Characterization of the traditional fermented fish product *Shidol* of Northeast India prepared from *Puntius sophore* and *Setipinna phasa*

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*Shidol* is a traditional fermented fish product popular in the North eastern part of India, because of its typical flavor and aroma. The proximate composition, biochemical, microbiological and sensory quality of two types of *Shidol* prepared from *Puntius sophore* (Hamilton) and *Setipinna phasa* (Hamilton) available in markets were studied. The results of the analysis showed that the market samples of *Shidol* were a good source of protein ranging from 27.2 - 38.35%. The pH and moisture content were from 6.1 - 6.2 and from 33.44 - 37.52%, respectively. The physicochemical analysis revealed that the products were of acceptable quality. The bacterial flora of *Shidol* comprised of *Staphylococcus aureus*, *Streptococcus* spp and *Escherichia coli* indicating unhygienic handling practices during preparation and storage. There were no visible fungal colonies on the products; however, when grown on agar medium, a few yeast and mould colonies were observed. The products had acceptable sensory quality. *Shidol* can be kept for more than one year at room temperature.

**Keywords**: Traditional fish product, Fermentation, Shidol, Proximate composition, Biochemical, Microbiological, Sensory quality

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Fermentation is one of the oldest and most economical methods for producing and preserving food in the North eastern part of India. Different ethnic people in this region use indigenous fermented fish products to provide the basic components of their diet, with diverse characteristics of nutrition, flavor, palatability and texture. In addition to preservation, fermented foods can also have the added benefits of enhancing flavour, increasing digestibility, improving therapeutic values. *Shidol* is a salt free fermented fish product with a paste surface, which is widely used by the people of the North eastern states of India. *Shidol* is never consumed in its fermented form. A *chutney* or sauce-like recipe, locally called *Shidol bhorta*, is prepared as a side dish for rice or bread. The popularity of the product is due to its flavour. In the tribal community of Tripura, hardly a day passes without *Shidol* being cooked. *Shidol* is an important component of a popular oil-free preparation known as *Godhak* in the tribal food culture. Fermented fish products are mostly produced in the household/small factory scale with limited process control to ensure product quality and safety. The procedures used for processing of fermented fish do not include steps, such as cooking or pasteurization, that destroy pathogens, and the products are often stored at an ambient temperature until consumption. This, in combination with a low-salt or salt-free concentration means that very high microbiological risks are associated with those types of products. *Shidol* is produced by natural and largely uncontrolled fermentation. In addition, the environment in which the fish is processed is not hygienic, paving the way for possible contamination. It is prepared exclusively from soft fin swamp barb, *Puntius sophore* (Hamilton, 1822), but now-a-days, *Shidol* prepared from other fish species like Gangetic hairfin anchovy, *Setipinna phasa* (Hamilton, 1822), Indian river shad, *Gudusia chapra* (Hamilton, 1822) are also available in the market and has become popular in the region. Though different preservative steps are involved in the curing process, yet the cured fish products undergo a gradual deterioration. The spoilage of the product is mainly due to bacterial, fungal or yeast action, rancidity, autolysis and other reactions, all of which are temperature and water activity dependant. There are a few reports on the quality of traditional fish products available in the markets of India, but there is

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no report available on the quality of *Shidol* commerce in north eastern part of India.

The present study has been carried out to assess the proximate composition, biochemical, microbiological and sensory qualities of two different *Shidol* prepared from *Puntius sophore* (*Puthi Shidol*) and from *Setipinna phasa* (*Phayssa Shidol*), which are popular in the market of Northeast India.

**Methodology**

*Shidols*, available in the Jagiroad dry fish market (the largest dry fish market in Asia) of Assam were used in the present study. For traditional *Shidol* preparation (Fig. 1), the raw fresh fish species were allowed to sundry for 4-5 days (Fig. 2) and filled in the airtight earthen pot (Figs. 3, 4, 5) (locally called *Koloh*) with the dry fish just after soaking for 5-10 minutes. Soaking of raw materials (Fig. 6) is very important in the preparation of *Shidol* and crucial for obtaining the best quality product. By repeated smearing of oil (fish oil extracted from the entrails of *Puntius sophore* or other fresh water fishes, through an indigenous crude method for smearing or vegetable oil) and subsequent drying under sun, the *Koloh* (round bottomed and narrow necked earthen vats, the capacity of which ranges from 10-40 kg) are saturated with oil. Unlike the other fermented fish products, salt is never added during preparation of *Shidol*. The filled earthen pot is then sealed air tight, thus providing an anaerobic condition inside and stored at room temperature for 3-4 months for fermentation (Fig. 7).

Two types of *Shidol*, i.e. *Phayssa Shidol* (Fig. 8) and *Puthi Shidol* (Fig. 9) were collected from the Jagiroad dry fish market and brought to the laboratory in aseptic condition, packed in low density polyethylene pouches (thickness:200 gauge) and stored under ambient conditions (30±2°C). *Shidol* were collected from the retailers after two days of opening the air tight sealed fermenting containers.

![Fig. 1—Preparation of Shidol by traditional method](image)

Retailers kept the product in plastic containers or in earthen pots (*Koloh*) itself for selling. The products were analyzed for different quality parameters. The analyses were done in triplicate in the case of both the samples.

**Biochemical analysis**

The proximate composition of *Shidols* was determined. The pH of homogenate (10 gm in 10 ml distilled water) was measured using a standard pH meter. The non protein nitrogen (NPN) was determined using the TCA extract (10%) of the samples. 5 gm of sample homogenized with 5% chilled NaCl solution and the supernatant part of sample solution was used to determine the salt soluble nitrogen (SSN) content by Microkjeldahl’s method. Ten percent trichloroacetic acid (TCA) extract was used to estimate total volatile base nitrogen (TVB-N) by Conway’s micro diffusion method. The peroxide value (PV) and free fatty acid (FFA) were determined from the chloroform extract of tissue.

**Microbiological & sensory analysis**

An amount of 10 gm of muscle from different part of the sample was collected aseptically and macerated with 90 ml sterile saline. The microbial quality of the samples was determined after making serial dilution in the same diluents. Sensory evaluation of the samples was carried out using the 9 point hedonic scale by a trained taste panel consisting of 10 members. Sensory quality of *Shidol* samples were judged for appearance, colour, texture, flavour intensity and overall acceptability. The colour was recorded, based on visual observation and texture by applying pressure by the finger tips.

**Results and discussion**

The proximate composition and biochemical quality parameters of dried fish products of *Puntius sophore* (*Puthi maach*) and *Setipinna phasa* (*Phayssa maach*) which are commonly used as raw materials for *Shidol* preparation is given in Table 1. The mean value of moisture, crude protein, crude fat and ash were found to be 20.90-22.53%, 52.86-58.32%, 7.33-17.10% and 8.1-10.08%, respectively. The pH value of the dry fish samples was 6.4 and 6.6. Good quality raw material is essential to produce quality end product. It was reported that good quality dry *S. phasa* was obtained on moderately sunny but windy days. The *Phayssa maach* collected during the winter period (October - December) was considered to be the
best raw material to obtain quality *Phayssa Shidol*. This may be attributed to the fact that this period coincides with the time of the maximum fat content of the fish. The higher values of fat in dried *S. phasa* was reported in winter (4.5%) compared to 3.67% in summer. The myofibrillar protein plays a major role in determining the textural quality of the fish and fish products. The functionality of fish proteins mainly depends on the solubility/extractability of myofibrillar protein. The higher value of salt soluble nitrogen (50.2-62.5% of total N) of collected dried fish products from market might be attributed to drying of fishes for short duration under low sun shine and higher relative humidity, as a result product was not sufficiently heated up for protein denaturation. Similar results of SSN content (37.2- 51.7% of total N) were reported in the case of dried fish samples available in the markets of Tripura. The results presented in Table 2 exhibit that the moisture content of *Puthi Shidol* and *Phayssa Shidol* are 33.44% and 37.52%, respectively. The moisture content was reported in ranges from 39.62 to 46.89% in *Chepa shutki*, a semi fermented fishery product prepared from *Puntius* spp collected from the markets of Bangladesh. The high value of moisture content in *Shidol* may be due to the possible absorption of moisture from the environment during storage, since in most places *Shidol* is stored in earthen pots or in plastic bottles during marketing. It was proposed to explain the similar reason for the high moisture content of *Chepa shutki* stored in bamboo baskets in the markets of Bangladesh. The present study reveals that the moisture content is within the range of BIS standard which prescribes a range of 10-35% for smaller fish and 40- 45% for bigger ones. The *pH* value of *Shidol* samples were in the range from 6.1 to 6.2. The mean value of moisture and *pH* of samples indicates that the *Shidol* is a stable product.

![Fig. 2-9—Raw material; (3) Dried fishes are filled in Koloh; (4) Dried fishes are filled in Koloh; (5) Koloh is ready for sealing; (6) Dried fishes for soaking; (7) Koloh are stored for fermentation; (8) Phayssa Shidol; (9) Puthi Shidol](image)

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Quality of raw materials used for preparation of <em>Shidol</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dried <em>Puntius sophore</em></td>
<td>Dried <em>Setipinna phasa</em></td>
</tr>
<tr>
<td>Moisture, %</td>
<td>20.90 ± 0.45</td>
</tr>
<tr>
<td>Crude protein, %</td>
<td>52.86 ± 0.95</td>
</tr>
<tr>
<td>Crude fat, %</td>
<td>17.10 ± 1.65</td>
</tr>
<tr>
<td>Ash, %</td>
<td>8.10 ± 0.43</td>
</tr>
<tr>
<td><em>pH</em></td>
<td>6.6 ± 0.01</td>
</tr>
<tr>
<td>Salt soluble nitrogen, (% of total N)</td>
<td>50.20 ± 0.55</td>
</tr>
<tr>
<td>Non protein nitrogen, %</td>
<td>1.1 ± 0.47</td>
</tr>
<tr>
<td>Total volatile base N, mg%</td>
<td>99.85 ± 1.72</td>
</tr>
<tr>
<td>Peroxide value (millimoles/gm of fat)</td>
<td>24.4 ± 0.34</td>
</tr>
<tr>
<td>Free fatty acids (% as oleic acid)</td>
<td>39.6 ± 0.69</td>
</tr>
<tr>
<td>Total plate count (log cfu/gm)</td>
<td>4.0</td>
</tr>
<tr>
<td>Yeast and mould (log cfu/gm)</td>
<td>1.0</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em> (log cfu/gm)</td>
<td>1.9</td>
</tr>
</tbody>
</table>

All values are mean ± standard deviation of three determinations
Meghalaya prepared from Danio spp was also a good source of protein (40.6 gm/100 gm)\(^{16}\).

The content of SSN (40.7-45.6% of total N), NPN (2.2-2.5%) and TVB-N (108.24-116.20 mg %) of the samples indicates the degradation of tissue protein that may be responsible for the generation of the typical flavor and aroma of the fermented fish product. The high value of NPN and TVB-N might be attributed to the subsequent microbiological and biochemical changes in the fish muscle during the drying and fermentation process. The value of NPN and TVB-N of salt fermented \textit{Lona ilish} was reported as 540 mg% and 48 mg%, respectively\(^{17}\).

The PV and FFA of \textit{Shidols} were found to be 39.12-51.96 millimoles/gm of fat and 64.5-74.6% of oleic acid, respectively (Table 2). The PV is a measure of the first stage of oxidative rancidity and fish lipid being highly unsaturated, is highly liable for both autolytic as well as oxidative rancidity\(^{18}\). Though the \textit{Shidol} fermentation is an anaerobic/micro aerophilic process, higher values of PV of the market samples might be attributed to direct exposure to air during retailing, resulting lipid oxidation of the product. A similar PV (41.3 meq O\(_2/kg\) fat) and FFA (31.84% oleic acid) has been reported in salted anchovy after 9 weeks of fermentation\(^{19}\). The PV and FFA value for \textit{Lona ilish}, a traditional salt fermented fish product of Northeast India was also recorded as 40.0 meq O\(_2/kg\) and 18.22 % oleic acid, respectively\(^{20}\).

The samples were analyzed for pathogenic contamination. Pathogenic contaminants like \textit{Staphylococcus aureus}, \textit{Streptococcus} spp and \textit{Escherichia coli} were detected in both Shidol samples. The count of \textit{S. aureus} and \textit{Streptococcus} spp were 1.8-2.4 log \textit{cfu/gm} and 1.0-1.1 log \textit{cfu/gm}, respectively, whereas the number of \textit{E. coli} was less than 1 log \textit{cfu/gm}. \textit{Salmonella} spp were not detected in both samples. The presence of \textit{S. aureus}, \textit{Streptococcus} spp and \textit{E. coli} in fermented fish products might be attributed to poor handling practices and faecal contamination during processing and storage\(^{21, 22}\). \textit{Staphylococcus aureus} was regarded as a poor competitor and its growth in fermented food is generally associated with a failure of the normal microflora\(^{23}\). It was also reported that the count of \textit{Bacillus cereus} was <10\(^2\) \textit{cfu/gm}, whereas the number of enterobacteriaceae and \textit{Staphylococcus aureus} were <10\(^3\) \textit{cfu/gm} in traditional fermented fish products \textit{Hentak}, \textit{Ngari} and \textit{Tungtap}\(^{24}\). In the case of naturally fermented Cassava fish (\textit{Pseudotolithus} spp), \textit{Bacillus} spp and \textit{Staphylococcus} spp were the predominant genera which accounted for 48.7% and 27.3% of the total number of isolates, respectively\(^{25}\). The total plate count of the Shidol was 5.1-5.4 log \textit{cfu/gm}. There was no visible fungal colony on the products. However, when grown on agar medium, a few yeast and mould colonies (1.2-1.7 log \textit{cfu/gm}) were observed. Yeast such as \textit{Candida} and \textit{Saccharomycopsis} were also present in \textit{Hentak}, \textit{Ngari} and \textit{Tungtap}-a few traditional fish products of Northeast India. Similar results were also reported from \textit{Nam-pla} and \textit{Kapi}\(^{26}\). The growth of spoilage/pathogenic bacteria and contamination can be prevented by the control of factory hygiene, sanitation and water quality.

The sensory quality of \textit{Shidol} is studied and presented in Table 2. The sensory attributes evaluated for different types of \textit{Shidol} reveals that the products have a good sensory quality and overall acceptability. Though the products were found to have good appearance (6.9-7.0), colour (6.5-7.1) and texture (6.7-
6.8), yet the overall acceptability of the product depends mainly on the intensity of flavor and aroma of Shidol. The complex interaction of enzymatic activity and oxidation during the fermentation, along with bacterial production of volatile fatty acids may be responsible for characteristic flavor and aroma of fermented fish products. A significant role of bacteria and muscle bacterial proteases in the process of fermentation and flavor and aroma producing process was recorded. Phayssa Shidol had bright and shining appearance, golden yellow colour, slight off sour odour with soft and spongy texture. Pathi Shidol also had shining appearance, silvery grey colour, characteristics good odour with firm and flexible texture. The overall acceptability of both the samples graded as good with firm and flexible texture. The overall acceptability (6.7-6.9) of both the samples in the present study reveals that the traditional salt-free fermented fish product Shidol available in the markets of North eastern states have a high nutritive value, as the protein, fat and ash content are observed to be high. The physicochemical quality of Shidol was found to be in the acceptable limit. The present findings suggest that the market sample of Shidol was contaminated with several pathogens which are generally associated with different clinical conditions of human beings. Though the absence of Salmonella spp is a good sign for consumers, yet the public health importance of the above findings cannot be ignored. Therefore, it is stressed that strict hygienic measures should be adopted right from the preparation of raw materials, use of utensils, handling practices, processing methods and during storage in order to safeguard the health of the consumers.

Conclusion
The present study reveals that the traditional salt-free fermented fish product Shidol available in the markets of North eastern states have a high nutritive value, as the protein, fat and ash content are observed to be high. The physicochemical quality of Shidol was found to be in the acceptable limit. The present findings suggest that the market sample of Shidol was contaminated with several pathogens which are generally associated with different clinical conditions of human beings. Though the absence of Salmonella spp is a good sign for consumers, yet the public health importance of the above findings cannot be ignored. Therefore, it is stressed that strict hygienic measures should be adopted right from the preparation of raw materials, use of utensils, handling practices, processing methods and during storage in order to safeguard the health of the consumers.

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