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Research Article

Nutritional comparison of experimentally and commercially sun-dried lean fish and small prawns of Bangladesh

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Abstract

Nutritional compositions (protein, ash, moisture, fat, energy and carbohydrate) of experimentally and commercially sun-dried fish items of Bangladesh, namely Punti (*Puntius sophore*), Mola (*Amblypharyngodon mola*), Chanda (*Chanda nama*), Phasa (*Setipinna phasa*) and small Prawn (*Macrobrachium rosenbergii*) were explored in this study. All the experiments were performed following standard AOAC methods. The moisture contents of both experimentally and commercially dried fish varieties were within the acceptable limit, ranging from 10.30±0.09% to 16.83±0.08% and 10.25±0.14% to 17.50±0.15%, respectively. Notable protein contents were found in the dried fish items ranging from 59.13±0.22% to 72.02±0.06% in experimentally dried and 56.74±0.09% to 65.17±0.04% in commercially dried samples. The ash contents varied from 10.05±0.03% to 17.68±0.04% in experimentally dried fish items, which ranged from 12.40±0.02% to 15.70±0.43% in commercially dried items. Overall, experimentally dried fish products were found to be nutritionally superior compared to commercially dried products. Therefore, the study recommends experimental method over commercial method to produce dry fish products, which is more hygienic and ensures maximum retention of nutritional qualities of the fresh fishes.

1. Introduction

In the fisheries sector of Bangladesh, there has been a dramatic increase in the production of inland and marine fish over the last four decades, from only 0.75 million metric tons in 1983-84 to 4.6 million metric tons in 2020-21, indicating the country's self-sufficiency in this sector [1]. The GDP growth in the fisheries sector is 2.08 percent and in the fiscal year 2021-22, this sector shared more than one-fifth of the overall agricultural GDP of Bangladesh [2]. An average Bangladeshi individual consumes about 63 g of fish per day against the recommended 60 g and obtains about 18% of daily total protein intake from fish, which is the second highest contributor to protein intake next to cereals [3].

Drying is the commonest traditional method of processing to preserve fresh fish from deterioration

and keep it edible for a desirable period of time [4]. Dry fish is a healthy food choice in the diet list of Bangladeshi people as a cheaper source of concentrated (up to 80%) high-quality animal protein. Besides, minerals such as iron, iodine, zinc, copper, calcium, phosphorus and magnesium are abundant in dry fish contributing significantly to our daily requirements for these nutrients [5-10]. Alongside providing ample amounts of such nutrients of public health importance, dry fish also contributes substantially to the export economy of Bangladesh; in 2019-20, Bangladesh earned around US$ 7 million (1 US$ = 80.59 Bangladeshi Taka) by exporting 4141.5 metric tons of dry fish of various types, which is the highest earnings from exporting dry fish in the last couple of decades [11].

Among the practiced methods, sun drying is the earliest method for dehydrating fresh fish in order to obtain species wise diversified flavors and textures which possess high commercial value. In Bangladesh, marine fish species are sun-dried in the coastal regions of high humidity and high temperature directly in open-air facilities, which are marketed for trading throughout the country [4, 12]. However, the majority of traditionally sun-dried commercial fish products do not get satisfactory consumer reviews in terms of sanitary and organoleptic qualities because of poor hygienic and maintenance practices [13]. Moreover, prolonged storage of improperly dried fish is reported to reconstitute moisture, leading to health hazardous microbial contamination, developing off-flavor due to hydrolysis of lipids and thus loss of nutritional values [14-15]. In addition, the illegal use of unauthorized insecticides and the use of permitted insecticides at harmful excessive levels by the processors pose long-term threats to consumers' health [16].

In order for maximum retention of nutritional values of fresh fish, proper drying with minimum mechanical and chemical processing is important, which would be cost-effective as well as safe for human health. Considering this, in the present experiment, minimally and hygienically treated sun-dried fishes were compared nutritionally with the same fish varieties dried commercially.

2. Materials and methods

2.1. Collection of samples

Four different species of lean fish and prawns (Table 1), both fresh and dried, were collected from different fish markets of Dhaka city. All of the fish samples (10 samples for each species) were collected at their highest level of freshness and transferred to the Fish Technology Research Section, Institute of Food Science and Technology (IFST), Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka for evaluating their qualities in fresh raw condition and in processed dried condition.

Table 1. Fish species (fresh and dried) collected for the experiment

Common name	Scientific name	Local name
1. Pool barb	*Puntius sophore*	Punti
2. Mola carplet	*Amblypharyngodon mola*	Mola
3. Elongate glassy perchlet	*Chanda nama*	Chanda
4. Anchovy	*Setipinna phasa*	Phasa
5. Small Prawn	*Macrobrachium rosenbergii*	Choto Chingri

2.2. Processing and drying of fresh fish samples

The fresh fish samples were descaled, degutted and cleaned with fresh water. After that, they were cleaned with 0.5% chlorinated water and treated with 2% salt solution for about two hours. The samples were then dried under the sun between 30 and 35 °C in a dust-free laboratory condition for five days.

2.3. Chemicals, reagents and equipment

All the chemicals and reagents used for the experiment were of analytical grade (E-Merck, Darmstadt, Germany). The equipment employed for the analyses of different parameters were Auto Kjeldahl system (KjeltecTM 2300 Foss Tecator AB, Hoganas, Sweden), Soxtec System (HT6, TecatorAB, Hoganas, Sweden), Muffle furnace (JSMF-45HT, South Korea), Moisture analyzer (Phoenix Instrument, BM-60, Germany), Electronic Balance (AS 220.R2, Poland).

2.4. Analyses of proximate compositions

The analyses of proximate composition were performed according to the methods of the Association of Official Analytical Chemists [17-18]. The moisture content was determined by using moisture analyzer (Phoenix Instrument, BM-60, Germany). The protein content was estimated by micro-Kjeldahl method (KjeltecTM 2300 Foss Tecator AB, Hoganas, Sweden). The crude fat was measured by Soxhlet extraction method (Soxtec System, HT6, TecatorAB, Hoganas, Sweden) using petroleum ether

as solvent. The ash content was determined by incinerating at 600 °C for 6 hours in a muffle furnace (JSMF-45HT, South Korea). The content of carbohydrate was calculated following by-difference method. The moisture, protein, fat, ash and carbohydrate contents of the analyzed samples were expressed on a percentage basis. The energy values of the samples were computed from the unit caloric content of carbohydrate, protein and fat, and were expressed as kilo calorie per 100 g (Kcal/100gm).

2.5. Statistical analyses

The results are expressed as mean±standard deviation of triplicate analyses of the parameters and were calculated using Microsoft Excel 2016. Statistical differences between the mean values were analyzed at $P < .05$ by Post Hoc Tukey HSD One-way ANOVA test using IBM SPSS software (version 22.0, Chicago, IL, USA).

3. Results and discussion

The proximate compositions of the fresh, experimentally and commercially processed sun-dried samples were analyzed (Table 2-6). The major comparisons were carried out between experimentally and commercially dried samples based on the objective of this study.

The moisture contents of all the fresh fish samples were more than two-thirds (ranging from 72.07 to 77.13%) of their total weight. In the dried samples, the moisture contents of the experimentally and commercially dried samples were significantly different ($P < .05$), with the contents of experimentally processed Mola (12.73%), Chanda (10.85%) and Phasa (10.30%) being lower, whereas Punti (13.36%) and small Prawn (16.83%) being higher than that of commercially dried samples, respectively. Other studies found the moisture contents ranging from 13-26.60% in Mola [19-21], 18.92-23.49% in Phasa [22] and 25.13% in Punti [21], which are higher compared to the findings (both experimentally and commercially processed samples) of the present experiment.

The protein contents of the experimentally dried Punti (66.05%), Mola (60.42%), Phasa (72.02%) and small Prawn (64.58%) were higher than the protein contents of respective commercially dried samples; in contrast, the protein content of experimentally dried Chanda (59.13%) was found to be slightly lower than that of the commercially dried sample and the contents of two types of samples differed significantly ($P < .05$). However, the protein contents of both experimentally and commercially dried samples were higher than the protein contents reported in the literature, 48.82% in Punti [21], 48.94-50.03% in Mola [20-21], 50.53% in Chanda [21] and 47.84-62.98% in Phasa [22-24].

Among the experimentally dried samples, the fat contents of Punti (10.04%), Phasa (5.95%) and small Prawn (4.94%) were lower, and the fat content of Chanda (11.69%) was higher compared to the fat content of corresponding commercially dried varieties. Experimentally dried Mola fish sample was found to contain fat content (13.41%) almost equal to that of the commercially dried sample. The fat contents of both experimentally and commercially dried samples were found to differ significantly ($P < .05$). Studies reported the fat contents as 9.84% in Punti [21], 10.06-12.16% in Mola [20-21], 13.03% in Chanda [21] and 6.22-23.91% in Phasa [22-24], which resemble the findings of the present study.

The ash contents of experimentally dried Punti (10.05%), Phasa (11.31%) and small Prawn (13.15%) were lower, and the ash content of Chanda (17.68%) was higher than the ash content of commercially dried sample of the same species and there were significant differences ($P < .05$) between them. Nevertheless, the ash content of experimentally dried Mola (12.53%) was not significantly different from that of commercially dried Mola. Literature reported the ash contents as 16.11% in Punti [21], 12.19-16.12% in Mola [20-21], 18.60% in Chanda [21] and 3.78-24.83% in Phasa [22-24], which are comparable to the findings of the current experiment.

The carbohydrate contents of experimentally dried Punti (0.50%) and Mola (0.90%) were higher than the carbohydrate contents of commercially dried samples and there were significant differences ($P < .05$). Also the carbohydrate contents of experimentally dried Chanda (0.63%) and Phasa (0.43%) were higher compared to the carbohydrate contents of commercially dried samples, but they were not significantly different ($P > .05$). However, the carbohydrate content of experimentally dried small Prawn (0.50%) was non significantly lower ($P > .05$) than that of commercially dried sample.

The computed energy values of experimentally dried Punti (364.20 Kcal/100gm) and small Prawn (311.77 Kcal/100gm) were significantly lower ($P < .05$) than

Table 2. Proximate composition of Punti fish (*Puntius sophore)*

Fish Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbo-hydrate (%)	Energy (Kcal/ 100gm)
Fresh Punti	76.22±0.18^{a}	18.12±0.03^{c}	3.37±0.06^{c}	1.66±0.11^{c}	0.63±0.11^{a}	107.54±0.89^{c}
Experimentally Processed Sun-dried	13.36±0.18^{b}	66.05±0.04^{a}	10.04±0.04^{b}	10.05±0.03^{b}	0.50±0.10^{a}	364.20±0.78^{b}
Commercially Processed sun-dried	11.75±0.04^{c}	59.41±0.20^{b}	14.09±0.05^{a}	14.68±0.18^{a}	0.07±0.01^{b}	372.12±0.40^{a}

Different alphabetic superscripts in the same column indicate statistically significant differences ($P < 0.05$)

Table 3. Proximate composition of Mola fish (*Amblypharyngodon mola*)

Fish Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbo-hydrate (%)	Energy (Kcal/ 100gm)
Fresh Mola	75.78±0.04^{a}	18.22±0.06^{c}	4.36±0.08^{c}	1.44±0.04^{b}	0.19±0.05^{b}	115.18±0.62^{c}
Experimentally Processed Sun-dried	12.73±0.05^{c}	60.42±0.11^{a}	13.41±0.09^{a}	12.53±0.16^{a}	0.90±0.04^{a}	373.50±0.60^{a}
Commercially Processed sun-dried	17.50±0.15^{b}	56.74±0.09^{b}	13.08±0.03^{b}	12.40±0.02^{a}	0.27±0.05^{b}	352.83±0.63^{b}

Different alphabetic superscripts in the same column indicate statistically significant differences ($P < 0.05$)

Table 4. Proximate composition of Chanda fish (*Chanda nama*)

Fish Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbo-hydrate (%)	Energy (Kcal/ 100gm)
Fresh Chanda	77.13±0.13^{a}	16.87±0.11^{c}	1.84±0.05^{c}	3.22±0.02^{c}	0.94±0.03^{a}	89.78±0.78^{c}
Experimentally Processed Sun-dried	10.85±0.12^{c}	59.13±0.22^{b}	11.69±0.17^{a}	17.68±0.04^{a}	0.63±0.09^{b}	351.45±0.63^{a}
Commercially Processed sun-dried	16.54±0.13^{b}	60.94±0.13^{a}	6.33±0.26^{b}	15.70±0.43^{b}	0.49±0.14^{b}	309.43±3.00^{b}

Different alphabetic superscripts in the same column indicate statistically significant differences ($P < .05$)

Table 5. Proximate composition of Phasa fish (*Setipinna phasa*)

Fish Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbo-hydrate (%)	Energy (Kcal/ 100gm)
Fresh Phasa	72.07±0.05a	16.62±0.18c	9.01±0.03b	1.94±0.02c	0.36±0.21a	151.61±0.05b
Experimentally Processed Sun-dried	10.30±0.09c	72.02±0.06a	5.95±0.06c	11.31±0.03b	0.43±0.14a	351.13±0.17a
Commercially Processed sun-dried	12.36±0.05b	65.17±0.04b	9.11±0.03a	13.13±0.08a	0.23±0.04a	351.07±0.36a

Different alphabetic superscripts in the same column indicate statistically significant differences (P < 0.05)

Table 6. Proximate composition of small Prawn (*Macrobrachium rosenbergii*)

Fish Sample	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbo-hydrate (%)	Energy (Kcal/ 100gm)
Fresh small Prawn	76.65±0.06^{a}	19.66±0.06^{c}	1.27±0.06^{c}	1.66±0.07^{c}	0.76±0.05^{a}	95.34±0.63^{c}
Experimentally Processed Sun-dried	16.83±0.08^{b}	64.58±0.11^{a}	4.94±0.07^{b}	13.15±0.15^{b}	0.50±0.17^{a}	311.77±1.04^{b}
Commercially Processed sun-dried	10.25±0.14^{c}	62.17±0.13^{b}	11.52±0.11^{a}	15.55±0.22^{a}	0.59±0.18^{a}	361.87±0.63^{a}

Different alphabetic superscripts in the same column indicate statistically significant differences ($P < 0.05$)

the energy values of the same varieties of commercially dried samples. In contrast, the energy values of experimentally dried Mola (373.50 Kcal/100gm) and Chanda (351.45 Kcal/100gm) were significantly higher ($P < .05$) than those of commercially dried Mola and Chanda, respectively. The energy value of experimentally dried Phasa (351.13 Kcal/100gm) was, however, not significantly different ($P > .05$) from that of commercially dried Phasa.

4. Conclusions

The present study revealed variable proximate compositions of experimentally and commercially dried fish items. The moisture contents of both types of dried fish varieties were within the ideal range

translating high quality dry food products. However, dried fish is nutritionally considered principally for its higher protein and ash compositions, and our study found comparatively higher content of these nutrients in experimentally dried fish items than commercially dried fish products. Besides nutritional quality factors, organoleptic quality attributes of dried fish are equally important to determine consumer appeals, which rely mostly on the methods employed for processing fresh fish prior to drying. In this experiment, high sanitation was maintained in the laboratory set-up for obtaining desired dried fish products, which also resulted in acceptable nutritional composition. Therefore, it is suggested that the pre-treatment methods followed in this study for fish drying might be preferred for maximum retention of nutritional qualities of fresh fish with greater consumer satisfaction.

Authors' contributions

Responsible for conceptualization, supervision, analysis, interpretation of the data, editing of the manuscript, M.Z.U.A.M.; Writing, drafting, reviewing and editing of the manuscript, M.S.H. and M.B.; Reviewing of the manuscript, M.A.S.; Performed the experiments; analyzed and interpreted the data, R.A.S.; S.Y. and L.F.; Formal analysis, S.A.; M.S.R. and M.A.A.M.

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Availability of data and materials

All data will be made available upon request to the corresponding author according to the journal policy.

Conflicts of interest

There is no potential conflict of interest or personal relationships that could have appeared to influence the work reported in this article.

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