Quality and Safety Aspects of Three Sun-Dried Marine Fish Species:
Chinese Pomfret (Stromateus chinensis), Bombay Duck (Harpodon nehereus) and Ribbon Fish (Trichiurus haumela)

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Abstract: In this study, investigation was conducted to assess different parameters on the various quality attributes of three marine dried fishes. The samples were evaluated by studying organoleptic, biochemical and bacteriological aspects and detection of heavy metals. Organoleptically good quality traditional dried fish which are available in the markets were collected. Proximate analysis showed that the mean value of moisture content of Chinese pomfret (Stromateus chinensis), Bombay duck (Harpodon nehereus) and Ribbon fishes (Trichiurus haumela) were 19.65±0.60%, 27.19±0.27 and 23.94±0.2 % respectively; the protein content were (60.03±0.94%), (41.28±0.35%) and 54.36±0.85% respectively; the lipid content were 11.92±0.33%, 10.48±0.22% and 11.45±0.16% respectively and the ash content were 7.21±0.18%, 20.06±0.36% and 11.05±0.69% respectively. The total volatile base-nitrogen (TVB-N) content of three dried fishes were 17.55±0.88, 11.51±0.86 and 20.37±0.71 mg/100g respectively. The bacterial loads of the traditional dried products were 3.8×10^5, 3×10^5 and 2.1×10^5 CFU/g respectively. The results of heavy metal analysis showed that concentration of Cadmium and Copper were 0.28 and 1.3µg/g in Chinese pomfret; 0.71 and 2.1µg/g in Bombay duck and 0.35 and 4.1 µg/g in Ribbon fish, indicating acceptable eating quality of the traditional marine dried fish products.

Key words: Quality • Safety aspects • Sun-dried • Marine Fish Species

INTRODUCTION

Fish drying, which is often regarded as a traditional and primitive method of fish preservation, varies from species to species, region to region and their availability all over the country. Fish plays an important role in the Bangladeshi diet, it constituting only animal protein source among rural households [1-3]. There are 260 indigenous, 24 exotic fish species and 24 species of prawn and also 475 species of marine fish [4, 5] available so far in the waters of Bangladesh. Fish drying method of preservation that practiced since time immemorial and dry fish is considered as a delicacy menu of many people in Bangladesh. Dublar char of Sunderbans, Saint Martin’s Island, Rangabali, Sonadia Island, Moheshkhali and Ibrahimpur of Sunamgonj are some important spots for fish drying. Traditional sun-drying is carried out in the open air, using the energy of the sun to evaporate the water and air currents to carry away the vapour. Theoretically, moisture content of the final product should be reduced to less than 15-16% where most of the microbiological and enzymatic activities are slowed down or stopped. The production of sun dried fish has been increasing acceptability by the people. A major problem associated with sun drying of fish is the infestation of the products by the fly and insect larvae during drying and storage which deteriorate the products before consumption [6]. The fish usually takes 5 to 7 days to dry during which it gets heavily contaminated. Consequently, as much as 25% of the flesh is lost and the products sell at about half the price of the unspoiled fish [7]. To protect the products from the infestation of insects, the
processors, whole sellers and retailers often use various harmful insecticides and fungicides indiscriminately such as DDT, Nogos, Rubral etc. [8]. Therefore, proper drying of fish is essential to save these valuable sources of protein by reducing the spoilage which can be used as human food. It needs proper research support to produce safe and quality products for export market. High levels of arsenic, cadmium, lead, copper and iron have been to cause rapid physiological changes in fish [9]. In our country, very little work has been done on the presence of heavy metals in freshwater fish. But work on arsenic, cadmium and chromium detection in fish is still imperative for the human health concern. The fish products obtained are sun dried and marketed in substantial quantities.

The present study was undertaken with the following objectives: determine the quality and safety aspects of marine sun-dried products by evaluating the proximate composition, Total Volatile Base Nitrogen (TVB-N) and their nutritional value of sun dried products.

**MATERIALS AND METHODS**

Traditionally dried marine water fishes namely Chinese pomfret (*Stromateus chinesis*), Bombay duck (*Harpodon nehereus*) and Ribbon fish (*Trichiurus haumela*) were collected from the local market of Cox’s Bazar. Dried fish samples were packed tightly in polyethylene bags and stored at room temperature for subsequent studies. Physical characteristics such as color, odor, taste, flavor and texture of the traditional dried fishes were observed by organoleptic method [10].

**Proximate Composition:** AOAC [11] method was followed to determine the proximate composition of the sun dried fish products.

**Moisture:** Moisture was determined by placing an accurately weighed known amount of ground sample in a pre-weighted porcelain crucible in an electric oven at 105°C for about 24 hours until constant weight was obtained. The loss of moisture was calculated as percent moisture.

\[
\text{Moisture content (\%)} = \frac{\text{Weight of wet material} - \text{Weight of dry material}}{\text{Weight of wet material}} \times 100
\]

**Ash:** About 3-5g prepared sample was taken in pre-weighed porcelain crucible and was placed in muffle furnace at 550°C for 6 hours. Then the crucibles were cooled in desiccators. The average in percentage of each sample of the remaining materials was taken as ash.

\[
\text{Ash content (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100
\]

**Crude Protein:** Kjeldhal method was used to determine protein content of the dried fish samples. Reagents used include digestion mixture (100g Na$_2$SO$_4$/K$_2$SO$_4$, 10g CuSO$_4$ and 1g selenium powder), Na$_2$S$_2$O$_3$ (8%), Concentrated H$_2$SO$_4$, H$_3$BO$_3$ (2%), NaOH (40%), Standard HCl (0.1N) and Mixed indicator (0.2g methyl red and 0.1g methyl blue in 100ml ethanol).

**Procedure:** Fish sample was taken and chopped into small pieces and was grinded by grinder. Approximately 1.0g of sample was taken in a clean kjeldahl flask and 4g of digestion mixture was added along with 25ml of conc. H$_2$SO$_4$ by swirling the flask. Then, the kjeldahl flask was placed on an inclined position on heating device of kjeldhal apparatus and were heated at 70°C for about 1-1.5 hours. The end point of digestion was indicated by a completely clear and of light blue color solution. The content of the flask were cooled at room temperature and 100ml of distilled water and 25ml of Na$_2$S$_2$O$_3$ were continuously added in each flask and were mixed and cooled. A few glass beads were added in each flask to prevent bumping. Then 100-120ml of 40% NaOH was added in each flask to make the solution sufficiently alkaline. The flask was immediately connected to distilling bulb on condenser. A conical flask containing 50ml of 2% H$_3$BO$_3$ with 2 drops of mixed indicator was placed under the condenser against kjeldahl flask to collect the distillate. After completion of distillation (about 100ml distillate) the collected distillates were titrated with standard HCl. The end point was indicated by light pinkish color.

Total nitrogen was calculated by using the following formula:

\[
\text{ml acid titrated} \times \text{normality of acid titrated} \times \text{milli}
\]

\[
\text{Nitrogen (\%)} = \frac{\text{equivalent wt N}^2 (0.014)}{\text{Weight of sample}} \times 100
\]

\%

% of crude protein = Nitrogen\% × 6.25

**Lipid:** Lipid content was determined by soxhlet apparatus using acetone as solvent. Accurately weigh samples (2-3g) were taken in thimbles and were dipped in pre-weighed aluminum cups with acetone. At first boiling was done for 15 minutes and then rising for 25 minutes and finally extraction was done for 10 minutes. After extraction, the aluminum cups were taken out from chamber and acetone was placed in an oven at 100°C for
30 minutes. The cups with lipid was cooled in desiccators and weighed again. The calculated value for lipid content was obtained as percent sample.

\[
\text{Lipid content (\%)} = \left( \frac{\text{Weight of lipid}}{\text{Weight of sample}} \right) \times 100
\]

**Total Volatile Base-Nitrogen (TVB-N):** For chemical evaluation of shelf-life TVB-N test was used. Total Volatile Base Nitrogen (TVB-N) was determined according to the methods given in AOAC [8] with certain modification. The following reagents were used: Perchloric acid (6%), NaOH(20%), standard HCl (0.01N), Boric acid (3%), Phenolphthalein solution and Mixed indicator. Exactly 10g of ground sample are weighed, mixed with 90ml of 6% perchloric acid and homogenized for 2 minutes with a blender. This should be done in cooled condition. 100ml of extract with 4 - 6 drop phenolphthalein is put in a kjeldahl flask after placing on the distillation on it and distillation should be continued for more or less 15 minutes. He distillate is collected in the conical flask containing 50ml of 3% boric acid and 1 drop mixed indicator. Distillation confirmed through changing in colour of mixed indicator, i.e. violate to greenish. After distillation the collected distillate was titrated with 0.01N HCl and regarding the violet colour of mixed indicator confirms the end point. The result can be calculated by the following formula:

\[
\text{TVB-N (mg/100 g sample)} = \left( \frac{\text{ml of titrant} \times 0.014 \times \text{Normality of titrant}}{\text{Weight of sample(g)}} \right) \times 100
\]

Determination of microbial load media used in this experiment are given below:

**Plate Count Agar (Hi Media):** Plate count agar was a commercial preparation (Hi media, India) that was used for enumeration of viable bacterial count in experimental sample. Accurately weighed and suspended 23.5 g of media was poured in 1000 ml distilled water and boiled to dissolve the ingredients completely. The media was then sterilized at 121°C for 15 minutes under 15 lbs/inch² pressure in an autoclave.

**Peptone Diluents (0.2%):** Peptone diluents were used as diluents in determining APC.

**Calculation of Microbial Load:** The microbial load of shrimp loaves from shrimp shell powder was calculated by using the following formula:

\[
\text{Colony Forming Unit (CFU/g)} = \frac{\text{No of colony} \times 10^n \times 10 \times \text{volume of solution}}{\text{Weight of sample}}
\]

**Quantitative Bacteriological Analysis:** Aerobic plate count (APC) was done by consecutive decimal dilution technique. Samples for the APC was accurately weighed and added with required amount of water and liquefied in a sterile blender jar and consecutive tenfold dilution were made in the test tubes. From all the dilutions spread plate cultures were made in duplicates and incubated at 35°C for 48 hours. Colonies developed on the plates were counted in a colony counter and plates having 30 to 300 colonies were selected for APC.

APC was calculated by the following formula:

\[
\text{APC/g} = C \times D \times V \times 10^S/100 \times S \ (\text{CFU/g})
\]

where, C= Number of colonies found, D= Dilution factor, S= Weight of sample in grams and CFU= Colony forming unit

**Determination of Heavy Metals:** Three commercially important marine water dried fish species were included in this investigation, the species are Chinese pomfret \( (Stromateus chinensis) \), Bombay duck \( (Harpodon nehereus) \) and Ribbon fish \( (Trichiurus haumela) \). Collected tissues were weighed by electronic balance and 5 ml of diacid mixture (5 ml concentrated HNO₃ : 3 ml 60% HClO₄) were added to each sample. The content mixed for overnight. Samples were then digested, initially at 80°C temperature and later on 150°C for 2 hours. The completion of digestion was indicated by almost colorless material. The brown fumes also cease to exist at completion of digestion. The samples were separately filtered by using an ash less filter paper and volume made up to 25 ml with 0.5% HNO₃, which prepared for the determination of arsenic, cadmium and chromium, Eboh et al. [12]. The samples were subjected to analysis by Atomic Absorption Spectrophotometer (HG-AAS, PG-990, PG Instrument Ltd. UK) at Professor Mohammad Hossain Central Laboratory, BAU, Mymensingh, followed the method of Clesceri et al. [13]. The wave length of Cd and Cu were 193.7 nm and 217 nm respectively. The concentration of Cd and Cu in fish samples were calculated by the following formula:

\[
\text{Metal concentration} = \frac{\text{ppm conc.Observed} \times \text{final volume of sample in ml}}{\text{Weight of tissues taken in g}}
\]
RESULTS AND DISCUSSION

Results of the observations of physical and organoleptic characteristics of samples of dried fishes are presented in Table 1. The quality of the dried fish products was assessed on the basis of color, odor, texture, insect infestation, presence of broken pieces and overall quality. The color of dried Chinese pomfret, Bombay duck and ribbon fish were from slightly silver to whitish color, which exhibit excellent color for the dried fish products. Texture was firm and flexible and odor was very much natural in all samples. Some insect infestation and no broken pieces were found in the products. It was observed that the flavor and color are important factors influencing the overall consumer acceptance, so the overall quality of these samples was of acceptable limit.

The result of proximate analysis (moisture, protein, lipid and ash) in wet weight basis and TVB-N content of dried Chinese pomfret, Bombay duck and Ribbon fishes are shown in Fig. 1 and 2. Moisture content of Chinese pomfret and Ribbon fishes were 19.65±0.60 % (Where highest and lowest value varies from 18.98 to 20.13 %) and 23.94±0.2% (Where highest and lowest value varies from 23.73 to 24.21%) whereas the moisture content of Bombay duck was 27.19±0.27% (Where highest and lowest value varies from 26.89 to 27.40 %). Siddique et al. [14] showed that the moisture level in the analyzed dried samples were varied from 22.22-34.99%, 20.76-32.65% and 13.81-20.50% respectively in three marine dry fishes (Harpodon nehereus, Johnius dussumieri and Lepturacanthus savala) during changes of storage period. For 2 years storing period, the moisture contents were increased by 12.77%, 11.89% and 6.69% for fishes. The findings of this study shows that the average moisture level obtained from our dry fishes are very close with the previous reports. Bhuiyan [15] observed 6.9-14.2% moisture in dried marine fishes. It shows dissimilarities from present study because the dry fish traders keep the dry fish in wet and unhygienic condition and do not control the moisture and air temperature of the warehouse. The protein content of Chinese pomfret 59.14 to 59.92 % and Ribbon fishes 53.42 to 55.08 % whereas the protein content of Bombay duck was 40.92 to 41.61%. The lowest mean value obtained from dried Bombay duck (41.28±0.35%) and the highest value from dried Chinese pomfret (60.03±0.94%) and 54.36±0.85% in Ribbon fish. Siddique et al. [14] observed that the protein level of three marine dried fishes (Harpodon nehereus, Johnius dussumieri and Lepturacanthus savala) was varied from 58.33-51.98%, 64.39-56.46% and 71.90-67.22% respectively during changes of storage period. Bhuiyan [15] observed 55.8-75.9% protein in dried fish sample (Harpodon nehereus and Johnius dussumieri respectively). A number of studies have been conducted on freshly stored dry fishes but these studies did not focus on the proximate compositions of longer time stored dried fishes. However, the findings of this study showed that the average protein level obtained from dried fishes were very close with the previous studies. The lipid content of Chinese pomfret was (11.60 to 12.25 %) and Ribbon fishes ranged from 11.33 to 11.63 whereas the Bombay duck was 10.22 to 10.61%. The lowest mean value10.48±0.22% was obtained from Bombay duck and the highest 11.92±0.33% from dried Chinese pomfret. On the other hand mean value Bombay duck was 10.48±0.22%. Siddique et al. [14] observed that the lipid level of three marine dried fishes (Harpodon nehereus, Johnius dussumieri and Lepturacanthus savala) was varied from 7.78-5.86%, 5.54-4.87% and 7.79-6.66% respectively during changes
Table 1: Organoleptic Characteristics of Dried Marine Fishes

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Color</th>
<th>Odor</th>
<th>Texture</th>
<th>Infestation</th>
<th>Broken pieces</th>
<th>Overall quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese pomfret</td>
<td>Slightly silver</td>
<td>Characteristic odor</td>
<td>Firm and elastic</td>
<td>Some infestation</td>
<td>No broken pieces</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Bombay duck</td>
<td>Whitish color</td>
<td>Characteristic odor</td>
<td>Firm and elastic</td>
<td>Some infestation</td>
<td>Some broken pieces</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Ribbon fish</td>
<td>Slightly silver</td>
<td>Characteristic odor</td>
<td>Firm and elastic</td>
<td>Some infestation</td>
<td>No broken pieces</td>
<td>Acceptable</td>
</tr>
</tbody>
</table>

Table 2: Total Aerobic Plate Count of Dried Marine Fishes

<table>
<thead>
<tr>
<th>Fish sample</th>
<th>APC(CFU/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chinese pomfret</td>
<td>3.8×10^5</td>
</tr>
<tr>
<td>Bombay duck</td>
<td>3×10^5</td>
</tr>
<tr>
<td>Ribbon fish</td>
<td>2.1×10^4</td>
</tr>
</tbody>
</table>

of storage period in 2 years. Bhuiyan [15] observed 9.21-6.84% lipid in dried marine fishes. Both of findings were less similar to the present study. The ash content of Chinese pomfret and Ribbon fishes were ranged from 7.02 to 7.38 % and 10.29 to 11.64 % whereas the ash content of Bombay duck was 19.64 to 20.31%. The lowest mean value was obtained from Chinese pomfret (7.21±0.18%) and the highest value from Bombay duck (20.06±0.36%) and also 11.05±0.69 % found from Ribbon fish. Siddique et al. [14] observed that the ash level of three marine dried fishes (Harpodon nehereus, Johnius dussumieri and Lepturacanthus savala) was varied from 7.56-4.76%, 6.37-4.89% and 4.86-4.64% respectively during changes of storage period which were dissimilar to present findings. Gheyasuddin et al. [16] found 9.98-4.56% ash in dried fishes which is in close quarters with the present investigation. Therefore, it is concluded that proximate composition of the fish is variable and dependent upon the species, size, sex and age of the fish, its geographical distribution and the season of the year.

The Total Volatile Base Nitrogen (TVB-N) content of Chinese pomfret, Bombay duck and Ribbon fish were 16.55 to 18.22, 10.55 to 12.20 and 19.56 to 20.89 mg/100g respectively in dry weight basis, where the lowest mean value obtained from Bombay duck 11.51±0.86 mg/100g and the highest value from dried Ribbon fish 20.37±0.71 mg/100g. In Chinese pomfret mean value was 17.55±0.88 mg/100g. Reza et al. [17] observed that the TVB-N content were 3.5 to 25.2, 1.9 to 8.9, 2.5 to 15.2, 3.6 to 15.6 & 5.3 to 19.0 mg/100g for silver jew fish, Bombay duck, big-eye tuna, Chinese pomfret and ribbon fish respectively. Islam [18] observed that Total Volatile Base Nitrogen (TVB-N) content of traditional dried ribbon fish, Bombay duck, big-eye tuna, silver Jew fish and Chinese pomfret ranged from 16.56-44.83 mg/100g. According to Connell [19] the upper limit of TVB-N is 30 mg/100g for fin fish dried products acceptability.

However, the findings of this study shows that’s the TVB-N content obtained from dry fishes are very close with the previous studies and it is acceptable limit.

The total aerobic plate count expressed as colony forming unit in one gram of sample (CFU/g) of the representative samples of Chinese pomfret, Bombay duck and Ribbon fish were determined by standard plate count method on plate count agar media. Bacterial load of dried products were 3.8×10^5, 3×10^5 and 2.1×10^5 CFU/g respectively with lowest value in Bombay duck and highest value in Chinese pomfret (Table 2). Reza et al. [17] observed that the aerobic plate count of dried marine fishes (silver jew fish, Bombay duck, big-eye tuna, Chinese pomfret and ribbon fish) were 1.8×10^5 to 2.6×10^5, 2.6×10^5 to 2.6×10^5, 5.4×10^4 to 6.0×10^5, 8×10^3 to 3×10^5 and 5×10^4 to 1×10^5 CFU/g respectively which is more or less similar to the values.

The results of heavy metal concentrations in Chinese pomfret was Cadmium 0.28µg/g and Copper 1.3µg/g, in Bombay duck was Cadmium 0.71µg/g and Copper 2.1µg/g and in Ribbon fish was Cadmium 0.35µg/g and Copper 4.1µg/g respectively in dry weight (Fig. 3). Kumar et al. [20] were determined the concentration of Cu and Cd as in muscle tissue of fish species collected from North East coast of India where range of Cu and Cd in fishes was 0.5-28.2 and 0.01-1.10 µg g^-1 dry wt. respectively which support to the present findings. The concentration of heavy metals was species specific and significantly different.

In the tropical region like Bangladesh, the finished sun-dried fish products are typical and its shape and structure make it almost impossible to pack well enough to prevent uptake of water and consequently some degree...
of spoilage is almost inevitable during storage. Therefore, it may be postulated that dried fish products even with low moisture content stored under no protection against high humidity can be the vehicle for most of the important types of bacteria responsible for food spoilage. It is pointless for the people engaged in artisanal fisheries to store the dried fish products in a moisture and oxygen proof package when the price of that packaging puts the elegantly wrapped products beyond the purchasing power of the consumer.

CONCLUSION

In the present investigation, the quality aspects of three species of commercially available dried fish products were evaluated by examining the physical and organoleptic properties, chemical composition, total volatile base-nitrogen (TVB-N) and total bacterial load of the samples. Organoleptically the color of dried Chinese pomfret, Bombay duck and ribbon fish were from slightly silver to whitish color, which exhibit excellent color for the dried fish products. Texture was firm and flexible and odor was very much natural in all samples. It was observed that the flavor and color are important factors influencing the overall consumer acceptance. Organoleptically it was observed that traditional dried products of both species can be stored up to 60 days in an acceptable level. The protein content of three dried fish was very high and moisture was minimum level. The lipid and ash content of these products were within the limit. Total volatile base-nitrogen (TVB-N) and the bacterial count of three dried marine fishes were also within acceptable level. So the overall quality of these samples was of acceptable limit. Heavy metal concentrations of three dried fishes were within the acceptable level for human consumption. Further studies also need to know the above parameters of commercial marine species of Bangladesh.

REFERENCES


