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Sensory evaluation and proximate composition analysis of export oriented and locally consumed fishes of Bangladesh

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Abstract. The study was conducted to investigate the sensory quality and proximate composition of export oriented and locally consumed fishes collected from four fish processing plants, four super shops and four local fish markets of Bangladesh. Sample of *Clarias batrachus*, *Amblypharyngodon mola*, *Ompok pabda*, *Labeo rohita* and *Anabas testudineus* were subjected to sensory evaluation for color, odor, taste, flavor and texture characteristics by organoleptic method and proximate composition for nutritional quality assessment using standard AOAC methods. Sensory quality evaluation revealed that average defect points of fish samples collected from processing plants, super shops and local markets were between 1.40 to 1.57, 1.67 to 2.31 and 1.36 to 2.64 respectively, indicating excellent quality of samples collected from processing plants compared to good/acceptable quality for those collected from super shops and local markets. The study of proximate composition revealed that moisture ranged from 79.71±0.07% to 66.77±0.7%, crude protein 19.05±0.31% to 16.01±0.13%, crude lipid 10.41±0.02% to1.25±0.19% and ash 3.73±0.07% to 1.43±0.04% in different fish species collected from different sources. In conclusion, the organoleptic assessment and proximate composition of collected samples indicated that the fish samples of fish processing plants were of good condition for export and consumption. The fish samples from local fish markets and super shops were within the acceptable level but not as good as the fish samples of fish processing plants.

Keywords: Fish market, Processing plant, Proximate composition, Quality assessment.

Introduction

Fish is an important part of a healthy diet and considered as rich source of protein, vitamin and minerals (Khalili *et al.* 2018). Fish received increased attention as a potential source of animal protein and essential nutrients for human (Arts *et al.* 2001, Yekeen and Olatunde 2011). Fish muscle is basically composed of water (66-81%), protein (16-21%), carbohydrates (<0.5%), lipids (0.2-25%) and ash (1.2 to 1.5%) (Shikha *et al.* 2020). It is considered to have important biological value due to the contribution of essential amino acids (Hatae *et al.* 1990) and micronutrients (McManus and Newton 2011), as well as, its high levels of fatty acids omega-3 and omega-6, higher than in most meat sold for human consumption (Gjedrem *et al.* 2012). The human body requires these elements and the deficiency in these principal nutritional elements induces a lot of malfunctioning; as it reduces productivity and causes diseases.

It is well known that fish body also contains different types of bacterial flora in gills, gut and skin (Sheng and Wang 2021). Following the death of fish, these bacteria are given a suitable environment in which to multiply quickly. The quality of fishing products is influenced by the bacterial flora on the fish (Shewan 1977). If the growing and harvesting environment of fish is polluted chemically or microbiologically, the fish are also polluted. So, consumption of fish

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specially raw or undercooked may cause disease due to infection or intoxication (Sheng and Wang 2021). As a result, consumer approval of fish and fish products is highly dependent on quality. Being highly perishable foodstuff, fish requires special care and attention from the catching site to the consumption table.

The quality of processed products is determined by the freshness of the raw materials, which is difficult to maintain due to the extended time between harvesting and processing. Inadequate processing has resulted in microbial growth which deteriorates quality and nutritional value of food products (FDA 2001). EU advised Bangladesh Government to implement HACCP system in processing industries to export safe and quality frozen food products (Naureen *et al.* 2006). The primary purpose of the fish processing industries in Bangladesh is to supply safe and high-quality products to foreign consumers. On the contrary, domestic consumers largely rely on local fish markets, as well as recently developed super shops in major metropolitan cities. People go to these markets to buy fish to meet their needs. In Bangladesh, super shops have a special corners for selling fish where modern facilities like quality water supply, refrigerated preservation, display tray, electric balance, attractive packaging system etc. are available (Begum *et al.* 2010). On the other hand, local fish markets are mostly unhygienic and lack modern sanitation systems. Local fish markets are often characterized by dirty floor, improper drainage, presence of fly, insufficient ice, poor quality water supply and packaging facilities which facilitate bacterial contamination (Alam *et al.* 2014). The fish in both types of markets, however, could have come from the same source. Freshwater fish are sold in most retail fish markets and super shops, however transportation of fish from various catching locations to distant markets takes time. Unhygienic handling, transit, and storage pose a constant risk of loss of quality and nutritional value (Begum *et al.* 2010). There are little or no information available on sensory evaluation and proximate composition of fishes collected from processing plants and domestic fish markets. This study was, therefore, designed for comparative analysis of sensory quality and proximate composition of magur (*Clarius batrachus*), mola (*Amblypharyngodon mola*), pabda (*Ompok pabda*), rohu (*Labeo rohita*) and koi (*Anabas testudineus*) collected from fish processing plants, super shops and local fish markets for evaluating their consumer acceptability.

Materials and Methods

Selection of fish samples: For the assessment, five commercially important fish species including magur (*C. batrachus*), mola (*A. mola*), pabda (*O. pabda*), rohu (*L. rohita*) and koi (*A. testudineus*) were selected because these species are popular among Bangladeshi living in-country and abroad. These 5 fish species are widely available in local fish market and super shops, they are also exported to other countries of the world as dressed block frozen.

Collection of fish samples: Fish samples were collected from four fish processing plants (Eurocross Frozen Foods Bd. Ltd., Sylhet; Saidowla (Pvt.) Enterprise Ltd., Sunamgonj; Snow King Frozen Food Ltd., Mirpur-1; Noakhali Gold Fish Processing Center, Noakhali) as processed block frozen for quality assessment. In contrast, samples of the selected fish species were collected from four local fish markets (Karwan Bazar Fish Market; Mohakhali Fish Market; Bishmail Fish Market, Savar; Savar Bus stand Fish Market) and four super shops (Agora Super Shop, Gulshan; Swapno Super Shop, Gulshan; Meena Bazar, Banani; Family Needs, Uttara). Export oriented fish samples from processing plants were collected as block frozen and transported to the laboratory in an insulated box and stored at -18^0 C. Samples from super shops and local fish markets were collected in sterile plastic bags and transported to the laboratory using icebox and then stored at -18^0 C.

Sensory evaluation: Sensory characteristics such as color, odor, taste, flavor and texture of *L. rohita, O. pabda, C. batrachus, A. mola and A. testudineus* were evaluated by organoleptic method (Howgate et al., 1992). The guidelines and methods given here using score on the organoleptic characteristics of fish as described by EC freshness grade for fishery products as shown in (Table I and II).

Table I. Grading of fresh fish

Grade	Points	Degree of freshness
A	< 2	Excellent/Acceptable
B	2 to < 5	Good/Acceptable
C	5	Reject

Table II. Determination of defect points

Characteristics of whole fish	Defect characteristics	Defect point	Grade
1) Odour at neck when broken	a) Natural odour	1	Acceptable
	b) Faint sour odour	5	Rejected
2) Odour of gills	a) Natural odour	1	Excellent
	b) Faint sour odour	2	Acceptable
	c) Slight moderate sour odour	3	Acceptable
	d) Moderate to strong sour odour	5	Rejected
3) Colour of gills	a) Slight pinkish red	1	Excellent
	b) Pinkish red or brownish	2	Acceptable
	c) Brown or grey colour	3	Acceptable
	d) Bleached; thick yellow slime	5	Rejected
4) General appearance	a) Full bloom; bright, shining; iridescent	1	Excellent
	b) Slight dullness and loss of bloom	2	Acceptable
	c) Definite dullness and loss of bloom	3	Acceptable
	d) Reddish lateral line; dull, no bloom	5	Rejected
5) Slime	a) Usually clear, transparent and uniformly spread	1	Excellent
	b) Becoming turbid, opaque and milky	2	Acceptable
	c) Thick, sticky, yellowish or green in colour	5	Rejected
6) Eyes	a) Bulging with protruding lens; transparent eye cap	1	Excellent
	b) Slight cloudy of lens and sunken	2	Acceptable
	c) Dull, sunken, cloudy	3	Acceptable
	d) Sunken eye covered with yellow slime	5	Rejected
7) Consistency of flesh	a) Firm and elastic	1	Excellent
	b) Moderately soft and loss of elasticity	2	Acceptable
	c) Some softening	3	Acceptable
	d) Limp and floppy	5	Rejected

Calculation for sensory quality assessment

$$SDP = \frac{\sum DP}{n}$$

Here, SDP = Score of defect point; $\sum$ DP = Summation of defect point; n = Number of characters

***Proximate composition analysis*:** Moisture content was determined in triplicate by placing an accurately weighed amount (1-2 g) ground sample in a pre-weighed porcelain crucible in a thermostat oven (BIOBASE Air Drying Oven, BOV-V35F, China) at 105°C for 24 h until a constant weight obtained. Crude protein was determined indirectly by measuring total nitrogen content by standard Micro-kjeldahl method by determining total nitrogen and applying the protein conversion factor of 6.25 to the results to convert total nitrogen into total protein, assuming that fish protein contained 16% nitrogen. For this purpose, known quantity of sample (approximately 30 mg), catalyst mixture (1.0 g) and concentrated H_2SO_4 (5 ml) was taken in a Kjeldahl tubes and digested in digestion unit (Model-DT220, FOSS Analytical A/S, Denmark) for 90 min to obtain a clear solution. The digest was then distilled and titrated simultaneously with a fully automatic distillation and titration unit (Kjeltec Model-DT8400, FOSS Analytical A/S, Denmark). Lipid content was determined by extracting required quantity of samples using hexane as solvent on an automatic solvent extractor (CU2046, FOSS Analytical A/S, Denmark). For this process, approximately 3g of sample were taken in thimbles and were dipped in hexane at glass vessels. Following the steps of preheating for 5 min, immersion for 1 h, washing for 30 min and recovery with the help of air for 15 min extraction of fat was completed. After extraction, the glass vessels were taken out from chamber and placed in an oven at 110°C for 30 min. The glass vessels with lipid were cooled in desiccators and weighed again. The results were then expressed as percentages, on the basis of sample weight. Ash content was determined by igniting the sample in muffle furnace at 550°C for 6 h.

***Statistical analysis*:** All the collected data were recorded and analyzed using Microsoft Excel 2007 and then presented in both graphical and tabular form.

Results and Discussion

***Sensory quality evaluation*:** It is essential to use sensory assessment wherever standards of quality need to be controlled or assured. Defect point in fish sample collected from processing plant (1.40 to 1.57) shows that they were in excellent condition. On the other hand, defect point of fish samples from super shop (1.67 to 2.31) and local fish market (1.36 to 2.64) were also found in acceptable as well as good physical condition (Table III).

Table III. Sensory evaluation of *C. batrachus, A. mola, O. pabda, L. rohita* and *A. testudineus* collected from different sources

Fish species	Defect point		
	Processing Plant	Super Shop	Local Market
Clarias batrachus	1.57	2.31	1.71
Amblypharyngodon mola	1.40	2.17	2.56
Ompok pabda	1.45	2.22	2.64
Labeo rohita	1.50	1.67	2.31
Anabas testudineus	1.55	1.71	1.36
Overall quality	Excellent	Good	Good

Sensory quality evaluation is still considered as one of the best technique to evaluate freshness and quality deterioration (Bernardi *et al.* 2013). Fish is a very perishable food due to is biochemical properties and needs to be handled with great care to extend its shelf life (Alasalvar *et al.* 2002). In the present study, fish samples in processing plants were in excellent quality because in Bangladesh 90% of the fish processing plants maintain HACCP system and equipped with modern processing facilities and product configuration system (Dhar *et al.* 2021). On the other hand, super shops have some modern facilities but they collect fish from the same source as local fish market. There is a risk of quality deterioration due to lack of hygienic handling, transportation and storage (Begum *et al.* 2010). May be due to this reason fish samples from super shops and local markets are not as good as processing plants.

Proximate composition

Moisture content: The moisture content of *C. batrachus*, *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* was between 78.59±0.15 to 79.71±0.07%, 70.48±0.4 to 74.23±0.43%, 70.47±0.04 to 72.19±0.43%, 74.48±0.54 to 76.74±0.1% and 66.77±0.7 to 69.40±0.12% respectively (Fig. 1). The highest moisture content was observed in *C. batrachus* (79.71±0.07%) among different fish species and the lowest moisture content (66.77±0.7%) was observed in koi. Among different sources of fish collection, the highest moisture content was observed in fishes that were collected from local market and the lowest was in fish samples collected from different processing plants.

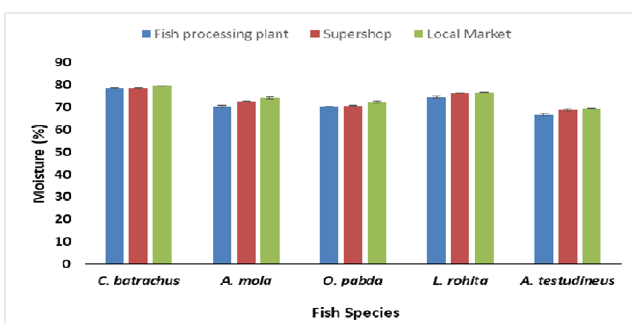

Fig.1. Moisture content in fish samples collected from different sources. The vertical bars denote SD.

Paul and Vogl (2012) found 74.89±0.91 % moisture content while studying *C. batrachus* (Hossain 1999) found 76.59% moisture content in *A. mola,* 70.87% in *O. pabda,* 73.39% to 78.09% moisture content in *L. rohita* and 76.59% moisture content while studying *A. testudineus* which is nearly similar to the findings of our present study. Bogard *et al.* (2015) studied nutritive composition of 54 species of fresh fish and found 81.3, 77.3, 70.0, 77.70 and 70.5% moisture content in *C. batrachus*, *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* fish respectively. So, the finding of the present study has shown the acceptable result over other studies.

***Protein content*:** The crude protein content of *C. batrachus*, *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* collected from different sources was between 16.59±0.15 to 16.25±0.13%, 16.64±0.25 to 15.39±0.44%, 16.92±0.26 to 15.93±0.15%, 19.03±0.26 to 16.89±0.32% and 19.05±0.31 to 17.75±0.19% respectively (Fig. 2). Paul and Vogl (2012) found 16.04±0.52% to 15.33±0.20% protein content initially while studying *C. batrachus*. Hossain *et* al. (1999) found 14.75, 15.34, 18.55 and 19.6% crude protein in *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* respectively. Bogard *et al.* (2015) studied nutritive composition of fresh fishes and found crude protein content between 16.5 to 18.2% during his study. Therefore, the findings of the present study are in line with other previous studies.

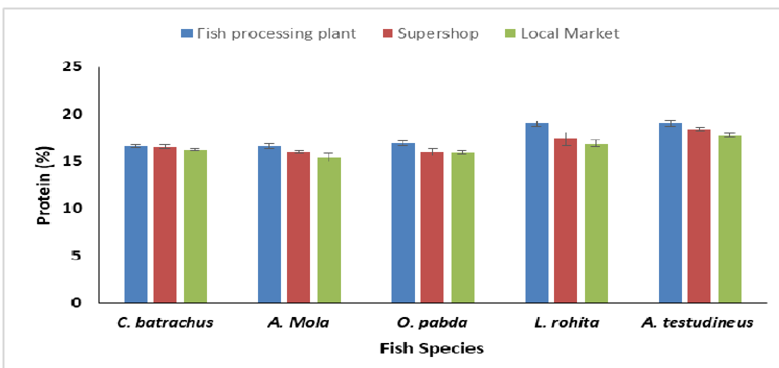

Fig.2. Crude protein content of fish samples collected from different sources. The vertical bars denote SD.

The highest amount of crude protein was observed in koi fish among five species of fishes. Among different sources of fish collection, the highest crude protein content was observed in fishes that were collected from the processing plants. This is perhaps due to the well preservation methods followed in fish processing plants. The lowest crude protein content was observed in fish samples that were collected from the local fish market. Local fish markets has lack of modern storage facilities (Begum *et al.* 2010). According to a study conducted by Obemeata and Christopher (2012) crude protein content reduces if fish samples are not stored at low temperature. Protein content of fish sample reduces 25.6% within 24 hours if the fish sample is stored at room temperature (Meenakshi *et al.* 2010).

***Lipid content*:** The lipid content of *C. batrachus*, *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* was found between 6.67±0.10 to 6.42±0.04%, 1.94±0.16 to 1.25±0.19%, 10.03±0.17 to 10.17±0.05%, 3.58±0.14 to 2.72±0.06% and 2.19±0.27 to 1.69±0.03% respectively (Fig. 3). The maximum lipid content was observed in *O. pabda* and the lowest was observed in *A. mola*. *O. pabda* is a good source of fatty acid specially polyunsaturated fatty acid (Alam *et al.* 2016). According to Dhar *et al.* (2019) *O. pabda* is a rich source of Omega-3 and Omega-6 fatty acid. Perhaps that is why the lipid content of *O. pabda* is higher than other fishes. Among the different sources of fish collection, the highest amount of lipid was found from the fishes that were collected from processing plants than the super shops and local markets. This is because fish processing plants has to follow safety and quality standards to satisfy the international market like Hazards Analysis Critical Control Point (HACCP) (Naureen *et al.* 2006), traceability (Islam *et al.* 2017) for the quality of aquaculture raw materials. The lipid content in fish is not affected much if it is stored at -80 ^{0}C, but lipid level could reduce 30-50% in one day if the sample is stored at room temperature (Meenakshi *et al.* 2010).

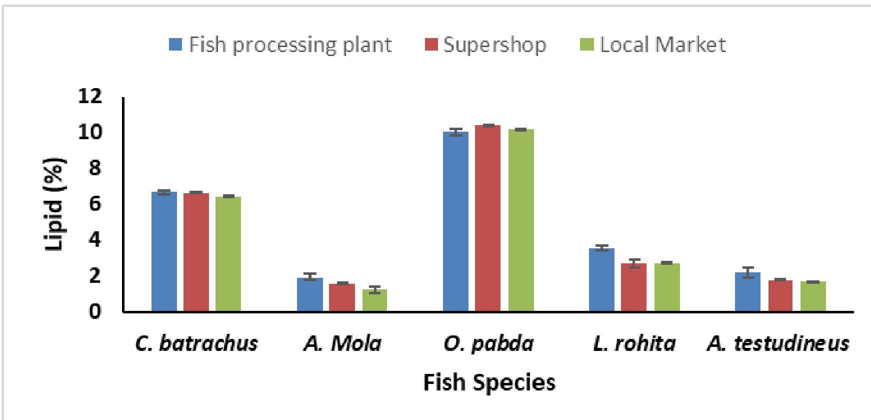

Fig.3. Lipid content of fish samples collected from different sources. The vertical bars denote SD.

***Ash content*:** The ash content of *C. batrachus*, *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* was ranged between 2.67±0.09 to 2.13±0.09%, 3.73±0.07 to 3.19±0.07%, 1.89±0.07 to 1.47±0.12%, 1.55±0.05 to 1.84±0.03% and 1.58±0.09 to 1.45±0.31% respectively (Fig. 4). The highest ash content was observed in *A. mola* during the study. According to Hossain *et al.* (1999) *A. mola* fish is very rich in mineral content (3.28%); specially, calcium and phosphorus. The maximum amount of ash content of *A. mola* fish was observed in fish samples collected from processing plants than super shop and local fish market. Bhatkar and Dhande (2000) found 2.67% ash content while studying *C. batrachus*. Hossain *et al.* (1999) found 3.28% ash content in *A. mola,* 2.35% in *O. pabda,* 1.84% ash content in *L. rohita* and 1.82% ash content while studying *A. testudineus* which is nearly similar to the findings of our present study. Bogard *et al.* (2015) found 1.1 %, 3.5%, 0.9%, 1% and 1% ash content in *C. batrachus*, *A. mola*, *O. pabda*, *L. rohita* and *A. testudineus* fish respectively. All these results indicates that the ash content found in fish samples collected from super shops and local markets are within the acceptable range but not as good as the samples collected from processing plants.

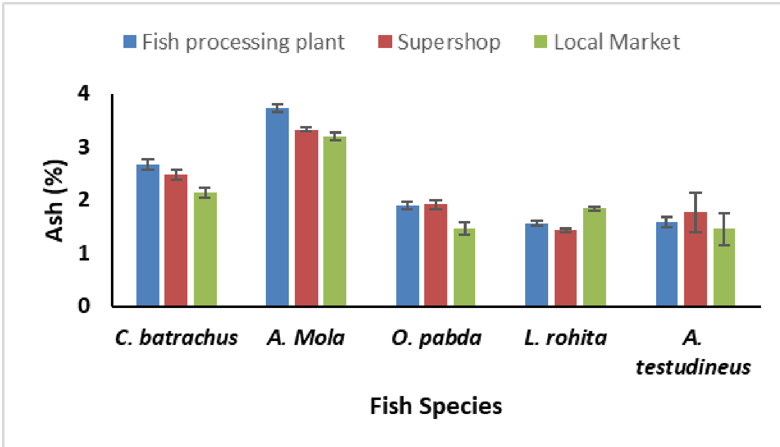

Fig.4. Ash content of fish samples collected from different sources. The vertical bars denote SD.

This study revealed that the export oriented fish samples collected from fish processing plants were of excellent quality because these plants follow HACCP system and international export guidelines during fish processing. On the other hand, sensory and nutritional quality assessment of fish samples of super shop and local fish markets were in acceptable condition but not as good as fish samples of processing plants. Good hygiene management is essential for quality fish and fishery product. Therefore, proper handling, cleaning, washing and icing facilities need to be ensured in local fish market.

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