ASSESSMENT OF NUTRITIONAL QUALITY OF '*SHIDAL*' A FERMENTED FISH PRODUCT OF NORTHEAST INDIA

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ABSTRACT

'*Shidal*' is a salt-free fermented fish product prepared from *Puntius* ss.caught in late monsoon period. *Shidal* is very popular amongst the inhabitants of Northeast India. The fermentation process of this product takes four to six months in anaerobic condition till the product gains a characteristic flavour and colour. Detailed studies on the biochemical and nutritive qualities of this product are very few. Therefore, in this paper we report the results of the proximate analysis, amino acid and fatty acid compositions. The results suggest that '*Shidal*' is a rich source of amino acids as well as of essential fatty acids like linoleic and linolenic acids. The n-3/n-6 ratio was found 0.51.

Keywords: *Shidal*, fermented fish, *Puntius* sp., PUFAs.

INTRODUCTION

Fermentation of fish, apart from being a preservation method, helps in developing suitable physicochemical characteristics responsible for favorable sensory properties. The fermented fish products find important place in the dietary lists of the people in Southeast Asian countries (Amano, 1962; Mackie *et al*, 1971). Fermented foods are commonly used as food condiments and are limited to local consumption (Saisithi *et al*, 1966). Fermentation, as a method of preservation, still enjoys popularity in many developing and underdeveloped countries owing to simplicity of preparation and low cost of processing (Zenitani, 1955). Traditional fermented foods have altered vitamin contents, better digestibility and longer shelf life (Van Veen and Steinkraus, 1970).

'*Shidal*' is a fermented fish product indigenous to the Northeastern region of India. Assam and Tripura are the major '*Shidal*' producing states. It is known for its strong flavour. Sarojnalini and Vishwanath (1988) reported about similar type of fermented products of Manipur, i.e., 'Hentak' and 'Ngari', which are prepared from sun-dried small-sized freshwater fishes. Though these products are very common in every household of Northeastern parts of India, scientific information regarding their composition, flavour compounds and nutritive value are very few. With regard to '*Shidal*' of Assam, the information available are on proximate composition (Muzadaddi, 2002, 2004). Though volatile fatty acids, amino acids and their derivatives usually contribute to flavour, taste and colour, there is no information available on these constitutents.

The method involved in Shidal preparation indicates possibility of development of volatiles. This product is prepared from *Puntius* ss.caught during late-rainy season when fat content of the fish is high. The fishes are caught and sun dried and stored till the rainy season is over. Sun-dried *Puntius* are water soaked and partially dried before packing (as compactly as possible) in earthen containers. Unlike other fermented fish products no salt is used during its fermentation. The pots are then covered with banana leaves, sealed with mud and are buried under the earth for anaerobic fermentation. Usually the fermentation period varies from four to six months. The shape of the fish remains almost unchanged except little disintegration near belly and caudal portion. The fish remain solid but the texture is softer. The colour of best quality product is dull white that gradually becomes light brownish to deep brownish on continuous exposure to air. The strong odour permeates the air in and around the storage and gives the area a characteristic smell of '*Shidal*'. The quality deteriorates very fast after breaking of seal of the container and exposure to air. This phenomenon indicates quick changes in fat. Our attempt was therefore to know the fatty acid and amino acid compositions of this product from nutritional point of view. In addition, the compositions would reflect on the characteristics colour and odour of the product.

MATERIALS AND METHODS:

Samples of '*Shidal*' were collected from the local fish markets of Agartala which were brought to the laboratory for biochemical analysis. Moisture, pH, ash, and salt contents were measured following standard method (AOAC, 1995). Ten-gram samples were homogenized with 10 ml of distilled water and the pH of the homogenate was then measured using a standard pH meter. Total titratable acidity (TTA) was measured according to AOAC (1995). The acidity was calculated as percent lactic acid. Differences in weight were recorded after drying the sample in hot air oven at 100±2ºC overnight to determine the moisture content. Incineration in a muffle furnace at 550±50ºC was done until the ash was obtained. The weight of the ash was expressed as percentage of the samples taken. The salt content was determined by titrating excess silver nitrate with ammonium thiocyanate using ferric alum as indicator (AOAC, 1995). Total nitrogen was measured by micro-kjeldahl method (AOAC, 1995). Ten percent trichloroacetic acid (TCA) extract was used to estimate non-protein nitrogen (NPN), total volatile basic nitrogen (TVBN) and free alpha amino nitrogen (FAN) by using micro-kjeldahl method (AOAC, 1995), Conway's micro-diffusion method (Conway, 1947) and by copper method (Pope and Stevens, 1939) respectively. Total lipid was measured by soxhlet extraction with petroleum ether. The peroxide value (PV) and the content of free fatty acids (FFA) were determined on the chloroform extracts of tissues according to the methods suggested by Jacobs (1958) and Takagi *et al.* (1984) respectively. Thiobarbituric acid (TBA) values were determined by the titrimetric method of Tarladgis *et al.* (1960) using thiobarbituric acid standard in 90% glacial acetic acid.

Amino acid composition was determined by hydrolyzing the samples in 6N HCl for 24 h at 110^{0}C. The acid was removed by vacuum evaporation, made upto a known volume with 0.05 N HCl and then analyzed by HPLC (Simadzu, Japan) on an ion exchange column and a fluorescence detector after converting to *o*-ophthalaldehyde derivatives (Chang *et al.*, 1991). Tryptophan content of the samples was determined after alkali hydrolysis (Sastry & Tummuru, 1985). For analysis of fatty acids, lipid was extracted by

using chloroform-methanol (2:1) mixture (Folch *et al.*, 1957). Fatty acid methyl ester (FAME) was prepared by "Boron trifluoride-methanol" method. Gas Chromatograph (Chemeto) equipped with FID and fused silica capillary (SP 2330, 30m x 0.2m, 0.2 µm thickness) was employed for the analysis. Initial oven temperature was kept at 100°C and then increased at the rate of 4°C/min to 230°C, then held for 45 min. The injection temperature and detector temperature was 230°C and 270°C respectively. The carrier gas was nitrogen and flow rate was 1.5 ml/min and 0.5microlitre of sample was injected. The relative percentages of the constituents were computed from GC (FID) peak areas without using correction factors. The fatty acid methyl esters were identified by comparison of the retention times of standards obtained from Sigma (Supelco37 Component FAME MIX).

Table 1. Proximate composition of *'Shidal' '*

Parameters	Quantity (%)
Moisture (%)	18.84 ± 0.90
Ash (%)	16.3 ± 0.67
Lipid (%)	16.73 ± 1.49
Protein (%)	38.93 ± 2.11
Non-protein nitrogen (%)	7.38 ± 0.91

Table 2. Quality characteristics of market sample of *'Shidal'*

Parameters	Quantity (%)
pH	6.9 ± 0.47
Total titratab le acidity (%)	1.66 ± 0.26
Free alpha amino-nitrogen (mg %)	79.54 ± 12.49
Total volatile basic nitrogen (mg %)	509 ± 43
Peroxide value (milli equiv O_2/kg fat)	18.10 ± 4.86
Free fatty acid (% oleic acid)	16.21 ± 2.11
Thiobarbituric acid value (TBA)	0.41 ± 0.03

Table 3. Amino acid composition of *'Shidal'* (values are the average of five determinations and expressed as g amino acid per100 g protein)

Amino acids	Quantity (%)	FAO reference protein	Amino acids	Quantity (%)	*#FAO reference Protein
Aspartic acid	7.71	-	Methionine	1.84	1.7 (Combined requirement with cystine)
Threonine	2.99	0.9	Isoleucine	4.19	1.3
Serine	2.10	-	Leucine	6.81	1.9
Glutamic acid	14.15	-	Tyrosine	1.57	-
Proline	Not detected	-	Phenylalanine	4.14	1.9(Combined requirement with tyrosine)
Glycine	2.88	-	Histidine	1.11	1.6
Alanine	7.55	-	Lysine	6.16	1.8
Cysteine	2.98	-	Arginine	1.97	-
Valine	4.51	1.3	Tryptophan	1.17	0.5

* World health organization , Report of a joint FAO/WHO/UNU meetng Geneva: World Health Organisation,1985(WHO technical report series, 724

Amino acid requirement of adults(Note : for children and preschool children, these requirements are higher)

RESULTS AND DISCUSSION

The mean proportion of moisture, ash, protein and lipid content of '*Shidal*' are 18.84%, 16.3%, 38.93% and 16.73% respectively (Table 1). These values slightly differ from the values obtained by Muzadaddi (2002) who obtained the proportion of moisture, ash, protein and lipid content as 15.0%, 16.75%, 39.35% and 6.48% respectively in the laboratory prepared '*Shidal*'. This variation can be attributed to differences in period of maturation and the state of fish before preparation.Usually, commercial manufacturers collect dryfish from various sources and use that for shidal manufacture. Low moisture content of '*Shidal*' was probably due to use of sun-dried fish (moisture content < 10%) in market samples. As described earlier, the variation of the lipid contents of the products between two studies may be attributed to the lipid content of the raw material. *Puntius* belongs to the group of 'semi fatty' fish (fat content usually ranges from 2.5% in breeding season). Increase of protein (38.93%) and fat content (16.73%) in the product is due to reduction of moisture content. Sarojnalini and Vishwanath (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.

Table 4 : Fatty acid composition of "Shidal' (values are average of five determinations and expressed as percent by weight of total fatty acids)

Fatty acids	Name	Symbol	Percent
Saturated	Lauric acid	C 12:0	0.05
	Myristic acid	C 14:0	1.38
	Palmitic acid	C 16:0	25.83
	Stearic acid	C 18:0	10.81
Monoenoic	Palmitoleic acid	C 16:1(n -7)	4.59
	Oleic acid	C 18:1(n -9)	25.33
	Oleic acid	C 18:1 (n -7)	0.45
	Eicosanoic acid	C 20:1(n -9)	0.73
	-	C 22:1(n -11)	2.27
	-	C 22:1(n -9)	0.14

Fatty acids	Name	Symbol	Percent
Polyenoic	Linoleic acid	C 18 :2(n -6)	10.77
	Linolenic acid	C 18:3(n -3)	4.18
	-	C 18:4(n -3)	0.23
	Arachidonic acid	C 20:4(n -6)	0.71
	EPA	C 20:5(n -3)	0.41
	-	C 22:5(n -3)	0.52
	DHA	C 22:6(n -3)	0.57
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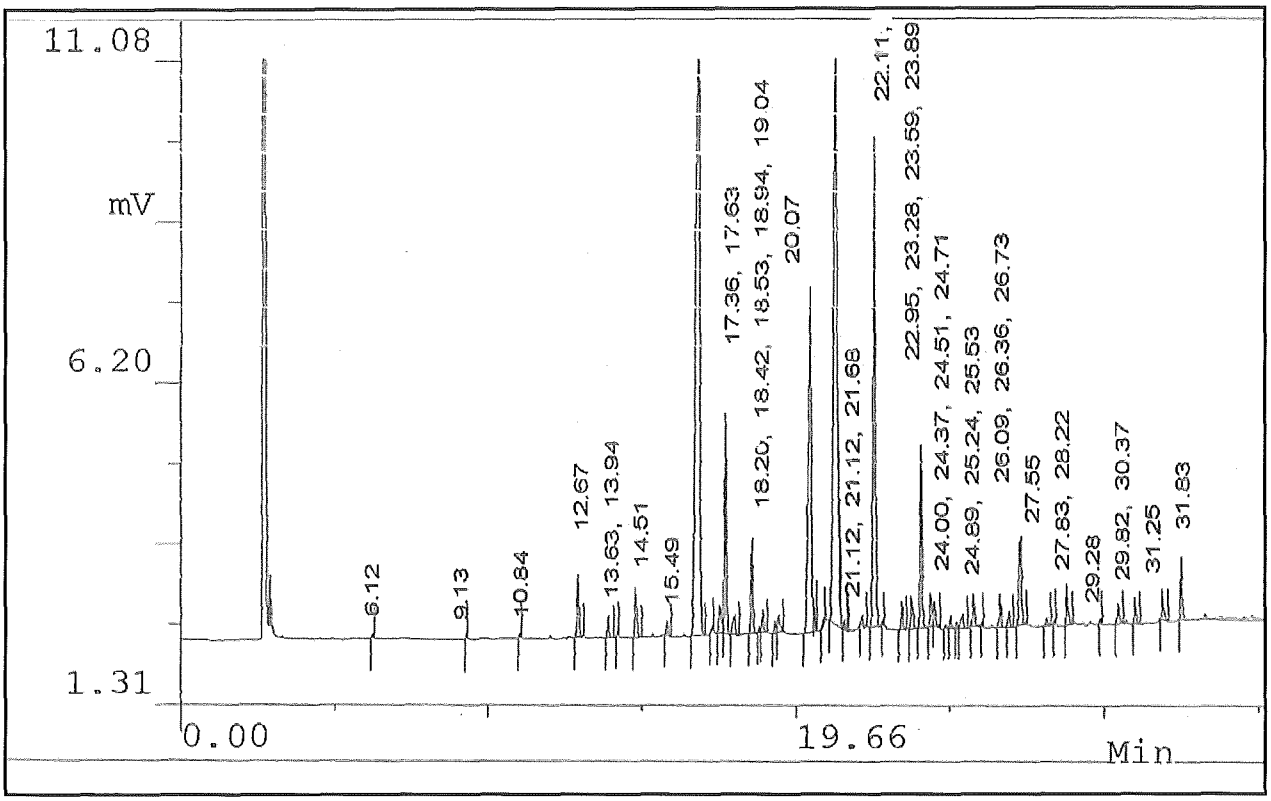
	Linolenic acid	C 18:3(n -3)	4.18
	-	C 18:4(n -3)	0.23
	Arachidonic acid	C 20:4(n -6)	0.71
	EPA	C 20:5(n -3)	0.41
	-	C 22:5(n -3)	0.52
	DHA	C 22:6(n -3)	0.57

Figure 1. Chromatogram of fatty acid composition of '*Shidal*'



The mean quality characteristics of shidal are presented in table 2. The pH and total titratable acidity (TTA) have been found as 6.9 and 1.66 respectively. Muzaddadi and Basu (2003) reported the pH and TTA of best quality '*Shidal*' as 6.3 and 1.75 respectively. The pH seems to be slightly higher in respect of other fermented fish products, but this may be due to higher amounts of volatile nitrogenous compounds produced during fermentation that accumulate in the product. Unlike salt fermented fish, there is no leaching out of nutrients from the '*Shidal*' product. Out of total nitrogen, the protein nitrogen and non-protein nitrogen (NPN) have been found as 46% and 54% respectively. Higher NPN (7.38%) may be attributed to enzymatic degradation of tissues during fermentation and their gradual accumulation in the product. The TVBN content of the product was also high and found to be 509 mg %. However, 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 free alpha amino nitrogen content (79.54 mg %) of the product was found to be in the moderate range. The contents of NPN and TVBN of the product are the indicative of high degree of fermentation.

Since fermentation is carried out in an anaerobic environment in salt free condition, a moderate peroxide value (18.1 milliequivalent O_2 /kg fat) and thiobarbituric acid value (0.41) has been found. Absence of salt (a potential pro-oxidant) and metals (as the fermentation is carried out in earthen

container) in the system that may be attributed for such low values of PV and TBA. The free fatty acid value has been found as 16.21 % (as oleic acid), that seems to be moderate.

Amino acids like glutamic acid, aspartic acid, leucine, alanine and lysine have been found in the higher proportion (Table 3). Out of aromatic amino acids, only phenylalanine has been found as 4.14%. Some amino acids such as tyrosine, histidine, arginine and tryptophan have been found very low in amount and proline was not detected. There is a possibility of formation of derivatives of amino acids such as amines and gluconeogenic substances during fermentation. The contribution of amino acids to the aroma of fermented fish sauce has also been reported by Saisithi *et al* (1966).

The chromatogram of fatty acid composition of '*Shidal*' is presented in figure 1. The fatty acids detected are presented in table 4. Amongst the saturated fatty acids, palmitic acid (25.83%) was found to be highest followed by stearic acid (10.81%). Oleic acid (25.33%) and palmitoleic acid (4.59%) were the most prominent among the monoenoic acids. The *n*-6 PUFAs in *'Shidal'* composed mainly of linoleic acid (10.77%) and a very low amount of arachidonic acid (0.71%). Amongst the *n*-3 PUFAs, linolenic acid (4.18%), EPA (0.41%) and DHA (0.57%) along with two others (C 18:4 and C 22:5) could be detected. The *n*-3/*n*-6 ratio was found 0.51. Majumdar (2005) reported the *n*-3/*n*-6 ratio of fermented hilsa, 'Iona ilish' as 0.39. The percentage of oil in fish and the percentage of fatty acids in fish oil, including *n*-3 fatty acids, vary widely with the species, the geographic location, the food available to the fish and the season (Sikorski, 1990). Usually freshwater fish contains more *n*-6 and less *n*-3 PUFAs and the reverse is true in case of marine fish. *Puntius*, being freshwater fish may possibly contain less *n*-3 fatty acids than that of true marine fish. Although EPA and DHA are less in '*Shidal*' but the presence of essential fatty acids such as linoleic acid and linolenic acids are moderate from the nutritional viewpoint. During fermentation or salting, significant loss occurs in some *n*-3 fatty acids (Pigott and Tucker, 1990). Hanafiah and Pigott (1987) reported a considerable loss of *n*-3 fatty acids during fermentation of Indian mackerel and preparation of fermented *'pedah'*. Further, Yankah *et al.* (1996) reported a loss in docosahexaenoic and eicosapentaenoic acids during processing and storage of Ghanaian fermented fish product *'momoni'*.

CONCLUSION:

This study reveals that '*Shidal*' is a rich source of amino acids and essential fatty acids like linoleic and linolenic acids. High levels of unsaturated fatty acids may be responsible for deterioration in quality on exposure to air. The strong flavour also makes it a suitable condiment and a food supplement as is used in the Norteastern India.

REFERENCES:

Amano, K. 1962. The influence of fermentation on the nutritive value of fish with special reference to fermented fish products of South-East Asia. *In*: Heen, H. and Kreuser, R. (*ed*). *Fish in Nutrition*. Fishing News. London. pp. 180-200.

AOAC, 1995. Official Methods of Analysis. Association of Official Analytical Chemists (16th edn.). Washington D.C.

Chang, C. M., Ohshima, T. and Koizumi, C., 1991. Lipid, free amino acid and organic acid composition of rice bran fermented sardine. *Nippon Suissan Gakkaishi*. 57: 1579-1585.

Conway, E. J., 1947. Microdiffusion analysis and volumetric error. 4th edition. Van Nostrad Co.Inc.,Newyork.

Folch, J., Lees, M. and Sloane Stanley, G. H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J. Bio. Chem.* 226: 497-509.

Hanafiah, T. A. R. and Pigott, G. M., 1987. Proceedings of World 7th Congress on Food Science and Technology, Singapore, Sept. 28-Oct. 2 (Cited by: Pigott and Tucker, 1990).

Jacob, M. B., 1958. The Chemical Analysis of Foods and Food Products. Kreiger Publishing Co. Inc. New York, USA. p 393-394.

Mackie, I. M. R., Hardy, R. and Hobbs, G., 1971. *Fermented Fish Products*. Fisheries Report No. 100, FAO, Rome.

Majumdar, R. K., 2005. Technology evaluation and improvement of 'lona ilish' a traditional salt fermented fish product of Northeast India. A Ph. D. thesis submitted to the Central Institute of Fisheries Education (Deemed University), Mumbai 400061.

Muzadaddi , A.U., 2002. Technology evaluation and improvement of seedal an indigenous fermented fish product of Northeast India. A Ph. D. thesis submitted to the Central Institute of Fisheries Education (Deemed University), Mumbai 400061.

Muzadaddi, A. U. and Basu, S., 2003. Microbiological and sensory changes during preparation of seedal a fermented fish product. *In*: Surendran, P. K. *(eds)*. *Seafood Safety.* Society of Fisheries Technologists (India), Cochin India. pp. 35-40.

Pigott, G. M. and Tucker, B. W., 1990. Seafood: Effects of Technology on Nutrition. Marcel Dekker Inc. New York.

Pope, C. G. and Stevens, M. F., 1939. The determination of amino nitrogen using a copper method. *J. Biochem*. 33: 1070-1076.

Saisithi, P. Kasemsarn, B. Liston, J. and Dollar, A. M., 1966. Microbiology and chemistry of fermented fish. *J. Food Sci*.31: 105-110.

Sarojnalini, C. and Vishwanath, W. S., 1988. Composition and digestibility of fermented fish foods of Manipur. *J. Food Sci. Technol.*, 35(6): 349-351.

Sastry, C. S. P. and Tummuru, M. K., 1985. Spectrophotometric determination of tryptophan in proteins. *J. Food Sci. Technol.* 22: 146-147.

Sikorski, Z. E. and Kolakowska, A., 1990. Freezing of marine food. In: Sikorski, Z. E. (ed). *Seafood: Resources: Nutritional Composition and Preservation.* CRC Press, Inc. Florida. pp. 112-124.

Takagi T. Hayashi K. Itabashi Y., 1984. Toxic effect of free unsaturated fatty acid in mouse assay of diarrhetic shellfish toxin by intraperitoneal injection. *Bull. Japan Sci. Fish.* 50: 1413-1418.

Tarladgis B. G. Watts B. M. Younathen M. T., 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. *J. Am. Oil Chem. Soc.* 37: 44-48.

Van Veen, A. G. and Steinkraus, K. H., 1970. Nutritive value and wholesomeness of fermented foods. *J. Agric. Food Chem.* 18(4): 576-578.

Yankah, V. V., Ohshima, T., Ushio, H., Fujii, T. and Koizumi, C., 1996. Study of the differences between two salt qualities of microbiology, lipid and water extractable components of Momoni, a Ghanaian fermented fish product. *J. Sci. Food Agric.* 71: 33-40.

Zenitani, B., 1955. Studies of fermented fish products. On the aerobic bacteria in "Shiokara". *Bull. Jap. Soc. Sci. Fish.* 21: 280-283.