Nutritional quality of dried fish from Bangladesh

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Abstract

The aim of this work was to determine the nutritional value of several dry fish samples produced and marketed in Bangladesh. Three common dried fishes (DF), namely Bombay duck (BD, *Harpadon nehereus*), ribbon fish (RF, *Trichiurus iepturus*), and white sardine (WS, *Escualosa thoracata*) were collected from three Bangladeshi regions: Cox's Bazar (C), Dhaka (D), and Mymensingh (M). Proximate composition analysis results showed that the DF contains 58%-75% of protein, 11%-26% of ash, 9%-16% of moisture and 2-17% of fat. The excessive amount of ash contented in Cox's Bazar region's DF may be related with its significantly high amount of sodium. Among five heavy metals, chromium content in BD, from three regions, all exceeded the maximum allowable level in fish/fish products. And in RF-D, excessive level arsenic (As) was detected. Amino acid composition data suggested that DF contains around ~18-24% of hydrophobic amino acids and 16.5-20% of essential amino acid. WS had a relatively high amino acid score compared to BD and RF.

Introduction

Dried fish (DF) plays a crucial role in the fishery industry because it is characterized by being cheap, less restricted to season, and easy to store and transport. However, the current research on nutritional properties of DF cannot meet the increasingly refined food safety requirements. For food safety purposes, it becomes imperative to explore the nutritional quality of DF, especially from Bangladesh, a major producer of this commodity.

Objectives

- To determine the moisture, ash, fat, and protein content in each DF.
- To determine the distribution of various amino acids in each DF protein and calculate the amino acid score of essential amino acids.
- To determine the levels of mineral elements and heavy metals in each DF.

Methodology

Dried Fish

Oven dried
50 °C overnight

AOAC Official Method 2015.01 Heavy Metals in Food, (2015)

Pre-Column Derivatization & HPLC (Bidlingmeyer et al., 1984)

Heavy metal profile ← **Blender** Fine powder → **Amino acid profile**

Proximate Composition Analysis & mineral analysis

AOAC Official Method Agricultural Chemicals, Contaminants, Drugs (Horwitz & Chemists, 2010)
Mehlenbacher et al., 2010

Results

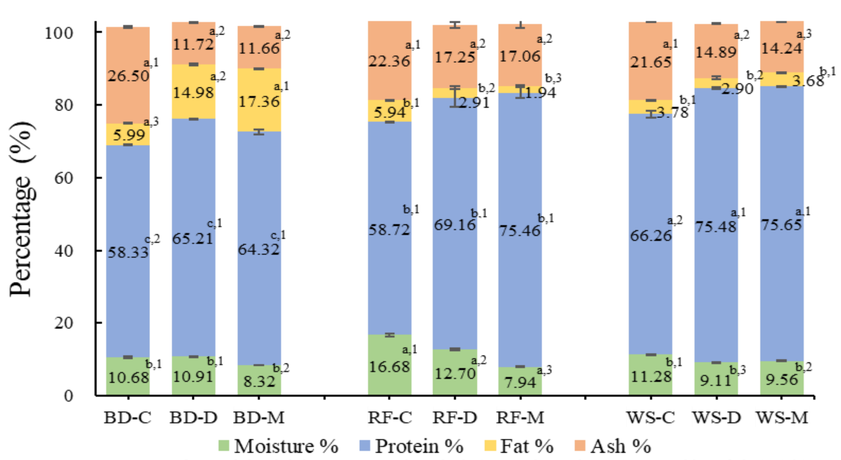

Figure 1. Proximate analysis of dried fishes. BD: Bombay duck (*Harpadon nehereus*); RB: ribbon fish (*Trichiurus iepturus*); WS: white sardine (*Escualosa thoracata*); C: Cox's Bazar; D: Dhaka; M: Mymensingh. Different letters (a, b, and c) represent significant differences between fish types via two-way ANOVA. Different numbers (1, 2, and 3) represent significant differences within the same fish type and different locations via one-way ANOVA.

Table 3. Heavy metal profile of dried fishes

	Hg	Cr	As	Cd	Pb
	ng/g dried fish				
ML	500	2	3.5	0.05	0.5
BD-C	33.58 ± 1.4 ^{c,3}	**4.58 ± 3.24** ^{a,1}	1.11 ± 0.03 ^{c,1}	< DL	0.11 ± 0 ^{a,2}
BD-D	46.99 ± 0.33 ^{c,1}	**2.76 ± 0.27** ^{a,1}	1.66 ± 0.02 ^{c,1}	< DL	0.14 ± 0.06 ^{a,12}
BD-M	37.56 ± 0.02 ^{c,2}	**5 ± 1.27** ^{a,1}	1.7 ± 0.37 ^{c,1}	< DL	0.3 ± 0.06 ^{a,1}
RF-C	85.08 ± 0.02 ^{a,2}	1.19 ± 0.33 ^{b,1}	2.58 ± 0.12 ^{a,3}	< DL	0.04 ± 0.01 ^{a,2}
RF-D	150.1 ± 13.34 ^{a,1}	0.83 ± 0.07 ^{b,1}	**6.2 ± 0.04** ^{a,1}	< DL	0.04 ± 0 ^{a,2}
RF-M	81.09 ± 3.27 ^{a,2}	1.42 ± 0.03 ^{b,1}	3.14 ± 0.15 ^{a,2}	< DL	0.24 ± 0.01 ^{a,1}
WS-C	32.98 ± 1.23 ^{b,3}	1.82 ± 1.63 ^{b,1}	3.48 ± 0.07 ^{b,1}	< DL	0.08 ± 0.01 ^{a,1}
WS-D	40.06 ± 0.17 ^{b,2}	0.61 ± 0.14 ^{b,1}	3.34 ± 0.09 ^{b,1}	< DL	0.4 ± 0.29 ^{a,1}
WS-M	44.06 ± 0.01 ^{b,1}	0.38 ± 0.46 ^{b,1}	1.93 ± 2.17 ^{b,1}	< DL	0.07 ± 0.07 ^{a,1}

ML: Maximum level of each heavy metal species allowed in fish/fish products (Health Canada, 2020); DL: detection limit; BD: Bombay duck (*Harpadon nehereus*); RB: ribbon fish (*Trichiurus iepturus*); WS: white sardine (*Escualosa thoracata*); C: Cox's Bazar; D: Dhaka; M: Mymensingh. Different letters (a, b, and c) represent significant differences between fish types via two-way ANOVA. Different numbers (1, 2, and 3) represent significant differences within the same fish type and different locations via one-way ANOVA.

Table 1. Mineral composition of dried fishes

Sample ID	P	K	Ca	Na	Mg	Mn	Cu	Fe	Zn
	Weight percentage (%)					mg/kg of dried fish			
BD-C	1.21 ± 0.00 ^{c,3}	0.79 ± 0.04 ^{c,2}	1.745 ± 0.02 ^{c,1}	**7.39 ± 0.18** ^{a,1}	0.33 ± 0.00 ^{a,1}	14.13 ± 0.99 ^{b,1}	8.61 ± 0.70 ^{a,2}	194.83 ± 3.67 ^{a,3}	43.72 ± 4.02 ^{b,1}
BD-D	1.48 ± 0.02 ^{c,1}	1.29 ± 0.04 ^{c,1}	1.67 ± 0.06 ^{c,1}	1.56 ± 0.03 ^{a,2}	0.19 ± 0.00 ^{a,3}	13.21 ± 0.60 ^{b,12}	9.26 ± 0.23 ^{a,2}	307.92 ± 40.64 ^{a,2}	61.18 ± 5.66 ^{b,1}
BD-M	1.26 ± 0.00 ^{c,2}	0.66 ± 0.01 ^{c,3}	1.73 ± 0.06 ^{c,1}	1.80 ± 0.01 ^{a,2}	0.24 ± 0.00 ^{a,2}	11.45 ± 0.65 ^{b,2}	80.85 ± 8.29 ^{a,1}	415.73 ± 27.32 ^{a,1}	59.67 ± 14.77 ^{b,1}
RF-C	1.75 ± 0.13 ^{a,3}	0.91 ± 0.03 ^{b,3}	2.78 ± 0.45 ^{a,2}	**5.99 ± 0.17** ^{b,1}	0.22 ± 0.00 ^{b,2}	12.61 ± 0.77 ^{b,1}	2.31 ± 0.07 ^{b,1}	84.04 ± 0.91 ^{b,3}	46.56 ± 0.76 ^{b,1}
RF-D	3.42 ± 0.01 ^{a,1}	1.48 ± 0.01 ^{b,1}	5.70 ± 0.04 ^{a,2}	0.94 ± 0.02 ^{b,3}	0.21 ± 0.01 ^{b,3}	15.86 ± 4.84 ^{b,1}	11.48 ± 10.58 ^{b,1}	174.36 ± 1.88 ^{b,2}	68.55 ± 13.34 ^{b,1}
RF-M	2.03 ± 0.06 ^{a,2}	1.30 ± 0.01 ^{b,2}	2.91 ± 0.28 ^{a,2}	2.11 ± 0.03 ^{b,2}	0.29 ± 0.00 ^{b,1}	13.94 ± 0.33 ^{b,1}	3.33 ± 0.24 ^{b,1}	261.43 ± 9.16 ^{b,1}	53.68 ± 11.12 ^{b,1}
WS-C	2 ± 0.03 ^{b,2}	1.23 ± 0.03 ^{a,1}	3.17 ± 0.02 ^{b,1}	**4.57 ± 0.04** ^{c,1}	0.26 ± 0.01 ^{a,1}	17.46 ± 0.42 ^{a,2}	3.84 ± 0.63 ^{c,1}	81.57 ± 4.45 ^{b,2}	89.41 ± 7.35 ^{a,1}
WS-D	2.21 ± 0.01 ^{b,1}	1.60 ± 0.21 ^{a,1}	2.95 ± 0.35 ^{b,1}	1.47 ± 0.08 ^{c,2}	0.27 ± 0.01 ^{a,1}	16.46 ± 0.25 ^{a,3}	5.88 ± 3.92 ^{c,1}	125.19 ± 0.70 ^{b,1}	105.02 ± 9.21 ^{a,1}
WS-M	2.24 ± 0.04 ^{b,1}	1.47 ± 0.02 ^{a,1}	3.09 ± 0.37 ^{b,1}	1.27 ± 0.04 ^{c,3}	0.25 ± 0.01 ^{a,1}	19.25 ± 0.04 ^{a,1}	4.15 ± 0.65 ^{c,1}	86.39 ± 15.78 ^{b,2}	97.70 ± 1.36 ^{a,1}

BD: Bombay duck (*Harpadon nehereus*); RB: ribbon fish (*Trichiurus iepturus*); WS: white sardine (*Escualosa thoracata*); C: Cox's Bazar; D: Dhaka; M: Mymensingh. Different letters (a, b, and c) represent significant differences between fish types via two-way ANOVA. Different numbers (1, 2, and 3) represent significant differences within the same fish type and different locations via one-way ANOVA.

Table 4. Percentage amino acid composition of dried fish (g/100g of dried fish)

Amino acids	Sample ID									Amino Acid Score (%)
	BD-C	BD-D	BD-M	RF-C	RF-D	RF-M	WS-C	WS-D	WS-M	
HIS	0.83 ± 0.00	0.97 ± 0.05	0.97 ± 0.15	0.96 ± 0.01	1.12 ± 0.05	1.18 ± 0.08	1.31 ± 0.19	1.41 ± 0.08	1.17 ± 0.01	52 a, 61 b, 60 c, 60 d, 70 e, 74 f, 82 g, 88 h, 73 i
THR	1.94 ± 0.09	1.68 ± 0.05	2.02 ± 0.02	1.91 ± 0.01	2.05 ± 0.01	2.60 ± 0.02	1.80 ± 0.03	2.29 ± 0.05	2.05 ± 0.11	78 a, 67 b, 81 c, 76 d, 82 e, 104 f, 72 g, 91 h, 82 i
LYS	3.72 ± 0.33	3.12 ± 0.04	3.89 ± 0.06	3.70 ± 0.01	3.97 ± 0.09	5.22 ± 0.14	3.28 ± 0.04	4.55 ± 0.20	4.20 ± 0.25	77 a, 65 b, 81 c, 77 d, 83 e, 109 f, 68 g, 95 h, 87 i
VAL	2.34 ± 0.10	2.09 ± 0.02	2.40 ± 0.03	2.17 ± 0.02	2.36 ± 0.03	2.980 ± 0.02	2.13 ± 0.01	2.72 ± 0.07	2.44 ± 0.13	58 a, 52b, 60 c, 54 d, 59 e, 74 f, 53 g, 68 h, 61 i
ILE	2.07 ± 0.08	1.84 ± 0.04	2.15 ± 0.07	2.03 ± 0.01	2.26 ± 0.03	2.85 ± 0.07	1.93 ± 0.01	2.44 ± 0.08	2.23 ± 0.13	69 a, 61 b, 71 c, 68 d, 75 e, 95 f, 64 g, 81 h, 74 i
LEU	3.59 ± 0.13	3.08 ± 0.03	3.73 ± 0.11	3.29 ± 0.05	3.66 ± 0.10	4.80 ± 0.07	3.26 ± 0.01	4.20 ± 0.14	3.83 ± 0.17	59 a, 50 b, 61 c, 54 d, 60 e, 79 f, 53 g, 69 h, 63 i
TRP	0.46 ± 0.02	0.51 ± 0.02	0.51 ± 0.01	0.42 ± 0.11	0.54 ± 0.11	0.50 ± 0.03	0.62 ± 0.04	0.70 ± 0.04	0.68 ± 0.02	69 a, 77 b, 77 c, 64 d, 81 e, 75 f, 93 g, 105 h, 103 i
PHE	1.92 ± 0.06	1.66 ± 0.03	1.96 ± 0.08	1.86 ± 0.01	2.06 ± 0.10	2.62 ± 0.03	1.89± 0.04	2.39 ± 0.05	2.20 ± 0.10	§ 94 a, 84 b, 90 c, 83 d, 95 e, 117 f, 83 g, 107 h, 97 i
TYR	1.93 ± 0.07	1.80 ± 0.01	1.75 ± 0.13	1.53 ± 0.05	1.85 ± 0.01	2.17 ± 0.08	1.50 ± 0.06	1.99 ± 0.02	1.77 ± 0.16	
CYS	0.36 ± 0.00	0.37 ± 0.01	0.35 ± 0.03	0.38 ± 0.01	0.51 ± 0.01	0.47 ± 0.02	0.45 ± 0.00	0.52 ± 0.01	0.50 ± 0.02	◆ 76 a, 98 b, 91 c, 77 d, 99 e, 96 f, 83 g, 97 h, 99 i
MET	1.38 ± 0.01	1.89 ± 0.07	1.73 ± 0.15	1.39 ± 0.01	1.76 ± 0.050	1.75 ± 0.09	1.45 ± 0.08	1.71 ± 0.03	1.78 ± 0.09	
SER	1.63 ± 0.10	1.48 ± 0.07	1.73 ± 0.02	1.70 ± 0.00	1.82 ± 0.03	2.38 ± 0.03	1.55 ± 0.02	1.99 ± 0.11	1.77 ± 0.09	
ARG	2.61 ± 0.18	2.44 ± 0.09	3.08 ± 0.05	2.72 ± 0.12	2.99 ± 0.02	4.01 ± 0.07	2.35 ± 0.00	3.22 ± 0.05	2.99 ± 0.17	
GLY	2.88 ± 0.20	2.63 ± 0.14	2.76 ± 0.06	2.80 ± 0.30	2.88 ± 0.09	3.22 ± 0.42	2.14 ± 0.01	2.59 ± 0.06	2.32 ± 0.05	
ASP	3.98 ± 0.45	3.91 ± 0.08	4.20 ± 0.28	4.22 ± 0.04	4.38 ± 0.19	5.98 ± 0.05	3.68 ± 0.29	5.03 ± 0.21	4.52 ± 0.27	
GLU	7.02 ± 0.57	6.28 ± 0.14	7.17 ± 0.41	6.50 ± 0.04	6.98 ± 0.21	8.950 ± 0.08	5.86 ± 0.37	7.66 ± 0.28	6.96 ± 0.37	
ALA	2.79 ± 0.24	2.66 ± 0.08	2.85 ± 0.13	2.66 ± 0.11	2.79 ± 0.10	3.34 ± 0.14	2.41 ± 0.07	3.06 ± 0.10	2.76 ± 0.15	
PRO	2.10 ± 0.16	1.87 ± 0.06	2.05 ± 0.02	1.94 ± 0.16	2.01 ± 0.04	2.39 ± 0.19	1.63 ± 0.01	2.00 ± 0.04	1.82 ± 0.06	
HAA	18.70 ± 0.52	17.77 ± 0.33	19.49 ± 0.09	17.66 ± 0.29	19.80 ± 0.18	23.86 ± 0.12	17.25 ± 0.23	21.72 ± 0.52	20.02 ± 0.77	
PCAA	4.54 ± 0.32	4.10 ± 0.10	4.86 ± 0.21	4.66 ± 0.02	5.09 ± 0.03	6.40 ± 0.07	4.58 ± 0.22	5.96 ± 0.28	5.37 ± 0.24	
NCAA	11.00 ± 1.02	10.18 ± 0.22	11.37 ± 0.70	10.72 ± 0.08	11.36 ± 0.40	14.93 ± 0.12	9.53 ± 0.67	12.69 ± 0.49	11.48 ± 0.64	
AAA	4.30 ± 0.15	3.97 ± 0.03	4.22 ± 0.22	3.81 ± 0.07	4.45 ± 0.21	5.29 ± 0.02	4.00 ± 0.05	5.07 ± 0.06	4.65 ± 0.24	
SCAA	1.74 ± 0.01	2.26 ± 0.08	2.09 ± 0.18	1.76 ± 0.01	2.27 ± 0.04	2.21 ± 0.07	1.90 ± 0.08	2.22 ± 0.03	2.28 ± 0.11	
BCAA	8.00 ± 0.32	7.01 ± 0.09	8.27 ± 0.21	7.49 ± 0.05	8.28 ± 0.16	10.63 ± 0.16	7.31 ± 0.02	9.36 ± 0.29	8.51 ± 0.43	
EAA	18.24 ± 0.80	16.84 ± 0.34	19.35 ± 0.04	17.73 ± 0.11	19.79 ± 0.28	24.49 ± 0.39	17.65 ± 0.34	22.40 ± 0.74	20.59 ± 0.77	

BD: Bombay duck (*Harpadon nehereus*); RB: ribbon fish (*Trichiurus iepturus*); WS: white sardine (*Escualosa thoracata*); C: Cox's Bazar; D: Dhaka; M: Mymensingh.
Asx = aspartic acid + asparagine; Glx = glutamic acid + glutamine; AAA = aromatic amino acids; BCAA = branched-chain amino acids; HAA = hydrophobic amino acids; NCAA = negatively charged amino acids; PCAA = positively charged amino acids; SCAA = sulfur-containing amino acids; EAA= essential amino acids. Amino acid score is calculated with EAA requirements for adults according to WHO and FAO (2013). a = BD-C, b = BD-D, c = BD-M, d = RF-C, e = RF-D, f = RF-M, g = WS-C, h = WS-D, I = WS-M.
§ = the overall score for PHE & TYR; ◆ = the overall score for CYS & MET.

Conclusions

- Dried fishes from Bangladesh in this study all contained more than 58% protein and can be considered as a good source of protein. Among them, the protein content of WS was significantly higher than that of the other two DFs (BD and RF).
- It was observed that the ash content of DF from Cox's Bazar was significantly higher than that from Dhaka and Mymensingh.
- Subsequent research on mineral content showed that the main reason for this result was that the DF in Cox's Bazar was much richer in sodium than the other two places.
- Comparing the heavy metal content of DF with the safe intake standard, it was found that the content of Cr in BD exceeded the safety level; the content of arsenic in RB-D was about twice the safe intake. Excessive intake of heavy metals may cause health risks.
- In addition, research on the amino acids of DF found that important amino acids accounted for 20%. Among them, the amino acid score of DF from Cox's Bazar was significantly lower than that of DF from other two regions.

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