A Comparative study of Shidol, a traditional fermented fish product of three different communities of Assam, India

Sarder Sabrina Zaman¹, Ratan Dhar², Pinky Deka³, Sashi P. Devi⁴*, Pradip K. Baruah⁵*

¹Department of Botany, University of Science and Technology Meghalaya, Meghalaya
²Duta Deepti Satsang Charitable Hospital, Satsang Nagar, Deoghar, Jharkhand
³Department of Food Science, University of Science and Technology Meghalaya

ABSTRACT: Shidol is a popular salt free fermented fish product due to its specific flavor and taste. Different communities viz. Goria Moria deshi, Koch-Rajbongshi and Bodo within Assam consume shidol to provide the basic nutritional value in their diet. The purpose of the study was to investigate the comparative analysis between the shidol of the three communities. Shidol sample was prepared then collected from two districts of Assam namely Dhubri and Kokrajhar. A survey was conducted to contract information regarding preparation techniques and handling purposes. Physicochemical analysis, microbial analysis of the fermented fish product was also studied following to the standard methods. A comparative analysis has been carried out in respect to the physicochemical properties of the shidol and observed that among the shidols of three different communities, the shidol of Koch-Rajbongshi has been found to be more nutritive. Presence of bacteria and fungal growth was also observed.

Key Words: Shidol, Fermented Fish Product, microbial activity, Physicochemical analysis

1. Introduction:
Fermentation provides a huge range of possibilities for the improvement of the nutritional and functional properties of food. The word fermentation originated from latin word “Fermentum” meaning “boiling”. It is the process of chemical digestion of certain substances which leads to the conversion of organic substances into simpler compounds [1]. Fermentation is one of the traditionally old and most-effective methods of preparation and preservation of food [2]. Preparation of traditional fermented food is one of the oldest biotechnological processes around the world [3]. However, the preparation techniques vary from one another.

Since time immemorial, fermented foods has been offering an important contribution to Indian diets as fermentation improves the nutritional value, enhances sensory qualities and it is also a cost-effective technology [4]. On the basis of empirical knowledge all fermented fish products have been prepared traditionally without any knowledge of microbes involved in the preparation until the development of modern microbiology [5]. Researches has begun to emphasis the role of microbes in the fermentation process of fermented fish and other products. It has been found that during fermentation the primary and secondary microbial metabolism are responsible obtaining the product quality [6][7].
In south-east Asia including India, fermented fish products are consumed generally as a condiment in rice dishes [8]. Multiple studies have showed a beneficial association between fish product consumption and human health for prevention, example, prevention of cardiovascular disease and reduction of metabolic syndrome [9][10]. Due to its high nutritional value and organoleptic properties fermented fish products has become popular in developing countries. It is a dietary source of food and has a good source of nutrition [11].

**Shidal, Shidol or Napham** is one of the most popular indigenous known fermented fish product widely used by the ethnic people of different communities of Assam and in various parts of North East India. The existence of shidol dates back to the British era i.e., before the year 1824 [12]. **Shidal** is a salt free fermented product indigenous to northeast India. **Shidol** has a strong flavour, palatability and texture which makes a difference from other cuisines in India. The color ranges from brown to dark brown as it gets old. **Shidal** permeates a strong putrid odor. Because of its typical flavour and strong aroma **shidol** is highly demanded in Assam, Northeast, India [13]. Moreover, the products possess high nutritional value. Different communities within Assam use fermented fish product (**shidol**) to provide the basic nutritional value in their diet.

Different fermented traditional products consumed by different communities with daily dishes connects to all aspects of some ethnic beliefs and are closely associated with socio-culture, spiritual life and health [13]. The fermented fish product, **shidol** has numerous local names like **shidol** used by Koch-Rajbongshi ang Goria-Moria Deshi community, **Napham** by Bodo community, **hukoti** by Sonowal Kochari and Ahom community, **Namsing** by Mising community of upper Assam and **Ngari** by the people of Manipur [14].

The Goria-Moria Deshi community hails from lower Assam, India, which were the undivided Goalpara district. Their ancestors are said to be converts from the Koch Rajbongshi kingdom in the early 13th century [15]. Koch Rajbongshi is an ancient tribe originally from the ancient Koch kingdom. The Koch Rajbongshi community is referred to as Rajbongshi, or Rajbanshi, or Rajvanshi. The word "Rajbongshi" literally means "royal community". They have a rich cultural heritage and their own language [16]. The Bodos were earlier known as Kachari, and one of the earliest settlers of plains Assam [17]. The historian H. K. Barpujari says, “The Kacharis who belong to the great Bodo race were perhaps one of the earliest aboriginal tribes of the Brahmaputra valley” [18]. Since the earliest time, people of different communities mostly were dependent upon fishing for livelihood. During peak fishing season (May to July), there were high demand of fishes which allowed them to earn. But subsequently post monsoon, people had to found out a way to earn by preserving fishes. Due to unavailability of ice or any modern technology, they have adapted the traditional way of preservation like using turmeric, mustard oil, sun drying passed from the ancestors. Furthermore, they might have stored the fishes in earthen pots called “matka” for months which eventually lead to fermentation with a strong smell. Moreover, to change the taste, use of raw materials like turmeric, mustard oil, arum were used and to make it soft and fluffy during fermentation, sodium bicarbonate was used. All these preparations techniques passed through by ancestors, were evolved spontaneously. **Shidal** originated traditionally from time immemorial and adds delicacies within the ethnic communities [19]. **Shidal** is prepared traditionally by different communities and the preparation, handling processes were eventually passed down from generation to generation. Due to advancement of commercial food processing, new generation of the same communities have undergone rapid change of diets and so the traditionally practices have slowly gone downhill [13].

Upon consumption of fermented fishes, it stabilizes the beneficial bacteria into the digestive tract by regulating sufficient digestive enzymes which results in higher nutrients absorption [20]. Breaking down of fish proteins by microbial or indigenous proteases results in bioactive peptides, hence, considerably increasing biological properties of the food [21].

It has been observed that peptides released from the proteins of fermented fishes shows various biological activities, such as antithrombotic and antioxidative activities, cholesterol-lowering ability, blood-pressure lowering effects and antimicrobial properties. Due to all these reasons, WHO food safety unit for the research in fermented fish products has considered it as high priority [12]. Stability and quality of fermented fish not only depends on the properties of raw materials but also focused on the series of antimicrobial released by microorganism during fermentation. These compounds include many organic acids, ethanol, hydrogen peroxide and bacteriocins, which inhibit the growth of pathogenic microorganism and prevent spoilage of the products [22]. Organic acids like lactic acid, acetic acid and propionic acid are observed to establish an acidic environment and inhibit the growth of acid
sensitive spoilage microorganisms [23]. In comparison with lactic acid, acetic acid is more inhibitory and observed to inhibit the growth of yeasts, moulds and bacteria [24].

Microflora plays a significant role in fermentation of fish. The presence of variety of microbial community and endogenic enzymes in fermented fish are able to provide the required properties such as longevity of the product and organoleptic properties. Flavour is the main characteristic quality and also the reason behind consumer purchasing decisions [25]. During fermentation, presence of microorganisms contributes to the degradation of proteins and development of flavor and aroma [26]. The balance of the microbial metabolites provides the characteristic flavor of the fermented fish [27]. The microbes and enzymes released contribute to good gut bacterial growth, leading to better digestive health. Several types of Bacteria and Fungi have been reported from fermented and traditionally preserved fish products all over the world [28]. In general, *Lactobacillus, Streptococcus, Pseudomonas* are predominant and are the common fermenting bacterial genera. *Lactobacillus* and other microorganisms in fermented food have been awarded the status of GRAS (Generally Recognized As Safe) due to the beneficial physicochemical properties imparted by these microbes and also boosted the commercial importance of fermented food products [29].

*Penicillium, Cladosporium, Aspergillus* etc are common fungal genera flourished and activity in the fish muscle results in the characteristics smell of fermented fish. It is suggested that the fermentation of fishes in Asia mainly produce lactic acid as organic acids [30]. It is necessary to study the benefits of this indigenous fermented food products for their nutritional importance, medicinal value and production of useful biproducts. Although some reports are available on the preparation, handling practices and physiochemical qualities but no assessment has been done on the comparative analysis of *shidol* of three different indigenous communities. The present study was carried out with an aim to understand the nutritional value and microbial composition of the different types of *shidol* prepared by three communities of Assam.

2. Materials and methods

2.1. Sample collection / Study area: *Shidol* sample was collected from three different communities of two districts of Assam, India, namely Kokrajhar and Dhubri (Fig 1). The study area included Bandhabpara village area of Bilasipara Subdivision of Dhubri district, Khailsanimari village area of Kokrajhar district and Bamunkura village area of Kokrajhar district.

2.2. Preparation of sample (Shidol): The data on the method of preparation of *shidol* was collected through field study and survey of three different communities in the study sites. The data were collected from local people and various preparation methods of *shidol* have been observed. The process of preparation of *shidol* varied in the studied communities (Fig 2, 3, 4). *Shidol* has been prepared by following the indigenous techniques and by maintaining all possible hygienic conditions.

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![Fig 1. Map of Assam, India; Box in the map represent Study sites](https://example.com/map.png)
2.2.1 Shidol (product of Goria-Moria deshi community)

Study sites and Sample collection: The study was carried out at Bandhabpara village (26.7175° N, 91.7134° E) area of Bilasipara Subdivision of Dhubri, Assam and the sample was collected from the same.

Preparation of raw materials

- 250 grams of *Chanda nama* (chanda fish) were collected from nearby ponds or wetlands, cut and cleaned, and sundried for about 15-20 days.
- One mature Arum (*Alocasia macrorrhizos*) stem was cut into pieces and peeled off, weighing about 25 grams.
- Bamboo soop, commonly known as *kula* on which the fishes were dried.
- A wooden mortar and pestle.
- One mature banana leaf.
- 3 full teaspoons of mustard oil.
- 2 full teaspoons of turmeric powder.
- 5-10 cloves of garlic.
- 1 full tea spoon of Sodium bicarbonate (baking soda).

Process of preparation

![Shidol preparation process](images)

Fig.1. Process of *shidol* preparation in Goria-Moria community

A The fishes were cut and cleaned and sundried for 10-15 days and grind in wooden mortar and pestle, B Arum were peeled and cut, and mixed with the grinded fishes, C Cloves of garlic and sodium bicarbonate is added into the mixture and kept overnight to ferment, D Next day the dough is again grinded, E Turmeric and mustard oil put into the dough, F The dough is smashed properly with hands to prevent breaks, G Small flattened balls were made, H Paste of turmeric and mustard oil is applied all over the balls made, I The balls were dried in the sun for 10-15 days.

2.2.2 Shidol (product of Koch-Rajbongshi community)

Study sites and Sample collection: The study was taken place at Khailsanimari village (26.4208° N, 90.0969° E) area of Kokrajhar district, Assam and the sample was collected from the same.
Preparation of raw materials

- Sundried *Chanda nama* fish, 250 grams collected from nearby ponds or wetlands, cut and cleaned, and sundried for about 15-20 days.
- One tender Arum (*Alocasia macrorrhizos*) stem weighing about 250 grams were peeled off and cut into pieces.
- Bamboo soop commonly known as *kula*.
- Wooden mortar and pestle (commonly known as *wural* and *gayen*).
- One mature banana leaf.
- Turmeric powder – 2 full teaspoons.
- Mustard oil – 3 full teaspoons.

Process of preparation

![Fig. 2. Process of shidol preparation in Koch-Rajbongshi community](image)

A The fishes were cut and cleaned and sundried for 10-15 days and grind in wooden mortar and pestle, B Arum were peeled and cut, and mixed with the grinded fishes, C the mixture is made into a dough, packed in a plastic bag and kept overnight for fermentation, D The next day, the dough is grinded again, E Turmeric and mustard oil put into the dough, F The dough is smashed properly with hands to prevent breaks, G Small flattened balls were made, H Paste of turmeric and mustard oil is applied all over the balls made, I The balls were dried in the sun for 10-15 days.

2.2.3 Shidol or Napham (product of Bodo)

Study sites and Sample collection: The study was taken place at Bamunkura village (26.4341° N, 90.0443° E) area of Kokrajhar district, Assam and the sample was collected from the same.

Preparation of raw materials

- 250 grams of *Puntius* spp, commonly known as *puthi* and *Chanda nama* commonly known as *chanda* were collected from nearby ponds or wetlands, cut and cleaned, and sundried for about 15-20 days.
- One dried banana leaf.
- Arum (*Colocasia esculentum*) weighed 200 grams were cut and peeled off.
- A wooden mortar and pestle (commonly known as *wural* and *gayen*).
- Part of bamboo stem closed at one end commonly known as *chungi*, which is washed and dried.
- One wooden stick.
- Ash 10 grams.
- A clean cloth.
- Plastic rope.

**Process of preparation**

2.3 Physicochemical analysis

Moisture content, ash, free fatty acid, and protein content was estimated as per the AOAC methods (2000). pH was determined by using digital pH meter (Eco Testr pH 1). The moisture content was determined by oven drying method at 105°C for 2 hours [14]. Ash content was assessed on dry weight basis accomplished with a muffle furnace at 550°C for 5 hours [14]. Free fatty acid was estimated as per the protocol of Cox and Pearson (1962). Protein was calculated following Lowry’s method using Folin-Ciocalteu reagent, at absorbance of 660nm.

2.4 Microbial analysis

2.4.1 Isolation and Identification of bacteria and fungi

An amount of 1gm of each sample was added to 5ml of sterile distilled water and the microbial quality of the samples were determined by agar plating method. Bacteria was isolated using

Nutrient agar (Hi-Media, India). Pure culture of the isolates was maintained in agar slants for further characterization and identification. The bacteria were identified on the basis of the growth obtained on MacConkey agar and Blood agar media. Colony characters of the bacterial isolates were observed after 24 hr of incubation at 30± 2°C. Morphological characters were noted and gram stain of all the isolates were performed.

Identification of bacterial isolates upto species level was done in Vitek 2 Compact according to the standard methods [31].

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**Fig. 3. Process of shidol (Napham) preparation in Bodo community.**

A The fishes were cut and cleaned and sundried for 10-15 days and grind in wooden mortar and pestel, B Arum were peeled and cut, and mixed with the grind fishes, C The mixture was put inside the bamboo stem(chungi), D Crinkled dry banana leaf is put above the mixture, E Ash packed in a plastic bag is put above the crinkled banana leaves, G With the help of a wooden stick all the layers are pushed towards the bottom of the chungi, H Then the chungi is covered with a clean cloth and tied with a rope, and kept for fermentation for a month.
The fungi were cultured in PDA (Hi-Media, India) culture media and incubated at 26°C for 7 days followed by pure culture. Fungi are identified based on visual characteristics such as colony morphology and colour followed by the handbook of soil fungi [32].

2.5 Statistical Analysis
Experiments were performed thrice, and all measurements have been executed in triplicate. Values had been expressed as mean ± standard deviation (SD).

3. Results and Discussion
Three types of shidol were studied about the preparation techniques, physicochemical and microbial analysis. The results of physicochemical analysis are presented in table 1.

Table 1. Physicochemical quality of shidol of three different communities

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Shidol of Goria-Moria community</th>
<th>Shidol of Koch-Rajbongshi community</th>
<th>Shidal of Bodo community</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.8±0.1</td>
<td>6.9±0.1</td>
<td>7.8±0.1</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>20±0.5</td>
<td>25±0.3</td>
<td>47±0.3</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>7.45±0.2</td>
<td>17.1±0.1</td>
<td>7.0±0.1</td>
</tr>
<tr>
<td>Free fatty acid (%)</td>
<td>55±1.2</td>
<td>20±0.8</td>
<td>18±0.7</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>0.5±0.6</td>
<td>0.6±0.7</td>
<td>0.2±0.7</td>
</tr>
</tbody>
</table>

Data given are mean ± standard deviation for three observations of each sample.

![Bar diagram showing the comparative analysis of physicochemical parameters of shidol of three communities](image)

**Fig.4.** Bar diagram showing the comparative analysis of physicochemical parameters of shidol of three different communities. Error bars indicate the Standard deviation of the value obtained in three observations.

<table>
<thead>
<tr>
<th>Shidol (product of Goria-Moria)</th>
<th>Aeromonas salmonicida, Francisella tularensis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shidol (product of Koch-rajbongshi)</td>
<td>Aeromonas salmonicida, Acinetobacter Iwoffii</td>
</tr>
<tr>
<td>Shidal (product of Bodo)</td>
<td>Francisella tularensis</td>
</tr>
</tbody>
</table>
Table 3. Colony characteristics of the isolated bacteria

<table>
<thead>
<tr>
<th>Sample ID</th>
<th>MacConkey agar</th>
<th>Blood agar</th>
<th>Gram stain</th>
</tr>
</thead>
<tbody>
<tr>
<td>KR1</td>
<td>No growth</td>
<td>Smooth, opaque, creamy, 1-2mm diameter</td>
<td>Gram Coccobacilli</td>
</tr>
<tr>
<td>KR2</td>
<td>No growth</td>
<td>Grey colony, smooth, creamy, 1-2mm diameter</td>
<td>Gram Negative Bacilli</td>
</tr>
<tr>
<td>GM2</td>
<td>No growth</td>
<td>Grey colony, smooth, creamy, 1-2mm diameter</td>
<td>Gram Negative Bacilli</td>
</tr>
<tr>
<td>GM3</td>
<td>No growth</td>
<td>Small white colony, &lt;=1mm diameter</td>
<td>Gram Coccobacilli</td>
</tr>
<tr>
<td>B2</td>
<td>No growth</td>
<td>Small white colony, &lt;=1mm diameter</td>
<td>Gram Coccobacilli</td>
</tr>
</tbody>
</table>

Table 4. Fungi identified in the shidol of three communities

<table>
<thead>
<tr>
<th>Product</th>
<th>Fungi identified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shidol (product of Goria-Moria community)</td>
<td>Cladosporium spp, penicillium spp</td>
</tr>
<tr>
<td>Shidol (product of Koch-Rajbongshi community)</td>
<td>Aspergillus spp, Penicillium spp</td>
</tr>
<tr>
<td>Shidol (product of Bodo community)</td>
<td>Trichoderma spp</td>
</tr>
</tbody>
</table>

Shidol, the fermented fish product plays a significant role in the dietary source of the people of Assam as well as Northeast sector of India. The results of physicochemical analysis revealed that the product of Koch-Rajbongshi has high nutritive value in respect to free fatty acid, ash, protein content as compared to the shidols of Goria-Moria and Bodo community (Fig 4).

The pH value of shidol samples ranged from 6.8±0.1 to 7.8±0.1. The pH of Bodo community shidol appeared to be higher with respect to other shidols, but this may be due to the higher amount of volatile nitrogenous compound production during fermentation that accumulated in fish (Puntius spp) used in the shidol of Bodo community [33]. Similar results were also observed by different researchers time to time [33] [34].

Moisture content was found to be highest in the shidol of Bodo community (47±0.3%) as compared to the shidol of Goria-Moria (20±0.5%) and Koch-rajbongshi (25±0.3%). The high moisture content observed in the shidol of Bodo community may be due to the absorption of moisture during the course of fermentation and storage. High moisture indicates an increase of unwanted microbial growth and reduced the shelf life of the product [35]. In case of free fatty acid, the highest 55±5% found in shidol of Goria-Moria community and lowest 18±5% found in shidol of Bodo community and 20±5% was found in the shidol of Koch-rajbongshi community. The difference in the free fatty acid contents among the three shidol samples might contributed to the lipid content of the raw fish used in the preparation [32]. Presence of high free fatty acid content indicates quick spoilage of the product. Ash contents of the shidols were within the range of 7.45±0.2% to 17.1±0.1%. The highest ash content was found 17.1±0.1% in shidol of Koch-rajbongshi community while lowest ash content was found 7.0±0.1% in shidol of Bodo community. However, a very small quantity of protein varying from 0.2±0.7% to 0.6±0.7% was observed in the studied fermented fish product. The highest protein content was found to be 0.6±0.7% in shidol of Koch-rajbongshi community while the lowest protein content was observed to be 0.2±0.7% in shidol of Goria-Moria community. Similar findings were also reported for fermented fish products by another researcher [34].
The presence of raw materials used in the preparation process plays an important role in making the final product nutritious and beneficial. Raw materials such as Arum (Alocasia macrorrhizos) which has been used in both the shidols of Koch-rajbonshi and goria-Moria community stem contain starch and structural carbohydrate content is high and also possess pharmacological activities [36]. Use of turmeric during preparation helps to increase the shelf life of the product by delaying the microbial spoilage and prevent disease caused by infectious pathogen [37]. Turmeric also have analgesic, antibacterial, antifungal, anti-inflammatory, antioxidant and digestive properties [38][39]. Like turmeric, mustard oil used in the preparation of shidol also have antimicrobial, antifungal, antibacterial properties. It prevents contamination and unwanted bacterial and fungal growth [40].

As per the microbial analysis, the bacteria isolated and identified are presented in Table 2 and 3. Presence of Aeromonas salmonicida, which can survive at room temperature and is capable of generating ATP but is also capable of switching to fermentation in absence of oxygen [41]. As for the presence of Acinetobacter lwoffii bacteria, it is found in fish and resistant to many disinfectants, irradiation and desiccation [42]. The presence of bacteria has found to be useful but may be poisonous if consumed in large quantities. The bacteria may contribute to development of flavour and odour due to their proteolytic and lipolytic activities [43].

The presence of Penicillium and Aspergillus indicates their role in fermentation. Penicillium promote flavour of the product and the metabolites also prevent the growth of surface contaminants [44]. Since many years, Aspergillus has been reportedly used for making fermented food and beverages. In addition, Aspergillus has been considered as a microorganism with safe status with many applications in industrial microbiology [45]. The observed physicochemical, microbiological, and nutritional values indicated that the fermented fish product shidol of the Koch-rajbonshi community is a good source of nutrients compared to the Bodo and Goria-moria communities of Assam

4. Conclusion

This study has revealed that among the shidols of three communities studied, shidol of Koch-Rajbonshi was the best quality with respect to the physicochemical analysis, raw materials used and microbial population. Shidol is regarded as the enhanced food value in relation to free fatty acid content, protein content, moisture content, ash content and other factors. This fermented product prepared only by the specific community people specifies their ethnic knowledge which has been passed through generation to generation. However, these practices are confined to some very specific places due to the advancement of processed foods. This study is beneficial and will open doors to future research of fermented fish products in order to highlight their benefits, nutritive values, storage and long-term use.

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