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RESEARCH ARTICLE

QUALITY AND SAFETY ASPECT OF SOME TRADITIONALLY PROCESSED FRESHWATER FISH AND FISHERY PRODUCTS OF MYMENSINGH DISTRICT IN BANGLADESH

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ABSTRACT

This research was conducted to assess the quality and safety aspect of important processed fish and fishery products prepared from freshwater fishes of the Brahmaputra river of Mymensingh district in Bangladesh. Three sun-dried fish, one semi-fermented fish product and a salted fish product, and frozen prawn were included in this research. Among the sun-dried fishes *Mystus tengra*, *Amblypharringodon microlepin* and *Wallago attu* were included in this research. Semi-fermented product prepared from *Puntius stigma* was included in this research. Salted fish prepared from *Hilsa ilisha* was included in the present research. Frozen freshwater prawn (*Macrobrachium rosenbergii*) was also included in this research. All samples were purchased from Fish Market of Mymensingh city. The samples were assessed by sensory quality test (Organoleptic test), estimation of nutritional composition e.g. Protein, Lipid, Ash, Moisture, TVB-N, TMA-N and heavy metal concentration e.g. Cd, Cr, Pb, Cu, Zn in laboratory experiments. Organoleptically the processed fish and fishery products of this research were excellent. The SDP was <2 in almost all samples which indicated excellent condition i.e. Grade A. The protein content of the processed fish and fishery products was between 18.5% in frozen prawn to 56.20% in sun-dried fish. Lipid content was between 2.15 % to 20.09%, ash content was between 1.24% to 19.07% and moisture content was between 18.88% to 79.65%. The TVB-N value of frozen freshwater prawn was 9.65 mg/100g. Whereas in sun-dried fish, salted fish, semi-fermented fish the TVB-N value was between 72.8 mg/100g to 87.28 mg/100g. The TMA-N value of the samples of present research was between 3.19 mg/100g to 9.68 mg/100g. The Cd concentration of the samples was below the maximum allowable limit (<1 ppm) except in sun-dried *Mystus tengra.* The Cr concentration in all samples was above maximum allowable limit (>0.05 ppm). The Pb concentration of all samples was above maximum allowable limit (>2 ppm). The Cu concentration of the samples was below maximum allowable limit (<10 ppm) except frozen freshwater prawn. The Zn concentration of the samples was below the maximum allowable limit (100 ppm) except sun-dried Kechki. Results of the present research indicated that the processed freshwater fish and fishery products possessed excellent sensory quality, nutritional quality, freshness quality. The materials are reasonably safe to eat with careful selection.

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INTRODUCTION

Fish is used as food from time immemorial. Any fish that could be caught was eaten unless by experience it was found to be detrimental to health. The fish first used were mainly composed of freshwater fish, littoral or anadromous species, the latter with their large migration run often being used for preservation. In order to catch and preserve fish, technologies were developed that must be of some of the oldest in man's history. Examples are the introduction of cords, nets, hooks, boats and the development of drying, salting, smoking and possibly in colder climates, chilling and freezing methods. Several factors encouraged the development of fish preservation methods either by salting or drying and also of a rudimentary form of fish farming (Connell and Hardy, 1982). Fish, processed fish and fishery products play an important role in the nutrition of many nations of the world. Fish, processed fish and fishery products have enjoyed an increase in status in recent years, particularly in rich industrial nations,

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and many supplier countries have used this trend to boost foreign earnings. Competition among suppliers is fierce. Suppliers, able to provide quality, safety, variety economically will survive in such competition. Fish processing technology is well developed in the traditional areas of freezing, salting, drying, smoking, fermentation, canning. Products and process based on fish mince and surimi are also now in use worldwide. At the same time new technologies are finding use in fish processing as a response to economic and environmental demands (Hall, 1992). Traditional processing techniques particularly 'curing' (salting, smoking, drying), as a means of preserving fish, has been practiced perhaps longer than any other preservation technique. Salting, smoking and drying have all continued as preservation techniques virtually unaltered from prehistory to the present day. Modern developments have centered around understanding and controlling the processes to achieve the standardized product demanded by today's market. A major exception has been exploitation of the sublimation of ice to dry food so that it resembled the starting material in volume and shape. For all the developments in cure-processing accommodating continuous production line, the time required to achieve a long shelf-life product purely by water removal is much greater than for any other commonly used preservation method (Horner, 1992).

In Bangladesh processed fish and fishery products are important for domestic consumption as well as for export to International market. It is highly desirable that, the requirement of a safe processed product should be available to all those who are concerned with the expansion and development of fish processing and preservation particularly in those regions of the world where an improvement can have a market effect on the standard of living of the people. Poulter et al. (1988) described losses of fish, which have been cured by salting, drying, smoking or a combination of these processes. Undue delay in processing and poor processing methods may lead to low value poor quality products, which cause a financial loss to fishermen or processor. Connell (1980) stated that the quality in terms of TVB-N and TMA-N is different among the processed fish and fishery products. The causes and extent of different types of quality reduction is described by the researchers. Excessive heat treatment is known to impair the availability of amino acids such as lysine in fish protein (Carpenter and Booth, 1973). Hoffman et al. (1977) found a significant reduction in lysine availability and net protein utilization in tropical fish dried at 75^0C and smoked at 100^0C. Post-harvest loss in dried fish product is estimated as 25% in Bangladesh (Doe *et al.*, 1977). Under very humid conditions cured fish reabsorb moisture. Rao et al. (1962) found that, a relative humidity of over 70% was conductive to mould attack. Fish damaged by mould has a lower price thereby resulting in economic loss. Good quality raw material supply is essential for value added product development for domestic consumption as well as for export. It needs proper research support to produce safe and quality product for export. Global climate change has lead to an increasing concern in recent years regarding the abundant entry of heavy metal into the water and their probable adverse effect that might be reflected on aquatic animal like fish and finally on human health through food chain. Attention to environmental pollution in Bangladesh was not adequate which is now affecting its fisheries resources. Fish living in the polluted water may accumulate toxic trace metals via their food chain. High level of lead (Pb), Copper (Cu), Chromium (Cr), Cadmium (Cd), Zinc (Zn) are harmful to fish as well as to consumers' health.

In Bangladesh some research have been conducted on the quality and safety aspect of freshwater fish, marine fish and sun-dried fish (Mansur *et al.*, 2013; Mansur, 2015; Mansur *et al.*, 2017). In the present study we attempted to create data and information, which will be helpful in producing a quality fish product and a safe product for domestic consumption as well as for export. The present study was undertaken with the aim to have a clear idea about the quality and safety aspect of processed and preserved fish. Such knowledge is important because a reasonable quantity of processed and preserved fish is consumed in Bangladesh and exported to International market every year. Results of the present investigation is expected to provide a clear idea on the quality and safety aspect of processed and preserved fish and fishery products of Bangladesh particularly sun-dried fish, salted fish, semi-fermented fish and frozen prawn.

MATERIALS AND METHODS

Collection, transportation and storage of the sample

Sun-dried fishes *Mystus tengra*, *Amblypharringodon microlepin* and *Wallago attu* were included in this research. Semi-fermented product prepared from *Puntius stigma* was included in this research. Salted fish prepared from *Hilsa ilisha* was included in the present research. Frozen freshwater prawn (*Macrobrachium rosenbergii*) was also included in this research. All samples were purchased from Fish Market of Mymensingh city. Samples were packed tightly in separate polyethylene bags and transported to the laboratory of the Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh-2202 by vehicle which required 45 minutes. On arrival to the laboratory a portion of each type of product were taken for sensory quality assessment. The rest of the samples were kept in separate plastic containers with air-tight lid. The plastic containers were stored at room temperature in the laboratory. Stored samples were used for consequent laboratory analysis. Frozen prawn was stored in a freeze at -20^0C.

Table 1. Freshwater fish species used in processing and product preparation

Product type	Scientific name	English name	Local name
Sun-dried fish	*Amblypharingodon microlepin*	Minnows	Kechki
	Mystus tengra	Bagrid cat fish	Bozuri Tengra
	Wallago attu	Eurasian catfish/Freshwater shark	Boal
Salted fish	*Hilsa ilisha*	The River shad	Ilish
Semi-fermented fish	*Puntius stigma*	Minnows	Puti/Jat Puti
Frozen Prawn	*Macrobrachium rosenbergii*	Giant freshwater Prawn	Chingri

Sensory Quality assessment

Sensory quality as for example colour, odour, taste, texture, broken piece, infestation, use of chemicals etc. of the samples e.g. sun-dried fishes, salted fish, semi-fermented fish and frozen prawn was conducted by organoleptic method as proposed and described by Howgate et al. (1992) as follows:

$$SDP = \frac{\Sigma DP}{n}$$

Here,
SDP = Score of defect point
$\sum$ DP = Summation of defect point
n = Number of characters

Table 2.1: Grading of the processed fish and fishery products

Grade	Defect Points	Degree of freshness
A	<2	Excellent/Acceptable
B	2 to < 5	Good/Acceptable
C	5	Reject

Table 2.2: Characteristics of sensory quality assessment of the processed fish and fishery products

Characteristics	Defect characteristics	Defect point	Grade
Use of Chemicals	Nothing	1	Acceptable
	Nogos, DDT	5	Rejected
1.Color	Off white and clear Yellowish	1	Excellent
	Brownish to yellowish	2	Acceptable
	Reddish	3	Acceptable
	Brownish in outer and reddish in inside	5	Rejected
2.Odor	Natural	1	Excellent
	Characteristic odor	2	Acceptable
	Slightly sour	3	Acceptable
	Sour	5	Rejected
3.Texture	Firm and flexible	1	Excellent
	Soft	2	Acceptable
	Soft and damp	5	Rejected
4. Broken	Nil	1	Excellent
5. Pieces	Slightly broken	2	Acceptable
	Broken	5	Rejected
6.Infestation	No infestation	1	Excellent
	Slightly infestation	2	Acceptable
	Infested by insects	3	Acceptable
	Infested by flies and insects	5	Rejected

Bio-chemical analysis

Nutritional composition or proximate composition (Protein, Lipid, Ash, Moisture), TVB-N and TMA-N of the processed fish and fishery products were estimated according to the method of A.O.A.C (1965) and AMC (1979). All estimations were done in triplicate and the average value has been reported. In doing so, slight modification/change in the use of apparatus was followed during this research.

Heavy metal analysis

Sample preparation for heavy metal analysis

At first the sample was chopped and finely homogenized (ground) with a blender. In this way sample was prepared from each processed fish and fishery product. Approximately 5g homogenized (ground) sample was taken in a crucible and dried at 105^0C for 24 hours in an electric oven. This dried sample was used for heavy metal analysis.

Sample digestion

Accurately weighed 0.5 – 1.0 g oven dried sample was taken in a Micro-Kjeldahl flask. A volume of 10 ml nitric acid was added to this flask. After that 5 ml perchloric acid was added to this flask. The Micro-Kjeldahl flask containing the sample and acid mixture was placed in an Electrothermal heater and heated at 30^0 – 80^0C. Heating started at 30^0C and gradually heating temperature was increased to 80^0C. During heating the colour of the liquid in flask (sample + acid mixture) was turned into reddish colour, which was turned into white colour afterwards. Then the flask with the contents was cooled. Then 6N 6 ml HCl was added to the flask. The Micro-Kjeldahl flask with its contents was placed in the Electrothermal heater and heated at 30^0 – 80^0C. Heating temperature gradually increased from 30^0C to 80^0C. This time the colour of the liquid (sample + acid) in flask was first yellow colour which was turned into white colour afterwards. Then the flask with its content was cooled. The content of the flask was taken in a 50 ml volumetric flask. The volume was made up to the mark (50 ml) by distilled water according to Eboh *et al*. (2006). This solution was filtered by ash less Whatman No.1 filter paper.

Atomic Absorption Spectrophotometric Analysis

This digested solution was then subjected to Atomic Absorption Spectrophotometric analysis according to the method of Clesceri et al. (1989). The absorbance of the colour of the solutions was measured by Atomic Absorption Spectrophotometer at a specific wave length. The wave length for such measurement was for As, Cr and Cd was 193.7, 127 and 217 nm, respectively. The absorbance and corresponding concentration of heavy metal was observed or determined from a standard graph which was previously prepared by standard compound of heavy metal.

Calculation

The actual concentration of heavy metal was calculated by the following formula:

Heavy Metal Concentration (ppm) =

$$\frac{\text{ppm conc. observed} \times \text{final vol. of sample in ml}}{\text{Weight of tissue taken in g}}$$

RESULTS AND DISCUSSION

Results of sensory quality assessment (organoleptic evaluation of physical characteristics) of the processed fish and fishery products was presented in Table 3. The sensory quality of these products was assessed on the basis of colour, odour, texture, insect infestation, broken piece, use of chemicals etc. The dried fishes were brown and slightly dark coloured, salted fish was yellow coloured, semi-fermented fish was deep brown coloured whereas the frozen prawn was white coloured. Texture condition and flavour of these processed fish and fishery products revealed that the overall quality was excellent. Rancid odour, off odour did not develop in any of the samples. Sensory quality assessment score SDP was <2 (SDP <2) which indicates that the products fall into the Grade A and of excellent quality.

Results of nutritional composition estimation was presented in Table 4. The protein content which is most important from nutritional point of view ranged from 18.5% in frozen prawn, 26.87% in salted river shad, 33.74% in semi-fermented fish, 49.23 – 56.20% in sun-dried fish. Lipid and ash content were in the range of 2.15% to 20.09% and 1.24% to 19.09% respectively. Moisture level of the frozen prawn was 79.65%, salted river shad was 30.20%, semi-fermented fish 36.63% and the sun-dried fishes 18.88% - 23.12%. For better comparison of data if the protein content, lipid content, ash content are recalculated on moisture free basis then the accurate quantity of each nutrient i.e. percentage of nutrients in the processed fish and fishery products would be clear. It has been shown in the data in parenthesis in Table 4.

Table 3. Sensory quality assessment of different processed fish and fishery products

Product type	Sensory quality	SDP	Grade	Overall quality
Sun-dried Kechki	Brown colour, hard texture, characteristic dried fish odour, no broken piece	1.8	A	Excellent
Sun-dried Bozuri Tengra	Slight dark colour, hard texture, strong dried odour, no broken piece	1.8	A	Excellent
Sun-dried Boal	Brown colour, moderate hard texture, strong dried fish odour, no broken piece	1.9	A	Excellent
Salted River shad	Light yellow colour, soft texture, cheese salted flavour, no broken piece	1.8	A	Excellent
Semi-fermented fish	Deep brown colour, soft texture, strong fermented odour, no broken piece	1.8	A	Excellent
Frozen prawn	White colour, soft texture, characteristic frozen fish odour, no broken piece	1.9	A	Excellent

Table 4. Nutritional composition of different processed fish and fishery products

Product type	Protein (%)	Lipid (%)	Ash (%)	Moisture (%)
Sun-dried Kechki	56.20 (70.57)	6.20 (7.78)	19.07 (23.94)	20.37
Sun-dried Bozuri Tengra	54.30 (66.93)	14.30 (17.62)	12.40 (15.28)	18.88
Sun-dried Boal	49.23 (64.03)	11.01 (14.32)	18.89 (24.57)	23.12
Salted River Shad	26.87 (38.45)	20.09 (28.78)	15.22 (21.80)	30.20
Semi-fermented fish	33.74 (53.24)	18.54 (29.25)	11.83 (18.66)	36.63
Frozen freshwater prawn	18.50 (90.90)	2.15 (10.56)	1.24 (6.09)	79.65

* Data in the parenthesis are on moisture free basis

Table 5. TVB-N and TMA-N content of different processed fish and fishery products

Product type	TVB-N (mg/100g)	TMA-N (mg/100g)
Sun-dried Kechki	72.80	7.52
Sun-dried Bozuri Tengra	87.28	8.89
Sun-dried Boal	70.56	7.78
Salted River Shad	82.92	9.68
Semi-fermented fish	81.68	6.78
Frozen freshwater prawn	9.65	3.193

* Estimation from TCA extract of the samples

Table 6. Heavy metal concentration in different processed fish and fishery products

Product type ↓	Heavy Metal (ppm)				
	Cd	Cr	Pb	Cu	Zn
Maximum Allowable Limit by WHO →	MAL =1.00	MAL= 0.05	MAL = 2	MAL=10	MAL=100
Sun-dried Kechki	0.66	8.82	8.18	2.64	192.97
Sun-dried Bozuri Tengra	1.10	23.932	10.44	2.41	104.53
Sun-dried Boal	0.99	26.99	8.68	1.18	26.28
Salted River Shad	0.73	3.637	7.54	3.73	32.96
Semi-fermented fish	0.63	7.48	6.75	2.22	90.96
Frozen freshwater prawn	0.47	72.55	4.32	22.24	67.44

* MAL is Maximum Allowable Limit as recommended by WHO (World Health Organization)

Nutritional composition i.e. proximate composition of the fishes depend on some factors of which species, size, sex, age of fish, its geographical distribution and season of the year are important. Result of nutritional composition of the processed fish and fishery products of present research is very similar to our previous investigations on fish and processed fish (Mansur *et al.*, 2014; Mansur *et al*., 2016). Results of TVB-N and TMA-N of the processed fish and fishery products were presented in Table 5. The TVB-N amd TMA-N value of the samples under present study were 9.65 mg/100g and 3.19 mg/100g in frozen prawn, 82.92 mg/100g and 9.68 mg/100g in salted river shad, 81.68 mg/100g and 6.78 mg/100g in semi-fermented fish, 70.56 mg/100g to 87.29 mg/100g and 7.52 to 8.89 mg/100g in sun-dried fish specie respection. This result was obtained from TCA extract of the samples. TVB-N and TMA-N are two parameters generally used to measure the degree of spoilage in fish, processed fish and fishery products. TVB-N indicates spoilage caused by bacteria and fish enzymes whereas TMA-N indicates spoilage caused by bacteria only. Considerable attention had been given to the TVB-N and TMA-N of fish, processed fish and fishery products and a Maximum Allowable Limit (MAL) is set. This MAL determines the acceptability and safety of fish, processed fish and fishery products on the basis of freshness and quality (Pearson and Muslemuddin, 1969; Connell *et al.*, 1976; Wong *et al.*, 1975). Fish muscle contain a little TMAO but the major portion of the TVB-N is considered to be ammonia. In well preserved fish ammonia originates from amino acids mainly from glutamine and asparagine (Haaland and Njaa, 1988)[23]. Selection of appropriate method for the accurate estimation of TVB-N is important.

Literature suggests that a number of methods for TVB-N estimation had been proposed by many researchers (Ritskes, 1975; Miller *et al*., 1972; Keay and Hardy, 1972; Murray and Gibson, 1972; Gruzer, 1972; Ward *et al*., 1979; Ruiter and Weseman, 1976; Parris, 1984). In the present research extraction with TCA and steam distillation was chosen because sophisticated methods were considered to be expensive and impractical for routine monitoring. In addition steam distillation method was found to be most reliable which is a recommended method too. This method was selected to find accurate result. The TVB-N and TMA-N content of the processed fish and fishery products are within the acceptable range as recommended by Connell (1980). Heavy metal concentration (pollution by metal and element) in the processed fish and fishery products of the present study was presented in Table 6. Among the metal and elements Cd, Cr,

Pb, Cu, Zn were included in this research. Chromium (Cr) and lead (Pb) were much above the MAL. Cadmium (Cd), Copper (Cu), Zinc (Zn) were within the acceptable limit as recommended by World Health Organization (WHO) except Zn concentration was above MAL (>100 ppm) in sun-dried Ketchki and Cu concentration was above MAL (>10 ppm) in frozen prawn. The reason behind the high level of Pb and Cr is water pollution by waste material dumping, industrial effluent discharge, lagoon and finally climate change or environmental change which reduce water depth and thus heavy metal in water is more concentrated which accumulate easily in fish muscle via food chain. Almost all heavy metal are harmful for consumers' health e.g. cause renal problem (kidney problem), cause health injury, Pb causes retarded growth in children. High level of heavy metal is detrimental to physiological process of fish too. A large number of potentially harmful metal and elements are known as pollutants despite Hg has been implicated in disease to man caused by eating fish and fish products. Pollution from any metal or element may cause unsuspected hazards to man.

The elements of most concern are cumulative poisons, that is, those that cause injury to health through progressive and irreversible accumulation in the body as a result of ingestion of repeated small amounts (Connell, 1980). Many countries are now taking voluntary or mandatory action to reduce pollution of the aquatic environment with heavy metal for the safety aspect of aquatic food particularly fish. Considering the affect of heavy metal on fish quality and safety the food regulatory and health authorities in some developed countries have taken serious view and adopted Maximum Allowable Limit of metal and element. Usually pollutants of metal and element category contaminate raw fish. In this way the concentration of harmful metal and element is also at danger level in processed fish and fishery products. On the basis of the results of present study it can be concluded that the quality of the processed fish and fishery products were excellent. Safety in terms of TVB-N and heavy metal concentration is at safe level except Pb and Cr concentration.

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