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Research Article

Nutritional attributes of oyster *crassostrea madrasensis* collected from the coastal regions of Bangladesh

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ABSTRACT

Oysters are power-packed with the essential vitamins, important minerals and Omega-3 fatty acids along with the most essential amino acids; thus, considered as superfoods all around the world in both culinary and nutrition industries. In the coastal regions of Bangladesh, production of the oyster is somehow evident, yet under-studied and not fully utilized. This study deals with the nutritional attributes of oysters (*Crassostrea madrasensis*) in the Maheshkhali Channel of Cox's Bazar and has been conducted throughout the 12-month period spanning from March 2018 to February 2019. After analyzing the proximate composition, the result indicated that protein content varies from 40.4% to 67.1%, while lipid varies from 6.8% to 13.8% depending on the season. Among essential amino acids, lysine (5.23 % protein) content was the highest followed by aspartic acid (3.79 % protein), threonine (2.69 % protein); and histidine (1.90 % protein). The lipid content of oysters consists of the higher amount of polyunsaturated fatty acids (PUFA) with a significant amount of Eicosapentaenoic acid (EPA), Docosahexaenoic acid (DHA) and linoleic acid. Both the amino acid and fatty acid contents were found to vary significantly with the seasonal variation. Regardless of the eco-physiological distinction, the nutritional quality of oyster meat was tremendously good, especially before gamete release. This study is dedicated to recognizing the necessity of introducing oyster into the culinary industry of our country as a better protein substitute instead of the red meats with high cholesterols.

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1. INTRODUCTION

In the recent era of commercialism, oysters have earned quite a popularity as a nutritious superfood. They are one of the best known and most widely cultivated marine mollusks due to their supreme delicacy and nourishing compounds. Its dramatic growth and natural abundance have encouraged efforts to culture this species as a cheap protein source in wide region of China (Cai, 1990), Japan (Cahn, 1950), Malaysia (Chin and Lim, 1975), Singapore (Cheong and Lee, 1984), the Philippines (Walter, 1982), Thailand (Chalermwat and Lutz, 1989) and India (Rajagopal *et al.*, 1998). Ample tidal amplitude and

current, relatively less amount of pollutants and highly abundant phytoplankton offers ideal culture environment (Ahmed, 1990) while their sparse dispersal, labor-intensive collection and season-dependent supply make oysters a vital option of coastal aquaculture around the Bangladesh coast. Information on marine oysters from Bangladesh was provided by Ali and Aziz (1976), Ahmed *et al.* (1978) and Ahmed (1990) which are confined mainly into systemic account with some notes on the ecology of the mollusk. Shahabuddin *et al* (2010) reported that oysters (*Crassostrea madrasensis*) are naturally abundant in coastal areas of Bangladesh along with green mussel and clam. Promising local commerciality has been identified for oysters among millions of people from Rakhain community at Cox's Bazar and the tribal people in Hill Tracts regions by Hossain (2004) and Ghosh (2004). Despite the considerable economic importance (Parulekar and Qasim, 1981), only a little information is available on the edibility percentage and condition index of Oyster from Bangladesh (Durve, 1964). As per profuse supposition, the acceptance of oyster as a superfood in our country will eventually promote development of aquaculture technology; ultimately contributing in future employment opportunities, ensuring economic growth and forming a new horizon for coastal aquaculture of Bangladesh. This research objectifies the seasonal variation of the proximate composition of oyster proving the recognition of oyster as a superfood.

2. MATERIALS AND METHODS

Study Area

Sampling was conducted in different areas of Maheshkhali channel where the oysters are abundant; located in 21°32'N-6°32'N latitudes and at 91°58'E- 47°57' Elongitudes.

Methods of Exploitation

Generally, oysters are found in the bottom attached with different types of substrates. Therefore, the collector must go to the bottom of the channel to collect the samples. Considering the depth of water and tidal fluctuation, the collectors followed two different types of diving procedures. In case of high tide as well as high water depth, it took too much time under water to collect the oyster from the bottom. In that situation, the diver dived into the water with oxygen support. Usually oxygen cylinder, oxygen tube and pumpers were used for oxygen support to the diver. One opening of the oxygen tube was in the mouth of diver and another opening was attached to the cylinder. The cylinder and the pumper are connected via a tube. Continuous pumping was required until the diver was back into the boat. In case of low tide and less water depth, diver easily collects the oyster from the bottom without any oxygen support. In this way, the oysters were collected every month from March 2018 to February 2019.

Biochemical Analysis of Proximate Composition

Moisture

All analyses ($n = 6$) were carried out in triplicate process. Moisture of the fish samples (10g) were determined according to the AOAC (2000)/APHA (2005) method by drying in an oven at 105°C ($n = 6$). Results were expressed as percentage (%) of wet weight.

Protein

The total protein content in the homogenized samples (5g) was determined using the Kjeldahl method. Results were expressed as a percentage of wet weight ($n = 6$) basis.

Lipid extraction

The estimation of crude fat content was done by continuous extraction of fat with petroleum ether according to the AOAC method (2000). Total lipids were extracted according to the method of Folch *et al.* (1957), using chloroform/methanol (2:1). Aliquots of the chloroform layer extract were evaporated to dryness under nitrogen and the lipids were quantified gravimetrically.

Ash

Ash content was determined by heating the sample (5g) for 12 hrs. in a silica crucible in a furnace at 525 °C ($n = 6$) according to the AOAC (2000) method. Results were expressed as percentage of wet weight. Minerals were assayed using the AOAC method.

Amino acids analysis

The total amino acid composition was determined following the method of Ishida *et al.* (1981) using a Shimadzu chromatograph LC-10AT high-performance liquid chromatography (HPLC) equipped with an ion-exchange column, quaternary pump, a 20µl injection valve and a fluorescence detector with 50 Hz frequency. Mobile phase A contained sodium citrate and ethanol (pH 3.5) and B had sodium citrate and NaOH (pH 9.8). The flow rate was constant at 0.4 ml/min, and the column temperature was set at 60°C. The fluorescence excitation and emission wavelengths were 340 and 450 mm, respectively. Samples were hydrolyzed in 6 NHCl in evacuated sealed tubes at 110°C for 24h. After

derivatization by O-phthalaldehyde, amino acids were identified and quantified by comparison of their retention times with those of standards (Sigma). The results were expressed in terms of gram amino acid per 100g of crude protein.

Fatty acid analysis:

Fatty acids methyl esters (FAMEs) were obtained by the method described by Metcalfe *et al.* (1966). A fraction of the lipid extract was saponified with 0.5 N NaOH in methanol followed by methylation in 14% boron trifluoride in methanol (BF3/MeOH). The methylated sample was then extracted with 8ml *n*-hexane. All of these reactions were performed in quadruplet for each sample. The resulting methyl esters were analyzed using an Agilent Gas chromatograph system 6890 N equipped with a Flame Ionization Detector (FID), a splitless injector and a polar fused silica capillary column (30m * 0.25mm i.d. * 0.25μm film thickness). The temperature of the injector and the detector were 250 and 275°C, respectively. Helium was used as a carrier gas with a flow rate of 1.5ml/min. Peaks were identified by comparison of their retention times with FAMEs standards (Supelco).

3. RESULTS AND DISCUSSION

Proximate composition

The biochemical analysis of moisture, protein, crude fat and ash content of *C. madrasensis* was recorded as 72.6%, 58.6%, 10.3%, and 7.4%, respectively considering the average value of the year-round data.

Figure 1. Collected Oysters

The protein percentage varies from 40.4% to 67.1% where the highest amount found during the month of Autumn and Rainy season and the lowest was observed in the Summer. The average percentage of fat was ranged from 6.8% to 13.8% with the highest in the Summer and the Autumn season and lowest during the Winter. The ash content was observed to be highest in the Autumn and lowest during the Summer with a percentage from 5.7% to 10.9% (Table 1).

Table 1. Seasonal Variation of the Proximate Composition of Oyster

Seasons	Average Moisture %	Average Protein %	Average Lipid %	Average Ash %
Summer	68.2	40.4	13.8	5.7
Rainy	69.4	64.5	9.8	6.7
Autumn	79.9	67.1	12	10.9
Late Autumn	76.9	63.4	8.6	7.3
Winter	69.3	63.7	6.8	7.5
Spring	71.6	52.7	11	6.3

The protein content of the oysters peaked in the rainy and autumn seasons and was found minimum in amount during the spring season. In the rainy season, they went to their reproductive phase that's why they needed more protein in their flesh. Jeng *et al.* (1979) observed an almost similar cycle but reported maximum protein content of 65%.; whereas Whyte and Englar (1982) reported peak protein content throughout August month just the same as this study.Whyte and Englar (1982) reported an average lipid content of 7.4% for tray-cultured oysters while Jeng *et al.* (1979) found an average of 8.7% with a maximum of 12.9% in February and a minimum of 7.15% in June which slightly derives from the respective study. Jeng *et al.* (1979) reported ash content varied from approximately 10 to 20% due to their feeding habit while Whyte and Englar (1982) depicted the concentration from 9 to 14%. This ash content varied significantly over the 12 months study period with a maximum in October of 12.1% (dry flesh weight basis) and a minimum of 4%

in May due to their muscle content (Linehan *et al.*, 1998). The main constituent of oyster flesh is water, which is tightly bound to the proteins in the structure in such a way that it cannot readily be expelled even under high pressure which acts as an index of freshness. In the rainy season, moisture content is higher due to the higher intake of water for osmoregulation. Linehan *et al.* (1998) reported variations in moisture content of oysters fluctuated from a maximum value of 79.5% in January to a minimum of 73.0% in August.

Amino Acid Profile

This study identified fifteen amino acids and also quantified from the wild samples of *C. madrasensis*. Among essential amino acids, lysine (5.23 % protein) content was the highest followed by aspartic acid (3.79 % protein), threonine (2.69 % protein) (Figure 2). In the case of non-essential amino acids, histidine (1.90 % protein) was present in high concentration (Fig. 2). The concentration of lysine in oyster protein is 5.23% of crude protein which is significantly similar with the FAO/WHO recommended reference lysine standard value of 5.8% of dietary protein for adult as well as for child (2-5 year). The richness of amino acids in wild oysters has also been related to the maximum maturity (Dridi *et al.*, 2007). This demonstrates the potential capability of *C. madrasensis*, growing in wild condition, to withstand salinity and adverse stress conditions during summer because glycine or its conjugate (glycine, betaine) was earlier reported to have unique osmolytic property (Eklund *et al.*, 2005) and helps to protect the cells during summer against osmotic injury. With the generous amount of amino acids found in Oysters, they already hold a place as a superfood among the food enthusiasts around the world.

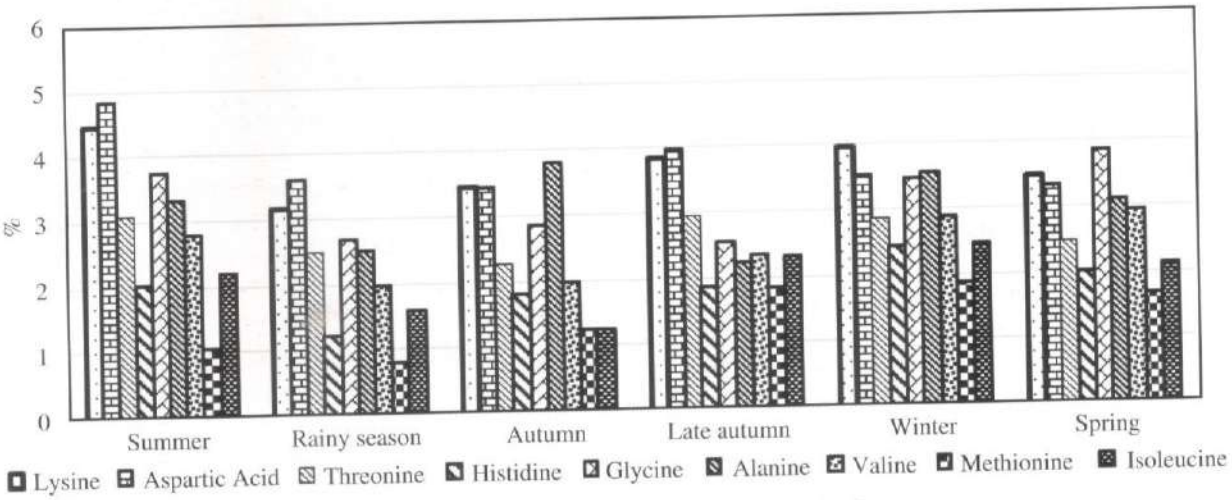

Figure 2. Seasonal variation of Amino Acids in Oyster

Fatty Acid Content

The level of different fatty acids content ranged from myristic (14:0) to docosahexaenoic (22:6) was observed during this research. The findings revealed that the fatty acid profile remained relatively constant during the study period with high concentrations of omega-3 fatty acids (18:3, 20:5 and 22:6). The overall lower concentrations of saturated fatty acids (14:0, 16:0 and 18:0) was observed during this study. Palmitic acid (16:0) and oleic acid (18:1) were the main saturated and monounsaturated fatty acid, in turn among the fatty acids content.

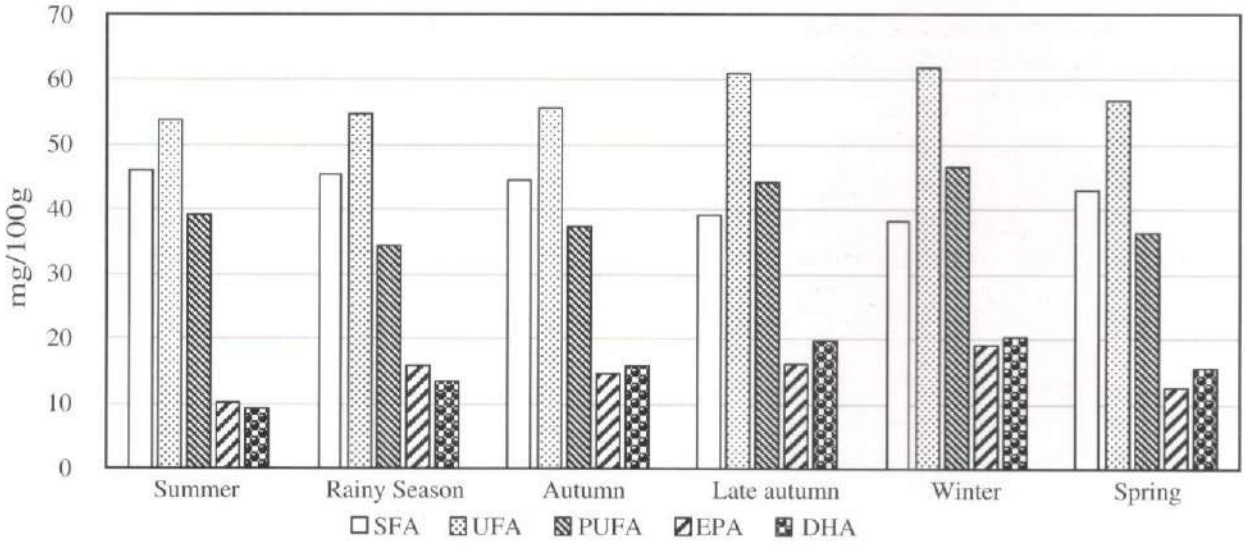

Figure 3. Seasonal variation of Fatty acid content of Oyster

Higher concentrations of saturated fatty acid, unsaturated fatty acid and polyunsaturated fatty acids were recorded during Late autumn, Winter and Spring season respectively. Higher concentrations of omega 3 fatty acids were recorded significantly during the winter while higher omega 6 concentrations were recorded during the spring. This variation in fatty acid occurred due to the changes in environmental variability such as salinity, temperature and availability of food. Sidwell *et al.*, (1979) reported that the variation of fatty acid concentrations in different site soccurs due to the changes of environmental parameters. The seasonal variation observed among the fatty acids in this study might provide a testimony to that.

4. CONCLUSIONS

As a developing country, Bangladesh needs to supply plentiful protein sources for her increasing population. Fish is one of the major sources of protein in here but sometimes it can be difficult to afford fish protein for some of the infra digitated population. If the fish protein can be replaced by the shellfish protein like Oyster, *Crassostrea madrasensis* then the demand of the protein may be fulfilled. Plus, the higher amino acids, omega 3 fatty acid content and consequently the higher omega 3/omega 6 fatty acid ratio in the oyster apparently contributes to lower atherogenic and thrombogenic indices that might even cure diseases. Introducing the oyster as superfood both to meet protein demand and to gain extraordinarily rich minerals and nutritional supplement is the call of the time now. Comparing the food availability of the oysters under different environmental conditions and water quality parameters result in better culture potentialities. Future studies are necessary for this sector to confirm the heavy metal concentration status in this species of dominant edible oyster in Bangladesh.

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