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EVALUATION OF NUTRITIONAL VALUES OF SMOKE CURED RIVERINE AND MARINE HILSA (*TENUALOSA ILISHA;* HAMILTON, 1882)

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Abstract: Present study was conducted to evaluate nutritional values of smoked hilsa fish (*Tenualosa ilisha*; Hamilton, 1882) in relation to its raw condition. Smoking is one of the processes of fish preservation from ancient period of our country. The nutrients values of the hilsa from two different regions were significantly ($p < 0.05$) varied. The nutritional values were different before and after processing of hilsa. Riverine hilsa contains relatively more moisture (56.45 ± 0.51%) and protein (15.98 ± 0.50%) than marine hilsa. Fat (16.18 ± 0.45%) and salt (1.92 ± 0.18%) contents are higher in marine hilsa; whereas ash (8.34 ± 0.35%) content was higher in riverine hilsa. Minerals like iron (4.72 ± 0.08 mg/100 g) and calcium (481.77 ± 6.20 mg/100g) remain in large amount on marine hilsa but phosphorus (115.73 ± 4.36 mg/100 g) content remain high level in riverine hilsa. In addition, the protein (raw condition, 19.54 ± 0.47%, riverine; 17.12 ± 0.42%, marine and smoked condition, 29.64 ± 0.41%, riverine; 28.51 ± 0.51%, marine) and fat (raw condition, 16.41 ± 0.46%, riverine; 20.07 ± 0.39%, marine and smoked condition, 20.71 ± 0.47%, riverine; 23.31 ± 0.47%, marine) content were higher in abdominal region of riverine and marine hilsa both raw and smoked condition than head region (protein in raw condition, 11.21 ± 0.51%, riverine; 10.51 ± 0.53%, marine and smoked condition, 17.14 ± 0.42%, riverine; 15.69 ± 0.4%, marine; fat in raw condition, 9.04 ± 0.45%, riverine; 11.21 ± 0.51%, marine and smoked condition, 12.32 ± 0.44%, riverine; 14.56 ± 0.47%, marine) and caudal region (protein in raw condition17.21 ± 0.52%, riverine; 15.22 ± 0.66%, marine and smoked condition, 27.68 ± 0.44%, riverine; 26.73 ± 0.46%, marine; fat in raw condition, 14.05 ± 0.5%, riverine; 17.28 ± 0.47%, marine and smoked condition, 17.35 ± 0.43%, riverine; 19.18 ± 0.51%, marine).

Key words: Riverine hilsa, marine hilsa, smoked hilsa, nutritional values

INTRODUCTION

Bangladesh is one of the world's leading fish producing countries with a total production of 41.34 lakh MT, where production of hilsa fish is 4.96 lakh MT (riverine 2.17 lakh MT; marine 2.79 lakh MT) in FY 2016-17 (DoF 2017). Bangladesh is ranked 4th in world aquaculture production (FAO 2016). Almost 60% animal protein comes from fish and it contributes 3.61% as agaomst hilsa contributes 1.06 per cent to our GDP and plays a significant role in the economy of Bangladesh (DoF 2017). Hilsa fish is largely an anadromous species and very popular and tasty fish among Bangladeshi people.

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Proximate composition generally comprises the estimation of moisture, protein, fat and ash contents of the fresh fish body. The percentage composition of these constituents accounts for about 96 - 98% of the total tissue constituents in fish (Nowsad 2007). Biochemical composition of fish flesh may vary within the same species of fish depending upon the fishing season, age, sex and habitat (Srivastava 1985, Shamim *et al.* 2011). In fishes, proximate composition means the composition of the fish flesh. The variation is also found within the different portion of the body (Jacquot 1961 and Mustafa *et al.* 2012). Fish flesh contains four basic ingredients in varying proportions major nutrients such as water (70 - 80%), protein (18 - 20%), fat (5%) and minerals (5%) and minor nutrients such as vitamin, carbohydrate (Khurseed and Mosharaff 1998). The fish has been found to contain specialized type of fat having about 50% of unsaturated fatty acids out of which about 2% w-3 fatty acids exists (Rao *et al.* 1977). It has high nutritional value in terms of fats and proteins that are not commonly available in other foods. Hilsa contains different types of fatty acids and amino acids which are helpful for human health (Mustafa *et al.* 2012). Moreover, it contains higher quality of Ca, P, Fe and vitamin A, D including trace level of vitamin B. Liver of hilsa contains 120 IU of vitamin A (Haldar *et al.* 2004). There are some information on the sensory, biochemical and bacteriological studies of hilsa (Mansur *et al.* 1998).

The aim of the present study was to determine the proximate composition, salt value and minerals of different portions of fish body from riverine and marine hilsa both raw and smoked condition.

MATERIAL AND METHODS

Study sites and sampling: Riverine hilsa (Padma river) and marine hilsa (Bay of Bengal) were procured from Sureswar Bazar, Shariatpur (23°31'22.23" N and 90°47'05.22" E) and Fishery Ghat, Chittagong (22°19'36.2" N and 91°51'38.5" E), respectively. The raw fish samples were purchased directly from local fishermen and landing centers during June - July, 2016. The samples were packed in separate polyethylene bags; appropriately labeled, preserved in iced condition (<4°C) in an insulated Styrofoam box and transported immediately to the laboratory and stored in a freezer (at –20°C) until required for analysis.

Smoked-drying of hilsa: The dressed fish samples were smoked in improved traditional type of smoking kiln (Sarkar 2005). The fish smoking kiln was operated by first loading clean wood chips and rice-husk into the heat chamber, preheating for 10 minutes and then loading the fish-samples onto removable wire mesh trays in its central chamber for the smoke-drying process. The desired temperature (75 - 80°C) was maintained manually for 4 hours. The cooled smoked fish samples were then separated at three different portion for further analysis.

Proximate composition: Proximate composition of fish was determined by conventional method of Association of Official Analytical Chemists (AOAC 2012) on weight basis. However, for moisture determination samples were dried in an oven at about 105ºC for about 8 to 10 hrs. The protein content of the fish was determined by micro Kjeldahl method. It involves conversion of organic nitrogen to ammonium sulphate by digestion with concentrated sulphuric acid in a micro Kjeldahl flask (AOAC 2012). The ash content of a sample is the residue left after in a muffle furnace at about 550 - 600ºC till the residue became white. For the estimation of fat content, the dried samples left after moisture determination were finely grinded and the fat was extracted with a nonpolar solvent, ethyl ether. After extraction, the solvent was evaporated and the extracted materials were weighed (AOAC 2012).

Salt value: Salt content of the samples were estimated by Mohor method (Alexiyev 1978). Fillets of fish samples were ground in a mortar with a pastel. The minced samples were weighed and salt was extracted with distilled water and made into volume of 100 ml and filtered. The filtrate with salt content was titrated.

Minerals value: Calcium (Ca) and iron (Fe) were determined by titration method (Vogel 1978). Determination of phosphorous (P) was carried out following the National Institute of Nutrtition manual (NIN 1976).

Data analysis: Data analyzed by using the computer software MS Word, Microsoft Office Excel 2007 and XL-stat version 16 for DMRT to understand the differences of the variables.

RESULTS AND DISCUSSION

The variation in proximate and biochemical composition of the fish in raw condition have been found to be dependent on season, sex, age, species, size, environment and even individuals (Thruston 1958). The proximate compositions of fish are moisture, protein, lipids and ash. Fishes from riverine catch is considered to be tastier than those from marine catch (Nowsad *et al*. 2012). The proximate composition and some minerals content of both fresh and smoked hilsa in Table 1 and 2, respectively.

Nutritional values of raw hilsa: Moisture is the major component of proximate composition. The highest value of moisture (61.11 ± 0.42%) was found in abdominal region (riverine hilsa) whereas the lowest value (46.24 ± 0.61%) was in head region (marine hilsa) of the fish. 50.33 ± 0.54% and 57.92 ±

Table 1. Proximate composition and minerals content of raw hilsa

Region	Portion	Proximate parameters (%)					Elemental composition (mg/100 g)		
		Moisture	Protein	Ash	Fat	Salt value	Fe	Ca	P
	Head region	50.33 ± 0.54	11.21 ± 0.51	19.20 ± 0.42	9.04 ± 0.45	1.12 ± 0.05	4.77 ± 0.16	537.38 ± 4.13	135.49 ± 4.05
Riverine	Abdominal "	61.11 ± 0.42	19.54 ± 0.47	2.04 ± 0.29	16.41 ± 0.46	0.99 ± 0.08	3.27 ± 0.08	276.88 ± 6.74	91.96 ± 3.83
	Caudal "	57.92 ± 0.56	17.21 ± 0.52	3.80 ± 0.36	14.05 ± 0.50	1.81 ± 0.17	3.92 ± 0.21	388.43 ± 6.27	119.74 ± 5.21
	Head "	46.24 ± 0.61	10.51 ± 0.53	16.21 ± 0.49	11.21 ± 0.51	1.88 ± 0.07	5.86 ± 0.04	678.24 ± 5.48	121.31 ± 4.62
Marine	Abdominal "	57.41 ± 0.46	17.12 ± 0.42	1.59 ± 0.51	20.07 ± 0.39	1.56 ± 0.24	4.08 ± 0.11	338.91 ± 5.89	79.39 ± 5.33
	Caudal "	55.42 ± 0.59	15.22 ± 0.66	2.52 ± 0.16	17.28 ± 0.47	2.33 ± 0.25	4.23 ± 0.09	428.17 ± 7.25	98.39 ± 4.47

*The values in the same column having similar superscripts did not differ significantly ($p < 0.05$).

Table 2. Proximate composition and minerals content of smoked hilsa

Region	Portion	Proximate parameters (%)					Elemental composition (mg/100 g)		
		Moisture	Protein	Ash	Fat	Salt value	Fe	Ca	P
	Head region	25.37 ± 0.63	17.14 ± 0.42	28.44 ± 0.49	12.32 ± 0.44	3.08 ± 0.31	7.19 ± 0.4	759.01 ± 3.84	159.96 ± 3.63
Riverine	Abdominal region	35.92 ± 0.39	29.64 ± 0.41	4.73 ± 0.37	20.71 ± 0.47	4.85 ± 0.41	5.12 ± 0.36	490.04 ± 4.60	114.56 ± 3.70
	Caudal region	32.15 ± 0.48	27.68 ± 0.44	8.58 ± 0.40	17.35 ± 0.43	5.83 ± 0.26	6.06 ± 0.41	582.87 ± 3.74	124.09 ± 3.41
	Head region	23.04 ± 0.52	15.69 ± 0.40	27.53 ± 0.46	14.56 ± 0.47	4.57 ± 0.40	8.13 ± 0.51	891.45 ± 4.47	154.80 ± 6.38
Marine	Abdominal region	33.51 ± 0.53	28.51 ± 0.51	3.95 ± 0.44	23.31 ± 0.47	5.88 ± 0.46	5.63 ± 0.38	446.84 ± 4.07	98.86 ± 3.07
	Caudal region	31.27 ± 0.55	26.73 ± 0.46	7.50 ± 0.44	19.18 ± 0.51	6.51 ± 0.35	6.44 ± 0.40	631.81 ± 4.41	118.08 ± 4.43

* The values in the same column having similar superscripts did not differ significantly ($p < 0.05$).

0.56% moisture were recorded in the head and caudal portion of riverine hilsa, respectively, where 57.41 ± 0.46%, 55.42 ± 0.59% were in the abdominal portion and caudal portion, respectively of the marine hilsa.

The protein content is slightly higher in the flesh of river hilsa (19.60%) when compared to Bay of Bengal hilsa (17.20%) (Moniruzzaman *et al.* 2014). Crude protein was relatively higher in riverine hilsa and the highest value (19.54 ± 0.47%) was in the abdominal region of riverine hilsa and the lowest value (10.51 ± 0.53%) was in the head region of marine hilsa.

The fat contents in different portion of fish body in different regions were observed. In this study highest fat content was estimated in the abdominal region of the marine hilsa (20.07 ± 0.39%) and the lowest value was in the head region of the riverine hilsa (9.04 ± 0.45%). Marine hilsa contains relatively more fat content than riverine hilsa fish. 19.4% fat in hilsa is estimated by Saha and Guah (1939) which was about to similar to our findings. Shamim *et al.* (2011) recorded fat content in ventral portion of fish body from the Chittagong region (20.28%) and the lowest is in dorsal portion of fish body from the Khulna region (18.65%).

The highest ash content (19.2 ± 0.42%) was recorded in the head region of the riverine hilsa and lowest value (1.59 ± 0.51%) was found in the abdominal region of marine hilsha fish. Ash content of Kirtonkhola river hilsa (2.81%), Meghna river hilsa (2.19%), Payra river hilsa (1.20%) and Marine hilsa (1.10%) are recorded by Moniruzzaman *et al.* (2014) which was nearer to the result of present findings. The highest ash content is recommended by Shamim *et al.* (2011) for ventral portion of fish body from the Khulna region (1.55%) and lowest in dorsal portion from the Khulna region (1.03%) was different to the result of our findings and might be due to age, season, habitat etc.

Salt content was relatively higher in marine hilsa than riverine hilsa fish. The highest value of salt content was calculated in the caudal region of marine hilsa (2.33 ± 0.25%) and the lowest value was in the abdominal region of riverine hilsa (0.99 ± 0.08%).

Fe (5.86 ± 0.04%) and Ca (678.24 ± 5.48%) remained in large amount at the head region of marine hilsa but P (135.49 ± 4.05%) content was high level in the head region of riverine hilsa. Elemental composition was found at a low level in the abdominal part of both fishes. The lowest value of Fe (3.27 ± 0.08%) and Ca (276.88 ± 6.74%) were in the abdominal region of riverine hilsa, where the lowest value of P (79.39 ± 5.33%) was in the abdominal region of marine hilsa. Mineral composition of the fresh hilsa is mentioned by Mohanty *et al.* (2012) which was correlated with the findings.

Riverine hilsa contains relatively more moisture (57.79 ± 0.51%) and protein (15.65 ± 0.50%) than marine hilsa. Fat (16.39 ± 0.51%) and salt (1.80 ± 0.14%) contents were higher in marine hilsa; whereas the ash (7.88 ± 0.35%) content was higher in the riverine hilsa. Minerals like iron (4.92 ± 0.32 mg/100 g) and calcium (480.02 ± 6.73 mg/100 g) remain in large amounts in the marine hilsa, but the phosphorus (112.36 ± 4.40 mg/100 g) content remains at a high level in the riverine hilsa (Debnath *et al.* 2018).

Nutritional values of smoke cured hilsa: Moisture content decreased and protein, fat and ash content increased significantly after smoke treatment of the samples. Smoking resulted in the concentration of nutrients due to low residual moisture level (Doe and Olley 1983). Hossain *et al.* (2012) stated moisture (39.40%) of smoked hilsa which was different of our observation. Highest moisture value (35.92 ± 0.39%) was calculated in the abdominal region of riverine hilsa and the lowest value (23.04 ± 0.52%) was found in the head region of marine hilsa.

Crude protein level was increased due to smoke cured of hilsa. Maximum protein value (29.64 ± 0.41%) was calculated in the abdominal region of riverine hilsa fish and lowest value (15.69 ± 0.4%) was estimated in the head region of marine hilsa. Protein content (24.26%) of smoked hilsa is recorded by Hossain *et al.* (2012) which was a little far from our estimation. Protein levels in two types of smoke-dried fishes significant increased iwhen compared with the fresh fish, suggested that protein nitrogen was not lost during smoke drying (Tao and Linchun 2008).

Ash content of smoke cured hilsa was in high level at head region (riverine, 28.44 ± 0.49%; marine, 27.53±0.46%) than other portion of the body. Smaller size fish species have higher ash content due to the higher bone of flesh ratio (Daramola *et al.* 2007). Highest ash value (28.44 ± 0.49%) was recorded in the head region of smoked riverine hilsa and the lowest value (3.95 ± 0.44%) was in the abdominal region of smoked marine hilsa. Hossain *et al.* (2012) determined ash content 3.54% in the muscle of smoked hilsa, which agreed with present findings.

Crude fat was high at smoked hilsa at raw condition. The highest crude fat value (23.31 ± 0.47%) was estimated in the abdominal region of marine hilsa and the lowest value (12.32 ± 0.44%) was found in the head region of riverine hilsa. Lipid content (24.515%) was reported by Hossain *et al.* (2012) in smoked hilsa which was greater than present findings.

Salt content of caudal region of hilsa was greater than other parts of the body. The highest salt content (6.51 ± 0.35%) was calculated in the caudal region of marine hilsa and the lowest value (3.08 ± 0.31%) was recorded in the head region of riverine hilsa.

The highest Fe (8.13 ± 0.51%) and Ca (891.45 ± 4.47%) were calculated in the head region of marine hilsa and the highest level of P (159.96±3.63%) was estimated in the head region of riverine hilsa. The lowest value of Fe (5.12 ± 0.36%) and Ca (446.84 ± 4.07%) were recorded in the abdominal region of riverine and marine hilsa, respectively where lowest P (98.86±3.07 %) was found in the abdominal region of marine hilsa.

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