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QUALITY EVALUATION OF DRIED FISH PRODUCTS COMMERCE IN ASSAM, INDIA

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ABSTRACT
Biochemical, microbiological and sensory quality of six dried fish products from species *Puntius sophore, Setipinna phasa, Amblypharyngodon mola, Pseudeutropius atherinoides, Pseudambassis ranga* and *Corica soborna* available in the markets of Assam were evaluated. The moisture, protein, fat and ash content of the dried fish products ranged from 9.8-22.5%, 52.9-58.3%, 7.3-17.6% and 8.1-15.2%, respectively. The salt soluble nitrogen (SSN) of the dried fish products was 38.9-62.5% of total nitrogen. The non protein nitrogen (NPN) and total volatile based nitrogen (TVB-N) content ranged from 1.1 to 2.6 g % and 78.8 to 121.4 mg %, respectively. The pH was in the range of 6.2-6.6. Free fatty acid (FFA) and peroxide value (PV) varied between 39.6-59.9 % as oleic acid and 24.4- 77.4 meq O_2/kg of fat in the samples. A significant difference (P<0.05) in proximate composition and nutritional quality between the different dried fish products studied was observed. The total plate count (log cfu/g) was 3.2-4.1. *Escherichia coli* and faecal *Streptococci* were undetectable (<10/g) and *Salmonella* spp. was absent in all products. *Staphylococcus aureus* was present in all samples in the range of 1.3-2.5 log cfu/g, but samples were free from visible fungal colonies. Products available in the markets of Assam were found to be of high nutritional quality but showed 70% of the products studied were of less overall acceptable sensory quality.

KEY WORDS: Dried fish products, biochemical quality, microbiological quality, sensory quality, Assam

INTRODUCTION

Sun drying is considered the least expensive and efficient food preservation method. The low cost of production, transport and storage gives the dried fish product a substantial market in India as well as in many tropical countries (Yean, 1998). In India, about 17% of the total fish catch is being used for salting and drying (Anon, 2001). Even though there is a gap between fish supply and daily demand of large section of fish eating population in the Assam, yet a sizable quantity of fish is being preserved traditionally by way of drying, salting, fermentation and other local specific methods as there is lack of sophisticated fish storage and preservation facilities in the state (Dutta *et al.*, 1992). Moreover, after recession of recurring flood and also during *jeng* fishing (a community fishing method practiced in Assam) fishes of different sizes are abundantly caught and sold at a cheaper rate; a lion's share of which are salted and sun-dried. Popularity of such products in the North-Eastern states is reflected by Jagiroad dry fish market of Morigaon district of Assam, which is considered as one of the largest dry fish markets in South East Asia and plays a key role in distribution of such dried and other preserved products in the region (Vijayan and Surendran, 2012). Major portions of dry fish products for distribution in this region come from distant centres of production in the coastal states as well as from interior fishing villages of the country.

The quality of the dried fish never receives much attention at any stage of processing, storage and marketing (Karthikeyan *et al.,* 2007). Little efforts were made to study the cause, nature and extent of deterioration of dried fish even though the poor quality of dried fish product is a well-known fact. The spoilage of dried fish is mainly due to bacterial, fungal or yeast action, rancidity, autolysis, browning and other reactions, all of which are temperature and water activity dependent (Doe, 1982). There are a few reports on the quality of dried marine fish available in the markets of the west and east coasts of India (Kalaimani *et al.*, 1988; Basu *et al*., 1989); and small freshwater dried fish products from the markets of Tripura (Karthikeyan *et al.,* 2007). But, there were no reports available on the quality of dried fresh water fish products marketed in Assam. Therefore, the aim of the present study was to assess the proximate composition, biochemical quality, microbiological quality and sensory quality of six dried fish products available in the markets of Assam.

MATERIALS & METHODS

Sample collection: Six dried fish products from species *Puntius sophore, Setipinna phasa, Amblypharyngodon mola, Pseudeutropius atherinoides, Pseudambassis ranga* and *Corica soborna* were collected from *Jagiroad* dry fish market of Assam. The fish products were packed, labeled and brought to the laboratory in aseptic condition, where, they were subjected to different quality analyses. The analyses were carried out in triplicates of each sample of dried fish.

Biochemical analysis

Moisture, protein, fat and ash content of the dried fish products were determined by AOAC (2000) methods, standard methods were used for the determination of salt soluble nitrogen (Dyer *et al.,* 1950), non protein nitrogen (AOAC, 2000), total volatile base nitrogen (Conway, 1947), peroxide value (Jacobs, 1958), free fatty acids (Olley and Loveren, 1960). pH was determined using a pH meter (Sartorius make), after homogenizing 5g of fish with 45ml distilled water.

Microbiological and sensory analysis

An amount of 10g of muscle from different parts of the sample was collected aseptically and macerated with 90ml sterile saline. The microbial quality of the samples was determined after making serial dilution in the same diluents by the methods of USFDA (2001) and APHA, (2001). It was assessed by determining the total plate count, *Escherichia coli* count, faecal Streptococci, *Staphylococcus aureus* and *Salmonella* spp. Potato dextrose agar was used for isolation of yeasts and moulds by pour plate method. The dried fish samples were also observed for visible fungal colonies.

Sensory evaluation of the dried fish products were carried out using the 9- point hedonic scale by a trained taste panel consisting of 10 members. The sensory quality of the samples was judged for appearance, colour, texture, odour and overall acceptability, following the methods described by Siddaiah *et al.* (2001).

Statistical analysis

The statistical analysis of the results was carried out by one-way analysis of variance (ANOVA) using the statistical package of social science program (SPSS-16), and differences (P<0.05) among the means were compared using the Duncan's Multiple Range Test (DMRT).

RESULTS & DISCUSSION

The proximate composition of the dried fish products evaluated is presented in Table 1. The moisture content of the dried fishes was in the range of 9.8 to 22.5% and showed a significant (P<0.05) variation between the products. The highest moisture content was recorded in *Setipinna phasa* and the lowest in *Corica soborna*. Moisture plays an important role in the spoilage of fish and fish products and reducing the level of moisture retards spoilage (Stansby, 1963). High value of moisture content of the products studied might be due to absorption of moisture during storage and marketing, as the packaging materials was not up to the mark and unscientific. The products were stored in low quality gunny bags and marketed in open conditions. Kalaimani *et al*. (1988) reported the moisture content in the range of 12.3-54.0% for 23 marine dried fish products in India. The moisture content of four dried fish samples in Bangladesh was reported to be in the range of 19.3-24.4% (Azam *et al*., 2003). But, the present study reveals that the moisture content of the products was lower than the BIS standards which prescribe a range of 10-35% moisture for smaller fish and 40-45% in respect to some bigger fishes (Gopakumar and Devadasan, 1982). A quality dried fish product with an expected shelf life of around 9-10 months should have moisture content below 20% (Gopakumar, 1997). The protein content of the dried fishes was in the range of 52.20-58.30%. The highest protein content was recorded in *Setipinna phasa* and the lowest in *Amblypharyngodon mola*. The fish products studied showed significant (P<0.05) difference in protein content. Protein content of 17.0-78.0% was reported for marine dried fishes (Kalaimani *et al*., 1988) and protein content of 58.8% was reported in dehydrated Rohu steaks (Smruti *et al*., 2003). About 90% of the proteins get denatured at about 60-65^{o}C (Opstvedt, 1988). The protein digestibility is adversely affected by the dehydration and storage of dried fish products (Raghunath *et al*., 1995). The species of fish, freshness of the raw material prior to drying, and the drying method could influence the reactions that lead to a reduction in the biological value of fish protein (Opstvedt, 1988).

The crude fat content of the dried fish products was varied between 7.3% and 17.6% (Table-1), but there was no significant (P>0.05) difference in fat content between the products, except in the case of *S. phasa*. The lowest fat content of 7.3% was in *Puntius sophore* and the highest of 17.6% was in *Pseudeutropius atherinoids*. Fat content of 3.7-17.8% and 3.0-8.2% were reported for dried fishes of India and Bangladesh, respectively (Azam *et al*., 2003).

TABLE 1: Proximate composition and biochemical quality of six dried fish products of markets of Assam

Parameters N=3	Quality of dried fish products					
	P. sophore	*S. phasa*	*A. mola*	*P. atherinoides*	*P. ranga*	*C. soborna*
Moisture, (%)	$20.9±0.45^{d}$	$22.5±1.34^{d}$	$16.5±0.97^{c}$	$12.7±1.33^{b}$	$11.9±1.07^{b}$	$9.8±0.77^{a}$
Crude protein, (%)	$52.9±0.95^{a}$	$58.3±0.66^{d}$	$52.2±0.68^{a}$	$55.2±0.63^{b}$	$56.8±0.81^{c}$	$57.9±0.65^{cd}$
Crude fat, (%)	$7.3±0.85^{a}$	$17.1±1.65^{b}$	$15.8±1.45^{b}$	$17.6±0.57^{b}$	$15.8±0.66^{b}$	$17.4±1.12^{b}$
Ash, (%)	$8.1±0.43^{a}$	$10.1±0.35^{b}$	$13.8±1.23^{c}$	$15.2±0.91^{c}$	$14.5±0.84^{c}$	$13.8±0.54^{c}$
pH	$6.6±0.01^{d}$	$6.4±0.02^{c}$	$6.2±0.01^{a}$	$6.3±0.01^{b}$	$6.4±0.02^{c}$	$6.3±0.01^{b}$
SSN, (% of total N)	$50.2±0.55^{d}$	$62.5±1.23^{e}$	$46.5±0.56^{c}$	$43.9±0.78^{b}$	$45.3±0.76^{c}$	$38.9±0.19^{a}$
NPN, (g %)	$1.1±0.17^{a}$	$1.8±0.27^{b}$	$2.2±0.66^{bc}$	$1.8±0.39^{b}$	$2.6±0.25^{c}$	$2.3±0.21^{bc}$
TVB-N, (mg%)	$99.8±1.72^{e}$	$52.2±0.75^{a}$	$78.8±1.11^{b}$	$87.5±0.46^{c}$	$121.4±1.31^{f}$	$90.0±0.34^{d}$
PV (meq O_2/kg of fat)	$24.4±0.34^{a}$	$36.7±1.2^{c}$	$31.7±1.78^{b}$	$39.3±0.53^{d}$	$38.8±1.27^{d}$	$77.4±1.23^{e}$
FFA (% as oleic acid)	$39.6±0.69^{a}$	$59.9±1.8^{c}$	$37.9±1.31^{a}$	$40.1±1.10^{a}$	$54.8±2.30^{b}$	$56.0±0.61^{b}$

All values are mean ± standard deviation; Different letters (a-d) in the same row indicate significant differences within the same fraction (P<0.05).

The ash content of the dried fish products varied from 8.1% in *Puntius sophore* to 15.2% in *P. atherinoides*. Basu *et al*., (1989) reported 11.6-22.1% ash content in the dried marine fishes available in Andhra Pradesh, which is attributed to the deposition of sand by wind, during drying.

The biochemical evaluation of a dried fish gives an index of the various changes taking place in the quality of its meat during drying. Salt soluble nitrogen (SSN) content of different dried fish products were in the range of 38.9-62.5% of total nitrogen and a significant (P<0.05) difference was observed between the products. The lower value (38.9%) of SSN in dried *Corica soborna* might be attributed to denaturation of protein due to heat treatment during drying. The higher value of SSN (62.5%) in dried *Setipinna phasa* might be attributed to drying of fishes for short duration under low sun shine and higher relative humidity, as a result products was not sufficiently heated 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 (Karthikeyan *et al.*, 2007). The myofibrillar protein plays a major role in determining the textural quality of the fish and fish products. The NPN values for the dried fish products were 1.1- 2.6 g% and varied significantly (P<0.05) between the products (Table-1). The lowest NPN value was recorded in *Puntius sophore* and the highest was recorded in *Pseudambassis ranga*. The high level of non-protein nitrogen in dried fish might be attributed to the variety of chemical reactions and break down of protein during the drying process (Thippeswamy *et al*., 2001).The pH of the dried fish ranged from 6.2 to 6.6 (Table 1). A significant (P<0.05) difference was observed in pH values between the products. The conventional air-drying at a relatively higher temperature is detrimental to fish muscle and results in changes in pH, which affect solubility and water binding properties (Zyas, 1997). Dried fish having pH in the range of 6.0-6.9 are considered to be of very good quality (FAO, 1981).

The TVB-N content of dried fish products was in the range of 52.2-121.4mg% and showed significant (P<0.05) variation between the products (Table 1). A lower TVB-N value indicates good quality of the products and a high TVB-N value correlate with high bacterial activity and high rate of spoilage, which results in unacceptability of product for human consumption (Joseph *et al*., 1983). The higher values of TVB-N also indicated degradation of tissue protein that might be responsible for typical flavour and odour of the product. Venkataraman and Valsan (1959) reported the acceptable limit of TVB-N as 200mg/100g of muscle and the products studied had TVB-N values within the acceptable limit. The lipid quality of the dried fish was evaluated through the peroxide values and free fatty acid values. The peroxide values of the dried fish were in the range of 24.4-77.4 mill equivalents O_2/kg of fat. A significant (P<0.05) difference in peroxide values between the products was observed. The higher PV values of dried fish products might be attributed to the oxidation of lipids during the drying process (Aitken and Connell, 1979). A low PV value of the dried fish product indicates an early phase of autoxidation or late stage of oxidized product where most hydro peroxides are broken down (Kannar, 1992). The oxidation of fat during drying may lead to a rancid flavour (Tsuchiya, 1961), which may decrease the acceptability of the product. High drying periods are required to achieve low moisture content and to ensure that the keeping quality of the product increases the tendency of the fat to become rancid (FAO, 1981).

Hydrolytic rancidity of fat is determined by measuring the free fatty acid level in the fish products. The FFA level of the dried fish was in the range of 37.9-59.9% as oleic acid. Lipid hydrolysis itself is of no significance to nutrition but accumulation of FFA in fish oil is undesirable, since it may lead to catalyzed secondary reaction such as increased susceptibility to oxidation and development of off-flavour (Lovern, 1962). In traditional cured products, hydrolysis of fish lipid is not totally unacceptable, as it imparts the desirable flavour to the product (Bligh *et al*., 1988).

The microbial safety and stability have been the prime consideration in food processing operations (Thampuran and Gopakumar, 1993). The cured fishes are often sun-dried unhygienically, which yields poor quality product, contaminated with sand, dust and dirt. Uncontrolled growth of microbes in such cured products may lead to serious implications on the keeping quality and safety of the product (Abraham *et al*., 1993). The dried fish had a microbial load (TPC) of 3.2–4.1 log cfu/g (Table 2), which was well under the acceptable limit (<5 log cfu/g) (ICMSF, 1986). Similar microbial load in dried marine fishes were reported (Abraham *et al*., 1993). The low bacterial counts in the products might be attributed to reduced water activity, which did not favour microbial growth (Smruti *et al*., 2003). None of the samples revealed presence of bacteria of public health significance like *Escherichia coli*, faecal *Streptococci* and *Salmonella* spp. The dried fish products were found to contain *Staphylococcus aureus* to an extent of 1.3-2.5 log cfu/g and this might be attributed to the unhygienic handling of fish products during drying and further storage.

TABLE 2: Microbiological quality of six dried fish products of markets of Assam

Parameters	Microbiological quality of dried fish products					
N=3	*P. sophore*	*S. phasa*	*A. mola*	*P. atherinoides*	*P. ranga*	*C. soborna*
TPC (log cfu/g)	4.0±0.14^{a}	3.7±0.33^{a}	3.2±0.42^{a}	4.1±0.25^{a}	3.4±0.32^{a}	3.7±1.12^{a}
Yeast and mould (log cfu/g)	1.0±0.10^{a}	1.0±0.00^{a}	1.1±0.07^{a}	<1	1.2±0.30^{a}	1.2±0.12^{a}
S. aureus (log cfu/g)	1.9±0.07^{c}	1.4±0.21^{ab}	1.3±0.13^{a}	1.8±0.23^{bc}	2.1±0.38^{cd}	2.5±0.21^{d}
E coli and faecal *Streptococci* were undetectable (<10/g) and *Salmonella* spp. were absent in all products.						

All values are mean ± standard deviation; Different letters (a-d) in the same row indicate significant differences within the same fraction (P<0.05).

The quality of the dried fish is often adversely affected by the growth of fungi (Chakrabarti and Varma, 1999) and substantial amounts of fish are discarded during drying, due to fungal growth (Gupta and Samuel, 1985). The dried fish samples of the present study were free from visible fungal colonies but plating on potato dextrose agar revealed presence of fungi to an extent of 1.0-1.2 log cfu/g in some of the fish products (Table 2).

For consumers, the perceivable sensory attributes of colour, appearance, aroma, taste and texture are the deciding factors in food acceptance. The sensory evaluation of the product helps in ensuring that the consumers get consistent, non-defective and enjoyable foods (Pal *et al*., 1995). The ultimate measure of quality is consumer acceptance and hence sensory quality of the product plays a major role in determining the quality of cured products.

The products were found to have overall acceptability score in the range of 6.1-7.2 (Table 3) and the present study revealed that four fish products (*Puntius sophore, Setipinna phasa, Amblyphryngodon mola* and *Pseudeutropius atherinoides*) were preferred moderately and two dried fish products (*Corica soborna* and *Pseudambassis ranga*) were liked by the panelists. The difference in the sensory quality and overall acceptability of the product might be attributed to the different degree of biochemical and microbiological changes the dried fish may have undergone during drying and subsequent storage.

TABLE 3: Sensory quality of six dried fish products of markets of Assam

Parameters	Sensory quality of dried fish products					
N=3	*P. sophore*	*S. phasa*	*A. mola*	*P. atherinoides*	*P. ranga*	*C. soborna*
Appearance	7.1 ± 0.49^{a}	6.8 ± 0.43^{a}	7.2 ± 0.60^{a}	6.4 ± 0.70^{a}	7.3 ± 0.50^{a}	7.4 ± 0.65^{a}
Colour	6.8 ± 0.48^{ab}	6.7 ± 0.50^{ab}	7.0 ± 0.35^{ab}	6.1 ± 0.45^{a}	7.2 ± 0.70^{ab}	7.3 ± 0.80^{b}
Texture	6.9 ± 0.78^{ab}	6.7 ± 0.30^{ab}	6.9 ± 0.50^{ab}	6.0 ± 0.70^{a}	7.4 ± 0.55^{b}	7.0 ± 0.20^{ab}
Odour	6.6 ± 0.45^{ab}	6.3 ± 0.65^{ab}	6.7 ± 0.80^{ab}	6.0 ± 0.20^{a}	7.0 ± 0.30^{ab}	7.1 ± 0.45^{b}
Overall acceptability	6.9 ± 0.39^{b}	6.6 ± 0.40^{ab}	6.8 ± 0.40^{b}	6.1 ± 0.30^{a}	7.2 ± 0.40^{b}	7.2 ± 0.20^{b}

All values are mean ± standard deviation; Different letters (a-d) in the same row indicate significant differences within the same fraction ($P<0.05$).

CONCLUSION

The dried fish products available in the markets of Assam were found to have high nutritional value. The sensory evaluation of the products revealed that 70% of the products were of less overall acceptable quality. Though the absence of *E. coli*, *Streptococcus* spp., and *Salmonella* spp. was a good sign for consumers, the presence of *Staphylococcus aureus* in the product indicates unhygienic handling during processing and storage. Therefore, care should be taken for strict hygienic measures 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. Packaging may also be improved for better keeping quality to increase shelf life of the products.

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