Journal of Traditional and Folk Practices
Volume 04(2), December 2016, 16 - 24.
ISSN 2278 - 5906
https://doi.org/10.25173/jtfp.2017.5.1.61

Scientific evaluation of *Shidal* technology - An age old traditional practice of fish preservation of Northeast India

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Received : 03 Nov 2016 Accepted : 29 May 2017

Abstract

Fermented fish products are consumed by the ethnic people of northeast India as part of their daily diet and also play a significant role in their traditional life style beside some traditional beliefs regarding their health beneficial effects. Among these, fermented fish product prepared from *Puntius* sp. and *Setipinna phasa*, known as *Shidal* is most popular and widely consumed in different states of northeast India. The study was conducted to evaluate the scientific technology regarding processing and production of *shidal* as well as quality characteristics of *Shidal* prepared from both the species. The proximate composition *shidal* indicate their importance in human nutrition particularly in terms of crude protein and lipid. Volatile nitrogenous compounds were found in higher range in both the products; however, lipid oxidation was limited may be due to absence of pro-oxidants. Both fermented *Puntius* sp. and *Setipinna phasa* samples of NEI were found to be loaded with higher number of microbes with significant contribution from lactic acid bacteria which indicates their probiotic importance.

Keywords: Fermented fish products, Northeast India, *Puntius* sp., *Setipinna phasa*, *Shidal*.

1. Introduction

The North Eastern region of India (NEI) is known for its vast natural resources and a cauldron of different people and cultures, lie deep in the lap of easternmost Himalayan hills in North-Eastern part of India, connected to rest of India by merely 20 km of wide land. The region comprises of States like Arunachal Pradesh, Nagaland, Manipur, Tripura, Mizoram, Meghalaya, Assam and Sikkim. The region is home to varied number of tribes (about 166). Every community of NEI have their own food habits based on the location specific diversities on crops and forest resources, culture, ecological edges and seasonal variability (Singh *et al*., 2007). The traditional foods consumed by tribes of Northeastern region are intimately connected to virtually all aspects of their socio-cultural, spiritual life and health. In India, fisheries have always been playing a pivotal role in the food security of the rural people especially in maritime and North-eastern states. Fish and fish products have been associated with the socio economic life of the people of Northeast India from time immemorial. The Northeastern people are very fond of fermented food products specially fermented fish products and these products serve a daily food recipe in the tasty dishes of NE Indians (Roy *et al*., 2014).

Shidal is a salt-free fermented fish product indigenous to the Northeast sector of India. *Shidal* is exclusively prepared either from *Puntius* sp. (generally *Puntius sophore*) which is popularly known as *Punti Shidal* (Fig. 1) or from estuarine

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fish *Setipinna phasa*, known as *Phasa Shidal* (Fig. 2). The product is very much popular due to its strong flavour. It is popularly called as '*seedal'*, '*sepaa'*, '*hidal'*, '*verma'* and '*Shidal'* in Tripura, Assam, Mizoram, Arunachal Pradesh and Nagaland. Especially Assam and Tripura is the major producer of *Shidal* amongst the Northeast states (Muzaddadi and Basu, 2012). The typical strong flavour of *Shidal* is due to break down of fish protein and lipid, which produce some peptides, amino acids, fatty acids, indole, skatole etc. producing a strong characteristic odour of *Shidal* (Roy *et al*., 2015). The appearance of the product is solid, bilaterally compressed and pasty and shape of the fish remains almost unchanged except little disintegration near belly and caudal portion. The colour of best quality product is dull white that gradually becomes slight brownish to deep brownish on continuous exposure to air.

Fig. 1. *Punti shidal*

Fig. 2. Phasa *shidal*

The technology is very old and originated in the erstwhile undivided India (now Bangladesh) and believed to have come into existence before the British Era in North eastern states of India, *i.e*., before 1824. It is revealed from the Indian history, that the people of this region did not know the use of salt before its introduction by the British Government. Even after the British Era, the salt used to be treated as a highly valued and scarce commodity and as an alternative of salt, people used to use a substance known as 'khar', made from banana or papaya plant. Thus, people could not afford spending salt in fish preservation and this may be one of the reasons to preserve fish in a unique way without using salt. The plains of Bangladesh and adjoining NEI is famous for their 'beel fisheries', which is a kind of weed infested shallow water body and gets dried up fully or partially during winter. The 'beel fisheries' is an excellent habitat for weed fish such as *Puntius* sp. which propagate naturally with the beginning of rainy season and form a good fishery when the water level starts decreasing with the onset of winter. The reason for exclusive use of *Puntius* sp. for *Shidal* production possibly lies with the huge availability of this fish particularly in the post monsoon period and probably this necessitated the evolution of this cheaper technology of fish preservation for their use in lean period.

Fermentation, an age old preservation method involves breakdown of proteins in the raw fish to simpler substances which are stable at normal temperature of storage. Cleavage of proteins by microbial or indigenous proteases yields the bioactive peptides, leading to substantial increases in the biological properties of the food (Steinkraus, 2002). Traditionally cured fish is a major source of dietary protein in many developing countries (Poulter, 1988).

In addition to preservation, fermented foods can also have the added benefits of enhancing flavour, increasing digestibility, improving therapeutic values (Jeyaram *et al*., 2009). Beside these, fermented products are also having good antioxidant activity and health beneficial bioactive compounds (Uchoi *et al*., 2015). The fermented fish products of NEI are generally prepared by the ethnic people of this region at their household and used to ferment naturally at ambient temperature. Moreover, people used to consume these products along with their daily dishes with some ethnic beliefs and these products are intimately connected to virtually all aspects of their socio-cultural, spiritual life and health.

Although the major *Shidal* producing states of NEI are Tripura and Assam, however, to a smaller extent all other states also produce *Shidal*. This study actually focuses on the scientific evaluation of the traditional process of the *Shidal* technology as well as quality characteristics of *shidal* prepared from both *Puntius* spp. and *Setipinna phasa*.

2. Materials and Methods

Shidal samples produced from *punti* fish (*Puntius sophore*) and *phasa* fish (*Setipinna phasa*) were purchased from different producers in local markets of Agartala, Tripura, India. All the samples were packaged in sterile polypouches and aseptically brought to the laboratory for chemical and microbial analysis.

2.1. Biochemical and Microbial analysis

Moisture, ash, crude protein, fat and total titratable acidity (TTA) contents of *Shidal* were determined according to AOAC methods (AOAC, 2000). Total volatile basic nitrogen (TVBN) was determined by distillation method (AOAC, 2000). Thiobarbituric acid (TBA) value was determined by using the method given by Buege and Aust (1978). Sample was homogenised with TBA-TCA-HCl solution followed by heating and subsequent cooling in tap water. The supernatant was collected and absorbance was taken at 532 nm. The pH of samples were determined by a pH meter (Sartorius, Goetingen, Germany), as described by Benjakul *et al*. (1997). Microbilogical analysis was done by using the standard method of USFDA (2001). For enumeration of Lactic acid bacteria, the MRS agar plates were incubated in an anaerobic condition at room temperature for 48-72 hours. Presence of pathogenic bacteria like *Salmonella* and *Vibrio* were also analysed by the methods given by Muzaddadi & Nayak (2001) and Panda & Nayak (2001) respectively.

2.2. Statistical analysis

All data were analysed for analysis of variance (ANOVA) using SPSS software version 16.0 (SPSS, USA). Significance of means was determined using the Duncan's Multiple Range Test (DMRT) at a 95% significant difference ($p < 0.05$).

3. Results and Discussion

3.1. Traditional *Shidal* technology and its scientific evaluation

Shidal is usually produced in the months of November–February. Dried salt-free *Puntius* species and *Setipinna phasa* are usually used for preparation of good quality *Shidal*. Although, salted dried fish are also used to reduce fermentation time, but the shelf life of the final product is less than the salt free raw materials. The different steps in *shidal* preparation are described here (Fig. 3).

3.2. Matka and its oil processing

"*Matka*" is the local name of the pear shaped earthen container used for fermentation of fish. Although *matkas* of different sizes are in use, the most common size has a neck diameter of 8 inches, middle with expanded diameter of 24 inches, and a height 36 inches. The capacity of a *matka* usually ranges from 40 to 60 kg. Since *matkas* are made of earth they are breakable, but can be used for several batches of fish until they break. The best quality "*matkas*" are made from very fine black soil, as these absorb much less oil during processing and provide much less air permeability. For the similar reasons, producers believe that the older the *matkas*, the better the product quality, and the less the cost of production. Before use, *matkas* are smeared with oil for the reasons which have been described earlier. Oil extracted from *Puntius* is generally preferred by fishing community and commercial producers when it is available in plenty. In the case of large scale production of *shidal*, vegetable oil, especially mustard oil, is preferred. Oil is smeared in both inner and outer walls of the *matka* followed by drying in the sun (Fig. 3.f). The oil smearing and subsequent drying process is continued for 7–10 days for new *matkas*, until they become fully saturated with oil and unable to absorb any more; they are now ready for packing with fish. In the case of re-used *matkas*, 2–5 days of oil smearing and subsequent drying is required.

3.3 Water soaking and drying of dried fish

The dried *Puntius* is cleaned and sorted (Fig. 3.b) and further dried in the sun for 3–5 days to remove moisture from the fish to maximum possible extent, and also to drive away the maggots, if any, although dried fish with signs of maggot infestations are not used for *shidal* production. Drying is followed by water soaking of the fish in porous bamboo baskets, usually for 5–10 minutes, preferably in running water (Fig. 3.e). The absorption of water is greater and quicker due to the previous drying of fish. After water soaking, fish are spread on bamboo mats or on a cement floor in the shade overnight for drying. The evening hours is the best time for water soaking, because the subsequent drying of water soaked fish for 8–10 hours passes without any problem from flies and birds. This step is very critical for the yield of a good quality *shidal* and for determining the total fermentation period. The duration of water soaking and subsequent drying is determined by previous experience, depending upon the quality needed, desired period of fermentation and shelf-life of the end product. After water soaking and drying, the fish becomes soft textured with a dry surface and are ready for packing into the *matka*.

3.4. Filling of matka

Before filling, the oil processed *matka* is placed in the ground by digging a hole in such a way that one third of the belly remains buried in the ground (Fig. 3.g). The dug out soil is gathered around the underground portion of the belly, and *matka* is fixed firmly, ensuring that it stands exactly vertical, so that it can withstand the pressure during the filling and compaction of the fish (Muzaddad & Basu, 2012). Clean gunny bags are spread surrounding the *matka* to avoid any raw material getting contaminated with the soil underneath. After fixing the *matka* in the ground, the partially dried fish are spread in a layer and uniform pressure is applied with bare hands or feet (in the case of large-mouthed *matkas*) (Muzaddad & Basu, 2012). Once the layer is tightly packed, subsequent layers are added in a similar manner until the layers reach near the neck (Fig. 3.h). Sometimes, a wooden stick is used along with the hands or feet to make an almost air tight packing. About 35–37 kg of dried *punti* is required to fill one 40 kg capacity *matka*.

3.5. Sealing of filled matka

Once the *matka* is filled to the neck, it is primarily sealed with a cover paste which is made from a dust of dry fish (wetted with oil) (Fig. 3.i & 3.j). The thickness of the cover layer is 2–2.5 inch. Then, either any broad leaf or newspaper is placed over the wet seal of cover paste and finally, the *matka* is sealed by a layer of wet mud made from clay soil (Fig. 3.k). This layer is checked on and often for any crack and is repaired immediately by fresh wet mud again. The filled *matkas* are lifted to the surface and left undisturbed in the shade for maturation (Fig. 3.l). The usual period of maturation is 4–6 months, but this may be extended for a year. About 40–42 kg *shidal* is obtained from each *matka*.

3.6. Bio-chemical and microbial quality of *Shidal*

The mean values of proximate composition, biochemical and microbial quality of *Shidal*s, namely, *punti* and *phasa Shidal* is given in Table 1. Low moisture content of '*Shidal*' was due to use of sun-dried fish (moisture content < 10%). *Puntius* belongs to the group of 'semi fatty' fish (fat content usually ranges from 2-5% in breeding season). The variation of the lipid contents of the two *Shidal* samples may be attributed to the lipid content of the raw fish. Increased protein and fat content of the product is due to reduction of moisture content. Sarojnalini & Viswanath (1988) reported the proximate composition of fermented products of Manipur, *i.e.*, '*Hentak'* and '*Ngari*' as ash (%) 11.43 and 5.49, moisture (%) 36.3 and 36.03, total nitrogen (%) 5.34 and 6.14, total lipid (%) 13.6 and 13.36 respectively.

The pH and total titratable acidity (TTA) have been found as 5.86±0.11, 0.115±0.01 and 6.62±0.07, 0.092±0.01 in *punti* and *phasa Shidal* respectively. The pH seems to be slightly higher in respect of other fermented fish products, but this may be due to higher amount of volatile nitrogenous compounds produced during fermentation that accumulate in the product. Similar pH values were also reported by several authors for different fermented fish products (Thapa & Pal, 2007; Majumdar & Basu, 2010; Kakati & Goswami, 2013; Yatsunami & Takenaka, 1996). Unlike salt fermented fish, there is no leaching out of nutrients from the *Shidal* product.

The TVBN content of the products was recorded to be 62.53±1.61 and 120.27±1.24 mg% in *punti* and *phasa Shidal* respectively. However, such high concentration of TVBN usually does not manifest any ammonia-like odour in the product. This may probably be due to masking of ammonical odour by the characteristic strong odour of *Shidal*. The content of TVBN of the product is the indication of high degree of fermentation. The high value of TVBN might be attributed to the subsequent microbiological and biochemical changes in the fish muscle during fermentation. Other workers also reported higher TVBN value in fermented fish product samples (Anihouvi *et al*., 2006; Roy *et al*., 2014). However, the limit of TVBN value for rejection of the fermented fish product for human consumption was reported to be approx. 500 mg N/kg (Silva *et al*., 1998). Degree of lipid oxidation as measured by estimating thiobarbituric acid (TBA) value was found to be 0.99±0.06 and 1.10±0.14 mg malonaldehyde per kg meat. Absence of salt (a potential pro-oxidant)

Fig. 3. Different steps in *Shidal* production


3.a) Raw materials (dried fish)


3.b) Sorting/cleaning of dried fish


3.c) Ready for washing/water soaking


3.d) Ideal water body for washing


3.e) Washing/water soaking of dried fish


3.f) Matka under oil processing


3.g) Filling of dried fish to matka


3.h) Filled matka


3.i) Paste from dried fish


3.j) Matka sealed with dried fish paste


3.k) Matka sealed with clay soil


3.l) Matka under fermentation shed


3.m) Transportation of filled matka


3.n) Final product – *punti Shidal*


3.o) Final product – *phasa shidal*

Table 1. Bio-chemical and microbial quality of *punti* and *phasa shidal* (n=5)

Parameters	*Punti Shidal*	*Phasa Shidal*
pH	5.86 ± 0.11	6.62 ± 0.07
TTA (g %)	0.115±0.01	0.092±0.01
Moisture (%)	38.26±0.89	43.48±1.58
Crude protein (%)	36.84±1.42	36.75±1.75
Total lipid (%)	14.30±2.24	7.85±1.26
TVBN (mg %)	62.53±1.61	120.27±1.24
TBA (mg malonaldehyde/kg meat)	0.99±0.06	1.10±0.14
TPC (log *cfu*/gm)	6.87±0.11	6.36±0.01
LAB (log *cfu*/gm)	4.5±0.08	4.8±0.14
Salmonella count	Nil	Nil
Vibrio count	Nil	Nil

and metals (as the fermentation is carried out in earthen container) in the system may be attributed for such moderate values of TBA. Priyadarshini *et al*. (2014) reported a TBA value of 0.69 mg malonaldehyde/kg meat in *Tungtap*, a fermented fish product of Meghalaya.

3.7. Microbiology of Shidals

The TPC and LAB were estimated as 6.87±0.11, 4.5±0.08 log *cfu*/gm and 6.36±0.01, 4.8±0.14 log *cfu*/gm in *punti* and *phasa Shidal* respectively (Table 1). Muzaddadi (2002) also reported a higher bacterial count of 6.5 to 8.0 log *cfu*/g in *Shidal* prepared with 2% and 5% salt. Aerobic mesophilic counts from three fermented fish products such an '*Ngari*, '*Hentak'* and '*Tungtup'* from NE India was reported to be in the range of log 4.3–7.3 log *cfu*/gm (Thapa *et al*., 2004). Similar TPC value also reported for *Lanhouin*, a traditional fermented fish product in the Republic of Benin (Anihouvi *et al*., 2006). Microflora plays an important role in fermentation of fish. The presence of microorganisms during fermentation contributes to the degradation of proteins and development of flavour and aroma (Salampessy *et al*., 2010). However, the higher count of microbes may be due to keeping pattern *i.e*., in open matkas for longer time and unhygienic handling (Roy *et al*., 2014). Moreover, higher moisture content and used cover paste are also some probable reasons behind higher microbial load in fermented fish products. The samples were also checked for the presence of *Salmonella* and *Vibrio*, but no contamination of pathogenic bacteria was detected.

4. Conclusion

The study provided information on traditional practice of *shidal* production in NE region of India besides its biochemical and microbiological quality. Results showed that traditional fermented fish product *shidal* is a good source of nutrition in terms of protein, lipid and minerals.Fermented fish product*, Shidal* plays a very important role in the nutrition of people of Northeast sector of India and no scientific intervention regarding the process has been made so far. Though no pathogenic bacteria was detected from the collected samples; however, good hygiene and sanitary condition should be adopted in the fermentation unit along with handling of raw materials, maintaining wash water quality including other processing steps and also in the retail markets in order to safeguard the products for consumers' health.

Acknowledgements

Authors thank Department of Biotechnology, Govt. of India, New Delhi for funding project (Grant No. BT/307/NE/TBP/2012, Dt. 06/12/2012) under which this work was undertaken. The assistances rendered by the technical staff of the Department of Fish Processing Technology is sincerely acknowledged.

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