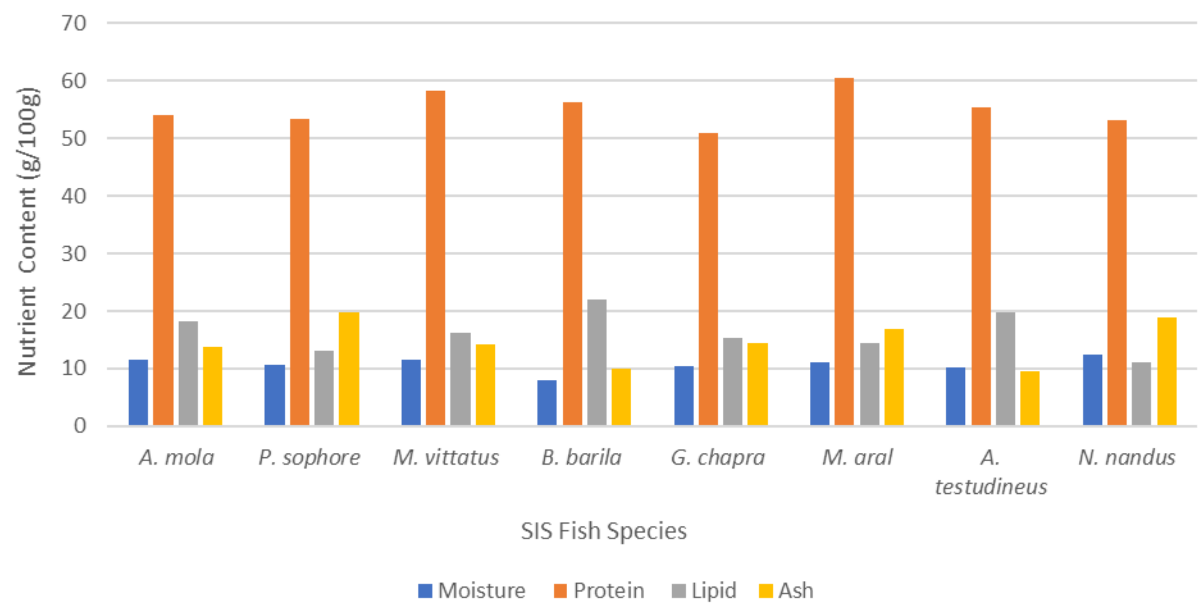

Fig. 2. Bar graph showing the proximate composition of *Numsing* prepared by different SIS Fish

Fig. 3. *Namsing* processing steps **(A-H), A.** Semi-dried B. *barila* fish, **B.** Fresh, degutted *G. chapra* fish ready for sundry, **C.** Drying N. *nandus* fish over fireplace, **D**. Slices of M. *balbisiana colla* stem, **E.** Ground fish product, **F.** Hollow bamboo tube with single internode, one side is open, **G.** Sealing the bamboo tube with rice straws, **H.** Final sealing the tube with clay

CONCLUSION

The present investigation shows the ability of fermented fish to supply important nutritious components. As a result of its deliciousness, low cost, and nutritional value, consumers in developed and developing nations alike wish to include fermented fish in their regular diets. People with low incomes in Assam may have more reliable access to nutrients due to these small indigenous fish products. It is therefore proposed that small fish species would be a useful alternative for Assam's large population of poor people to help them meet their daily nutritional needs and improve their general state of health. This study focused solely on the proximate composition of *namsing* prepared from eight selected small indigenous fish species (SIS). The high levels of proximate nutrients suggest that these fish are likely to be rich in other essential nutrients commonly found in small fish products.

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