Vol 5 No 4 December 2024 Pages 22-29 e-ISSN 2708-5694

Journal of Agriculture, Food and Environment (JAFE)

Journal Homepage: https://journal.safebd.org/index.php/jafe

https://doi.org/10.47440/JAFE.2024.5405

Research Article

Variability in organoleptic characteristics and proximate composition of three dried fish products from Nazirartek fish drying yard under different storage temperatures

Shikha FH[1], Hossain MI[1]*, BejoyHH[1], Islam A[2], Rahman M[1], Binti NT[1], Hasan MH[1]

[1]Dept. of Fisheries Technology, Bangladesh Agricultural University, Mymensingh.
[2]Dutch Bangla Bank, Savar, Dhaka.

Article history

Received: 08 October 2024

Revised: 10 December 2024

Accepted: 21 December 2024

Published online: 31 December 2024

***Corresponding author**

Hossain MI
E-mail: ihossain.ft@bau.edu.bd

Keywords

Dried fish, Quality assessment, Ribbon fish, Bombay duck, Gangetic hairfin anchovy

How to cite: Shikha FH, Hossain MI, BejoyHH, Islam A, Rahman M, Binti NT, Hasan MH (2024). Variability in organoleptic characteristics and proximate composition of three dried fish products from Nazirartek fish drying yard under different storage temperatures. J. Agric. Food Environ. 5(4): 22-29.

A B S T R A C T

The study was conducted at the *Nazirartek* fish drying yard in Cox's Bazar, Bangladesh, to evaluate the quality parameter of three popular dried fish species—Dried Ribbon fish (*Trichiurus haumela*), Dried Bombay duck (*Harpadon nehereus*), and Dried Gangetic hairfin anchovy (*Setipina phasa*). The experiment was carried out in the Department of Fisheries Technology at Bangladesh Agricultural University to evaluate the quality parameters of the three dried fish samples. The study was also conducted to examine the impact of storage conditions on the quality retention of dried fish samples. During the sensory analysis, the dried fish samples were graded as 'A' (Excellent, highly acceptable), 'B' (Good/acceptable), and 'C' (Rejected). After six months of storage at frozen temperature (-18ºC to -20ºC), the samples retained their 'A' grade. However, at room temperature (28ºC to 32ºC), Dried Ribbon fish and Dried Bombay duck were rated to grade B, while Dried Gangetic hairfin anchovy received a grade C. The protein content of Dried Ribbon fish, Dried Bombay duck, and Dried Gangetic hairfin anchovy at collection was 59.73±1.7, 53.75±1.2, and 60.04±1.56, respectively. After six months at room temperature, these values decreased significantly to 48.24±1.78, 48.31±1.34, and 51.85±1.29, whereas storage at frozen temperatures preserved higher protein levels of 57.34±1.7, 52.72±1.2, and 57.79±1.5, respectively. Moisture content fluctuated between 24.36±0.23% and 29.45±0.84% at room temperature but remained lower in frozen storage, ranging from 19.23±0.69% to 26.29±0.45%. The findings suggest that frozen storage significantly preserves the nutritional quality and sensory characteristics of dried fish by slowing biochemical reactions and reducing nutrient degradation. It highlights the importance of frozen storage for extending shelf life and maintaining the quality of dried fish products.

INTRODUCTION

The proximate composition is very important in determining the quality, shelf life, and market value of dried fish products. The nutritional value, sensory attributes, and storage stability of dried fish are primarily influenced by its main chemical constituents, namely moisture, crude protein, lipids, and ash content. Understanding these components is essential for ensuring product quality, optimizing processing methods, and maintaining consumer acceptability Many investigators, including Rubbi *et al.* (1987), Mollah *et al.* (1998, 2000), Nurullah *et al.* (2002, 2003), Islam *et al.* (2003), Mazumder *et al.* (2008), and Flowra and Tumpa (2012), have examined the biochemical composition of fish in Bangladesh. The nutritional makeup of different dried fish products differed considerably. During the fishing ban, demand for dried fish ascends due to a scarcity of fresh fish on the market (Das *et al.*, 2013). Approximately 20% of the whole marine fish is dried annually, with substantial output occurring from October to April. This product is promoted in both national and global markets (Shamsuddoha, 2007). The distribution and consumption of fish consist of

approximately 70% fresh, 25% dehydrated, with the remaining portion comprising locally processed forms, including fermented and frozen products (Islam, 2006). Salted dehydrated fish served as an essential source of animal protein, accessible at lower prices to economically disadvantaged populations, particularly in coastal regions (Prasad *et al.*, 1999). At times, the nutritional value of dried fish is superior to that of fresh fish, as determined by its unit weight. A distinctive flavor is much preferred by people of many ethnic backgrounds. In the 2022-2023 fiscal year, Bangladesh exported 70,000 metric tons of preserved fish, valued at roughly 4,790.34 crore taka in foreign currency (DoF, 2024). Our conducted research is focused on assessing the sensory quality and proximate composition of dried fish, along with tracking the temporal variations in these parameters. The fish were collected from the Nazirartek fish drying center and preserved under various storage temperatures. The study also investigates whether storing dried fish at frozen temperatures can preserve their nutritive quality, extend shelf life, and prevent spoilage.

MATERIALS AND METHODS

Sample collection

Three of dried marine fishes are sourced from the Nazirertek fish drying yard: Bombay duck (*Harpadon nehereus*), Ribbon fish (*Trichiurus lepturus*), and Gangetic hairfin anchovy (*Setipina phasa*). Dried fish samples were securely packaged in polyethylene packets and transported to the Department of Fisheries Technology at Bangladesh Agricultural University for subsequent analysis.

Storage Condition

Two types of storage system are used after sampling. These are given below:

1) Sample packaged in several small polythene zipper bag in room temperature (28ºC to 32ºC)
2) Sample packaged in small polythene zipper bag in freezing condition (-18ºC to -20ºC)

Sensory or organoleptic assessment of dried fish

The Quality Index method was applied in the laboratory to assess the freshness of dried fish. This method is based on organoleptic attributes such as color, odor, texture, flavor, insect infestation, general appearance, and overall acceptability. The tastes of the panelists are typically considered while performing sensory evaluations on dried fish. The sensory examination utilized ten (10) trained panelists who were specifically selected. The attributes of the fish were assessed on a scale of 1 to 5 following the scoring methodology (Tables 1 and 2).

Table 1: Defect characteristics used for organoleptic quality assessment of dried fish products collected from the *Nazirartek* fish drying yard of Bangladesh

Characteristics of dried fish	Defect characters	Defect point
Color	Whitish and shiny	1
	Off white to yellowish	2
	Shining yellowish to brownish	3
	Brownish outer reddish in inner	4
	Blackish to bleached	5
Odor	Natural dried fishy odor	1
	Bland odor	2
	Slightly to moderate fishy	3
	Decomposed sour odor	4
	Extremely decomposed sour spoiled	5
Texture	Firm, tender and flexible	1
	Slightly to moderate Soft	2
	Extremely soft and slightly juicy	3
	Brittle near to broken	4
	Broken, juicy and skin raptured	5
Flavor	Natural and slight salty	1
	Slight to moderate flavor	2
	Strong and completely spoiled	5
Insect Infestation	No infestations	1
	Slightly to moderate infestation	2
	Complete infestation	5
General appearance	Excellent	1
	Good	2
	Slight to moderate good	3
	Bad	4
	Very bad	5
Total defect point		
Average defect point		

A score of average defect points below 2 is categorized as exceptional, a score ranging from 2 to less than 5 is categorized as good/acceptable, and a score of 5 or above is categorized as rejected. Aroma, hue, consistency, taste, pest infestation, overall look, and general attractiveness. A numerical grading system was developed within the quality index scheme for dried fish to assess evaluations in the categories of excellent/highly acceptable, acceptable/good, deteriorating/not acceptable, and spoiled/rejected (Jaman *et al.*, 2021).

The recommendations and techniques for the organoleptic properties of dried fish were derived from the organoleptic method (Howgate *et al.*, 1992), incorporating specific adjustments as detailed in Tables 1 and 2. The organoleptic evaluation was assessed using the following formula-

Average grade points = Total grade point/ Number of characteristics

Table 2: Grading of dried fish acceptance

Grade	Defect point	Degree of acceptance
A	<2	Excellent, highly acceptable
B	2 to <5	Good/ acceptable
C	5	Rejected

Preparation of sample

Polythene bags were used to store the dried fish samples that were collected. The packets were tightly wrapped to prevent the entry of any unwanted particles or insects. These packages were stored in a cool, dry location within the laboratory. The dried fish samples were cut into pieces with a sharp knife, dried in an oven, and subsequently ground into a powder using a mechanical grinder for chemical analysis. This ground sample was employed for additional biochemical analysis. The samples are weighed using an electric weight machine and placed in a separate container for the subsequent step. Once the sample has been measured, the kjeldhal apparatus should be used to ascertain the protein composition.

Determination of proximate compositions

The moisture, crude protein, ash, and lipid composition of fish were determined using the following Association of Official Analytical Chemists (AOAC, 2006) methods, with slight modifications as indicated below:

Moisture

The moisture content reflects the entire water quantity in the sample, ascertained by evaluating the weight variations before and after drying in an oven at 105°C for 24 hours. Each sample was allocated an unoccupied porcelain crucible, and its mass was measured using an electronic balance and recorded. A sample of roughly 2-3 grammes was transferred to a porcelain crucible using the same balance and then subjected to a hot air oven at 105°C for 24 hours. The sample was carefully retrieved from the crucible with specialised forceps and placed in a desiccator for around 15 minutes to cool. The mass of the crucible containing the sample was subsequently measured again.

The moisture content percentage in the sample was calculated using the subsequent formula:

Moisture content = (Y-Z)/S x 100

Were,

S= sample weight

Y= Sample + crucible weight

Z= Dry sample + crucible weight

The loss of moisture was calculated as percent moisture using following formula-

$$\text{Moisture content (\%)} = \frac{\text{Weight of wet material} - \text{weight of dry meterial}}{\text{Weight of wet material}} \text{x100}$$

Ash

The following methods were utilized in order to ascertain the amount of ash present: An electronic balance was used to weigh empty porcelain crucibles, and three replication crucibles were made for each sample. The crucibles were labeled by the researchers. Using an electronic balance, the amount of sample that was contained in each crucible was around two to three grams. Next, the crucibles were heated to 550 degrees Celsius in a muffle furnace for a period of six hours. After six hours, the muffle furnace was turned off so that it could take a break for the night. The door of the muffle furnace was opened once it had cooled down, and a spatula was used to carefully remove the crucibles from the furnace. Two independent electronic balances were used to perform the weighing of each of the samples. Data was organized in a table, and the percentage of ash content was calculated by applying the following formula to the data:

Percent (%) of Ash content = (Dry sample + crucible) – empty crucible/Weight of sample x 100

The ash content was calculated by using the following formula-

$$\text{Ash content (\%)} = \frac{\text{Weight od ash}}{\text{Weight of samples}} \text{ x 100}$$

Crude Protein

Crude protein was quantified using the classic micro-Kjeldahl nitrogen method, with a Behrosetinkje M digestion apparatus and a Behr S I steam distillation apparatus obtained from Technique GmbH in Düsseldorf, Germany. The ammonia-containing distillate was collected in a 4% boric acid solution before being titrated with 0.2N HCl. Crude protein was calculated by multiplying the nitrogen content of animal and plant sources by a factor of 6.25 and 5.85, respectively. Titration data were accurately documented for each sample, and crude protein concentration was calculated using the following formula:

% Of Nitrogen = [Mili equivalent of N_2 x Strength of HCI x Titrant used (ml)]/Weight of sample (gm) x 100

Where,

Milliequivalent of N_2 = 0.014

Strength of HCI = 0.2N

Percent (%) of crude protein = % Of Nitrogen x Conversion factor (6.25 for animal-based sample)

Lipid

The Crude Lipid (CL) or fat content was determined by drying samples in an oven at 105°C and extracting the fat with acetone in a Soxhlet extractor for 4 hours.

Approximately 2-3 grams of the sample are weighed on an electronic balance and then placed in a paper thimble. The paper thimbles were kept in the primary chamber of the Soxhlet device. Acetone (150-180 ml) was poured to the ground joint round-bottom flask, which was then heated to 70°C. A constant supply of tap water was kept in the condenser to regulate the temperature and encourage the condensation of acetone vapour into liquid form. Acetone evaporated when heated and was allowed to drip gently after condensing on the sample inside the paper thimble. Acetone was slowly added into the cavity until the lipid/fat solvent was extracted from the ground joint round bottom flask. The lipid-containing solvent was placed in pre-weighed, clean, and dry glass beakers, which were then weighed. The extract-filled beakers were then baked in an oven to allow the acetone to evaporate. The beakers were then placed in desiccators to cool. The weights of the beakers containing the samples were measured on the same electronic balance.

The crude lipid content of the sample was determined using the following formula:

Percent (%) of crude Lipid content = (D – B)/A x 100

Where,

D = Weight of crude

B=Empty beaker weight

A = weight sample

The lipid content was calculated by using the following formula:

$$\text{Lipid content (\%)} = \frac{\text{Weight of lipid}}{\text{Weight of sample}} \times 100$$

Statistical analysis of experimental data

The data that was gathered in the local unit was transformed into a standard unit in order to reduce the number of errors that occurred. After that, the data was grouped into a table and then sent to a computer. The 2019 version of Microsoft Excel was used for all of the computations.

RESULTS & DISCUSSION

Organoleptic assessment of three dried fish samples

The results of the organoleptic quality assessment for three different dried fishes preserved under three varying conditions are presented in Tables 3 and 4. The evaluation of dried fish products was conducted based on parameters such as color, odor, texture, insect infestation, the presence of broken pieces, and overall quality. Upon consideration of the defect point, the products were classified as "A," "B," and "C," representing excellent, highly acceptable, good/acceptable, and rejected, respectively. Ribbon fish, Bombay duck, and Gangetic hairfin anchovy achieved a grade of "A" at the zero-month mark of the experiment, as indicated by Tables 3 and 4. The degree of acceptance is "excellent or highly acceptable" and the number of defect points is less than 2. Grade "A" is indicative of this. Most of the samples were rated "excellent" by Imtiaz *et al.* (2017), but some were only rated "good" because they had broken pieces of salt and turmeric-treated dried ribbon fish, insects, and great color, smell, and texture. After six months of storage at room temperature (28ºC to 32ºC), Ribbon fish and Bombay duck were rated as "B" and Gangetic hairfin anchovy as "C" in Tables 3. The degree of acceptance is "good or acceptable" and the defect points are 2 to <5. That is the grade "B." Grade "C" indicates that there are five defect marks and that the degree of acceptance is "rejected." Haque *et al.* (2013) and Jaman *et al.* (2021) observed that the conventional sun-dried fish samples obtained had a color gradient ranging from silvery to white, encompassing a diverse array of species.

Furthermore, all goods demonstrated a durable and flexible quality. No damaged components were identified. The overall quality of all products from the producer was satisfactory; nevertheless, the cumulative color scores were not especially appealing. Quality of the identical products procured from the wholesale market was significantly diminished. Compared to the original products, the color and texture of the products deteriorated as a result of being stored for 5 to 7 months. A mildly acidic to sour odor was observed in several products. A significant number of them were often subjected to infestations by flies, various insects, as well as their eggs and larvae.

Table 3: Change in organoleptic properties of Dried Ribbon fish, Dried Bombay duck and Dried Gangetic hairfin anchovy based on defect characteristics during 6 months of storage at room temperature (28°C to 32°C)

Characteristics of dried fish	Months						
	Dried Ribbon fish						
	0	**1**	**2**	**3**	**4**	**5**	**6**
Color	2	2	2	3	3	4	4
Odor	1	1	1	3	3	4	4
Texture	1	1	1	1	2	2	2
Flavor	2	2	2	2	5	5	5
Insect infestation	1	1	1	1	1	1	1
General appearance	2	2	3	3	3	3	5
ΣDP	9	10	11	13	17	19	21
	Dried Bombay duck						
	0	**1**	**2**	**3**	**4**	**5**	**6**
Color	1	1	1	2	2	3	3
Odor	1	1	2	2	3	3	4
Texture	1	1	2	2	2	2	4
Flavor	2	2	2	2	5	5	5
Insect infestation	1	1	1	1	1	1	1
General appearance	1	2	2	3	3	4	4
ΣDP	7	8	10	12	16	18	20
	Dried Gangetic hairfin anchovy						
	0	**1**	**2**	**3**	**4**	**5**	**6**
Color	1	1	2	2	4	5	5
Odor	1	2	2	3	4	4	5
Texture	1	1	1	2	3	4	5
Flavor	2	2	2	2	5	5	5
Insect infestation	1	1	2	3	3	4	5
General appearance	1	2	2	3	3	4	5
ΣDP	7	9	11	15	22	26	30

A few of the products were observed to have broken fragments. According to Relekar *et al.* (2014), dried ribbon fish with a firm texture, slight dry fishy odor, slight yellow-brown discoloration, and a stale appearance were rated as "moderately good" in terms of overall acceptability. Furthermore, the evaluations associated with appearance, color, taste, odor, texture, and overall satisfaction were found satisfactory.

Table 4 demonstrated that Ribbon fish, Bombay duck, and Gangetic hairfin anchovy achieved a grade of "A" after being stored at a frigid temperature of -18ºC to -20ºC for six months. Grades of "A" indicate that the degree of acceptance is "excellent or highly acceptable" and that the number of defect points is less than 2. A comparative analysis of sensory quality between Table 3 & 4 revealed that the samples stored at frozen temperature (-18ºC to -20ºC) achieved a superior result compared to those stored at room temperature (28ºC to 32ºC). This suggests that low-temperature storage of dried fish products has a beneficial effect.

Table 4: Change in organoleptic properties of Dried Ribbon fish, Dried Bombay duck and Dried Gangetic hairfin anchovy based on defect characteristics during 6 months of storage at refrigeration temperature (-18ºC to -20ºC)

Characteristics of dried fish	Months						
	Dried Ribbon fish						
	0	**1**	**2**	**3**	**4**	**5**	**6**
Color	2	2	2	2	2	2	2
Odor	1	1	1	1	1	1	1
Texture	1	1	1	1	1	1	1
Flavor	2	2	2	2	2	2	2
Insect infestation	1	1	1	1	1	1	1
General appearance	2	2	2	2	2	2	2
ΣDP	9	9	9	9	9	9	9
	Dried Bombay duck						
	0	**1**	**2**	**3**	**4**	**5**	**6**
Color	1	1	1	1	1	1	1
Odor	1	1	1	1	1	1	1
Texture	1	1	1	1	1	1	1
Flavor	2	2	2	2	2	2	2
Insect infestation	1	1	1	1	1	1	1
General appearance	1	1	1	1	1	1	1
ΣDP	7	7	7	7	7	7	7
	Dried Gangetic hairfin anchovy						
	0	**1**	**2**	**3**	**4**	**5**	**6**
Color	1	1	1	1	1	1	1
Odor	1	1	1	1	1	1	1
Texture	1	1	1	1	1	1	1
Flavor	2	2	2	2	2	2	2
Insect infestation	1	1	1	1	1	1	1
General appearance	1	1	1	1	1	1	1
ΣDP	7	7	7	7	7	7	7

Proximate analysis of three samples under different storage conditions

Proximate analysis is a quantitative method that is used to ascertain the percentage of protein, ash, fiber, carbohydrate, lipid, and moisture in desiccated fish. The nutritional profile of the dried fish sample is indicated by the proximity analysis. The findings of the proximate analysis conducted in the present study show a range of variations in response to the different storage conditions of the samples under analysis. Tables 5 and 6 present an in-depth analysis of the alterations in proximate composition observed in three dried fish samples subjected to storage at room temperature (ranging from 28℃ to 32℃) and at frozen storage temperatures (between -18℃ and -20℃). The percent protein content of the three dried fishes ranged from 53.75±1.2 to 60.04±1.56, while the percent lipid content varied from 5.28±0.29 to 10.23±0.34. Table 5 also demonstrates that the percent ash content of three distinct dried fishes varied from 10.2±0.09 to 11.49±0.08, and the percent moisture content ranged from 18.49±0.69 to 21.48±0.45 at the outset of the experiment. The high protein content of dried fish immediately following collection is indicative of their excellent condition. The moisture, lipid, and ash content were also satisfactory. Siddique *et al.* (2011) demonstrated that the moisture level in the dried samples analyzed in three marine dry fish species (*Harpodon nehereus*, *Johnius dussumieri*, and *Lepturacanthus savala*) varied from 22.22-34.99%, 20.76-32.65%, and 13.81-20.50%, respectively, during variations in storage period over a two-year period. The lipid content of Chinese pomfret was found to be between 11.60% and 12.25%. In contrast, ribbon fishes revealed lipid levels ranging from 11.33% to 11.63%. Additionally, the Bombay duck show a lipid content that varied from 10.22% to 10.61%, as reported by Pravakar *et al.* (2013). Bombay duck yielded the lowest mean value of 10.48±0.22%, while preserved Chinese pomfret yielded the highest mean value of 11.92±0.33%. Relekar *et al.* (2014) discovered that the biochemical quality of Ribbon fish dried using improved procedures was as follows: The composition includes a moisture content of 75.66%, a crude protein content of 17.66%, a fat content of 2.08%, and an ash content of 0.76%. According to the findings presented by Jamil *et al.* (2017), the protein content of sun-dried Bombay duck was determined to be 32.21±1.05 %, while that of Ribbon fish was found to be 31.64±1.28 %, respectively. Hossain *et al.* (2017) identified in their study that the ash content percentage of Silver Pomfret was measured at 15.75±0.39, while that of Perch was found to be 11.50±0.26. However, the content of protein, lipid, ash, and moisture found in the subsequent study exhibits comparability to the findings previously discussed.

Table 5: Changes in crude protein and crude lipid content of Dried Ribbon fish, Dried Bombay duck and Dried Gangetic hairfin anchovy during 6 months of storage at room (28ºC to 32ºC) and refrigeration temperature (-18ºC to -20ºC)

Period (month)	Ribbon fish		Bombay duck		Gangetic hairfin anchovy	
	28°C to 32°C	**-18°C to -20°C**	**28°C to 32°C**	**-18°C to -20°C**	**28°C to 32°C**	**-18°C to -20°C**
	Changes in crude protein content					
0	59.73±1.70	59.73±1.70	53.75±1.20	53.75±1.20	60.04±1.56	60.04±1.56
1	58.59±0.38	59.49±0.22	53.12±1.28	53.59±1.32	58.87±1.34	59.82±1.46
2	57.08±0.32	59.02±0.87	52.41±0.23	53.44±0.36	57.28±1.27	59.62±1.21
3	55.29±1.49	58.89±1.32	51.89±0.93	53.56±0.64	55.65±1.32	59.29±1.41
4	53.03±0.43	58.53±1.56	51.12±1.23	53.35±0.74	54.18±1.27	58.98±1.54
5	51.78±1.28	58.18±0.78	50.45±1.34	53.13±0.34	53.12±1.54	58.48±1.64
6	48.24±1.78	57.34±1.70	48.31±1.34	52.72±1.20	51.85±1.29	57.79±1.50
	Changes in crude lipid content					
0	8.11±0.58	8.11±0.58	10.23±0.34	10.23±0.34	5.28±0.29	5.28±0.29
1	8.09±0.78	8.10±0.52	10.11±0.26	10.22±0.32	5.27±0.20	5.27±0.23
2	8.06±0.28	8.09±0.43	10.05±0.43	10.21±0.34	5.25±0.23	5.26±0.20
3	8..03±0.93	8.08±0.44	9.91±0.23	10.19±0.31	5.24±0.22	5.25±0.26
4	7.98±0.34	8.06±.0.33	9.79±0.27	10.18±0.32	5.20±0.28	5.21±0.24
5	7.95±0.75	8.03±0.07	9.65±0,75	10.17±0.34	5.16±0.20	5.18±0.22
6	7.91±0.57	8.00±0.58	9.47±0.84	10.15±0.30	5.09±0.22	5.13±0.29

Table 6: Changes in moisture and ash content of dried Ribbon fish, dried Bombay duck and dried Gangetic hairfin anchovy during 6 months of storage at room (28ºC to 32ºC) and refrigeration temperature (-18ºC to -20ºC)

Period (month)	Ribbon fish		Bombay duck		Gangetic hairfin anchovy	
	28°C to 32°C	-18ºC to -20ºC	28°C to 32°C	-18ºC to -20ºC	28°C to 32°C	-18ºC to -20ºC
Changes in moisture content						
0	18.49±0.69	18.49±0.69	19.63±0.34	19.63±0.34	21.48±0.45	21.48±0.45
1	18.95±0.43	18.55±0.69	20.04±0.22	19.92±0.34	22.57±0.22	21.73±0.45
2	19.56±0.22	18.68±0.69	20.64±0.15	20.15±0.34	23.79±0.34	22.67±0.45
3	20.61±0.34	18.80±0.69	21.26±0.22	20.47±0.34	24.96±0.23	23.64±0.45
4	21.55±0.42	18.92±0.69	22.47±0.34	20.72±0.34	26.67±0.45	24.45±0.45
5	22.98±0.34	19.05±0.69	23.53±0.35	21.08±0.34	27.87±0.30	24.23±0.45
6	24.36±0.23	19.23±0.69	24.78±0.47	21.45±0.34	29.45±0.84	26.29±0.45
Changes in ash content						
0	11.49±0.08	11.49±0.08	10.70±0.06	10.70±0.06	10.20±0.09	10.20±0.09
1	11.46±0.06	11.41±0.08	10.59±0.05	10.62±0.03	10.17±0.07	10.20±0.09
2	11.42±0.06	11.33±0.08	10.49±0.03	10.53±0.05	10.15±0.06	10.20±0.08
3	11.37±0.08	11.26±0.08	10.38±0.05	10.41±0.04	10.11±0.03	10.20±0.08
4	11.31±0.07	11.16±0.08	10.23±0.03	10.36±0.06	10.06±0.05	10.20±0.08
5	11.27±0.08	11.09±0.08	10.07±0.04	10.27±0.04	10.03±0.04	10.20±0.07

Tables 5 and 6 clearly illustrate that the percentage of protein content in the three dried fish samples ranged from 48.24±1.78 to 51.85±1.29 following a storage period of six months at room temperature. In addition, the percentage of lipid content showed variation, ranging from 5.09±0.22 to 9.47±0.84. The ash content observed in the three dried fish samples revealed a variation from 9.92±0.02 to 10.23±0.07, while the percentage of moisture content fluctuated between 24.36±0.23 and 29.45±0.84. The dried fish that were preserved at room temperature for six months contained a significant amount of moisture. Nevertheless, there was a reduction observed in the percentages of protein, lipid, and ash content. Siddique and Aktar (2011) found that there was a significant increase in the mean percentage of moisture content as the duration of storage was extended. During the two-year storage period, the moisture content of the three dried fish species—*Harpodon nehereus*, *Johnius dussumieri*, and *Lepturacanthus savala*—exhibits increase of 12.77%, 11.89%, and 6.69%, respectively. The findings of this investigation further reveal that the average percentages of protein (6.35, 7.93, and 4.68), lipid (1.92, 0.67, and 1.13), and carbohydrate (1.70, 1.81, and 0.66) in the three desiccated fish exhibited a significant decline throughout a two-year storage duration. In contrast, the percentage of protein content in three varieties of dried fish ranged from 52.72±1.20 to 57.79±1.50 throughout the duration of the frozen storage period, whereas the percentage of lipid content fluctuated between 5.13±0.29 and 10.15±0.3. Table 3.4 also demonstrates that the percent ash content of three distinct dried fishes ranged from 9.90±0.09 to 11±0.08 and the percent moisture content from 19.23±0.69 to 26.29±0.45. A substantial quantity of protein was present in the desiccated fish during the collection process, which serves as an indicator of the sample's freshness. The percentages of moisture, lipid, and ash content were likewise found to be elevated. The proximate composition of the specimens stored at room temperature and frozen storage temperature was compared, and it was determined that the samples stored at frozen temperature (-18ºC to -20ºC) possessed superior nutritive quality compared to the samples stored at room temperature (28ºC to 32ºC). This occurred due to the fact that the rate of biochemical reaction and nutrient degradation is significantly slower at frozen storage temperatures than at room temperature, which allows for the preservation of the nutritional quality of dried fish.

CONCLUSION

The variations observed in the findings related to organoleptic characteristics and proximate composition analysis of dried fish samples subjected to various storage temperatures show the critical role that low temperature preservation plays in ensuring both the organoleptic properties and the nutritional compositions of dried fish products. Where frozen storage temperature considerably reduced the changes in crude protein, crude lipid, moisture and ash content from storage room temperature. In the dried fish samples kept frozen rather than room temperature, the percentages of protein and fat content are pretty acceptable. These findings lead one to believe that frozen condition storage of dried fish extends its lifetime.

Conflict of interest

The authors affirm that there are no conflicts of interest that could be perceived as compromising the impartiality of the study presented.

REFERENCES

AOAC 2006: Official Methods of Analysis. 18th Edition, Association of Official Analytical Chemists, Washington DC.

Cox JR 1992: DDT Residues in Dried Fish. Bangladesh Analytical Report, NRI Report.

Das A, Upadhyay AD, Kumar NR, Prakash S, Debnath B, Datta M 2013: Marketing profile of selected fish markets of Tripura. *Agricultural Economics Research Review*. **26**(1) 15120.

DoF 2024: Yearbook of Fisheries Statistics of Bangladesh 2022-23. Fisheries Resources Survey System (FRSS), Department of Fisheries. Bangladesh: Ministry of Fisheries and Livestock, 160p.

FAO 1982: Food and Agriculture Organization of Rome. Manual to codes of practices for fish and fishery products.

Faruque MO, Nazrul KS, Tonny US, Islam KR, Dey SC, Mona SJ, Saha D 2012: Status of an ideal dry fish market of Bangladesh: A study on Asadganj dry fish market, Chittagong. *International Journal of Life Sciences Biotechnology and Pharma Research*. **1** 214-225.

Flowra FA, Tumpa AS, Islam MT 2012: Biochemical analysis of five dried fish species of Bangladesh. *University Journal of Zoology, Rajshahi University*. **31** 09-11.

Food and Agriculture Organization of the United Nations. Rome. FAO, *Fisheries Technical Paper*. pp: 444.

FRSS 2016: Fisheries Resources Survey System (FRSS), Fisheries Statistical Report of Bangladesh. Department of Fisheries. **32** 1-57

Geetha S, Govinda Rao V, Muddula Krishna N, Ram Sai Reddy N, Ramesh Babu K 2014: Some Aspects of Biochemical and Microbial Analysis of Sun Dry Fish *Trichiurus Lepturus* Linnaeus, 1758 from the East Coast Off Visakhapatnam. *International Journal of Advanced Biological Research*. **4** 462-465.

Ghose B 2014: Fisheries and aquaculture in Bangladesh: Challenges and opportunities. *Annals of Aquaculture and Research.* **1**(1) 1-5.

Haque E, Kamruz zaman M, Islam MS, Sarwar T, Rahman SS, and Karim MR 2013: Assessment and comparison of quality of solar tunnel dried Bombay duck and Silver pomfret with traditional sun-dried samples. *International Journal of Nutrition and Food Sciences*. **2** 187-195.

Hoque MM, Rayhan A, Uddin KB and Sarker SK 2018: Qualitative assessment of improved traditional fish drying practices in Cox's Bazar. *International Journal of Natural and Social Sciences*. **5**(3) 30-36.

Hossain MN, Jamil MGM, Mia MM, Uddin MN, Mansur MA 2017: Studies on the Proximate Composition, Quality and Heavy Metal Concentration of two Sun Dried Marine Fish (Sun-Dried Silver Pomfret and Sun-Dried Perch) of Cox‟s Bazar District of Bangladesh. *Journal of Environmental Science and Natural Resources*. **10** 25-32.

Howgate PA, Johnson P, and Whittle KJ 1992: Multilingual Guide to EC freshness grades for fishery products. Torry Research Station, Aberdeen. Food Safety Directorate, Ministry of Agriculture, Fisheries and Food, UK. pp: 9.

Huss HH, Ababouch L, Gram, L 2003: Assessment and Management of Seafood Safety and Quality. pp: 239.

Imtiaz MM, Haque SA, Sarker MR, Mufty MM, Ali MM, Parvez MS, Reza MS, Bhuyan MS, Rahman MA 2017: Quality Assessment of Improved Sun-Dried Ribbon Fish (*Trichiurus haumela*) by Salt and Turmeric Powder Treatment. *International Journal of Advances in Chemical Engineering and Biological Sciences*. **4**(1) 162-167.

Islam MA, Hossain BBM, Bhuiyan AS, Absar N 2003: Biochemical composition and nutritional value of *Cirrhina reba* (Hamilton-1822) of Bangladesh. *J. Bio-Sci.* **11** 127-130.

Islam MR 2006: Managing Diverse Land Uses in Coastal Bangladesh: Institutional Approaches. In: CT Hoanh, TP Tuong, JW Growing, B Hardy (Editors) Environment and Livelihoods in Tropical Coastal Zones. pp. 237-248, CAB International.

Islam MS, Akterruzzaman M, Ahmed N 2006: Study on marketing and value chain of some commercially important coastal and marine aquatic products of Bangladesh. Research report, Bangladesh Fisheries Research Forum, Dhaka, Bangladesh.

Islam MT, Ahmed S, Sultana MA, Tumpa AS, Flowra FA 2013: Nutritional and food quality assessment of dried fishes in Singra upazila under natore district of Bangladesh. *Trends in fisheries research*. **2** 2319-4758.

Islam MT, Kamal M, Islam MN, Neazuddin M, Mehbub MF 2006: Organoleptic, biochemical and bacteriological aspects of the low-cost tunnel dried fish products. *Bangladesh Journal of Fisheries Research*.**10** 175-183.

Jaman MN, Hoque MS, Yeasmin F, Hasan MM, Ripon MAS, Akter A, Jhumur MA 2021: Comparative assessment of dried fish quality collected from market and drying centre at Kuakata in Patuakhali, Bangladesh. *Bangladesh Journal of Fisheries*, **33**(1), 137-146.

Jamil MGM, Hossain MN, Mia MM, Mansur MA, Uga S 2017: Studies on the Proximate Composition, Quality and Heavy Metal Concentration of Sundried Bombay Duck and Sun-dried Ribbon Fish of Cox's Bazar District of Bangladesh. *J. Environ. Sci. & Natural Resources*. **10**(1) 55-60.

Khan MAA 1992: Study on dry fish (marine) with special reference to insect infestation, use of health hazard insecticides and control effect of pirimiphos methyl. MS thesis, Institute of Marine Sciences, University of Chittagong.

Khan MAA, Khan YSA 2001: Insect's infestation and preventive measures in dry fish storage of Chittagong, Bangladesh. *Journal of Biological Sciences*. **1** 963-965.

Kleih U, Alam K, Dastidar R, Dutta U, Oudwater N, Ward A 2003: Livelihoods in Coastal Fishing Communities, and the Marine Fish Marketing System of Bangladesh. NRI Report No. 2712. Greenwich University, Natural Resources Institute, London

Lilabati H, Vishwanath W, Singh M 1999: Changes in bacterial and fungal quality during storage, Esomus danricus of Manipur. Fishery Technology. **36** 36 - 39.

Majumdar BC, Afrin F, Rasul M, Khan M, and Shah AKM 2017: Comparative study of physical, chemical, microbiological and sensory aspects of some sun-dried fishes in Bangladesh. *Brazilian Journal of Biological Sciences*. **4** 323-331.

Mansur MA, Rahman S, Khan MNA, Reza MS, Uga S 2013: Study on the quality and safety aspect of three sun-dried fish. *African Journal of Agricultural Research*. **8** 5149-5155.

Martins AM 1994: Fisheries processing: Biochemical applications. Published by Chapman and Hall, London. pp. 1-88.

Mazumder MSA, Rahman MM, Ahmed ATA, Begum M, Hossain MA 2008: Proximate composition of some indigenous fish species in Bangladesh. *Int. J. Sustain Crop Prod*. **3**(4) 18-23.

Mollah AH, Hasan F, Azad TMA, Salam SMA, Alam MT 2000: Biochemical and nutritional status of *Eutropichtys vacha* (Ham-Buchanan). *J. Bio. Sci*. **8** 23-26

Mollah AH, Rahman MS, Alam MT 1998: Study of proximate chemical analysis of Bangladeshi freshwater fish *Rita rita* (Ham.) and seasonal variation of lipid, protein and related substances. *Univ.j. zool. Rajshahi Univ*. **17** 1-6.

Nowsad AKMA 2005: Low-cost Processing of Fish in Coastal Bangladesh. BGD/97/017 Field Doc: 05/2005. Food and Agriculture Organization of the United Nations. Dhaka. pp.73.

Nowsad AKMA 2007: Participatory Training of Trainers: A New Approach Applied in Fish Processing. pp. 329.

Nurullah M, Kamal M,Islam MN, Ahasan CT, Thilsted SH 2007: Shelf life of dried products from small indigenous fish species under various packing and storage conditions. *Bangladesh. Fish. Res*., **11**(2) 229-236.

Nurullah M, Saha SC, Kamal M, Wahab MA 2002: Nutritional values of traditional dried products of freshwater small indigenous fish species of Bangladesh. *Bull. Fac. Edu., Ibaraki Univ (Nat. Sci).* pp. 75-86.

Nurullah M, Saha SC, Kamal M, Wahab MA, Islam MN, Ahsan CT, Thilsted SH 2003: Nutritional quality of some small indigenous fish species of Bangladesh. In: (MA Wahab, SH Thilsted and ME Hoq Editors) Small indigenous fish species of Bangladesh. Bangladesh Agricultural University, Mymenshing, Bangladesh. pp. 151-158

Patterson J, Ranjitha G 2009: Qualities of commercially and experimentally sun-dried fin fish, Scomberoides tol. *Afr. J. Food Sci*. **3** 299-302.

Paul CP, Reza SM Md, Islam NM, Kamal M 2018: Quality Assessment of Traditionally Dried Marine Fish of Bangladesh. *Asian Food Science Journal*. **5**(1) 1-11.

Prabhakaran N, Gupta R 1990: Handling, processing and marketing of tropical fish, Fishery Technology. **27**: 66-69.

Prasad MM, Gopakumar K, Seenayaa G 1999. Major microbial points (MMP) in halobacterial contamination of fish curing environments of Andhra coast, India, *Indian J. Fisheries* **46**(3): 227-236.

Pravakar P, Mansur MA, and M Asadujjaman 2013: Quality and Safety Aspects of Three SunDried Marine Fish Species: Chinese Pomfret (*Stromateus chinensis*), Bombay duck (*Harpodon nehereus*) and Ribbon Fish (*Trichiurus haumela*). *World Journal of Zoology*. **8**(4) 381-387.

Prescott LM, Harry JP, Klein DA 1999: Food and Industrial Microbiology: Chapter 43, 4th Edition, Mc Graw Hill publication, New york.

Relekar SS, Joshi SA, Gore SB, Kulkarni AK 2014: Effect of improved drying methods on biochemical and microbiological quality of dried small head ribbon fish (*Lepturacanthus savala*). *International Journal of fisheries and Aquatic studies*. **1**(5) 60-66.

Reza MS, BAPARY M, Islam MN, Kamal MD 2009: Optimization of marine fish drying using solar tunnel dryer. *Journal of food processing and preservation.* **33** 47-59.

Reza MS, Bapary MAJ, Azimuddin KM, Nurullah M, Kamal M 2005: Studies on the traditional drying activities of commercially important marine fish species in Bangladesh. *Pakistan Journal of Biological Science*. **8** 1303-1310.

Reza MS, Bapary MAJ, Islam MN, Kamal M 2008: Optimization of marine fish drying using solar tunnel dryer. *Journal Food Processing and Preservation*. **33** 47-59.

Rubbi SF, Muzibar M, Khan AR, Jahan SS, Majeda B 1987: Proximate composition and quality of some commercial species of fresh water fishes. *Bangladesh J. Sci. Res*. **5**(1) 1-20.

Saha SC 1999: Studies on production, marketing and nutritional aspects of traditional dried products of Bangladesh. MS thesis, Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh, Bangladesh. pp. 62.

Shamsuddoha M 2007: Supply and Value Chain Analysis in the Marketing of Marine Dried Fish in Bangladesh and Non-Tariff Measures (NTMs) in International Trading. 10th Seminar of the EAAE, Pro-poor Development in Low Income Countries: Food, Agriculture, Trade, and Environment. pp. 25-27.

Shamsuzzaman MM, Islam MM, Tania NJ, Abdullah Al-Mamun M, Barman PP, Xu X 2017: Fisheries Resources of Bangladesh: Present Status and Future Direction. *Aquaculture and Fisheries*. **2**(4) 145–156.

Siddique MAM, Aktar M 2011: Changes of nutritional value of three marine dry fishes (*Johnius dussumieri*, *Harpodon nehereus* and *Lepturacanthus savala*) during storage. *Food and Nutrition Sciences*. **2** 1082.

Undeland I, Hall G, Lingnert H 1999: Lipid oxidation in fillets of herring (Clupea harengus) during ice storage. *Journal of Agricultural and Food Chemistry*. **47** 524-532.

Valsan AP, Nambiar VN, Damle SD, Garg DK, Iyer TSG 1985: Quality of dry non-penaeid prawn of Bombay markets. In: Harvest and Post-harvest Technology of fish. pp. 661-664.

Ward AR 1992: Report on a visit to Bangladesh to investigate the use of DDT on dried fish. NRI Report R1835.