Naturally evolved fermented fish products of Northeast India (Seedal and Shidal) - A comparative study

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The indigenous fermented fish products of Northeast India namely seedal and shidal were studied to record the preparation processes and general biochemical and microbiological characteristics of the products. The production centers of different states including Assam and Tripura were surveyed and the data were recorded through personal interview and on the spot observation. The most common methods have been reported for the products including seedal and shidal from Assam and Tripura, respectively. These solid products are prepared from small fish species belonging to the carp family (Cyprinidae) by a combined process of drying and semi-fermentation which are then consumed with further elaborate cooking. Seedal was found to contain better original organoleptic characteristics than shidal. The proximate composition of moisture and protein showed significant changes (P<0.05), e.g. less moisture content in shidal (30%) than in seedal (36%); however, more protein content was evident in shidal (39%) than in seedal (31%). The protein breakdown products such alpha amino nitrogen, Total Volatile Bases (TVB-N) and Non-Protein-Nitrogen (NPN) showed minimal protein degradation in both the products which is a major peculiarity of these products. The indices for lipid hydrolysis including Peroxide Value (PV), Free Fatty Acid (FFA) and Thiobarbituric Acid number (TBA) showed significantly higher lipid oxidation in shidal than in seedal. The pH also showed significantly higher value in seedal than in shidal. Total Plate Count (TPC) was recorded significantly higher in shidal (7.2 log CFU/g) than in seedal (6.4 log CFU/g) having the Total Fungal Count (TPC) almost negligible in both the products. Being produced in large scale, shidal contained more dry fish like characters than seedal which had higher market value than the other.

Keywords: Fermented fish, Fish Products, Northeast India, Seedal, Shidal, Puntius spp.
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Introduction

The Northeastern region of India is a treasure of natural products pertaining to agriculture, food, medicine, and natural resources management1. The region has over 100 tribes and communities, each having their unique ethnic foods developed through the ages. In recent years a number of ethnic foods and food products traditionally prepared by different tribes/communities of the region has been reported1-11 including fish products such as shidal/seedal5,6, ngari1,11, hentak1,11, and tungtap5,11. The low-valued small fish are dried, moistened, packed in oil smeared earthen pots and kept at room temperature for about 6 months. These products are eaten after elaborate cooking as a condiment with rice. These semi-fermented products retain almost original shape and size of the fish that are used as raw material. These non-salty solid products have no similarity with classical fermented products of Southeast Asian countries such as Patis of the Philippines, Nuac mum of Korea, Taiwan and Vietnam which are mostly paste or semi liquids with salt as a major component.

The fermented products probably came into existence at least before the British Era in Northeastern states of India [before 1824, The Yandabu Agreement between British Govt. and Burma (now Myanmar)] when the British first introduced salt in the region. Interestingly, in all the fermented fish products of this region no salt is used as ingredient which is a major difference with the other fish based fermented fish products of Southeast Asian countries such as Nuac-mum of Vietnam, Budu of Malaysia, Patis of the Philippines, etc. Even after the British Era, people used to treat salt as a highly valued and scarce commodity and they used to take an alternative commodity, for example khar in Assam, made from banana plant or papaya. Hence, they could
not afford spending salt in fish preservation and they were bound to preserve fish in their own cheaper and easier way. As Saisithi (1994) suggested, it is quite natural that the simple drying might have prolonged due to frequent rainfall resulting in high humidity in the atmosphere particularly during the peak fishing seasons, i.e., monsoon and post-monsoon from May to September. Consequently, the experienced fishers had to find out a method through which they could preserve the instant heavy catches comprising of very less valued small fishes like Puntius spp., Amblypharyngodon sp., Trichogaster spp., Channa spp., Mystus spp., Botia spp., Danio spp., Rasbora spp., Chanda spp., Nandus sp., etc. for the consumption and sale in the dry seasons (November to April) when raw fresh fish used to be scarce in the market. Due to the unavailability of ice and good road communication facilities, fishers could not even transport this highly perishable catch to the distant markets where they could have received a profitable price. As a matter of fact, the fishers would never earn good price in the village markets through instant sale of these fish.

Furthermore, the people, perhaps, wanted to change the taste and flavor of their daily rice-fish dish, which had become bland and monotonous. As a result, they invented the methods of preparation of such fermented fish products. For instance, people must have stored the semi-dried fish in earthen vats (locally called mutkas) for months together which eventually allowed the fermentation process to set in and resulted in a semi-pasty and product with strong smell “seedal” in Assam. People gradually acquired the taste and aroma of such fermented products and especially the disadvantaged economic conditions of the people, perhaps, created compulsion for accepting these products. The primary objectionable smell of these products was taken care of while preparation of the culinary dishes by adding hot spices including green chili, ginger, garlic, onion, red pepper, salt and oil and by frying or boiling with subsequent grinding into pastes.

Mostly Puntius spp. or Setipinna phasa which are abundantly available during monsoon and post-monsoon seasons in the water bodies of the region are utilized as a means of preservation for future use when fresh fish are scanty. The use of small economic varieties of fish in fermented fish products and their popularity in Northeast may be due to several reasons such as: [1] Highly perishable nature of such fish did not allow transport to the distant markets for better price, thus compelling fishers to go for preservation, [2] Variability of size and shape of individual species in the whole catch, however, species wise uniformity in size such as Puntius spp. made it easier to sort and segregate this particular species for processing for preparation of seedal. [3] The fish oil required for product processing could be extracted sufficiently from the same fish, hence no dependency on other oil source and a low cost product. [4] The other options like preparation of silage were not known to the fishers. [5] Simple sun drying was difficult enough due to frequent rain, infestation by pests and creation of unpleasant atmosphere in the courtyard. [6] Believing such products to be of medicinal value. [7] The culinary preparations of these products used to be efficient appetizer and taste enhancer to serve as condiment with rice.

These traditional methods are spontaneously evolved by the people who have been actively engaging themselves in fish related activities. The products originated traditionally from time immemorial and are the delicacies of tribes and non-tribes of the region with amazingly high demand in the market. The popular belief is, these products have pharmaceutical values which may be proven in affirmative by conducting organized scientific research.

**Materials and Methods**

The information was collected through extensive field study and survey. The study area was Nagaon district of Assam and West Tripura district of Tripura (Plate 1). Three production centers from each district were surveyed and the persons actively engaged in the production were interviewed. From the many variations of the preparation procedures adopted in the study region, a common method of preparation of the product has been worked out after eliminating insignificant deviations having little bearing on the finished product quality.

**Plate 1**—The study area (red circle mark) in Assam and Tripura in the North-east states of India
The product quality characteristics were recorded by sensory evaluation which was given by 10 judges randomly selected from the regular consumers of seedal and shidal and the scores were given in 10-point Hedonic scale such as 10-Excellent, 9-Very good, 8-Good, 6-7-Average, ≤ 5-Lost property/unacceptable. The mean value of the scores was taken and the results were supplemented by information provided by the fishers engaged in product preparation.

The samples of seedal and shidal were collected in polyethylene bags immediately after opening the mutka from the production centers of Assam and Tripura respectively during a period of six months in 2011. Total 10 samples of each product were analyzed in the laboratory of the Department of Fish Processing Technology, College of Fisheries, Tripura. Moisture, protein, ash, acid insoluble ash, total fat content, pH, free fatty acid and non protein nitrogen (NPN) were estimated following standard AOAC methods\textsuperscript{[13]}. Alpha-amino nitrogen was determined by the method given by Pope and Stevens\textsuperscript{[14]} Total Volatile Base Nitrogen (TVB-N) was determined by Conway’s micro-diffusion method\textsuperscript{[15]}, Peroxide Value (PV) by the method given by Jacob\textsuperscript{[16]} and Thiobarbituric Acid (TBA) number by method given by Tarladgis \textit{et al}\textsuperscript{[17]}.

Total Plate Count (TPC) and Total Fungal Count (TFC) were done by spread plate techniques (APHA, 1995). Exactly 10 g of shidal sample was introduced aseptically in a sterile stomacher bag (Seward stomach BA6141CPG standard bags) and blended for 2 minutes with 90 mL of sterile diluents (0.85% NaCl) and blended for 2 minutes with 90 mL of sterile diluents (0.85% NaCl). Serial decimal dilutions of 1/100 was prepared using 9 mL of sterile physiological saline and 1 mL homogenized sample and it was well mixed in cyclomixer. For TPC, 0.1 mL portions of various dilutions were spread on the surface of preset surface-dried Soybean Casein Digest Agar/Trypticase Soya Agar (TSA) (MU290, Himedia, India) plates and for Total Fungal Count (TFC) same portions were spread on the surface of preset surface-dried Rose Bengal Chloramphenical agar (M640, HIMEDIA) plates using a sterile glass spreader. For TPC, plates were incubated at 35°C for 24-48 h while fungal plates were incubated at 25°C for 3-5 days. The plates containing 25-250 colonies were counted for TPC and plates with 15-150 colonies were selected for TFC. Representative samples of the product were inoculated directly (0.1 mL without dilution) onto replicate plates of brain heart infusion (BHI) agar (M211, HIMEDIA) with different concentrations of NaCl such as BHI + 5% NaCl, BHI + 10% NaCl, and BHI + 20% NaCl in order to see the growth halophilic/halotolerant bacteria. These plates were incubated at 35°C for 24-48 h.

Statistical analysis was done by performing one way ANOVA (Post Hoc, Duncan) and student’s t-test to compare the means using SPSS\textsuperscript{[18]}.

\textbf{Results and Discussion}

\textit{Seedal (Product of Assam)}

\textit{Seedal} is a paste and solid product in which the shape of the fish (\textit{Puntius} spp.) remains almost intact. Instead of salt, as in many other indigenous fermented fish product, extra oil is added here during product preparation. Hence, rancidity is a must in \textit{seedal}.

\textit{Puntius} spp. is exclusively used for the preparation of seedal (Table 1). The rural fishers procure them from beels and rivers. Commercially it is prepared from dried \textit{Puntius} spp. which can be grouped into four groups in Assam. The first group is \textit{Desi pathi}, produced locally and considered to be the best quality raw material for \textit{seedal} production. The dried \textit{Puntius} spp. belonging to the other groups come from Madras, Lucknow and Gorakhpur, hence named as \textit{Madrasi Pathi, Lucknowi Pathi} and \textit{Gorakhpuri Pathi}. All these varieties are procured from Jagiroad Fish Market (about 50 km east to Guwahati City, Assam). As they are imported from distant places through truck loadings, their quality deteriorates during transportation due to the unpredictable delay. However, due to the short supply of \textit{Desi pathi}, the imported varieties are used by the commercial producers by compulsion which made the producers able to produce \textit{seedal} throughout the year and maintain sustained supply to meet the high market demand. Moreover, it made them independent of the highly erratic availability of \textit{Deshi pathi}.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|}
\hline
S. No. & Scientific Name & English common name & Assamese local name & Normal size range (cm) \\
\hline
1. & \textit{Puntius chola} (Hamilton, 1822) & Swamp barb & Doloni pathi & 2-5 \\
2. & \textit{P. sarana} (Valenciennes, 1842) & Olive barb & Seni pathi & 3-8 \\
3. & \textit{P. sophore} (McClelland, 1839) & Pool barb & Soru pathi & 3-6 \\
4. & \textit{P. ticto} (Hamilton, 1822) & Two spot barb & Tita pathi & 3-8 \\
\hline
\end{tabular}
\caption{The major species of \textit{Puntius} used in the preparation of \textit{seedal} and \textit{shidal}}
\end{table}
*Mutkas* are round bottom and narrow necked specially made earthen pots, the capacity of which ranges from 8 to 40 kg (Plate 2). *Mutkas* can be used for preparation of many batches of product until they break. Older the *mutkas* better the product quality and lesser the cost of production, the reason being the older *mutkas* absorb very less amount of oil and provide very good gas barrier property.

Fish oil extracted from the entrails of *Puntius* spp. or other fresh water fish through an indigenous crude method is used by the rural producers. Oil is used to smear the *mutkas*, perhaps to increase gas barrier property by filling the minute pores in the earthen pot. Although fish oil is treated as the best oil for smearing *mutka*, for the commercial production vegetable oil such as mustard oil is used as an alternative of fish oil due to its easy availability and inexpensiveness in comparison to fish oil. Semi-dried or fully dried fish are often crushed into powder and a paste is made from it which is used to fill in the mouth portion of *mutkas*.

Any broad leaf of plants such as *Colocasia* or banana leaves, bottle-guard leaves or a piece of newspaper is used to seal the cover paste temporarily. A thick mud is prepared from humus rich and fine coarse soil, which is used to seal the mouth.

This procedure is popular among the rural fishers where raw fresh fish are available in plenty. Fishers extract fish oil from entrails of *Puntius* spp. and make use of it in *seedal* preparation (The indigenous method is illustrated in Fig. 1-Flow chart). This naturally evolved procedure is most economic and climate friendly and mostly practiced in the backyard of fishers. Although the *seedal* produced by this method (Plate 3) is considered to be the best, the commercial producers do not normally follow this method, perhaps due to inconsistent supply of raw material.

**Shidal (product of Tripura)**

*Shidal*, a *seedal* like product is prepared in Tripura (one of the states of Northeast India) mainly from two

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**Plate 2— Earthen pots (*mutka*) used in *seedal* preparation**

Raw material (Raw fresh fish *Puntius* spp.)

- Descale, gut and wash
- Semi-dry in the sun (about 50% of the total moisture is retained in fish)
- Pack the semidried fish in oil-processed *mutkas*
- Fill the mouth portion (from the neck to rim of the *mutka*) with the cover-paste
- Cover the paste with the cover-leaf and take out the *mutka* from the ground
- Keep it in a sheltered place for 3-4 days as such.
- Put a layer of thick mud on the paste after removing the cover leaf
- Keep in a dry and sheltered place. If cracks appears on the mud-seal, put another layer of mud layer on the previous one and repeat it till there is no crack on the seal
- Now keep the *mutka* undisturbed for 3-4 months
- Remove the mud and putrefied paste carefully and take out the final product one layer after another

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**Fig. 1— (Flow chart)-Indigenous method of *seedal* preparation**
species of fish such as *Puntius* spp. and *Setipinna phasa*. Completely dry fish are used here and vegetable oil is used instead of the fish oil for smearing of mutka. The dried fish is further dried under sun after a thorough sorting from the whole lot. The uniform sized fleshy fish (not infested by maggots) are dried to reduce the moisture level to about 15%. The fish are then washed thoroughly and dipped into water 10-15 minutes in order to make them slightly soft. These fish are then dried under shade over night spreading under a drying shed. In the very next morning, the mutkas are packed by putting the fish in layers in a pre-processed mutka very tightly. Mutkas are processed by smearing with mustard oil and repeatedly dried under sunlight until they become saturated with oil (Plate 4). These mutkas are kept under ventilated shade for 3-4 months for fermentation (the method is illustrated in Fig. 2- Flow chart). The fermentation time varies depending on the texture of dry fish which is used as raw material. The advantages of this method may be listed as:

Plate 3—Good quality seedal with golden brown colour

Plate 4—Earthen pot (mutka) after oil processing used in shidal preparation

Fig. 2—(Flow chart)- The method of shidal preparation
i. No dependency on seasonally available fresh fish, thus shidal can be prepared round the year.
ii. The large scale commercial production is possible due to a sustained supply of raw material.
iii. The fish oil, with short supply, is replaced with vegetable oil resulting in large scale production.

Table 2 summarizes the characteristics of seedal and shidal. The acceptability of these products depends on the post-fermentation organoleptic qualities including the appearance, texture and especially the typical shidal/seedal odour. The seedal scored 10 points (excellent) under 10 point Hedonic scale analysis when it had sticky surface, golden brown colour, hard texture and strong ammoniacal smell; whereas shidal with moderately dry surface, silvery gray/light brown colour, hard texture and moderate ammoniacal odour was given 10 points. These characteristics decide the unit price of these products in the market. In fact, seedal always fetches better price than shidal due to its originality.

Although all types of small carps belonging to the genera Puntius are used for preparation of quality products, best quality product is prepared from the matured fish of approximately 3-6 cm in length. The rural fishers believe that the fish before bearing eggs are best suited for seedal or shidal preparation.

Shidal is prepared in commercial scale to meet the demand in the Northeast states of India. As a matter of fact, the commercial producers modified the traditional method to suit large scale production. Hence, they compromised with the traditional originality of the product and incorporated those raw materials which have a constant supply for year round production along with reduction of normal fermentation time. Consequently, the product (shidal) retained nearly the original shape of the raw material (Plate 5) containing less organoleptic properties compared to seedal.

![Good quality shidal with shape nearly intact with silvery grey colour](image)

Table 2—General characteristics of best quality seedal and shidal

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Properties/characteristics</th>
<th>Seedal*</th>
<th>Shidal*</th>
<th>Sensory Score#</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Appearance</td>
<td>Retains the shape of raw material, structurally looks like Puntius spp., soft and sticky surface</td>
<td>Retains the shape of raw material, structurally looks like Puntius spp. or Setipinna phasa, firm and moderately dry surface</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Colour</td>
<td>Golden brown with pale red tinge</td>
<td>Silvery gray or light brown</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>Texture</td>
<td>Moderately hard texture</td>
<td>Hard texture but softer than dry fish</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Odour</td>
<td>Strong odour (ammoniacal and putrefied)</td>
<td>Moderate odour (ammoniacal and putrefied)</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Raw material</td>
<td>Exclusively Puntius spp.</td>
<td>Puntius spp. and Setipinna phasa</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Shape of Mutka</td>
<td>Round bottom spherical with short neck, made with black soil</td>
<td>Pointed bottom oval spherical with long neck, made with red soil</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Mutka capacity</td>
<td>8-40 kg</td>
<td>15-40 kg</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cover leaf</td>
<td>A broad plant leaf, such as Colocassia or banana plant</td>
<td>Polythene</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Oil used in mutka processing</td>
<td>Fish oil extracted from fish</td>
<td>Mustard oil</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Normal fermentation period</td>
<td>4-6 months</td>
<td>3-4 months</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Shelf life outside mutka</td>
<td>Approx. 1 month [dusted with salt, packed in polythene and stored under ambient temperature (30°C)]</td>
<td>Approx. 2 month [dusted with salt, packed in polythene and stored under ambient temperature (30°C)]</td>
<td></td>
</tr>
</tbody>
</table>

*Characteristics are based on sensory evaluation by 10 judges (regular seedal and shidal eater) supplemented with the information provided by the traditional seedal/shidal producers.

#In 10-Point Hedonic scale, 10-Excellent, 9- Very good, 8- Good, 6-7- Average, ≤ 5- Lost property/unsatisfactory
The biochemical properties of both the products are summarized in Table 3. The moisture and protein contents showed significant differences \((P<0.05)\), whereas all other parameters did not differ significantly. Perhaps, the moisture content of shidal was less (30%) due to loss of water holding capacity of protein of sun-dried fish which was used as raw material. On the other hand, seedal prepared from fresh half-dried fish, its muscle portion could hold more amount of moisture resulting in less bulk density. Thus, the raw material contained less protein and high moisture. Although ash content was higher in shidal (14.8%), its acid insoluble ash content (0.23%) was less than seedal, i.e. 13.8% (total ash) and 0.53% (acid insoluble ash), which indicates more sand contamination in seedal than in shidal. The salt content in both the products was very less, because no additional salt was used during preparation. However, small amount of salt may come from other cured fish which were handled in the same processing shed. On the other hands, the lipid content also was found to be less in shidal (15.77%) and that of seedal (18.9%). The possible cause may be the oxidation of lipids during sun-drying which is accelerated by heat and impurities in water. Seedal contained more lipids partly because of using fish oil for smearing raw fish during packing. The NPN and alpha amino nitrogen contents were almost similar in both the products with small values showing similar protein degradation process in muscle of fish. The reason may be the use of dry or semi-dry fish with scales and skin on. The dried scales and skin with high content of collagen protect fish from undergoing excessive protein breakdown by enzymatic or microbial activity. Moreover, due to the use of gutted fish (entrails removed) in product preparation, the gut enzymes are also not involved in the protein degradation process leading to limited protein hydrolysis and providing a special characteristic to the products. The TVB-N content of seedal (223.67 mg %) is significantly different \((P<0.05)\) from that of shidal (123.67), which indicates production of nitrogenous volatile compounds such as ammonia and aliphatic amines is more in seedal than in shidal. Perhaps, the sun-dried fish as raw material in shidal might be the reason for this. During long sun drying process fish either lost most of the volatile compounds due to evaporation or their precursors were denatured due to the solar heat. Same may be the reason for which the indices of lipid oxidation such as PV, FFA and TBA showed greater lipid oxidation in shidal than in seedal. The values of PV and FFA of shidal (27.2 and 42.6, respectively) were almost double of the values of seedal (14 and 20.6, respectively) which clearly indicates more oxidative and hydrolytic rancidity in shidal than in seedal. The TBA value too, which is 4 times greater in shidal (8 mg malonaldehyde/1000 g) than in seedal (2 mg malonaldehyde/1000 g) strongly supports high oxidative rancidity in shidal than in seedal. The earlier study also suggests that seedal has short shelf-life (10 days) outside mutka due to lipid oxidation and loss of volatile components that contribute to the typical flavour of products\(^6\). The pH showed significant difference \((P<0.05)\) with a value of 6.3 in seedal and 4.5 in shidal. The production of high content of nitrogenous bases in seedal might have kept the pH high.

<table>
<thead>
<tr>
<th>Biochemical properties</th>
<th>Seedal</th>
<th>Shidal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (w/w %)</td>
<td>36.02±0.90</td>
<td>30.02±0.50</td>
</tr>
<tr>
<td>Ash (w/w %)*</td>
<td>13.8±0.18</td>
<td>14.8±0.12</td>
</tr>
<tr>
<td>Protein (w/w %)</td>
<td>31.06±0.05</td>
<td>39.06±0.15</td>
</tr>
<tr>
<td>Lipid (w/w %)*</td>
<td>18.87±0.42</td>
<td>15.77±0.52</td>
</tr>
<tr>
<td>Acid-insoluble Ash (w/w %)</td>
<td>0.53±0.02</td>
<td>0.23±0.12</td>
</tr>
<tr>
<td>Salt (w/w %)*</td>
<td>0.72±0.17</td>
<td>0.42±0.15</td>
</tr>
<tr>
<td>Non-protein Nitrogen (w/w %)*</td>
<td>5.49±0.24</td>
<td>4.49±0.14</td>
</tr>
<tr>
<td>Free Alpha Amino Nitrogen (w/w mg %)*</td>
<td>60.67±6.7</td>
<td>55.67±3.17</td>
</tr>
<tr>
<td>Total Volatile Base Nitrogen (mg %)</td>
<td>223.67±3.28</td>
<td>123.67±4.28</td>
</tr>
<tr>
<td>Peroxide Value (milliequivalent peroxide oxygen/1000g)</td>
<td>14.03±0.32</td>
<td>27.22±0.42</td>
</tr>
<tr>
<td>Free Fatty Acid (% as oleic acid)</td>
<td>20.62±0.17</td>
<td>42.62±0.47</td>
</tr>
<tr>
<td>Thiobarbituric Acid Number (mg malonaldehyde/1000 g)</td>
<td>2.21±0.64</td>
<td>8.11±0.34</td>
</tr>
<tr>
<td>pH</td>
<td>6.3±0.2</td>
<td>4.5±0.2</td>
</tr>
</tbody>
</table>

*The biochemical properties with asterisks do not differ significantly \((P>0.05)\)

Table 4—The microbiological properties of seedal and shidal, values are mean ± SD, n=10.

<table>
<thead>
<tr>
<th>Microbiological property</th>
<th>Seedal</th>
<th>Shidal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Plate Count (log CFU/g)*</td>
<td>6.4±0.9</td>
<td>7.2±0.5</td>
</tr>
<tr>
<td>Total Fungal Count (log CFU/g)</td>
<td>3.4±0.1</td>
<td>3.5±0.3</td>
</tr>
<tr>
<td>Total Halophilic Count (log CFU/g)</td>
<td>UD</td>
<td>UD</td>
</tr>
<tr>
<td>Presence of anaerobic bacteria</td>
<td>ND</td>
<td>ND</td>
</tr>
</tbody>
</table>

*The microbiological properties with asterisks do not differ significantly \((P>0.05)\), UD- undetectable level, ND- Not detected
Although many conditions are similar with process of seedal production, the use of half-dried raw fish might have reduced bacterial count in it. Almost anaerobic packing of earthen pots probably reduced the growth of fungi in the products. The halophilic bacteria were in undetectable level in both the products. Analysis for anaerobic bacteria such as Clostridium botulinum was not carried out since its growth is unlikely. The environment inside the earthen pot was not completely anaerobic because of porous earthen pots used as fermenting vessel. Moreover minute amount of air remained in between fish layers inside the pot making the internal environment unfavourable for the growth of anaerobic bacteria.

Conclusion

Both the products are eaten after elaborate cooking and preparation of chutney like preparations, mixed curry with vegetables, making paste with bamboo shoots. At present these products costs more than rupees 500/- per kg in Tripura and Assam. However, the price is still higher in hilly states including Arunachal Pradesh, Manipur, Meghalaya and Nagaland. In order to improve the quality of the products, we recommend:

i. Use of hygiene practices during production including use of cemented processing shed, chlorinated washing water, regular disinfection of the premises etc.;

ii. Use of accelerated and improved method for increased production which has been developed by College of Fisheries, Central Agricultural University;

iii. Government intervention for undertaking more research, awareness programmes and technology upgradation and transfer. In order to throw light on other aspects of these products, research works are being conducted by the author under sponsored projects.

Acknowledgements

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References