



Studies on the Proximate Composition, Quality and Heavy Metal Concentration of Sun-dried Bombay Duck and Sun-dried Ribbon Fish of Cox's Bazar District of Bangladesh

M. G. M. Jamil¹, M. N. Hossain², M. M. Mia², M. A. Mansur^{1*} and S. Uga³

¹Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh-2202,

²Department of Fisheries, Ministry of Fisheries and Livestock, Government of the People's Republic of Bangladesh,

³Department of Nursing, Faculty of Nurse, Kobe Women's University, 4-7-2 Minatojima-nakamachi, Chuo-ku, Kobe 650-0046, Japan.

*Corresponding author: mansurft63@gmail.com

Abstract

Proximate composition, quality aspect and heavy metal concentration of sun-dried Bombay Duck (*Harpodon nehereus*) and sun-dried Ribbon fish (*Trichiurus haumela*) were studied in a series of laboratory experiments. Sun-dried fishes were collected from a fish market of Cox's Bazar town. These sun-dried marine fishes were collected from the stock after first drying procedure. Organoleptically most of these sun-dried fishes were in 'B' grade that means in 'Good' condition (SDP 2.33 and 2.35 respectively). Crude Protein, Lipid, Moisture, Ash, TVB-N and TMA-N content (%) of sun-dried Bombay Duck (*Harpodon nehereus*) was 32.21±1.05 %, 3.51±0.38 %, 37.26±0.70 %, 16.22±0.56 %, 115.45±1.73 mg/100g, 9.37±0.13 mg/100g respectively. Whereas in sun-dried Ribbon fish (*Trichiurus haumela*) the content (%) of Crude Protein, Lipid, Moisture, Ash, TVB-N and TMA-N was 31.64±1.28 %, 5.06±0.10 %, 35.78±0.97 %, 12.33±0.27 %, 107.69±1.37 mg/100g and 9.91±0.23 mg/100g respectively. Heavy metal concentration i.e. Cd, Cr, Pb, Cu and Zn concentration (ppm) in sun-dried Bombay Duck (*Harpodon nehereus*) was 0.82, 8.38, 8.28, 2.21, 55.38 ppm. Whereas heavy metal concentration (ppm) in sun-dried Ribbon fish (*Trichiurus haumela*) was Cd 0.48 ppm, Cr 6.96 ppm, Pb 5.46 ppm, Cu 1.40 ppm, Zn 19.95 ppm.

Key words: Proximate composition, Sun-dried bombay duck, Sun-dried ribbon fish, Sensory quality and TMA-N

Introduction

Fresh fish rapidly deteriorates unless some way can be found to preserve it. Drying is a method of food preservation that works by removing water from the food, which inhibits the growth of microorganisms. Open air drying using sun and wind has been practiced since ancient times to preserve food. Water is usually removed by evaporation (air drying, sun drying, smoking or wind drying) but, in the case of freeze-drying, food is first frozen and then the water is removed by sublimation. Bacteria, yeasts and molds need the water in the food to grow, and drying effectively prevents them from surviving in the food (Historical Origins of Food Preservation, 2011).

Fish are preserved through such traditional methods as drying, smoking and salting. The oldest traditional way of preserving fish was to let the wind and sundry it. Drying food is the world's oldest known preservation method, and dried fish has a storage life of several years. The method is cheap and effective in suitable climates; the work can be done by the fisherman and family, and the resulting product is easily transported to market (Grandidier, 1899).

Various types of fish processing methods are practiced in Bangladesh. Among them drying, freezing, salting, smoking are the most prominent. Fish drying as a means of preservation has been practiced since the time immemorial in Bangladesh (Doe *et al.*, 1977). Sun drying is one of the most important low cost methods of fish preservation and the product plays an important role particularly in providing nutrition for the poor and economically disadvantaged people. About 20% of the artisanal catch is sun dried and consumed in the internal domestic market. Dry fish ('Shutki' in Bengali), is the most popular food item in Bangladesh. It is the main

protein source in many areas including Chittagong, Dhaka, Chandpur, Kuakata, Barisal and recently exported abroad where the main consumers are immigrants and workers of the developing countries.

All species of fish are a good source of protein. Protein content of fish is most important for study from nutritional point of view. In Bangladesh, fishes meet the demand of protein and contribute 60% of total protein (DoF, 2014). Dried fish contain high amount of protein rather than wet fish. According to protein value dry fish is cheaper than wet fish. People in our country can easily fulfill their protein requirement by up taking dry fish. Poor people of the country meet their nutritional demand by consuming fish. Dried Bombay duck (*Harpodon nehereus*) and Ribbon fish (*Trichiurus haumela*) are good source of protein that can fulfill protein demand and also commercially very important due to their availability.

Proximate composition generally comprises the estimation of moisture, protein, fat and ash contents of the fresh fish body. Proximate composition of fish varies widely from species to species and even within the same species from one individual to another. This individual variation is normally due to some factors such as size, age, season, sex and geographical location (Stansby, 1962). Fish technologists and nutritionists need to know the proximate composition of fish in order to estimate the intake of the principal nutrients in the human diet and to calculate energy values of different fish. From technological point of view, it is also important to know the proximate composition of any fish species for quality control during fish processing in industry.

Total volatile base nitrogen (TVB-N) is important characteristic for the assessment of quality in seafood

products and appears as the most common chemical indicator of marine fish spoilage (Amegovu *et al.*, 2012; Wu and Bechtel, 2008). Total volatile bases (TVB) is a group of biogenic amines formed in non-fermented food products during storage (Horsfall *et al.*, 2006). The combined total amount of ammonia (NH₃), dimethylamine (DMA) and trimethylamine (TMA) in fish is called the total volatile base (TVB) nitrogen content of the fish and is commonly used as an estimate of spoilage and has been widely used as an index for freshness of fish (Wu and Bechtel, 2008).

Quality and safety aspect of fish and fishery products has received considerable attention. Dried fish is also under such attention. Quality and safety aspect of sun-dried marine fishes need to be elucidated. This is important for the protection of consumers' health as well as for continuing export to International market. Presence of heavy metal e.g. Cd, Cr, Pb, Cu, Zn is harmful for fish as well as for consumers' health. Some research have been carried out in our previous investigation on the heavy metal concentration of freshwater fish, marine fishes and fishery products of Bangladesh (Mansur *et al.*, 2013; Pravakar *et al.*, 2013; Mansur *et al.*, 2014; Mansur *et al.*, 2016; Mansur *et al.*, 2017). The present research was conducted on sun-dried marine fish. Objective of the present research was determination of sensory quality, nutritional composition (Protein, Lipid, Ash, Moisture), freshness and quality (TVB-N and TMA-N) and safety aspects in terms of heavy metal concentration e.g. concentration of Cd, Cr, Pb, Cu, Zn. Such research is important and expected to contribute in producing reliable data and information. Such data and information will be helpful to develop effective quality control and Assurance Programme as well as to produce a safe product for export as well as for domestic consumption.

Materials and Method

Source of Sun-dried fish

Sun dried Bombay duck and sun dried Ribbon fish were collected from Cox's Bazaar District about a year before the beginning of analysis. After collection the samples were transported to the laboratory of Fisheries Technology Department, Bangladesh Agricultural University, Mymensingh. Finally carefully packed in several jars and kept in store room at room temperature. Stored samples were used for consequent laboratory analysis.

Sensory Quality assessment

Sensory quality as for example colour, odour, taste and texture, infestation, broken pieces of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) was conducted by organoleptic method of Howgate *et al.* (1992). In doing so the SDP (Score of Defect Points) was calculated first. Then Grading was done according to the recommended Table shown below.

Table 1. Quality grade of fresh fish with SDP

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

Table 2. Determination of defect points

Characteristics of whole fish	Defect characteristics	Defect point	Grade
Use of chemicals	Nothing	1	Acceptable
	Nogos, DDT	5	Rejected
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
Odor	Natural	1	Excellent
	Characteristic odor	2	Acceptable
	Slightly sour	3	Acceptable
	Sour	5	Rejected
Texture	Firm and flexible	1	Excellent
	Soft	2	Acceptable
	Soft and damp	5	Rejected
Broken pieces	Nil	1	Excellent
	Slightly broken	2	Acceptable
	Broken	5	Rejected
Infestation	No infestation	1	Excellent
	Slightly infestation	2	Acceptable
	Infested by insects	3	Acceptable
	Infested by flies and insects	5	Rejected

Calculation of organoleptic assessment

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

Here,

SDP=Score of defect point

∑ DP= Summation of defect point

n= Number of characters

Bio-chemical analysis

Proximate composition (Protein, Lipid, Ash, Moisture), TVB-N and TMA-N of the sun-dried fish samples were conducted according to the method of A.O.A.C (1965) and AMC (1979). All determinations were done in triplicate and the average value has been reported mentioning the standard deviation. 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

The sun-dried fish were chopped and finely homogenized (ground) with a blender. Approximately 5g homogenized (ground) sample was taken in a crucible and dried at 105°C 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-

Calculation

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

$$\text{Heavy Metal Concentration (ppm)} = \frac{\text{ppm conc. observed} \times \text{final vol. of sample in ml}}{\text{Weight of tissue taken in g}}$$

Result and Discussion

This research was conducted to estimate the proximate composition (Protein, Lipid, Ash, Moisture), TVB-N, TMA-N, Heavy Metal particularly Cd, Cr, Pb, Cu and Zn of two sundried marine fish e.g. sun dried Bombay duck and sun dried Ribbon fish. Result of the present research is presented below.

Sensory quality

During this experiment organoleptic characteristics and overall quality of some samples of sun dried Bombay duck and sun dried Ribbon fish were not excellent. Sensory characteristics were not so fresh, slightly dark, soft texture and fresh odor. The results of the organoleptic quality assessment during the experiment are presented in Table 3.

Kjeldahl flask containing the sample and acid mixture was placed in an Electrothermal heater and heated at 30⁰ – 80⁰C. Heating started at 30⁰C and gradually heating temperature was increased to 80⁰C. 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 30⁰ – 80⁰C. Heating temperature gradually increased from 30⁰C to 80⁰C. 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.

Table 3. Organoleptic characteristics of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*)

Sample	Organoleptic quality (physical characteristics)	SDP	Overall quality
Sun dried <i>Harpadon nehereus</i>	Slightly dark appearance, Soft texture with characteristics of fresh odor	2.33	Good and Acceptable
Sun dried <i>Trichiurus haumela</i>	Slightly dark appearance, Soft texture with characteristics of fresh odor	2.35	Good and Acceptable

Proximate composition, TVB-N and TMA-N

Proximate composition is an important factor that determines the nutritional value of the species. On the

other hand TVB-N and TMA-N value shows the result of microbial decomposition. Proximate composition, TVB-N and TMA-N value of sun dried Bombay duck and sun dried Ribbon Fish has been given in Table 4.

Table 4. Proximate composition, TVB-N and TMA-N components of experimented fishes

Parameters	Sun dried <i>Harpadon nehereus</i>	Sun dried <i>Trichiurus haumela</i>
Moisture (%)	37.26±0.70	35.78±0.97
Protein (%)	32.21±1.05	31.64±1.28
Lipid (%)	3.51±0.38	5.06±0.10
Ash (%)	16.22±0.56	12.33±0.27
TVB-N value (mg/100g)	115.45±1.73	107.69±1.37
TMA-N value (mg/100g)	9.37±0.13	9.91±0.23

Moisture content (%) of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 37.26±0.70 and 35.78±0.97 respectively. The result shows that sun dried *Harpadon nehereus* (37.26±0.70) contain much amount of water than sun dried *Trichiurus haumela* (35.78±0.97). The moisture content of the sun-dried marine fishes was slightly higher than expectation. Two reasons may lay behind it. First reason is that the sun-dried marine fishes were collected after first year of storage during this time the products absorbed moisture from the atmosphere. The second reason is that the traders keep the sun-dried marine fishes in wet and unhygienic condition and do not control the moisture and air temperature of the warehouse.

The protein content (%) which is most important from nutritional point of view. The protein content (%) of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 32.21±1.05 and 31.64±1.28 respectively. The lowest value was found in sun dried *Trichiurus haumela* (31.64±1.28) and the highest value in sun dried *Harpadon nehereus* (32.21±1.05). Result of the present research is close to the results of Chakraborty *et al.* (1997).

The lipid content (%) of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 3.51±0.38 and 5.06±0.10 respectively. The lowest value was found in sun dried *Harpadon nehereus* and the highest value in sun dried *Trichiurus haumela*. Result of the present research is close to the results of previous research by Siddique and Akter (2011) where the lipid content of sun-dried marine fishes was ranged from 5.86% to 7.78% and 6.84% to 9.21%.

The ash content (%) of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) from the study were 16.22±0.56 and 12.33±0.27 respectively. The lowest value was found in sun dried *Trichiurus haumela* (12.33±0.27) and the highest value in sun dried *Harpadon nehereus*

(16.22±0.56). Pravakar *et al.* (2013), found ash content in sun dried Chinese pomfret, Bombay duck and Ribbon fish as 7.21±0.18%, 20.06±0.36% and 11.05±0.69% respectively. Result of the present research is close to these results.

The TVB-N content of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 115.45±1.73 mg/100g⁻¹ and 107.69±1.37 mg/100g respectively. The lowest value was found in sun dried *Trichiurus haumela* and the highest value in sun dried *Harpadon nehereus*. According to Connell (1980) the TVB-N content should not greater than 100-200 mg/100g for a variety of salted and dried fish. So the present study is within the range.

The TMA-N content of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 9.37±0.13 mg/100g and 9.91±0.23 mg/100g respectively. The lowest value was found in sun dried *Harpadon nehereus* and the highest value in sun dried *Trichiurus haumela*. Mansur *et al.*, (2013) reported that in Britain the Tri-Methyl Amine Nitrogen (TMA-N) content in *Clupea harengus* (Herring) and *Scomber scombrus* (Mackerel) were 2.6±1.29 (mg/100g) and 4.0±1.14 (mg/100g) and the TMA-N content in salted *Clupea harengus* and *Scomber scombrus* were 6.2±1.73 (mg 100g⁻¹) and 12.0±2.16 (mg 100g⁻¹).

Heavy metal concentration

Arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), mercury (Hg), silver (Ag), Zinc (Zn) and the platinum group elements constitute heavy metals. The metals get into the tissues of aquatic animals mainly via their food mostly the fishes are in polluted water. A great number of anomalies and abnormalities in the fishes are reported due to the concentrations of metals exceed the environment standards (Shesterin, 2001). The trace elements can be accumulated by fish through the food chain and water intake. Fish living in the polluted water may accumulate higher amount of toxic heavy metals through their food chain (Hadson, 1998). The results of heavy metals concentration of the present study are given in table 5.

Table 5. Heavy Metal concentration concentration of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*)

Parameters	Sun dried <i>Harpadon nehereus</i> (ppm)	Sun dried <i>Trichiurus haumela</i> (ppm)	Maximum Allowable Limit (WHO/FAO) (ppm)
Cadmium (Cd)	0.824	0.485	1
Copper (Cu)	2.210	1.401	10
Chromium (Cr)	8.380	6.969	0.05
Lead (Pb)	8.281	5.465	2
Zinc (Zn)	55.38	19.95	100

The Cd concentration of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 0.824 ppm and 0.485 ppm respectively. The lowest value was found in sun dried Ribbon fish (*Trichiurus haumela*) and the highest value in sun dried Bombay duck (*Harpadon nehereus*).

The Cu concentration of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 2.210 ppm and 1.401 ppm respectively. The lowest value was found in sun dried Ribbon fish (*Trichiurus haumela*) and the highest value found in sun dried Bombay duck (*Harpadon nehereus*).

The Chromium (Cr) concentration of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 8.380 ppm and 6.969 ppm respectively. The lowest value was found in sun dried Ribbon fish (*Trichiurus haumela*) and the highest value in sun dried Bombay duck (*Harpadon nehereus*).

The Pb concentration of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 8.281 ppm and 5.465 ppm respectively. The lowest value was found in sun dried Ribbon fish (*Trichiurus haumela*) and the highest value found in sun dried Bombay duck (*Harpadon nehereus*).

The Zn concentration of sun dried Bombay duck (*Harpadon nehereus*) and sun dried Ribbon fish (*Trichiurus haumela*) were 0.824 ppm and 0.485 ppm respectively. The lowest value was found in sun dried Ribbon fish (*Trichiurus haumela*) and the highest value in sun dried Bombay duck (*Harpadon nehereus*).

WHO suggests the maximum limits Mn, Cu, Zn, Pb and Cd for fish are 1µg/g, 30µg/g, 100µg/g, 2µg/g, 1µg/g and FAO suggests the maximum limits Cu, Zn, Cd for fish are 10µg/g, 100µg/g and 0.2µg/g (Adedeji *et al.*, 2011). According to the experiment values of heavy metal concentrations in sun dried *Harpadon nehereus* and sun dried *Trichiurus haumela* showed an acceptable level for human consumption except for Lead (Pb) and Chromium.

Conclusion

On the basis of this experiment it is confirm that all the nutritional component present in satisfactory level. TVB-N and TMA-N value sometimes high but within the range. Except Lead (Pb) and Chromium (Cr) all heavy metals are in tolerable level. So all parameters shows that experimented sun dried fish is unacceptable quality.

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