Fish and Fishery Products: Participation in the Demand for Nutrition from Animal Source to the People of Bangladesh

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Summary

Among different food items, fish/fishery product is the healthier one. For maintaining sound health and extending life span, along with fruits, vegetables, meat, fish/fishery products may contribute a lot. As a source of animal protein, healthy fat, vitamins, and minerals, fish is a very good option. The country has 0.29 million ha of inland closed (culture) water fisheries bodies along with littoral shrimp farms (National Fisheries Policy, 1998). It is also blessed with a territorial sea of more than 118,813 square km of area including 200 nautical miles (NM) of Exclusive Economic Zone (EEZ) with all kinds of living and non-living resources under the continental shelf up to 354 nautical miles from the Chittagong coast (MoFA, 2014). Fish and other aquatic organisms from these water bodies are being caught for internal consumption as well as for export purposes. Mostly, this catch is sold as wet fish; some products are also prepared traditionally like dried, salted, and fermented. Smoked, canned, fish mince-based value-added products are not prepared yet on a commercial basis. For better utilization of the county's catch and to contribute to the nutritional demand of the people it is necessary to take proper steps. Several academic and scientific institutes of the country are being engaged in developing fishery products and observing their storage possibilities. Here, findings of some researches performed on fish and fishery products in the Department of Fisheries Technology, Faculty of Fisheries, Bangladesh Agricultural University are discussed.

***Keywords**:* Fish and Fishery Products, Animal source protein, Bangladesh

Introduction

Fish and fishery products play a very important role in the dietary patterns of the people of Bangladesh. Fish, fishermen, fishing activities are integral parts of the culture and livelihoods of this country. In Bangladesh, the average fish intake amount is 19.71 kg/person/year (WorldFish; 2017). Among the animal protein sources, fish is the most commonly consumed one. At a time, fish is a good source of healthy fats, such as omega-3 fatty acids. It is also a good source of vitamins such as D and B2 (riboflavin), calcium, and phosphorus. The various species of fish are enriched in minerals, such as iron, zinc, iodine, magnesium, and potassium. In terms of nutritional profile and potential health benefits, fish muscles are different from other types of meat. For example, red meat is high in saturated fat, vitamin B12, niacin whereas fish are in unsaturated fatty acids, thiamine, selenium. Seafood, algae, and fatty fishes like salmon, bluefin tuna, sardines, and herring are the best sources of omega-3 fatty acid and DHA (docosahexaenoic acid). For the active human brain, Omega-3 fatty acids, DHA contributes well. They may contribute to improving memory. Visual development and the health of the retina in the back of the eye may be improved by taking DHA and Omega 3 enriched fishes. "For most individuals, it is fine to eat fish every day," says Eric Rimm adding that "it's certainly better to eat fish every day than to eat beef every day" (in an article of Today.com, August 30, 2015).

Like other regions of the world, in Bangladesh also fish harvest or capturing of fish from nature has declined. Due to excessive fishing in the same place, environmental pollution, and damage to the natural habitats, both the quantity of catch (biomass) and the number of available species of fish (biodiversity) are decreasing day by day. During 1991 and 2010, the consumption of fish from capture fisheries in Bangladesh reduced by 33% (Bogard et. al, 2017). Contrary, aquaculture or farming of fish, which is known as the "blue revolution", is expanding very fast. With average annual growth of

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8%, aquaculture has been the most rapidly growing food production sector in the world. In the 1980s, aquaculture was introduced to Bangladesh and at present, the country is the world's sixth largest producer of aquaculture products according to the FAO report (2016). This growth in aquaculture has compensated for the declines in the quantity of fish available from capture fisheries and over time it has increased fish consumption.

Hossain and Wahab (2010) reported that capture fisheries of the country are dominated by about 300 species of "small indigenous fish" which are often consumed whole (with head and bones). Small indigenous fishes are very good sources of important micronutrients like iron, zinc, calcium, and vitamin A, D as well as high-quality protein. The nutritional value varies greatly from species to species. Local species are generally more nutritious than the species from capture fisheries that are farmed here. Aquaculture is dominated by a large number of species, both indigenous and exotic fish. Only the flesh/ muscle of farmed fishes are usually eaten, which is a good source of high-quality protein, but these fishes lack micronutrients. Due to much intake of cultured fish, the possibility of getting other nutrients (vitamins and minerals) from fish has decreased. Thus, it has serious implications for widespread suffering from malnutrition of the people of the country (Bogard et. al, 2017). Changes in lifestyle and food habits both in rural and urban areas with the changing time, economic status of the people of this country are also correlated with the issue of malnutrition/ lack of nutrition.

From time immemorial people of this subcontinent, especially the people of Bangladesh taken fish with rice. The traditional way of taking fish in the diet is in the form of curry or fish fry. In the past due to the unavailability of low-temperature preservation facility people used to preserve their remaining catch for the future utilizing different traditional techniques. Among those techniques, sun drying is the most common one. Fish products like "Chepa shutki" and "Shidil" are being prepared using fermentation techniques mostly in Mymensingh area and in the northern part of the country. In the southern part of the country, particularly Khulna, Bagerhat, Satkherra region small catches of shrimp are

Plate: Traditional and value-added fishery products of Bangladesh

being smoked during the rainy season for preservation. After the development of low-temperature preservation facilities, the country has entered the export chain of fish and fishery products. In 2013-14, the country earned BDT 4,776.92 core by exporting 77.33 thousand MT of fish and fisheries products. This is the highest export earnings in the last 10 years, starting from 2017.

In FY 2016-17, BDT 4,287.64 crore was earned by this sector exporting fish and fishery products of almost 68.31 thousand MT. Shrimp (frozen) is one of the major export items of the country. The total production of shrimp and prawn (including capture) has increased from 1, 60,000 MT in 2002-03 to 2, 46,000 MT in 2016-17 (Shamsuzzaman, 2020). Besides frozen shrimp and prawn frozen and chilled finfish, some dried, salted/ dehydrated fish, crab, kuchia, shark fin, fish maws, etc. are also exported from the country.

Following the demand of time, it is necessary to take proper initiatives for applying modern techniques along with traditional techniques for diversified utilization of the country's fisheries resources. Urbanization has changed the lifestyle of the people thus value addition to food has been receiving much attention in the last few years The demand for value-added products is raising due to social and cultural changes (Pagarkar et. al., 2011). Therefore, the development of various kinds of value-added products from low-cost fishes could be a new era in producing and supplying nutrition from animal sources to the people of the country. At the same time, these value-added fish products could be profitable export items.

Though various fish products have already established markets in many countries of the world, countries like Bangladesh are yet to be developed. Some research projects have been completed and some are in progress on the development of various fishery products including value-added products at the research laboratories of relevant academic and scientific organizations. To meet the nutritional demand of the people of this country these fishery products may contribute a lot as well as may become an important part of export earnings.

Researches on the nutritional aspects of some fishery products have been performed in the laboratories of the Department of Fisheries Technology of Bangladesh Agricultural University are discussed below-

Dried fish products and their nutritional aspects

From time immemorial drying is one of the most popular methods of fish processing around the world including Bangladesh due to the simplicity and versatility of this method. The nutritional quality of the fish product prepared by drying keeps almost intact (as per unit weight) and it possesses a characteristic flavour which is very appealing to many people. For the drying of fish, both sun drying and dehydration processes are being used. In the case of traditional sun drying, the quality of dried products often results unsatisfactory due to lack of maintenance of hygienic conditions throughout the process. The traditional dried fishes are vulnerable to infestation with blowfly larva and beetle attacks. Farmers frequently apply insecticides like DDT in fish for safe storage (Bala and Mondol, 1998) which ultimately creates environmental problems and health hazards in a broad spectrum.

Hasan et al. (2006) studied the shelf-life of rotary and solar tunnel dried SIS products under different packaging and storage conditions. The initial percentage of moisture content of dried fishes varied from 13.71 to 22.84. After storage of 2 months at ambient and chilled temperature percentage of moisture content of dried products was in the range of 15.09 to 25.11 and 14.49 to 25.01, respectively which indicated the usefulness of sealed pack and chilled storage for ensuring the good quality of dried products for a certain period.

Uddin et al. (2014) studied the effect of salt content on the drying performance of silver jewfish (*Otolithes argentatus*) in a Hohenheim-type solar tunnel dryer. Results showed that the use of salt significantly reduced the drying period in solar tunnel dryer to 34hr compared to those of 40hr for control fish. To reduce moisture content use of 10% salt was much effective in comparison to other salt percentages indicating that-addition of salt in raw material reduced drying time and contributed to improving the quality of the product.

Rana and Chakraborty (2016) studied the changes in nutritional and microbiological quality parameters of salt-smoke-dried (SSD) product prepared with tengra (*Mystus tengara*) during storage of 2 months at ambient (26-28°C) and refrigeration (4°C) temperature. The percentage of moisture content was 76.06, protein13.45, lipid 7.46, and ash 2.80 in fresh fish. In SSD products, the values were 18.80 for moisture, 63.40 for protein, 19.95 for lipid, and 16.55 for ash content. After two months of storage of SSD products at ambient temperature, the percentage of protein, lipid, and ash content decreased to 62.75, 19.07, and 15.99, respectively whereas these values were found 62.54, 19.54, and 16.12 respectively

for SSD products stored at refrigeration temperature on dry matter basis.

Influence of salt concentration on quality parameters of solar tunnel dried silver jewfish (*Pennahia argentata*) was carried out by Uddin et al., (2017). Prior to drying, fishes were treated with 0, 10, 15, 20, and 25% salt solution. Reconstitution property was greatly influenced by salt treatment. The lowest reconstitution was obtained for 25% salt-treated solar dried fish at 80 °C Eating quality of the final product was poorer here compared to 10% salt-treated dried fish. Protein content was also found highest (68.16%) for the product treated with 10% salt suggesting that for production of better quality dried silver jewfish products, treatment with 10% salt may be recommended.

Jahan et al., (2019) carried out a study for 2 months on the quality aspects of salt-treated sun-dried ribbonfish (*Trichiurus lepturus*) stored in polythene bag both at ambient (28-33°C) and refrigeration temperature (4°C). Samples were named as- T1, control dried, i.e., treated with no salt, T2, treated with 15% salt, T3, treated with 25% salt. The initial moisture, crude protein, lipid, and ash contents of T1, T2, and T3 dried fishes were 14.40, 62.74, 9.05, and 13.65%; 20.03, 55.15, 7.40, and 16.96%; and 22.80, 51.60, 7.22 and 18.30%, respectively. After two months of storage, no significant differences could be found in the proximate composition in the dried fish samples. Among the two salt concentrations, dried fish treated with 15% salt was found to be of superior quality in terms of organoleptic properties and proximate composition.

Changes in the quality parameters of salt-smoke-dried tengra (*Mystus tengara*) during storage at room temperature (28 to 32°C) in various packing conditions were .studied by Hossain et al., (2019). The precent moisture content of tengra fish decreased from an initial value of 77.17 to a range of 18.56 to 29.09, protein from 51.36 to a range of 40.54 to 51.36, lipid from 16.20 to a range of 6.50 to 16.20, and ash from 13.40 to a range of 8.17 to 13.40 in salt-smoke-dried product during storage. Results showed that- properly salted, smoked and dried tengra can be stored at room temperature (26 to 28°C) for about 6 months without major deterioration of the product and vacuum packets might be the better option for storing this type of product among three types of packets (tied, sealed, vacuum-sealed packs).

Salted products and their nutritional aspects

While fish is salted, ageing of fish progresses with the removal of water and uptaking of salt in fish muscle because of complex action of autolysis, enzymes, and microbes. Thus a characteristic texture and flavour are developed in the salted product. This is known as the ripening of salted fish which indicates the endpoint of the salting process. In the ripened fish, the products of proteolysis and lipolysis predominate. Maillard browning reactions produce some products which play a significant role in the production of the flavour of wet salted fish (Jones, 1962). But for the dry salted product, browning is not desirable as it might deteriorate the quality of the product.

Rahman et al., (2000) studied the overall quality of hilsa (*Hilsa ilisha*) salted by different methods and stored at ambient temperature (26-30°C). The hilsa salted with saturated brine had the longest shelf life (12 weeks) while the other two products had a shelf life of 8 weeks only. Maximum rancidity occurred in the dry salted hilsa and the non-protein nitrogen content also was found highest in this product.

Changes in the nutritional quality of *M. Tengra* (Hamilton-Buchanan, 1822) prepared with different salt curing methods were studied by Latifa et al., (2014). After salting the percent values of moisture, protein, fat, and ash were 41.41, 22.05, 10.65, and 26.15, respectively of dry salted (DS) fish and for pickle salted (PS) fishes the values were 45.88, 20.43, 9.40, and 24.62 respectively. During storage, the percent moisture content increased in dry salted fish to 44.82 (7 months) and 49.09 (6 months) in pickle salted fish. The percent protein, fat, and ash contents of dry salted fish decreased to 20.99, 9.59, and 25.00 respectively within 7 months of storage and to 19.28, 8.68, and 23.41 in pickle salted fish with 6 months of storage.

Effects of different salting on the preparation of salted fish products from taki fish (*Channa punctatus*) and nutritive values of the salted products were investigated by Farid et al., (2016). In fresh, dry salted, pickle salted and brine salted taki percent moisture contents were 78.65±.07, 46.21±.04, 52.71±.06 and 62.28±.02; protein contents were 16.89±.10, 23.58±.01, 21.39±.02 and 18.02±.01; fat contents were 2.50±.06, 3.93±.01, 3.40±.01 and 2.76±.01. Among the minerals, Ca contents were 16.35, 600, 497.5, and 123 mg/100g of fish whereas Mg contents were 9.425, 147.75, 65.5, and 52.5 mg/100g of fish. In the experimental products, Fe contents were found 1.275, 3.75, 2.95, and 2.07 mg/100g of fish; and Zn contents 0.425, 1.525, 1.43, and 1.175 mg/100g of fish.

Fermented products and their nutritional aspects

Fermentation is a method which attacks the ability of microbes to spoil fish. It does this by making the fish muscle more acidic; bacteria usually cease multiplying when the pH drops below 4.5. A modern approach, biopreservation, adds lactic acid bacteria to the fish to be fermented Fermentation has been a popular technology for the preservation of fish in south-east Asian countries from time immemorial. In most cases, the process is accelerated by the use of salt, as well as by added carbohydrates.

Nayeem et al. (2010) collected semi-fermented fish products, known as *Chepa Shutki* from different stakeholders like producers, wholesalers, and retailers to analyse the proximate composition of the product. After the analysis, it was observed that percent moisture content varied between 39.62 to 46.89 where the highest value was obtained in the product collected from the retailer and the lowest value collected from the producer. Percent protein content in *Chepa Shutki* varied between 32.46 to 33.83 and lipid content from 19.25 to 24.97. In both cases, the highest value was recorded in products collected from producers and the lowest value collected from the retailer. In the case of percent ash content, the values varied between 0.81 and 1.01 where the highest value was observed in Chepa Shutki collected from wholesalers and retailers and the lowest value collected from the producer.

Nine freshwater species of small fishes namely, Kholisa, Tit Punti, Jat Punti, Tengra, Taki, Gutum, Guchi, Veda, and Bujuri were used to prepare fish sauces in the laboratory using 25, 30, and 35% of table salt by Faisal et al., (2013). On the basis of total nitrogen, percent crude protein contents were found 14.58, 13.88, and 12.6 in 25, 30, and 35% salt-treated sauces. The highest percent ash content was obtained 22.97 in 35% salt-treated sauces. Fish sauce prepared with 25% salt was selected as best in terms of quality.

Quality parameters of traditionally prepared *Nga-pi* (mostly by Rakhain people) at Cox's Bazar area were studied by Shikha et al., (2019). After collection of the samples from local producers were stored in various types of packets at different temperatures. The result of the proximate analysis showed that percent moisture content in collected *Nga-pi* samples ranged between 58.29 to 61.06, crude protein 25.88 to 27.12, crude lipid 4.18 to 5.12, and ash content 7.30 to 8.40. During 90 days of storage of *Nga-pi* at refrigeration temperature (5 to 8°C) in airtight polythene packets percent moisture, ash content increased but the percent protein and lipid content decreased with progress in the storage period.

Hossain et al. (2019) conducted a study for the development of fish sauce from small indigenous species (SIS) by using 25% salt concentration and examined their organoleptic, biochemical, and microbiological changes during the fermentation period. For this purpose Gulsa (*Mystus cavasius*), Mola (*Amblypharyngodon mola*), Tengra (*Mystus vittatus*), Chanda (*Chanda nama*), and Punti (*Puntius sophore*) were used. At the initial stage of fermentation the moisture, ash, protein, lipid in fish content were found to be 75.75%, 3.76%, 14.64%, and 4.89%. After 210 days of fermentation the moisture, ash, protein, and lipid content changed to 74.03%, 19.37%, 2.96%, and 3.42% respectively. The proximate compositions of the final product in the fish sauce were 68.17% moisture, 17.02% ash, 12.04% protein, and 2.68% lipid and the Na content was 12.13%. Fish sauces prepared in the laboratory were compared with one commercial fish sauce (Anchovy extract, King Bell brand). The physical properties and chemical composition of laboratory prepared sauce and commercial fish sauce were found to be almost similar.

Fish sauce was prepared in an earthen container utilizing underutilized spined anchovy (Stolephorus tri, locally called 'kata phasha') with 25% (w/w) salt by Khair et al., (2020) to characterize essential quality parameters. After the completion of 7 months of the fermentation process, moisture and mineral content of the sauce reached high values of 68.54 ± 0.35% and 22.56±0.35%, respectively but a concomitant decrease was found in protein (5.03 ± 0.05%) content. The TVB-N and TN values of the sauce were 18.42±0.00 mg/100 g and 0.76±0.02 g N/100 ml, respectively with a high bacterial load of 7.14±0.02 log cfu/ml.

Shikha et al. (2020) carried out a study on the shelf life of laboratory-prepared improved Nga-pi stored in various types of packets at different temperatures. Results showed that, During 180 days of storage, percent moisture increased in the airtight polythene packet to 63.03 from its initial value of 57.18 at frozen temperature. At this temperature percent protein in the sample decreased to 15.86 from the initial value of 29.78 in open polythene packet. Percent lipid content also declined during storage from 5.05 to 4.0 at refrigeration temperature in open polythene. Percent moisture content increased throughout the storage period but the rate of increase was quite slow at

frozen temperature. Observing all the results, air-tight polythene packet storage was found better than mospata or open polythene packet storage.

Smoked products and their nutritional aspects

Smoking is one of the methods of preserving fish. Smoke contains numerous types of substances that kill bacteria and thus help to preserve the products. The heat produced during the burning of wood also partially cooks and dries the fish. There are two types of smoking viz. cold smoking and hot smoking where cold smoking is done at ambient temperature at around 37°C. In some cases like the canning procedure, this smoked fish is used as pre-treated fish. On the other hand, for hot smoking high temperature (70 to 80°C) is used.

The quality of smoked Thai pangas (*Pangasius hypopthalamus*).prepared using two different temperatures (60°C and 75°C) was assessed by Rayhan et al., (2017). The result showed that due to cooking moisture content reduced but protein, lipid, and ash content of the products increased. On the basis of data obtained for quality parameters of two smoked products indicated that hot smoking resulted in a better product and it had a shelf life of 66 days.

Shelf life of smoked Tilapia (*Oreochromis niloticus*) prepared using two different temperatures and times (2hrs in 60ºC and 1.5hrs in 80ºC) and stored at refrigeration temperature (4°C) was studied by Das et al., (2017). Immediately after smoking, the percent moisture, protein, lipid, ash were obtained 67.55, 18.77, 4.26, and 3.52 in tilapia fish smoked at 60°C and 72.05, 17.64, 4.24 and 4.36 in the fish smoked at 80°C, respectively. In the case of tilapia fish smoking for 2hrs at 60°C resulted in products of longer shelf life of 65 days whereas products remained acceptable for 45 days with smoking for 1.5hrs at 80°C.

To study the shelf life of Spotted snakehead, Taki (*Channa punctatus*) Bormon et al., (2020). treated fishes with no salt and 20% salt before smoking, then stored smoked fishes at ambient temperature (30-35ºC) and refrigeration temperature (4ºC). Obtained results showed that due to cooking, a significant amount of moisture was reduced but there was an increase in protein, lipid, and ash content of the products.

Four species of small shrimps namely Horina, Chali, Chaka, and Khogda were smoked in laboratory conditions using improved techniques by Hossain et. al (2020) and changes in biochemical parameters were compared with the traditionally smoked shrimps of the same species collected from Koyra, Khulna during storage at refrigeration temperature (5 to 8°C). Immediately after smoking the percent moisture level of improved smoked shrimps (Horina, Chali, Chaka, and Khogda) ranged from 14.22 ± 0.02 to 16.15 ± 0.03 with the highest value for Khogda, but for traditionally smoked shrimps highest value was obtained for Chali (17.53 ± 0.11). At the end of 150 days of storage at refrigeration temperature, the moisture content ranged from 10.02 ± 0.0 to 12.81 ± 0.03 for all the stored smoked shrimps. During the storage, percent protein content decreased with the lapse of time and ranged between 52.14 ± 1.12 to 54.47 ± 1.12. The same decreasing trend was followed in the values for lipid. On the other hand, in the case of percent ash content values, an increasing trend was observed and values ranged from 11.06±0.14 to 23.00 ± 0.21 indicating the positive contribution of improved techniques followed in the laboratory for improving the quality of smoked shrimps. Among the three types of packets, airtight and vacuum-sealed packets serve better for storing the smoked samples.

Fish mince based value-added products and their nutritional aspects

Fish muscle without bone and skin, which is known as fish mince itself is a fish product that has drawn much attention. Fish processing industries of the country might get immediate benefits by preparing different value-added products using fish mince (Nowsad et al., 1994). In the world market, there are many fish mince-based products like kamaboko, fish ham, fish ball, fish sausage having different shapes, flavours, colours, and textures. To meet the consumer's demand appearance and flavour of these products can be altered easily by adding various ingredients to the fish mince. For domestic consumption, relatively acceptable products can be manufactured according to our own taste and flavour preference. The abundance of low-valued white-fleshed meso-pelagic or demersal species with good gelling capacity is the initial requirement for the preparation of minced-based products. While the fish mince is directly cooked at high temperature (80-90°C) without precooking at low temperature a rigid gel is formed but the elasticity of this gel is less (Niwa et al., 1991).

The shelf life of fish burgers developed from pangas catfish (*Pangasius sutchi*) during storage at room (28ºC) and refrigeration (5ºC) temperature was studied

by Ejaz et al., (2009). Variable levels of mashed potato were used in the preparation of the burger among which 25% showed the best sensory performance thus recommended for further production. The results obtained through quality parameter studies showed that the shelf life of pangus fish burgers was relatively short, in fact not more than 24 hours at room temperature (without frying) whereas at refrigeration temperature (without frying) this burger may remain in good condition until 72 hours.

Fishball was prepared with washed and unwashed mince of frozen stored striped catfish (*Pangasianodon hypophthalmus*) by Akter et al. (2013) to assess the quality parameters of the product. Results enumerated that due to frozen storage the quality (texture, flavour, and colour) of the fish muscle was affected and washing also had a negative effect on the colour and flavour of the products.

Fish pickle was prepared with dorsal and whole fish muscle (without bone and skin) from Thai pangus (*Pangasianodon hypophthalamus*) using mustard and soybean oils by Shikha et al., (2018) to observe the changes in the nutritional quality of the pickle during storage at room temperature (30-35°C). Until 12/13 days all the samples were in acceptable condition. Moisture, protein, lipid contents, and pH value decreased but ash content increased with the progress of storage time. Pickle prepared using soybean oil deteriorated faster than the pickle prepared using mustard oil.

Rahman et al., (2019) also prepared fish pickle with Thai Pangus (*Pangasianodon hypophthalmus*) to observe the changes in quality of the product during longer storage at refrigeration (5°C to 8°C) and frozen (-20°C to -18°) temperature. With progress in the storage period, percent moisture content decreased from 58.20 ± 0.194 to 48.53 ± 0.345 and 58.67 ± 0.180 to 43.90 ± 0.245 at refrigeration and frozen temperature, respectively. A decrease in percent protein content was also found in the range of 22.35 ± 0.385 to 18.85 ± 0.097 and 22.70 ± 0.141 to 14.69 ± 0.137, respectively for these temperatures. Contrary, percent lipid content increased until five months of storage and then decreased gradually at refrigeration temperature, whereas at the frozen temperature it increased gradually throughout the storage period.

Hossain et al. (2019) developed fish condiments from Thai pangus (*Pangasianodon hypophthalmus*).to study the changes in quality parameters of the product during storage at three different temperatures. The results of the experiment showed that- the TVB-N and peroxide values increased gradually with the progress of the storage period but the pH value decreased irrespective of storage temperature. At room temperature, prepared fish condiments remained in acceptable condition for a shorter period but at refrigeration temperature, they remained acceptable until 90 days and more than 120 days at frozen temperature.

Shikha et al. (2019) prepared fish balls from unwashed mince of silver carp (*Hypophthalmichthys molitrix*) incorporating with white potato, red potato, and boiled rice to study the changes in quality parameters while stored at room temperature (28°C to 32°C).and refrigeration temperature (5°C to 8°C). The white potato smash (25%) gave the better result. Percent moisture content lightly increased while stored at non-sealed polythene packets but slightly decreased in sealed polythene packets at room temperature storage while at refrigeration temperature both in non-sealed and sealed polythene packets moisture content decreased. Percent protein content decreased at both temperatures stored in non-sealed and sealed polythene packets. Percent lipid and ash content increased with the lapse of storage time in all packets.

Fish sticks were prepared using silver carp (*Hypophthalmichthys molitrix)* fish mince along with mashed potato (0, 10, 15, and 20%), wheat flour, salt, sugar, monosodium glutamate, cooking oil, and different spices like onion, ginger, garlic, green chilli paste, hot spices /garam masla by Shikha et. al (2020). During storage at ambient temperature (28 to 32°C), changes in sensory, biochemical, and microbiological parameters of prepared fish stick were determined. Results showed that the moisture, pH, and protein contents of the product decreased but lipid and ash content increased than those values obtained for raw fish mince. Among the different amounts of mashed potato in fish stick, 10% performed the best in sensory parameter analysis and thus was recommended for further production.

Incorporating silver carp (*Hypophthalmichthys molitrix*) mince in the substitution levels of 0, 20, 25, and 30% with wheat flour and different spices Shikha et. al (2020) prepared fish noodles and assessed its cooking quality. The result showed that the percent ash, protein, fat content, and calories increased with the increasing levels of fish mince in the formulations whereas the moisture content and total carbohydrate decreased. The noodles with 30% silver carp mince had higher levels of protein, fat, and calories (per 100 g).

Besides, mice-based value-added fish products some other researches also have been done in this Department. Fish pickle was prepared with Mola (*Amblypharyngodon mola*) fish by Hossain et al. (2019) to observe the changes in the biochemical parameters of the product while stored at room temperature (28°C to 32°C) in different types of packets. The percent moisture, protein, and lipid content declined gradually with the lapse of storage time but the ash content increased in sealed and vacuum-sealed packets. The shelf life of the Mola (*Amblypharyngodon mola*) pickle was very short. Pickle remained in acceptable condition until 12 days in the sealed pack and 30 days in the vacuum-sealed pack.

Some value-added seaweed food and functional food products (seaweed jelly, soup, ice cream, curd, and two functional food products viz., seaweed singara, samosa) were prepared by Sarkar et al. (2019) to study the shelf life of the products at room and refrigeration temperatures. Percent crude protein content of seaweed jelly, soup, ice cream, and curd was 8.71, 9.04, 14.96, and 16.60; lipid content was 6.76, 12.67, 10.33, and 1.10; moisture content was 42.75, 56.94, 51.68, and 58.06; ash content was 19.05, 16.27, 8.02 and 9.10, respectively. Average proximate composition percent values of seaweed singara, samosa were respectively 9.80 and 10.01 crude protein, 6.88 and 6.17 lipid, 32.08 and 27.44 moisture, 13.20 and 10.01 ash. Products kept at room temperature had a shelf life of nearly three days and in the freezer, they remained acceptable until 1 month.

A study was carried out by Shikha et. al (2020) to observe the packaging effect on the quality parameters of laboratory prepared mustard ilish at room temperature (28°C to 32°C). Biochemical and microbiological changes in the prepared product were determined. Results showed- percent moisture, protein, lipid, ash content and pH value of the product decreased than those values obtained for raw fish. Moisture and ash percentage of the product increased but protein and lipid percentage decreased during storage. At this temperature, mustard ilish though remain in acceptable condition for a short time but packaging has some effect for the extension of shelf life.

Besides, the products discussed above there are lots of scopes to research different species of fish and other aquatic organisms naturally available in the sea and inland water bodies. Utilization of modern techniques of fish culture, fishing, product development, quality control under the appropriate plan, the fisheries sector might contribute a lot to meet the nutritional demand of the people and strengthen the country's economy.

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