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Post Harvest Techniques and Utilization of Some Fishes and Small Prawns with Market Study

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POST HARVEST TECHNIQUES AND UTILIZATION OF SOME FISHES AND SMALL PRAWNS WITH MARKET STUDY

Thesis Submitted to
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Submitted by
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Dedicated

to my

Beloved son Nafees

DECLARATION

I do hereby declare that the work contained in this thesis submitted for the degree of Ph. D. is the result of my own investigation and when the works of others that mentioned have properly been cited. The thesis has not been submitted elsewhere in part or full for any degree or prize.

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CERTIFICATE

This is to certify that Syeda Nusrat Jahan, Ph.D. Fellow (Session 2009-2010, Roll. No. 09808), Faculty of Agriculture, University of Rajshahi, Rajshahi-6205, Bangladesh, has carried out the research work on "Post Harvest Techniques and Utilization of Some Fishes and Small prawns with Market study" under my continuous supervision. During her research period, she presented her activities among the professors, researchers and fellows through seminar organized by the authority of Department of Fisheries. She has fulfilled all the requirements and regulations relating to the nature and period of research for the Degree of Doctor of Philosophy.

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Abstract

The study was carried out during July 2009 to June 2015. The studied fish species (*Labeo rohita*, *Cirrhinus mrigala*, *Hypophthalmichthys molitrix*, *Puntius sophore* and Small prawns) were collected from five fish markets such as Shaheb bazar fish market, Binodpur fish market, Shalbagan fish market, Laxmipur fish market and Court bazar fish market of city corporation area, Rajshahi, Bangladesh and brought in to the Laboratory of Department of Fisheries, University of Rajshahi, Bangladesh for processing, preservation and utilization. After processing, the prepared fish powder were brought into the laboratory of Bangladesh Council for Scientific and Industrial Research (BCSIR), Rajshahi, Bangladesh, Central Science Laboratory and Institute of Biological Sciences, University of Rajshahi, Bangladesh, for the determination of biochemical compositions and shelf life assessment. The highest after dressing and washing weight was 920.5g (small prawns) and lowest was 728.9g (*H. molitrix*). After dressing and washing waste was found highest in *H. molitrix* (271.1g) and lowest was found in small prawns (79.5g). The lowest landing of the studied species was observed 40kg/day (Court bazar) and highest was 500 kg/day (Shaheb bazar). The average price of the fishes and small prawns varied from BDT. 61.3 (*H. molitrix*) to 260/kg (*P. sophore*). Different types of snacks items were prepared including fish powder such as, fish khoi cake, fish vegetable cake, fish luci and vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and papadom. The highest production cost was found BDT. 2212 (Shashlik in Small prawns) and lowest was BDT. 246 (Fish luci in *H. molitrix*). The cost benefit ratio was lowest 0: 0.26(Fish vegetable cake in *L. rohita*) and highest 0: 2.49 (Fish papadom in *H. molitrix*). The appearance, odour, colour, test, texture, flavour and overall acceptability of the fortified snacks items were good and excellent. The lowest protein content of fish powder was found 54.31% (*P. sophore*) and highest was 68.50% (Small prawns). The lowest lipid content was observed 13.33% (*P. sophore*) and highest was 19.33% (*L. rohita*). The moisture content varied from 11.55% (*L. rohita*) to 13.95% (*H. molitrix*) and the ash content varied from 0.16% (Small prawns) to 0.44% (*C. mrigala*). The lowest carbohydrate content was found 1.75g/kg (*L. rohita*) and highest was 19.23g/kg (*P. sophore*). Among the minerals contents phosphorus, calcium and iron content varied from 0.95g/kg (*L. rohita*) to 1.91g/kg (*P. sophore*), 2.49g/kg (*L. rohita*) to 2.55g/kg (Small prawns) and 0.43g/kg (*H. molitrix* and *P. sophore*) to 1.85g/kg (*C. mrigala*), respectively. In normal room temperature, total bacterial load varied from 1.5×10^2 (Small prawns) to 4.4×10^7 CFU/g (*P. sophore*) and the TVB-N values varied from 4.18 (Small prawns) to 36.65 mg N/100g (*P. sophore*). In refrigerated temperature, TVB-N values varied from 0.16 (Small prawns) to 0.74 mg N/100g (*L. rohita*) and no microbes were observed in fish powder in the present study.

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CHAPTER-1
General Introduction

General Introduction

Fisheries are one of the major components of agricultural activities, playing a significant role in nutrition, employment, income generation and foreign exchange earnings in the economy of Bangladesh. The fisheries sector has acquired a unique status in the national economy contributing to the socio-cultural setting, rural employment, as well as food and nutritional security of Bangladesh. Because of its vast span, conducive ecological conditions and immense potential for development, Bangladesh has a unique position in the sub-tropical region, within the delta of three great rivers-the Gangas, the Brahmaputra and the Meghna (Nowsad, 2014). She has 4.57 million ha of extensive water resources including i. inland capture water bodies such as river, estuaries, Sundarban, beel, Kaptai lake, flood plain etc. (39,16,828 ha), ii. inland culture water bodies such as pond, ditch, baor, shrimp/prawn farm (7,82,559 ha), and iii. marine capture area (Nowsad, 2014; DoF, 2014). The total fish production of the country in 2012 was 34.10 lakh mt. which contributed 4.37% of the gross domestic production of Bangladesh (DoF, 2014). In the year 2012-2013, the total amount of export earnings from fisheries sectors was BDT. 43126.1 million which contributed 2.01% of the total foreign exchange earnings of Bangladesh where BDT. 360.3 million came from dry fish sector. Fisheries sector contributes about 60% of the animal protein intake of Bangladesh (DoF, 2014).

Fish and fisheries play an important role in the Bangladeshi diet, constituting the main and often irreplaceable animal source food in poor rural households. Rice and fish govern the diet of Bangladeshi people to such an extent that the old proverb, ‘‘mach bhatee bangali,’’ which can be translated as ‘‘fish and rice make a Bengali,’’ continues to hold true (Roos *et al.*, 2003) from time immemorial till now. But, of all the food items we eat and see around us, fish spoils most quickly. Fish flesh is easily digestible due to low percentage of connective tissue. It is one of the most highly perishable food products, during handling and storage, quality deterioration of fresh fish rapidly occurs and limits the shelf life of the product (Sallam, 2007) if it is not properly preserved. Preservation techniques are applied to prevent fish spoilage and lengthen shelf life. A number of

methods are used to preserve fish. There are various techniques based on temperature control, using ice, refrigeration or freezing; others on the control of water activity that includes drying, salting, smoking and freeze-drying (Moneim *et al*., 2012). Among all of these preserving techniques, drying is more popular techniques of preserving fish. In Bangladesh, sun drying is the most widely used and least expensive method for fish preservation (Balachandran, 2001). Dried fish is an important source of protein in Bangladesh and it is relished by many people of coastal, central and north-eastern districts (Nowsad, 2007). Since fish is a food item and it undergoes post mortem spoilage very quickly, the fishermen, traders and processors should carefully consider all sorts (transportation, retail distribution, processing, preservation and marketing) of possible measures to delay or stop such spoilage. Proper handling of fish is necessary to control and slow down spoilage so that it reaches the consumer fresh (Nowsad, 2007). Fish is said to have spoiled when it is unfit for human or animal consumption. It is very essential that the fish reach the consumer in a highly acceptable condition. A large amount of fish is lost after harvesting with respect to quality and quantity due to hot weather, low levels of post harvest technologies and poor handling methods (Ugwumba, 1992). In Bangladesh, the post harvest fisheries sector suffers from serious qualitative and quantitative losses every year during handling and processing at different stages of the supply chain from the harvest to retail distribution. Low quality fish is of great concern to food security and public health. It also results in serious economic loss for the fish traders and processors (Nowsad, 2014). Fish harvesting, handling, processing, preservation and distribution provides livelihood for millions of people as well as providing foreign exchange to many countries (Al-Jufaili and Opara, 2006). In many rural fishing communities, the infrastructures for post harvest processing and preservation of fish is inadequate. As a result losses reach up to 40% of the total catch by weight (FAO, 1981). FAO (1994) estimated that post harvest losses remain about 25% of the total world catch annually. These losses have a profound adverse impact on fishing communities whose status and income often depend on post harvest activities. Such losses also have a detrimental impact on the socio-economic life of the fishing communities and reduce the amount of animal protein available to large segment of the population. So, for the reducing of post harvest losses, knowledge on general principles of fish processing and preservation is very

important of commercial fisheries. Post harvest research contributes to sustainability by finding alternatives to chemicals which have polluting effects on the environment and are hazardous for human health and contributes to reducing poverty by enhancing income earning opportunities for poor people and by providing time-saving processed foods to the urban people. This provides income opportunities for small stake holders and for landless laborers, which tend to be among the poorest strata in developing countries. It is done in such a manner that the fishes remain fresh for a long time, with a minimum loss of flavour, taste, odour, nutritive value and the digestibility of their flesh.

Marketing is of high importance to fisheries and fisheries development depends on improved production and processing technology and also on effective marketing system. Therefore, fish marketing is a vital aspect for sellers, consumers and other facilitating agencies. Fish marketing is not only limited to selling of fish but also includes all the activities which exert considerable impacts on the exploitation, production, distribution, preservation and transportation of fish in addition to actual sale of fish by reducing middlemen (Agarwal, 1990). Fish markets have become a major issue for aquaculture sector, where consumers demands, international competitiveness, health and quality product are important (Muir *et al.*, 1996). The prices usually fluctuated seasonally due to variations in the supply and demand (Shang, 1981). The consumers' acceptance and price levels of the market are major factors that determine economics viability in many situations (Sadanandan *et al*., 1992). Fish market making fish available to consumers at reasonable prices at right time and place in fresh condition requires an effective marketing system (Asaduzzaman *et al*., 2010). The availability and price of fish are also known to people through fish market.

Now-a-days consumer demand is expected to be high for ready to use convenience products with high nutritional value that require minimal processing before consumption. Demands for fish protein ingredients including dried fish protein to develop functional food or ready-to-eat products are gradually growing in the world (Thorkelsson *et al*., 2009). Though, dry fish is a very popular item in Bangladesh but many people do not like dried fish as for strong odour. However, fish powder having no off flavour would be a great source of high protein, lipid, ash, minerals and carbohydrate. It is dry, concentrated

and easy-to use. This high protein fish powder is uniquely processed to retain the maximum nutritional benefits of fish. Minced based fish products such as surimi, kamaboku, fish burger, fish cutlets, fish fingers, fish ball etc. are popular in many countries. Fish powder can also be used in any kind of food such as curry, soup, snacks items etc. Fish Powder is an excellent dietary supplement which can be added to a diverse range of any kind of products (Ihm *et al*., 1992a; Ihm *et al*., 1992b) to provide a healthy source of easily digested protein and can benefit the heart by lowering blood pressure and plasma total cholesterol.

In our country, a large amount of people suffer from protein deficiency. Malnutrition is a serious problem which is caused mainly due to animal protein deficit in the diet (Nuruzzaman, 1992). In Bangladesh, it is often argued that mothers and children are generally the first victims of malnutrition. Fish powder can reduce this problem. A well balanced diet that includes a variety of powder of fishes and shellfishes can also promote the growth and development of children. Fish is an excellent source of protein in the diet of Bangladesh. It is well known that fish flesh has some unique characteristics as having high protein content with balanced profile of amino acids, polyunsaturated and essential fatty acids with ω-3 series of fatty acids and low level of harmful cholesterol and saturated fat (Edwards and Kaewpaitoon, 1981). It is one of the main food constituents in our diet as it contains essential fatty acids, amino acids and some of the principal vitamins and minerals in sufficient amounts for healthy living (Borgstrom, 1961). Carbohydrates and non-protein compounds are also important constituents of fish but are present in small amounts and are usually ignored during analysis (Cui and Wootton, 1988; Love, 1980). Furthermore, some nutritional components such as, fish oil is one of the most important natural sources of polyunsaturated fatty acids having eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which have been proven to have useful effects on human body (Saoud *et al*., 2008). The live weight of majority of fish usually consists of about water (70-80%), protein (20-30%) and lipid (2-12%) (Love, 1980). The composition, however, varies greatly from species to species due to age, sex, environment, feeding, time of the year and physical activity (Huss, 1995; Weatherley and Gill, 1987). Fish powder is equally nutritive as raw fish. According to Basu and Gupta (2004), fish

specially dry fish is a rich source of protein, lipid, calcium, iron and zinc. Dried fish and prawns are an important source of protein (Azam, 2002). About 20% of total fish caught are sun dried and mostly consumed in the domestic market annually (BBS, 2005). So, fish powder would be a great source of protein, lipid, carbohydrate and fat because fish powder is made from dry fish. Knowledge on biochemical composition will help the processors to identify optimum processing and storage conditions and a proper understanding about biochemical constituents has also become a primary requirement for the students, researchers, nutritionists, dieticians and the conscious consumers (Nowsad, 2007).

Fish is highly susceptible to deterioration (Okonta and Ekelemu, 2005). This may be due to physical, chemical or microbiological effects either separately or in combination. Chemical spoilage includes chemical contamination from fuel oil, kerosene and insecticides. The other common form of chemical spoilage is due to oxidation of lipids leading to rancidity. Normally after the death of fish, the oxygen supply in the tissue ceases due to disruption of the circulatory system. In short time of post-mortem, the mitochondrial system ceases to function and finally spoilage due to microbial action and release of mucus. Enzymes from spoilage microorganisms can metabolize the amino acids of the fish muscle producing a wide variety of volatile compounds resulting off-flavors and odors. The combined total amount of ammonia (NH3), dimethylamine (DMA) and trimethylamine (TMA) in fish is called the total volatile base (TVB) nitrogen content of the fish and is commonly used as an estimate of spoilage. Total volatile nitrogen has been widely used as an index for freshness of fish (Stansby *et al*., 1944). Physical effects include loss due to birds, dogs, etc. and the effects of beetle attack or fly larvae infestation. The quality of fish powder depends upon the quality of dry fish. According to Eyo, (2001), Quality assurance investigates all aspects capable of influencing the end products and it is aimed at ensuring that the initial quality is maintained so as to reduce incidence of quality shortcomings. According to Azam *et al*. (2003), microbiological and biochemical assessment is necessary to ensure the food safety of any processed product. So, it is clear that shelflife assessment is necessary to ensure the safety of any kind of food as well as fish powder.

In spite of huge amount of dry fish consumption, there are a few reports on the nutritive or caloric values of dried fish and small prawns and no reports on the nutritive or caloric values of fish powder. In order to produce safe fish powder, knowledge of processing and preservation techniques, biochemical composition, quality and shelf life assessment of fish powder are essential which can also be helpful to prepare and consume popular snacks items with fish powder for safe human consumption.

Several research works on fresh fish marketing, fish drying, biochemical and nutritional studies of some freshwater raw and dried fish species and utilization of fish as snacks and fast food items have been conducted such as Stansby (1962), Kamaluddin *et al.* (1977), Gheyasuddin *et al.* (1979), Sipos *et al.* (1979), Maga and Reddy (1985), Siaw *et al.* (1985), Rubbi *et al.* (1987), Ihm *et al.* (1992a and 1992b), Clayton and Miscourides (1993), Choudhury (1994), Foegeding *et al.* (1996), Dalgaard (2000), Azad (2001), Alasalvar *et al.* (2002), Azam *et al.* (2003), Nowsad (2003), Mathews *et al.* (2003), Chytiri *et al.* (2004), Ozogul *et al.* (2004), Nowsad (2005), Reza *et al.* (2005), Shammi (2005), Flowra (2006), Hozbor *et al.* (2006), Ozogul *et al.* (2006), Nowsad (2007), Sallam, (2007), Naser *et al.* (2007), Kong *et al.* (2008), Pansawat *et al.* (2008), Mazumder *et al.* (2008), Hernandez *et al.* (2009), Samad *et al.* (2009), Dileep *et al.* (2010), Liu *et al.* (2010), Nowsad (2010), Khan and Nowsad (2012), Rahman *et al.* (2012), Flowra *et al.* (2012a and b), Flowra *et al.* (2013a, b and c), Haq *et al.* (2013), Islam *et al.* (2013), George *et al.* (2014), Jinadasa (2014) and Nowsad (2014), but no attempt has so far been taken to find out processing and preservation techniques of fish powder, market study of the selected species, prepare different kind of snacks items (fish khoi cake, fish vegetable cake, fish luci and vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom), biochemical composition and shelf life assessment of fish powder in Bangladesh. Therefore, the present study has been carried out to know the effective processing, preservation and utilization of fish powder (*L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns) and also know the biochemical composition, shelflife assessment of fish powder with the market study of the selected species. The carp species is most popular, nutritious and available in Bangladesh. But small sized carp fishes are less acceptable to consumer and price is also low. Alam *et al.* (2010) reported

that the price per kilogram of carp increases with size for both native and exotic species. Puti and small prawns are also available of the studied region. So, small sized carp species and small prawns are selected for the study.

Objectives of the study

- To know about the processing and preservation techniques of fishes and small prawns
- To know the shelf life of processed dried fisheries product (fish powder)
- To make some snacks items from processed dried fisheries product (fish powder)
- To determine the problems of preservation
- To know the biochemical analysis of fish powder
- To know the landing and price of different fishes and small prawns

CHAPTER-2

Review of Literature

Review of Literature

The aim of this chapter is to review the previous research and survey works related to the present study. The present work is deals with the processing and preservation of fish powder, market study of the selected species, utilization of fish powder, biochemical composition of fish powder and shelflife assessment of fish powder. The results of major relevant studies are reviewed separately on the topics.

Processing and Preservation

Connell (1957) reported that fresh fish species dried in the sun reabsorb water to a comparatively small extent and, when reconstituted, are very tough, almost rubber-like fibrous, compact and dry in mouth. During drying and also during subsequent storage, certain irreversible changes occur which affect the texture and the reconstitute properties of the products.

Boisot and Gauzit (1966) reported that 30 percent by weight of the fish was destroyed by insect infestation and that none of the conventional methods of control was successful during drying. They used various doses of radiation and the dose necessary for sterilization was estimated as between 15000 and 40000 rad (irradiation); no organoleptic changes were observed at 50000 rad (irradiation). They also studied the taste and nutritional value of the dried and smoked fish after exposing them to radiation doses ranging from 20000 to 50000 rad (irradiation); no adverse effects were reported.

Daget (1966) used ionizing radiation for the disinfestation of dried fish in sealed containers; this resulted in death or sterilization of the insects without any harmful effects to the products.

Kordyl (1976) observed that under warm and humid condition, sun-dried fish rapidly become infested by blowfly larvae.

Waterman (1976) reported that the drying and salting are traditional methods, which have been used of centuries for preserving fish.

Doe *et al.* (1977) stated that post harvest loss in dried fish product is estimated as 25% in Bangladesh.

Frazier and Westhoff (1978) stated that sun drying and smoke drying all associated with increased germicidal action with increasing temperature.

Clucas (1982) stated processing, preservation and storage are the methods which include smoking, sun drying, salting, frying or a combination of these.

Tobor (1984) reported that processing methods generally practice in Nigeria are traditional and consist of sun drying, salted and smoke drying.

Stirling (1985) reported that preservation prevents the growth of bacteria, fungi and micro-organisms as well as retarding fat oxidation which causes rancidity.

Maruf *et al.* (1990) stated that the major quality control issues encountered in dried salted fish are the variable but often low quality final product, its high salt content, insect infestation and microbial contamination which induce a rapid rate of deterioration during transport, distribution and storage.

Hossain and Afroze (1991) reported that percentage of edible flesh is higher in small sized fishes than in large sized fishes.

Neiland (1991) reported that traditional fish processing methods including smoking, char burning and sun-drying and post harvest losses persist in Lake Chad.

Kamruzzaman (1992) stated that in India, utilization of dried fish comes next to fresh fish about 8 million tons of fish (25-30%) of the world catch are being used for human consumption as dried, salted, smoked or treated by some combination of these processes.

Bonell (1994) recommended that to reduce bacterial processes immediately on dead fish, it should be beheaded, gutted, washed and chilled to inhibit unfavorable enzymatic and microbial processes.

Clucas and Ward (1996) mentioned that proper sun drying of premium quality fresh fish can minimize the post-harvest loss and thus reduce the amount of fish spoilage. During sun drying evaporation of water from fish is accomplished in two distinct phase. In the first phase, when the surface of fish wet, the rate of evaporation depends on the conditions of the air surrounding the fish. In the second phase when all the surface moisture is carried away, drying of fishes depend on the rate at which moisture can be brought of the surface of fishes.

Kilara and Harwalkar (1996) mentioned that method of processing affects the solubility of protein especially if they are exposed to heat.

Sanjeev and Surendran (1996) stated that on the global basis, 14% of the marine landings are processed by curing.

Lydia (1997) reported smoking deposits a coating of antimicrobial material or substance on the surface of the fish while at the same time impacting an attractive sheen and pleasant taste which is cherished by the local populace.

Bala and Hossain (1998) observed that during drying period, to avoid such insect infestation and microbial continuations commercial dry fish processors often apply several harmful insecticides in fish.

Neuschler (1998) found that in Bangladesh, a large quantity of dried fish is spoiled each year due to lack of proper drying, preservation and storage facilities particularly during the glut season.

Anon (2001) stated salting and drying is an ancient and simplest method to preserve fish. In India about 17% of the total catch is being used for salting and drying.

Balachandran (2001) stated that in Bangladesh, sun drying is the most widely used and the least expensive method for fish preservation.

Shanthini and Patterson (2002) observed that preservation of fishes by salt curing has long been practiced in Tuticorin as a traditional technique, the ratios of salt-to-fish are too low to ensure adequate preservation.

Azam *et al.* (2003) found that lack of proper amenities like proper handling during loading, unloading time and exposure of the fish to the high environmental temperature, lack of knowledge about scientific and hygienic methods of handling from the time to catch until it is processed into finished products contribute significantly to the loss of quality.

Haruna (2003) reported that fish is a low-acid food that supports the growth of pathogens if not carefully handled and rapidly processed after harvesting.

Pervin (2004) showed that the traditional drying of fish depends on solar.

Nowsad (2005) stated that improper handling and processing that lead to spoilage as low quality products impose threats to the public health country wide. Large quantities of dried fishes are spoiled each year due to lack of proper drying, preservation and storage facilities, particularly during the dull or bad season.

Okonta and Ekelemu (2005) stated the processing and preservation of fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses.

Reza *et al.* (2005) reported that the widespread use of chemicals and insecticides before and after drying and during storage of dried fish products in the coastal region of Bangladesh.

Akinola *et al.* (2006) reported different types of preservation methods; such as drying, smoking, freezing, chilling and brining.

Barat *et al*. (2006) observed that the freshest raw material was found to give the lowest overall yield and the lowest salt uptake.

Ahmed and Agbelege (2007) reported that smoking is one of oldest and most common methods used for fish preservation in the Chad basin.

Nowsad (2007) stated sun drying is relished by many people of coastal, central and north-eastern district.

Chowdhury (2008) stated that there was no major difference between after dressing and washing weight and waste weight of 8 SIS species and the weight of sun dried fish and fish powder are more or less same in summer, winter and rainy season.

According to **Davies *et al.* (2008)**, the processed fishery products were still stored using traditional processing and storage technologies, respectively.

Samad *et al.* (2009) stated that the traditional method of preserving fishes through sun drying is an old practice in areas adjacent to the beel.

Davies and Davies (2009) stated that efficient preparation of fish is important when top quality, maximum yield and highest possible profits are to be achieved.

Hakimeh *et al.* (2010) stated that the cooking loss was different depending on the cooking process.

According to **DoF (2011)**, in Bangladesh about 63% and 34% of frozen shrimps are exported to European Union and United States respectively.

Flowra *et al.* (2012a) observed that the rate of salt mixing in the study area was found as 1 Kg salt for 13 Kg of fishes and the duration of drying recorded to be varied from 2-6 days depending on the size of the raw fishes at normal weather condition.

Flowra and Bhuiyan (2013) reported that the time duration of drying of *H. molitrix* and small prawn were 6-5 days.

Flowra *et al*. (2013a) studied the insect infestation of dry fish at Singra, Rajshahi, Bangladesh.

Market study

Thakur (1974) described the importance of analysis of marketing margin to determine the market efficiency.

Bucksimiar (1977) observed the problem of transport and marketing of marine fishery products and their remedy.

Ahmed (1983) stated that in Bangladesh fish is marketed through many different channels and out lets. There is lack of marketing infrastructure for both wholesale and retail market. For the most part, the transportation and storage facilities are poor. The involvement of large percentage of the middlemen and commission agents reduce benefit to the fish products.

Beierlein and Woolverton (1991) stated that marketing channel is the path a product follows from the farm to the consumer.

UNIDO (1991) also reported that domestic and international marketing are handled in different way by separate agencies and organizations in the centrally planned economy of China. There are no complex marketing systems or network of distribution channels. The major markets of Chinese fishery products are Japan, U. S. A. and Hong Kong. However, the study7 found seven principal types of market intermediaries, auctioners, processors, purchase commission agents, wholesalers, retail commission agents, retailers and vendors for dry fish trade in different countries.

World Bank (1991) stated that marketing is entirely in the hand of private sector where the supply is inadequate compared to market demand. Widespread explosion of fishers and extraction of rent by traders and middle agents are evident.

Nuruzzaman (1993) reported that presently the fish marketing system of our country is important because it is often considered to be a limiting factor for fisheries development. The fish market in our country is virtually cluster disorganized activities and always

remains in the control of a influential person of the surrounding area depending on a wide range of social, economic and political factors.

Mazid (1994) noted that the involvement of large number of middlemen and commission agents reduce the benefit to fish producers. The available reports also suggest that in Bangladesh, fish is marketed through many different channels and outlets. There is lack of marketing infrastructure for both wholesale and retail market. For the most part, the transportation and storage facilities are poor.

Ali and Ahmed (1995) stated fish price also depends on the transported by truck, bus, train, van, tomtom etc. There is a connection between fish transportation and marketing. Because the quality and market price of fish in many causes depend upon the transportation facilities.

Bhuiyan and Choudhury (1995) stated that the domestic marketing system in our country is not well organized and surveillance of fish markets by government officials is only sporadic.

Hossain (1996) reported on the marketing system of prawns and indigenous fishes.

Rahman (1997) reported that in Bangladesh, fish marketing is almost exclusively a preserve of the private sector. However, the most serious marketing difficulties seem to accrue in remote communities, which lack of transport, preservation poor road facilities and where the farmers are in a particularly weak position in relation to intermediaries.

Rokeya *et al.* (1997) worked on the marketing system of native and exotic major carps of Rajshahi districts.

Mansur (2001) mentioned that the major portion of the annual fish catch in Bangladesh is caught and marketed privately. Some species are exported as dried, salted, fermented etc. Usually these frozen, dried, salted and fermented freshwater fish and sea fish species are exported to those countries where a good number of Bangladesh citizen have been living for a long period.

Reza *et al.* (2002) reported that in Bangladesh, dry fish is marketed through different channels and outlets. The marketing system operates through a series of intermediaries.

Khanam *et al.* (2003) worked on the supply and marketing of small indigenous species of fish and livelihood strategy of the retailers in a peri-urban fish market, revealed that the supply of SIS in the market is merely 25% of the total fish supply and the dominant SIS are tengra, koi, shing, punti, magur and tarabaim. Price of SIS in many cases, are higher than that of the large fishes (large catfishes, exotic and Indian major carps and hilsa). However, very erratically the price (TK 10-300/kg) depends on several factors like day-to-day supply, demand and freshness of fish.

Nurrullah *et al.* (2003) worked on the types of markets, marketing channel, types of gears used for catching of SIS. They also worked on the availability, price range and amount of losses of fishes during handling and transportation of SIS etc.

Islam *et al.* (2004) mentioned that in market, no price policy fixed by the government, fisheries co-operatives or by the trade associations. The price is fixed by supply and demand interaction. In general, fish prices have been increasing faster in proportion to other commodities. Price of fish varies with the species and size of fish, season of the year and freshness of fish. Seasonal fluctuation of landing and price was found in the surveyed markets and also observed that price of fish increased with size and seasonally fluctuations of dry fish are also common.

Ahmed and Rahman (2005) stated that inadequacy cold storage creates a serious problem of fish market.

Hossain *et al.* (2005) conducted a survey on the socio-economic condition of three fish markets at Mymensingh. The selected markets were categorized at rural market, peri-urban market and urban market. It was learnt from the survey that the availability of SIS declined to a great extent over the last few years and at presently many of such fish species are either threatened or at edge of extinction. The total supply of SIS fluctuated from 25% to 35% throughout the year in these markets. The cumulative average supply was 844 kg/month in these three markets and price of SIS ranged widely from taka 50-450/kg depending on species, location of market, time of purchase and the condition of fish.

Nurrullah *et al.* (2005) conducted a survey to evaluate the present status of harvesting, transportation and marketing of freshwater SIS of Bangladesh showed that among the 56 to 73 species of SIS, the abundance of puti, *Barbades sarsana* was highest (7-9%) followed by mola, *Amblypharyngodon mola* (7-8%), tengra, *Mystus vittatus* (6-7%) and chapila, *Gudusia chapra* (5-6%) in all the invested areas.

Afroz (2007) conducted a study on availability and marketing of fishes in three different markets in Mymensingh town. She found that a number of intermediaries: local fish retailers, agents, wholesalers and retailers in market chain. The price of fish depends on market structure, species quality, size and weight. It was found that the price per kilogram of carp increases with size. The price of catla varied from Tk. 110-140/kg, rohu Tk. 95-120/kg, mrigal Tk. 88- 110/kg, ilish Tk. 240-270/kg, Pangus Tk. 38-50/kg, Tilapia Tk. 60-80/kg and Thai koi Tk 175-225/kg. It was found that 73.33% of the retailers have improved their livelihood status through fish selling.

Ara *et al.* (2010) conducted a study on present study of fish marketing of beel Dhakatia in Khulna region. They found two marketing channel where both fishermen and intermediaries (viz. arotdar, paiker and retailer) were involved. The average marketing margin price per quintal of fishes for fisherman was Tk 340.56 and for *aratdar*, paiker, retailers were Tk 334.65, Tk 515.8 and Tk 340.4 respectively.

Nayeem *et al.* (2010) stated that the marketing system operates through a set of intermediaries performing useful commercial functions in a chain formation from the producers to the final consumers.

Amin *et al*. (2012) stated that the price was increased nearly double from dry fish producer to consumer.

Flowra *et al.* (2013c) observed in three fish market of Partipur Upazilla of Dinajpur district that the fish marketing channel starts with the fish farmer and after passing through a number of intermediaries ends at the ultimate consumer.

Utilization

Van Veen (1953) reported on a preparation called *krupuk* widely used in South-east Asia.

Venegopalan and Govindan (1967) reported that fish flakes (fish crackers) prepared from cooked and deodorized fish.

According to **Paulus *et al.* (1979)**, for the determination of sensory quality of the fish burgers scoring test was used.

According to **YU *et al.* (1981)** Fish crackers, known as *keropok*, are a very popular delicacy in Malaysia and other Asian countries.

Niki *et al.* (1983) stated the Fish Protein Powder can be turned into wet mince/leached mince (surimi) by adding four times the weight of water and has excellent functional properties such as the ability to form kamaboko gels.

Nowsad (1994) stated that value-added fish minced products will bring immediate benefit to the existing fish processing industries of the country.

Venugopal *et al.* (1996) reported that fish protein powder is an excellent source of highly digestible amino acids, but production costs normally limit its use.

Chung *et al.* (2000) stated that the Fish Protein Powder can be used in the food industry as a binder, dispersing agent and emulsifier in preparing herring roes, fillet blocks and re-structured products from beef, pork and chicken due to its strong interactions with other proteins and its high gelation ability.

Sehgal and Sehgal (2002) reported that fish patties and fingers made from carps have been suggested as convenience products, as they are preferred to traditional preparations of this fish.

Nowsad *et al.* (2004) stated a noble initiative was taken to produce fish burger from low-cost silver carp and sea catfish.

Yerlikaya *et al.* (2005) stated the demand for ready to eat and/or ready to cook products are gradually growing because of their convenience.

Ejaz (2008) used Pangus fish for the preparation of fish burger.

Ejaz *et al.* (2009) stated that the burger with fish mince was prepared using mashed potato levels of 0%, 10%, 15%, 20% and 25% of the mince.

Thorkelsson *et al*. (**2009**) reported demands for fish protein ingredients including dried fish protein to develop functional food or ready-to-eat products are gradually growing in the world.

Elyasi *et al.* (2010) reported that seafood products, such as fish fingers, fish cutlets and fish burgers could supply a variety of healthy food to increase the per capita consumption.

Shaviklo *et al.* (2010) stated that the Fish Protein Powder is a dried and stable fish product, intended for human consumption, in which the protein is more concentrated than in the original fish flesh.

Shaviklo (2011) stated that dried fish protein can also be used for producing formulated seafood and enrichment of food products.

Rahman *et al.* (2012) examine the effect of fish powder in soup mix, evaluate the nutrient specification and content of soup mix side by side drying characteristics of ingredients.

Haq *et al.* (2013) stated that obviously, in the days to come, any products with fish powder will share an important business in growing fast food industries.

Jeyasanta *et . al.* (2013) stated that the prepared edible fish powder of *Leiognathus* sp. was colorless and odorless and almost contained 90% protein.

Shaviklo (2015) stated that fish protein powder can be dried successfully and dried fish protein powder can be potentially applied as functional ingredients and nutritional supplements.

Bio-chemical Analysis

Stansby (1954) has established that information on the chemical composition of fish in respect to the nutritive value is important to compare with other source of animal protein, foods such as meat and poultry products.

Borgstrom (1961) stated that fish is one of the main food constituents in our diet as it contains essential fatty acids, amino acids and some of the principal vitamins and minerals in sufficient amounts for healthy living.

Jacquot (1961) stated that the chemical composition of flesh may vary largely between and within species.

According to Qudrat-i-Khuda *et al.* (1962) the protein content of sun-dried shutki of both marine and fresh water fishes varied from 55.50 to 74.18% in *Labotes surinamensis* (Katkoi) and *Chanina marulius* (Gazar), respectively.

Stansby (1962) reported that the proximate composition of the flesh contents for the edible portion of the different fishes which show a wide range of variation as moisture 28-90%, protein 6-28%, fat 0.2-64 % and ash 0.4-1.5%, respectively.

Jafri and Khawaja (1968) determined the chemical composition and nutritional value of some small fishes.

Jafri (1969) also determined the bio chemical composition and nutritional value of *Wallago attu*.

Love (1970) stated that moisture, fat, protein and minerals are the main components of fish meat and the analysis of the same is referred to as 'proximate composition'.

A report from **INFS (1977**) revealed that the fresh water fishes contain 70-80% moisture, 0.1-8% fat and 15-18% protein.

Love (1980) observed that the live weight of majority of fish usually consists of about water (70-80%), protein (20-30%) and of lipid (2-12%).

According to Rubbi *et al.* (1978), the market samples of sun-dried *Gadusia chapra* had moisture ranging from 9.61% to 18.64%.

Rubbi *et al.* (1987) mentioned proximate composition of some commercial species of freshwater fish.

Weatherley and Gill (1987) studied that the composition of nutrient varies greatly from species to species due to age, sex, environment, feeding, time of the year and physical activity.

Cui and Wootton (1988) stated that carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis.

Darnton-Hill *et al.* (1988) observed that the protein content of fishes ranges from 14 to 18g/100g raw edible parts.

Salam *et al.* (1995) stated that variation in proximate composition of fish flesh may vary with species variation, season, age and the feeding habit of fish.

Afroze *et al.* (1997) stated that at present time, fish is said to be not only healthier and cholesterol free source of protein but also it is the richest source of calcium, phosphorus, irons, fats, minerals and vitamins of our regular diet and also other by products.

Thilsted *et al.* (1997) reported that vitamin A, calcium, iron and zinc are present in commonly consumed small fish species of Bangladesh.

Mollah *et al.* (1998) studied the seasonal variation of the proximate composition dried *Rita rita* and found that the highest amount of moisture was 17.84%, protein 69.13%, mineral 1.41%, crude fiber 6.25% and lipid 13.92%.

According to **FAO (1999)**, usually, moisture and lipid contents in fish fillets are inversely related and their sum is approximately 80 %.

Mollah *et al.* (2000) stated that the highest moisture content with the lowest dry matters was observed in season-2 (June-July). Season-3 (October-November) was the best for the optimum amount of protein where as season-2 (June-July) was superior in the respect to micronutrient (Ca, P and K) in the fish fillet.

Andrew (2001) stated that fish is one of the most important sources of animal protein and has been widely accepted as a good source of protein and other elements for the maintenance of healthy body.

Murray and Burt (2008) stated that protein, fat and water content of fish is important to consumers, scientists and manufacturer for nutritional value, seasonal variations and considerations regarding processing.

Azam (2002) stated that dried fish is an important source of protein.

Salam (2002) stated that the protein content of *Heteropneustes fossilis* was found to be 18.25%.

Azam *et al.* (2003) studied biochemical assessment of fourteen selected dried fish and observed that moisture content ranging from 18.23-24.46%, protein varied between 40.69-68.09%. Ash and fat content were in the range of 5.08-16.02% and 2.97-26.13% respectively.

Islam *et al.* (2003) determined the biochemical constituents of *Cirrhina reba* (male and female) from a polder. The moisture 75.69% and ash 1.70% were found higher in female, while protein (19.74%) and fat (8.03%) were found higher in male. In protein wise analysis of two fish (male and female), phosphorus 293 mg/100g, calcium 822mg/100g was found in male. Comparatively nutritional value is higher in male than that of female.

Nurullah *et al.* (2003) showed that moisture content in freshly caught fish ranged from 72.97 to 76.36% with the highest moisture content in chapila and lowest in punti. Protein

content was in the range of 14.08 to 21.70 with highest value in kakila and a lowest in chapila. Ash content ranged from 0.98 to 4.54%. The highest amount of potassium (990mg/100g) was found in gol chanda while that of magnesium (200mg/100g) and calcium (400mg/100g) was found in batasi and iron (42.2 mg/100g) in chapila.

Basu and Gupta (2004) showed that the nutritional and food qualities of traditional dried products of freshwater small indigenous species (SIS) of Bangladesh content right protein and lipid. The most important and significant variation was observed in moisture content where most of the samples had higher than 15% moisture.

Hoq (2004) concluded that normally the sun-dried fishes contain 60 to 80% protein.

Shahiduzzaman *et al.* (2004) conducted an investigation on the seasonal variation of biochemical composition in batasi fish. Fat and moisture contents remained around 3% and 73% respectively. However, there is no seasonal variation of mineral contents like calcium, phosphorus and iron.

Nowsad (2005) studied bio-chemical assessment of fourteen selected dried fish and observed that moisture content ranging from 18.23-24.46%, protein varied between 40.69-68.09%. Ash and fat content were in the range of 5.08-16.02% and 2.97-26.13% respectively.

Nargis (2006) found that protein content of koi was 10.24 ± 0.79% for males and 11.07 ± 0.31% for females.

Roos *et al.* (2006) worked on the contribution of small indigenous fish species in vitamin A, calcium and iron intake and stated that vitamin A content in SIS varies from less than 100 to more than 2500 equivalents (RE) per 100g of raw edible parts.

Karthiyan *et al.* (2007) showed that freshwater fish dried to a moisture content of 6.8 to 19.9%.

Naser *et al.* (2007) stated the proximate composition of shellfish (prawn and shrimp) in Bangladesh.

Mazumder *et al.* (2008) found the moisture content of *P. chola, A. mola, G. chapra and in P. atherinoides* was 74.43%, 76.38%, 75.06% and 73.32%, respectively.

Chukwu and Shaba (2009) observed that the ash content of *Clarias gariepinus* is 3.06%.

Minar *et al.* (2012) observed that the moisture content of ilish was 66.04%.

Islam *et al.* (2013) stated that the moisture content of the dried fishes obtained from the studied area was in the range of 29.25 – 34.43%.

Flowra (2013b) stated that the moisture, ash, protein, phosphorus, calcium and iron of the dried small prawns were 40.04%, 36.77% , 32.80% , 409 mg/100g, 650 mg/100g and 4.80 mg/100g, respectively.

Sankar *et al.* (2013) recommend that the moisture content was high in 25-30 g size group and low in 3-5g size group.

Aberoumand (2014) observed that the protein content was estimated as 22%, 13.02%, 26.9%, 22% and 24% in *T. alalunga, E. japonica, C. lentillifera, O. unicolor* and *E. affinis* respectively.

Shelf life assessment

Kimura and Kiamakura (1934) recommended that TVB-N level of 10 mg/100g or less for fresh fish, 20–30mg/100g for beginning of spoilage and over 30mg/100g for spoiled fish.

Beatty and Gibbons (1936) first proposed to use of the TMA-N, as an index of fish freshness.

Stansby *et al.* (1944) stated that Total volatile nitrogen has been widely used as an index for freshness of fish.

Jones (1954) stated that the early reaction of spoilage is autolytic and bacterial enzymes become progressively the more active in the later stages.

Rao *et al.* (1962) found that, a relative humidity of over 70% was conductive to mould attack.

Janice and Lee (1968) observed that the APC of bacteria varied from 1.3×106 to 3.0x106 cfu/g in shrimp.

Graikoski (1973) stated that the stands points of quality, product deterioration and food safety, particular attention should be focused on the microbiology of dried fishery products. The physical factors used in processing, dehydration, heat and chemical preservatives, limit microbial proliferation but do not control it.

Shewan (1976) stated that spoilage is the result of whole series of complicated deteriorative changes brought about in dead fish tissue by its own enzyme, by bacteria and by chemical action.

Frazier and Westhoff (1978) stated that, generally no microbe could grow in dried products with moisture content below 15%.

Troller and Christian (1978) suggested that the microbial stability of dried fish products during processing and storage is depended upon their moisture content.

Boee *et al.* (1982) working on the storage of shrimp has observed that TVB-N increased evenly.

Malle *et al.* (1983) stated that in freshly caught fish TVB-N content is generally 18-20 mg/100g for mackerel.

Estrada *et al.* (1985) observed that the TVB-N of whiting (*Sillago maculates)* showed slow increase during the first half of storage, and levels increases more rapidly during the later stage at ambient temperature.

Reilly *et al.* (1985) stated that TVB-N are not reliable as indices of quality.

According to **ICMSF (1986),** the international accepted limit of APC of bacteria for fresh and frozen fish was $1x10^5$ cfu/g.

Iyer *et al.* (1986) reported that TVB-N level of fish in retail market was as high as 98 mg/100 g.

El Marrrakchi *et al.* (1990) reported in freshly caught fish TVB-N content is generally superior to 10 mg/100g and does not exceed 15 mg/100g except for pelagic fish, 16-18 mg/100g for sardine.

Pérez-Villarreal and Pozo (1990) recommended that in freshly caught fish TVB-N content about 30 mg/100 g for albacore tuna.

Kamruzzaman (1992) observed that when water content of fish falls below 25% of the wet weight bacterial action stop. While the water content is further reduced to below 15%, mould ceases to grow. When salt is added to the fish before drying, less water needs to be removed to achieve of 35%, depending on amount of salt present is often dry enough to inhibit the growth of moulds and bacteria under most climatic condition.

According to **Siddaiah *et al.* (2001),** the acceptability limits of TVB-N were reported at 30 mg/100g meat for silver carp (*Hypophthalmichthys molitrix*).

Jamin and Ayinla (2003) reported that spoilage of fish is slowed down at freezing temperatures.

Salim in (2005) observed in Hilsha, the APC of bateria was 1.6×10^5 cfu/g.

Osho *et al.* (2007) stated that *A. niger* and *A. flavus* had been reported as the common agents of food spoilage most especially in the tropics where their spores are widely distributed.

Hossain (2010) observed that the APC of bacteria in raw block frozen shrimp was $8.1\pm0.47\times10^4$ cfu/g and in cooked IQF shrimp was $1.30 \pm 0.29\times103$ cfu/g.

Ali *et al.* (2010) showed that the acceptable amount of TMA varies from 6.81 ±.17 mgN/100g to 13.25 ±21 mgN/100g, 13.57±37 to 26.40±100g is moderately acceptable whereas 33.12±.11 mg/100mg is just acceptable, 39.37±.33 mgN/100g to 71.41±.35 is unacceptable for shrimp.

Quaiyum *et al.* (2012) observed that the APC in raw and frozen product of Chapila and Tengra was found to be in the acceptable limit ranged between 0.8x105 cfu/g to 3.2x105 cfu/g.

Hassan *et al.* (2013) stated that most of the quantitative loss was found in storage (18.7%) and during marketing (7.9%).

Islam *et al.* (2013) stated that the bacterial load of dried Puti, mola, taki and bele were 2.3×10^5, 2.5×10^5, 3.6×10^7 and 9.4×10^5 cfu/g, respectively.

Farid *et al.* (2014) stated that TVB-N, pH value, FFA (Quality parameters) of fresh Shoal and Taki fishes were 4.41 mgN/100g, 6.9 and 0.6% and 3.43mgN/100g, 7.0 and 0.5%, respectively.

CHAPTER-3

Processing and Preservation

Introduction

Processing and preservation are very important part of commercial fisheries. It is done in such a manner that the fishes remain fresh for a long time, with a minimum loss of flavour, taste, odour, nutritive value and the digestibility of their flesh (Wikipedia, 2015a and b).

The term fish processing refers to the processes associated with fish and fish products between the time fish are caught or harvested, and the time the final product is delivered to the customer. Although the term refers specifically to fish, in practice it is extended to cover any aquatic organisms harvested for commercial purposes, whether caught in wild fisheries or harvested from aquaculture or fish farming. Processing fish involves primarily the application of preservation techniques in order to retain quality and increase shelf life. It may also deal with value-adding to produce a wide variety of products (Wikipedia, 2015a).

Fish is highly perishable due to its chemical composition. Fish flavour and texture change rapidly during storage after death (Emere and Dibal, 2013). It is also a high protein product which makes it susceptible to rapid degradation by micro-organisms. Fish is thus a product that needs proper handling and processing in order to preserve nutrients and its functional components that promote good health. A central concern of fish processing is to prevent fish from deteriorating, and this remains an underlying concern during other processing operations. Fish processing can be subdivided into fish handling, which is the preliminary processing of raw fish and the manufacture of fish products. Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces dried, chilled, frozen and canned products for the retail and catering trades (Wikipedia, 2015a).

Fish preservation is also a very important aspect of the fisheries. Normally the fish farms or other fish capturing sites are located far off from the market place and there is chance

of fish decomposition and the uncertainties of their sale in market. When the fishes are caught in numbers, greater than the amount of consumption, their preservation becomes a necessity for their future use. Preservation techniques are needed to prevent fish spoilage and lengthen shelf life. They are designed to inhibit the activity of spoilage bacteria and the metabolic changes that result in the loss of fish quality. Spoilage bacteria are the specific bacteria that produce the unpleasant odours and flavours associated with spoiled fish. Fish normally host many bacteria that are not spoilage bacteria, and most of the bacteria present on spoiled fish played no role in the spoilage. To flourish, bacteria need the right temperature, sufficient water and oxygen and surroundings that are not too acidic. Preservation techniques work by interrupting one or more of these needs. Ancient methods of preserving fish included drying, salting, pickling and smoking (Wikipedia, 2015b).

All of these preserving techniques, drying is the more popular technique of preserving fish. It is the removal of moisture in food to make them less perishable. It is also the oldest technique used to hinder the decomposition of food products. As early as 12,000 B.C., Middle Eastern and Oriental cultures were drying foods using the power of the sun. Though the technology of food preservation and processing has undergone revolutionary changes over the years and several new products processed employing diverse techniques have made their firm presence in the market, drying still continues to be the most widely used method for preservation of several foods including fish. Drying provides the following advantages: a) Dried food requires less storage space than other types of food b) Dried food weighs much less than the equivalent amount of canned products and c) Food can be preserved without the addition of sugar or any other preserving agent (Wikipedia, 2015b).

In many areas of the world, drying is still the principal means of preserving fish. Although dried fish does not give similar flavor, taste or texture of fresh fish, it is linked and consumed by a large number of people of the world because of its characteristics taste and flavor developed in the products during the drying process. Freshly prepared dried fish will have an attractive creamy colour. The main problem of traditional sun drying is fly

larvae infestation, where 30% of the fish dried is wasted in addition in exposed to dust and rain (Doe *et al.,* 1977).

In Bangladesh, according to a local estimation about 20% of the artisanal catches are sun dried and consumed in the domestic market. In the country large losses of fish occur due to spoilage every year. It has been estimated that about 8% of the catch amounting to 4.25 million tones never reached the market and become spoiled due to lack of preservation. Much fish is preserved by traditional method of sun drying (Ahmed, 1957; Rubbi *et al.*, 1978). Proper sun drying of premium quality fresh fish can minimize the post- harvest loss and thus reduce the amount of fish spoilage.

Drying is the biggest fish processing activity in both value and volume in coastal region as well as all over Bangladesh. In 2011-12 and 2012-2013 the total fish harvest of Bangladesh were 32.61 and 34.10 thousand metric tons (DoF, 2014). More than 95% of the total fish are harvested by artisanal fishing boats. Quality processed fish product (dried fish) depends on the quality raw materials. But, in Bangladesh most of the artisanal fishermen are illiterate who are mainly performing the process of drying of fishes. There are frequent complaints from the consumers about the quality of the dried fish products. Lack of proper amenities like proper handling during loading, unloading time and exposure of the fish to the high environmental temperature, lack of knowledge about scientific and hygienic methods of handling from the time to catch until it is processed into finished products contribute significantly to the loss of quality (Azam *et al*., 2003). Improper handling and processing that lead to spoilage as low quality products impose threats to the public health country wide. Large quantities of dried fishes are spoiled each year due to lack of proper drying, preservation and storage facilities, particularly during the dull or bad season.

It is known that dried fish is an important source of animal protein intake of poor households and fish drying is popular and easy method to the fishermen of Bangladesh. According to Basu and Gupta (2004), fish specially dry fish is a rich source of protein, lipid, calcium, iron and zinc. Most of the fishermen of Bangladesh are poor and they have

no modern preservation facilities. So, drying is the appropriate method to them for preserving fish.

It is desirable that the requirement of satisfactory and hygienic dried products should be available to all those who are concerned with the expansion and development of fish processing, particularly in those regions of the world where an improvement in the fishery would have a marked effect on the standard of living of the people (Janakantha, 2001). So, it is necessary to know about the proper processing and preservation techniques of fish and other fisheries items, for the identification of the problems of traditionally preservation techniques of dried fishery product and contamination with unhygienic materials which affect the quality of dried product.

Although, several research works with few efforts on fish drying (Nowsad, 2003; Nowsad, 2005; Reza *et al*., 2005; Nowsad, 2007; Chowdhury, 2008; Samad *et al*., 2009; Flowra *et al*., 2012a; Flowra, 2013a; Flowra and Bhuiyan, 2013) have been conducted in Bangladesh but no such work has been carried out on the processing and preservation techniques of fish powder of the selected species. Therefore, the present study is an attempt to know the effective processing and preservation techniques of fish powder of some fishes and small prawns.

Materials and Methods

Collections of specimens

The five fisheries items like Rui (*Labeo rohita*), Mrigel (*Cirrhinus mrigala*), Silver carp (*Hypophthalmichthys molitrix*), Puti (*Puntius sophore*) and small prawns were collected in a fresh condition from five fish markets of city corporation area, Rajshahi, Bangladesh. After collection, all the samples were brought into the Laboratory of Department of Fisheries, University of Rajshahi, for further investigation.

Measurements

At first, the excess water was removed with the help of tissue paper from the samples and then weighed with the help of kitchen balance. Then total length and standard length were measured in centimeter scale with the help of measuring board. Discarded part was separated with the help of kitchen knife and then washed with fresh water and excess water was soaked with the help of blotting paper and then weighed also.

Different lengths and weights measurements:

Total length (TL): The length from the tip of the snout up to end of the caudal fin was taken.

Standard length (SL): The length from the tip of the snout up to base of the caudal fin was taken.

Total weight (TW): Total weight of the fishes.

After dressing weight (ADW): Fins, alimentary tract, jaw, gills, head and scales of the fishes were removed. Then the fishes were washed thoroughly with tap water and the fishes were weighed.

Waste weight (WW): Fins, scales, alimentary canal, jaw, head and gills were separated. The waste weight was calculated by subtracting the after dressing and washing weight from the total weight.

Processing:

At first the specimens were washed thoroughly with tap water and socked with blotting paper or tissue paper to remove excess water. Then scales, fins and viscera were separated from the abdomen. Rinse the fish in running water. Then the fishes in the laboratory were weighed with the help of kitchen scale. After weighing the fresh fishes were taken in the plate for drying.

Sun drying:

Drying involves removal of water from a body, in context of fish. Sun drying was carried out in the open air. During sun drying fishes and small prawns were kept covered by net to prevent bird and fly infestation. After the drying of fishes and small prawns the dried species were also weighed.

Powdered product

The dried fishes and small prawns were kept at natural condition and then powdered with the help of kitchen blender then it sieved for separating the smallest bones from the powder. Then the powder was weighed by digital balance and again dried under sun.

Preservation

The powder of the dried fishes and small prawns were kept at natural room condition and in home refrigerator in plastic container.

Temperature and humidity record

Air temperature was recorded by thermometer and humidity was recorded by hygrometer.

Statistical analysis

Data were expressed as mean ± SD and done by computer software MS Excel.

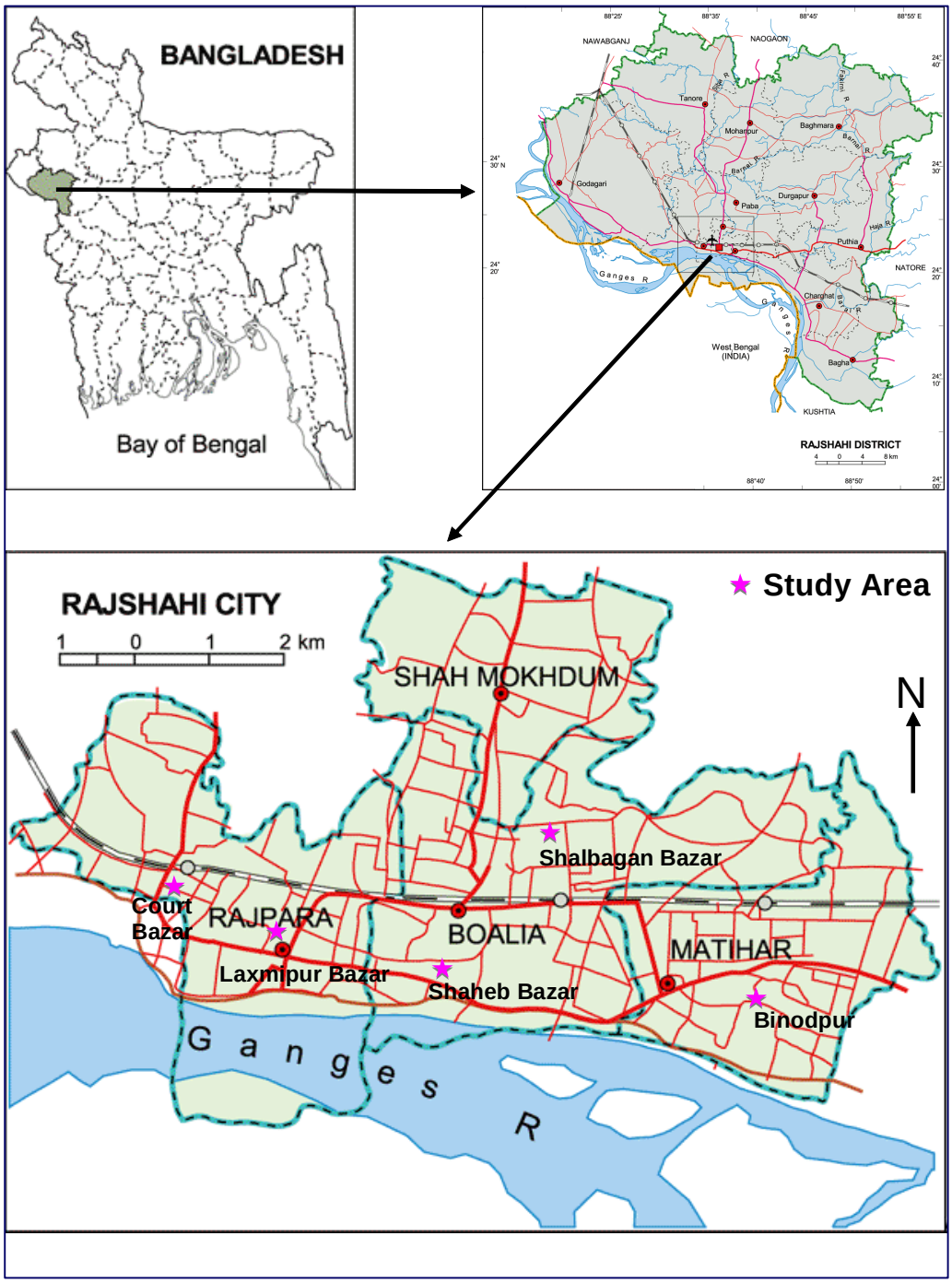


Fig. 3.1: The study area of the present study

Plate-3.1: Raw fishes and small prawns for drying

Plate-3.2: Shows the measurement of total length and standard length of fish by using measuring board

Plate-3.3: Shows the weighing of small prawns by using kitchen balance

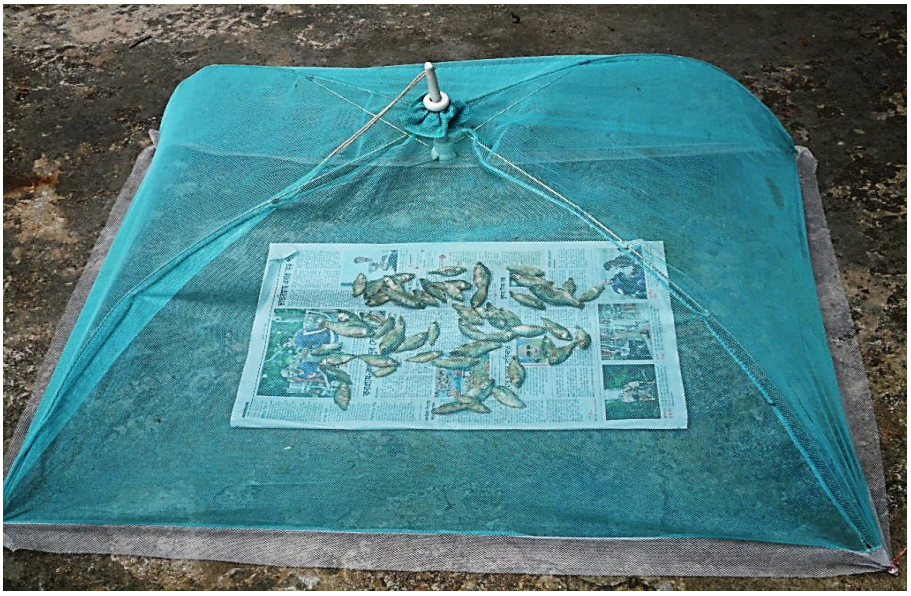


Plate-3.4: Shows the fishes during drying period covered by net

Plate-3.5: Shows the small prawns after drying

Plate-3.6: Shows the process of powdered from dry fish in the study

Plate-3.7: Shows the fish powder

Plate-3.8: Digital balance used for the weighing of powder

Plate-3.9: Fish powder preserved in plastic container in normal room temperature

Plate-3.10: Fish powder preserved in plastic container in refrigerator

Results and Observations

The present study was conducted on some different species and small prawns such as *Labeo rohita*, *Cirrhinus mrigala*, *Hypophthalmichthys molitrix, Puntius sophore* and small prawns. The temperature and humidity were recorded in the drying period. The total length, standard length and different weight of different stages of fishes and small prawns during drying period were also recorded. In the present study, four types of carps and small prawns (Three types of species) were used for the experiment. The common name, local name, scientific name, family and habitat of the selected species are presented in Table-3.1.

Table-3.1: Common name, local name, family, scientific name and habitat of the fishes and small prawns

Common name	Local name	Family	Scientific name	Habitat
Carp	Rui	Cyprinidae	*Labeo rohita*	Freshwater
Carp	Mrigel	Cyprinidae	*Cirrhinus mrigala*	Freshwater
Carp	Silver carp	Cyprinidae	*Hypophthalmichthys molitrix*	Freshwater
Minnows, Barb	Puti	Cyprinidae	*Puntius sophore*	Freshwater
Golda river prawn	Goda chingri, Brammoni chingri	Palaemonidae	*M. dolichodactylus*	Freshwater and Brakish water
Kuncho river prawn	Kunchu chingri, gura nicha	Palaemonidae	*M. lamrrei*	Freshwater and Brakish water
Monsoon river prawn	Chotca icha, jhati golda, choto golda	Palaemonidae	*M. malcolmsonii*	Freshwater and Brakish water

In the drying period of different species the temperature varied from 26.30 to 34.45˚C. In case of *L. rohita* the temperature varied from 26.30 to 33.35˚C with an average 29.8± 3.32. In case of *C. mrigala* the temperature varied from 26.65 to 34.40˚C with an average 30.5±2.88. In case of *H. molitrix* the lowest temperature was 23.63˚C and highest temperature was 31.6˚C with an average 27.6±2.65. The temperature ranged from 26.72 to 34.45˚C in case of drying period of *P. sophore* with an average 30.6±3.65 and the temperature ranged from 26.55 to 34.25˚C in case of drying period of small prawns with an average 30.4±3.85 (Table-3.2). In the drying period the humidity varied from 84 (*P. sophore*) to 86.25% (*H. molitrix*) with an average 85.1±0.84. The time duration were varied from 3 to 6 days with an average 5.2±1.30 (Table-3.2) in different species.

Table-3.2: Temperature, Humidity and Duration of drying of different fish species and small prawns (Appendix table 1 and 2)

Species	Temperature (ºC)			Humidity (%)	Days
	Max	Min	Mean±SD		
L. rohita	33.35	26.30	29.8±3.32	84.75	6
C. mrigala	34.40	26.65	30.5±2.88	85	6
H. molitrix	31.6	23.63	27.6±2.65	86.25	6
P. sophore	34.45	26.72	30.6±3.65	84	5
Small prawns	34.25	26.55	30.4±3.85	85.5	3
Mean±SD	33.61±1.20	25.97±1.31	29.25±1.78	85.1±0.84	5.2±1.30

The highest total length was found 29.5 cm in *H. molitrix* and lowest was 3.5 cm in small prawns. The average total length of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 19.31 cm, 25.55 cm, 28.54 cm, 5.1cm and 4.89 cm, respectively. The highest standard length was observed 24.4 cm in *H. molitrix* and lowest was 2.9 cm in small prawns. The average standard length of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 15.4 cm, 20.5 cm, 23.33 cm, 4.2 cm and 4.05 cm, respectively (Table-3.3).

Table-3.3: Total length (TL) and Standard length (SL) of the selected fishes and small prawns (Appendix table 3-7)

Species	No. of specimens	Range of TL (cm)			Range of SL (cm)		
		Min	Max	Mean±SD	Min	Max	Mean±SD
L. rohita	10	17.1	19.8	19.31±1.27	13.7	17.1	15.4±0.96
C. mrigala	06	25.2	26	25.55±0.33	20	21.1	20.5±0.41
H. molitrix	04	27.7	29.5	28.54±0.74	22.8	24.4	23.33±0.68
P. sophore	80	3.8	6.4	5.1±0.77	3.1	5.3	4.2±0.68
Small prawns	500	3.5	6.9	4.89±1.15	2.9	5.2	4.05±0.74

The amount of each fresh species was 1000g before dressing and washing. But after dressing and washing, different species showed different weight. The highest after dressing and washing weight was 920.5g (small prawns) and lowest was 728.9g (*H. molitrix*). After dressing and washing waste weight was found highest in *H. molitrix* (271.1g) and lowest was found in small prawns (79.5g).

After dressing and washing weight of *L. rohita*, *C. mrigala* and *P. sophore* were 745.5g, 730.7g and 800.2g, respectively whereas the waste weight were 254.5g, 269.3g and 199.8g respectively. The average ratio between the weight of after dressing and washing and waste product was 1: 0.27 (Table-3.4 and Fig. 3.2).

Table-3.4: Ratio between the weight of fish and waste part after dressing and washing

Sl. No	Species	Mean wt. of fish (g)	After dressing and washing		Ratio between weight after dressing and washing and waste part
			Wt. of fish and small prawn (g)	Waste wt. (g)	
1	*L. rohita*	1000	745.5	254.5	1: 0.34
2	*C. mrigala*		730.7	269.3	1: 0.37
3	*H. molitrix*		728.9	271.1	1: 0.37
4	*P. sophore*		800.2	199.8	1:0.24
5	Small prawns		920.5	79.5	1: 0.08
Mean±SD		1000	785.16±81.00	214.84±81.00	1: 0.27

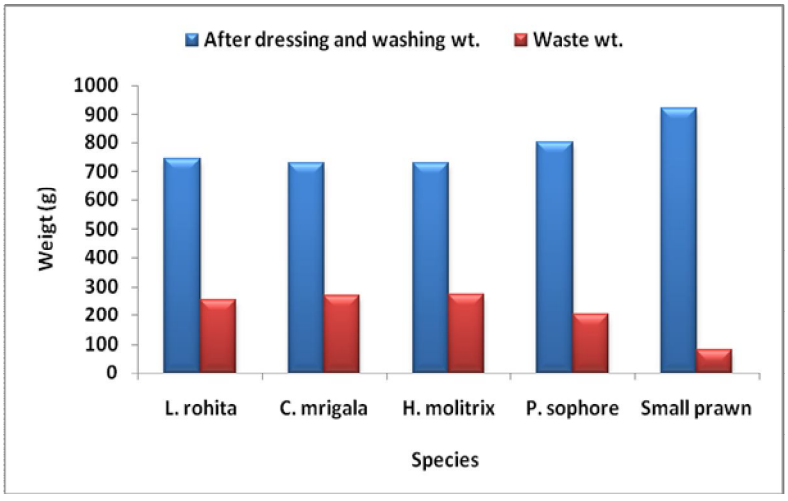


Fig. 3.2: After dressing and washing weight and waste weight of fishes and small prawns

Relative percentage of after dressing and washing weight (ADW) was found highest 92.05% in small prawns and lowest was 72.89% in *H. molitrix* whereas the relative percentage of after dressing and washing waste weight (WW) was found highest 27.11% in *H. molitrix* and lowest was 7.95% in small prawns. Relative percentage of after dressing and washing weight (ADW) of *L. rohita*, *C. mrigala* and *P. sophore* were 74.55%, 73.07% and 80.02% whereas the relative percentage of after dressing and washing waste weight (WW) were 25.45%, 26.93% and 19.98%, respectively (Table-3.5, Fig. 3.3).

Table-3.5: Relative percentage of after dressing and washing weight (ADW) and waste weight (WW) of fishes and small prawns

Sl No.	Species	ADW (%)	WW (%)
1	*L. rohita*	74.55	25.45
2	*C. mrigala*	73.07	26.93
3	*H. molitrix*	72.89	27.11
4	*P. sophore*	80.02	19.98
5	Small prawn	92.05	7.95
Mean±SD		78.51±8.10	21.48±8.10

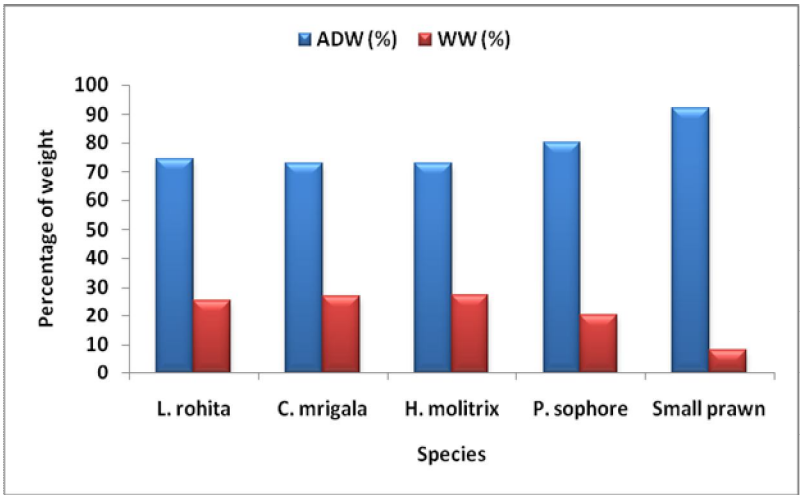


Fig. 3.3: Relative percentage of after dressing and washing weight and waste weight of studied species

The highest weight of sun dried fishes was found 276.9g in small prawns and the lowest weight was found 152.4g in *H. molitrix*. The sun dried weight of *L. rohita, C. mrigala* and *P. sophore* were 154.3g 162.5g and 200.2g, respectively. The highest weight of fish powder was found 268.5g in small prawns and lowest was found 112.4g in *H. molitrix*. The weight of powder of *L. rohita*, *C. mrigala* and *P. sophore* were 115.4g, 125.5g and 180.5g, respectively (Table-3.6, Fig. 3.4 and 3.5).

Table-3.6: After dressing and washing weight, dried weight and weight of powder product of fishes and small prawns

Sl. No.	Species	Wt. of fishes and small prawns after dressing and washing (g)	Weight of dried fishes and small prawns (g)	Weight of powder (g)
1	*L. rohita*	745.5	154.3	115.4
2	*C. mrigala*	730.7	162.5	125.5
3	*H. molitrix*	728.9	152.4	112.4
4	*P. sophore*	800.2	200.2	180.5
5	Small prawns	920.5	276.9	268.5
Mean±SD		189.26±52.67	21.8±6.86	160.46±66.40

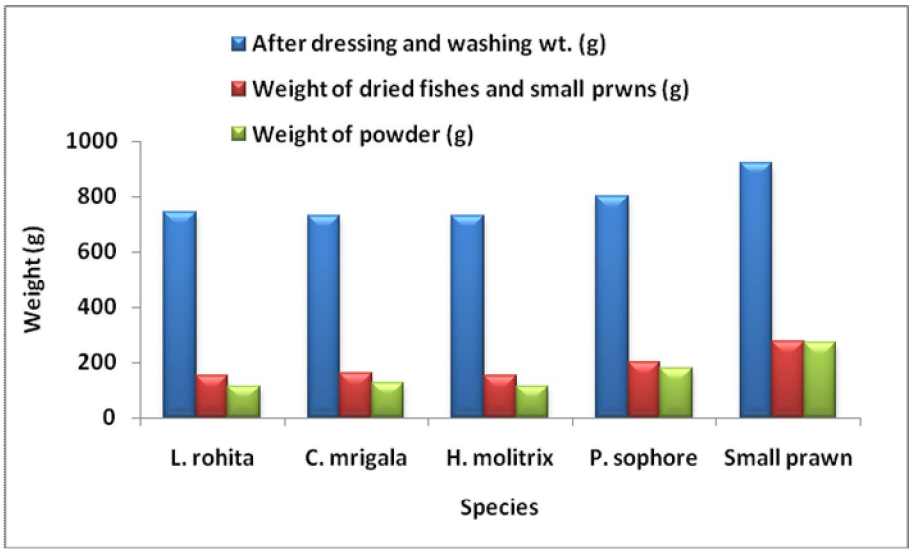


Fig. 3.4: After dressing and washing weight, weight of dried fishes and small prawns and powder

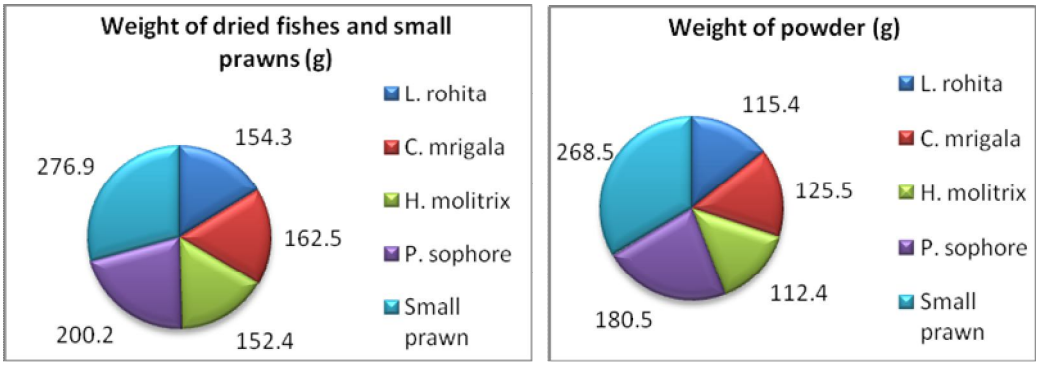


Fig. 3.5: Weight of dried fishes and small prawns and weight of powder

Discussion

The present study was conducted on five species such as *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns. The temperature and humidity were recorded in the drying period. The total length, standard length and different weight of different stages of fishes and small prawns during drying period were also recorded.

In the drying period the temperature varied from 26.30 (*L. rohita*) to 34.45˚C (*P. sophore*). In the drying period the humidity varied from 84 (*P. sophore*) to 86.25% (*H. molitrix*). The time duration of drying of fishes and small prawns varied from 3 to 6 days (Table-3.2). Haq (2005) stated that the duration of time varied from 5-7 days. The small fishes take relatively short time than that of large fishes. These findings are more or less similar with the present study.

The highest total length was found 29.5 cm in *H. molitrix* and lowest was 3.5 cm in small prawns. The highest standard length was 24.4 cm in *H. molitrix* and lowest was 2.9 cm in small prawns. Afroze *et al.* (1997) reported that the total length of 59 species ranged from 1.9-16.5 cm which is lower than the present study. Because in this experiment large and small both sized of species were used.

The highest after dressing and washing weight was 920.5g (small prawns) and lowest was 728.9g (*H. molitrix*). After dressing and washing weight of *L. rohita, C. mrigala* and *P. sophore* were 745.5g, 730.7g and 800.2g, respectively. Flowra (2006) found that among 5 SIS species and 2 other fish species the highest weight of after dressing and washing was 852 g in *M. pancalus* and lowest was 652.20g in *M. armatus.* Chowdhury (2008) also found among 8 species highest weight of after dressing and washing was 758.92g and lowest was 746.57g. The highest wt. of after dressing and washing of the present study is higher than the mentioned value, it would be because of the discarded part of small prawns are very low and the lowest wt. is more or less similar with Chowdhury (2008).

After dressing and washing waste was found highest in *H. molitrix* (271.1g) and lowest was found in small prawns (79.5g). The waste weight of *L. rohita, C. mrigala* and

P. sophore were 254.5g, 269.3g and 199.8g, respectively (Table-3.4, Fig. 3.2). Chowdhury (2008) also found among 8 species highest waste weight of fishes (after dressing and washing) was 253.43g and lowest was 241.08g. The highest waste wt. is more or less similar with the present study and the lowest waste wt. of the present study is lower because of small prawns. The average ratio between the weight after dressing and washing and waste product was 1: 0.27. Roos *et. al*. (2006) reported that cleaning practices depend on the species and size.

Relative percentage of after dressing and washing weight (ADW) was found highest 92.05% in small prawns and lowest 72.89% in *H. molitrix* whereas the relative percentage of after dressing and washing waste weight (WW) was found highest 27.11 % in *H. molitrix* and lowest 7.95% in small prawns (Table-3.5, Fig. 3.3). Relative percentage of after dressing and washing weight (ADW) of *L. rohita, C. mrigala* and *P. sophore* were 74.55%, 73.07% and 80.02% whereas the relative percentage of after dressing and washing waste weight (WW) were 25.45%, 26.93% and 19.98%, respectively (Table-3.5, Fig-3.3). Flowra (2006) worked on 5 SIS species and 2 other dried fishes and found maximum relative percentage of after dressing weight 85.2% in *M. pancalus* and minimum 65.52% in *M. armatus* whereas the maximum relative percentage of waste weight was found 34.48% in *M. armatus* and minimum 16.33 % in *G.giuris*. The Relative percentage of after dressing and washing weight was higher than the mentioned value for the large sized fishes and waste weight was higher than the present study because in case of small prawns the discarded part are very low. Roos *et. al*. (2006) reported that average cleaning waste for SIS was 13% of the whole fish, whereas large fish it was 22% of the whole fish including 8% plate waste consisting mainly bone.

The highest weight of sun dried fish was observed 276.9g in small prawns and the lowest weight was 152.4g in *H. molitrix*. The sun dried weight of *L. rohita, C. mrigala* and *P. sophore* were 154.3g 162.5g and 200.2g, respectively. The highest weight of powder product was found 268.5g in small prawns and lowest was 112.4g in *H. molitrix*. The weight of powder of *L. rohita, C. mrigala* and *P. sophore* were 115.4g, 125.5g and 180.5g, respectively (Table-3.6, Fig. 3.4 and 3.5). Hossain and Afroze (1991) reported that percentage of edible flesh is higher in small sized fishes than that of in large sized

fishes. So the amount of fish powder is also high in small sized fishes than that of large sized fishes.

The present study indicates that small size fishes are more appropriate than that of large sized fishes for getting fish powder. This might be possible due to low oil content and small sized bone of small fishes.

CHAPTER-4

Market Study

Introduction

A fish market is a market place used for marketing fish products. It can be indicated to wholesale trade between fishermen and fish merchants. Fish markets were known in antiquity. They served as a public space where large numbers of people could gather and discuss current events and local politics. Because fish is quick to spoil, fish markets are historically most often found in seaside towns. Once ice or other simple cooling methods became available, some were also established in large inland cities that had good trade routes to the coast. Since refrigeration and rapid transport became available in the 19th and 20th century, fish markets can technically be established at any place. However, because modern trade logistics in general has shifted away from market places and towards retail outlets, such as supermarkets, most seafood worldwide is now sold to consumers through these venues, like most other foodstuffs. Consequently, most major fish markets now mainly deal with wholesale trade, and the existing major fish retail markets continue to operate as much for traditional reasons as for commercial ones. Both types of fish markets are often tourist attractions as well (Wikipedia, 2014).

Marketing is the process of planning and executing the conception, pricing, promotion, and distribution (4 Ps) of ideas, goods and services to create exchanges (with customers) that satisfy individual and organizational objectives. According to (Kotler, 2001), “Marketing” is typically seen as the task of creating, promotions and delivering goods and services. Generally marketing provides the channel of communication between the producers and consumers. The concept of marketing is the determination of consumer needs and the purpose of the business organization should be profitable fulfillment of this consumer needs (Beierlein and Woolverton, 1991). Fisheries marketing comprise all the activities and agencies conducting them, involved in the movement of fish or fish products from the farm or industries to the final consumers or end users. The fish marketing should not have the object only catching and selling of fish but the fish marketing should have the wide scope for exploitation production, distribution, preservation and transportation of fish in addition actual sale of fish by reducing middlemen (Agarwal, 1990).

Marketing system may be thought of as the connecting link between specialized producers and consumers (Kohls and Uhl, 2005). An efficient marketing system is essential for earning fair profit for the fish farmers and traders. Marketing functions may be defined as major specialized activities performed in accomplishing the marketing process of concentration, equalization and dispersion (Kohls and Uhl, 2005). Dry fish marketing system consisted of marketing channels, the various traders involved in marketing channels and marketing functions performed by dry fish processors. Marketing channel is the path a product follows from the farm gate to the consumer. Fresh fish are also marketed through various marketing chain like primary, secondary and consuming market (Coutler and Disney, 1987). Marketing chains are important steps where quality changes occur in fish during different stages of handling and transportation and quality of dry fish depends upon the quality of fresh fish. So, for getting the quality dry fish and quality fish powder, knowledge of marketing is essential.

In most developing countries like Bangladesh there is an elasticity of supply of fish or relatively low supply. This may largely be due to limitation of distribution system coupled with perishability of freshwater fishery products in high and moderate temperature. The marketing structure can be assessed as efficient if it offers aqua products at prices, which reflect realistically demand and supply situation. There is a great seasonal and regional variation in the supply and type of fish all over Bangladesh. The peak harvest season of riverine fish is November-December. Fish from floodplain comes to the market between May and December (Khanam *et al*., 2003). The supply of fishes highly fluctuate and far less than the market demand. The price depends upon the seasonal variation and availability of fish in fish market. Due to involvement of middlemen in the marketing chains the price of the dry fish at the processing is low but at the consumers area it is high. Sometimes, it goes double at consumer level from the processor. The middlemen in the fish marketing sector have established a new chain based on the extreme exploitation of the fish farming communities by setting up an artificial pricing through intermediaries at different levels.

The fresh fishes are mainly marketed in the vicinity of the households in the rural market of Bangladesh. The fishes, which are not sold in fresh condition, are generally used for

producing dried and fermented products. The highest quality loss of 35% occurs due to longer exposure of fish at high temperature followed by 25% rough handling and excessive pressure (Alam *et al*., 2010).

The socio-economic variability, production function and the consumption of fishes determine the present status of a fish marketing system. Poor infrastructure of most of the fish markets, rough handling, insufficient storage facilities, unhygienic conditions make hazardous situation in the market. Therefore, it is very important to evaluate the existing supply, price and marketing systems of fish and fishery products. The increased production of dry fish will be meaningless, if the processor can not transfer the dry fish efficiently to consumers at a fair price.

In Bangladesh about 97 percent of the fish production is marketed internally for domestic consumption, while the remaining part is exported (Rahman, 1997). Though fish farming is regarded as an industry and fish marketing system is well practiced in many countries of the world, the fish farmers in Bangladesh hardly get any chance to communicate directly with the consumers. However, the serious marketing difficulties seem occur in remote communities because of lack of transport, ice and poor road facilities and where the farmers are particularly in weak position in relation to intermediaries (DFID, 1997). As fish is highly perishable with unpredictable supply, analysis of fish marketing system is essential considering the fact that fish is the main protein source in the diet of people, which supplements 60% of total animal protein (DoF, 2012).

Different studies were conducted on fish marketing system in different times in different regions by Ahmed (1983), Quddus (1991), Rokeya *et al.* (1997), Rahman (1997), Flowra *et al.* (2000), Gupta (2004), Ahmed and Gupta (2005), Rahman *et al*. (2009), Alam *et al*. (2010), Asaduzzaman *et al.* (2010), Flowra *et al.* (2012b), Aktar *et al*. (2013), Flowra *et al.* (2013c) and Jamali *et al*.(2013) but no such work has been carried out to the specific landing and price of the selected carp species and small prawns. In the present study fish powder was prepared and utilized. So, knowledge about the price and landing of the selected species was most important to determine the cost benefit ratio of the prepared snacks items and for the selected species availability of the studied market. So, the present study also aimed at knowing the landing and price of some freshwater fishes and small prawns.

Materials and Methods

The study was conducted on five fish markets such as Court bazar fish market, Shaheb bazar fish market, Shalbagan fish market, Laxmipur fish market and Binodpur fish market. For the market study the following methods were used.

Data collection

During the present study the selected five fish markets under Rajshahi city corporation area were visited monthly and different data were collected from the fish retailers and aratders.

Questionnaires of Investigation

Questionnaires interview method was done for the following purposes

1. Source of the selected species and small prawns
2. Landing of selected fishes and small prawns in different market
3. Price of the selected fishes and small prawns

All the calculation was done by computer software MS Excel.

Plate- 4.1: Court bazar fish market of Rajshahi city

Plate- 4.2: Shaheb bazar fish market of Rajshahi city

Plate-4.3: Shalbagan fish market of Rajshahi city

Plate-4.4: Laxmipur fish market of Rajshahi city

Plate-4.5: Binodpur fish market of Rajshahi city

Results and Observations

The study was conducted on five fish markets such as Court bazar fish market, Shaheb bazar fish market, Shalbagan fish market, Laxmipur and Binodpur fish market. In this chapter the sources, landing and price of the selected species were observed.

Source of the selected freshwater fishes and small prawns

The studied species were collected from the five fish market of the Rajshahi city corporation area. In the present study it was observed that the fishes of the studied market came from the ponds, beels, ditches, canals and rivers of Katakhali, Bypass, Bagmara, Khorkhori, Parila, Mohonpur, Keshor, Nouhata, Bagdhani, Meherchandi, Ramchandrapur, Bamonshir, Tanore, Damkura, Godagari, Keshobpur, Horian, Darusha, Titlai, Premtali, Rajabari and Bagha etc.

Landing of the selected species

Average landing of fishes and small prawns are presented in Table-4.1, 4.2 and Fig. 4.1, 4.2. The average landing of Court bazar fish market varied from 40 to 80 kg/day with an average 62.83±0.54. In Shaheb bazar fish market, the average landing varied from 170 to 500 kg/day with an average 297.16±95.41. The average landing of Shalbagan fish market varied from 83 to 216 kg/day with an average 134.33±49.00. In Laxmipur fish market the average landing varied from 50 to 86 kg/day with an average 70.67±11.2. The average landing of Binodpur fish market varied from 35 to 120 kg/day with an average 77.08±26.46.

The average landings of *L. rohita* were 22.25, 114.58, 50.83, 24.5 and 32.16 kg/day in five fish market and the average landings of *C. mrigala* were 13.83, 68.33, 32.58, 15.25 and 16.5 kg/day in Court bazar fish market, Shaheb bazar fish market, Shalbagan fish market, Laxmipur and Binodpur fish market, respectively. In the five fish market the average landings of *H. molitrix* were 17, 70.16, 29.41, 17.91 and 19.83 kg/day. In case of *P. sophore* the average landings were 4.58, 21.41, 10.83, 6 and 3.91 kg/day. The average

landings of small prawns were 5.16, 22.66, 10.66, 7 and 4.66 kg/day, respectively. The average landings of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 48.86±38.41, 29.29±23.10, 30.86±22.51, 9.34±7.26 and 10.02±7.44 kg/day, respectively in five fish market (Table-4.2).

Table-4.1: Minimum, maximum and average landing of freshwater fishes and small prawns in five fish market (Appendix table-8)

Fish market	Landing (kg/day)		Average landing (kg/day)
	Min	Max	
Court bazar	40	80	62.83±0.54
Shaheb bazar	170	500	297.16±95.41
Shalbagan bazar	83	216	134.33±49.00
Laxmipur bazar	50	86	70.67±11.27
Binodpur bazar	35	120	77.08±26.46

Table-4.2: Average landing of studied fishes and small prawns in five fish market (Appendix table 9-13)

Fish market	*L. rohita* (kg/day)	*C. mrigala* (kg/day	*H. molitrix* (kg/day	*P. sophore* (kg/day	Small prawn (kg/day
Court bazar	22.25	13.83	17	4.58	5.16
Shaheb bazar	114.58	68.33	70.16	21.41	22.66
Shalbagan	50.83	32.58	29.41	10.83	10.66
Laxmipur	24.5	15.25	17.91	6	7
Binodpur	32.16	16.5	19.83	3.91	4.66
Mean±SD	48.86±38.41	29.29±23.10	30.86±22.51	9.34±7.26	10.02±7.44

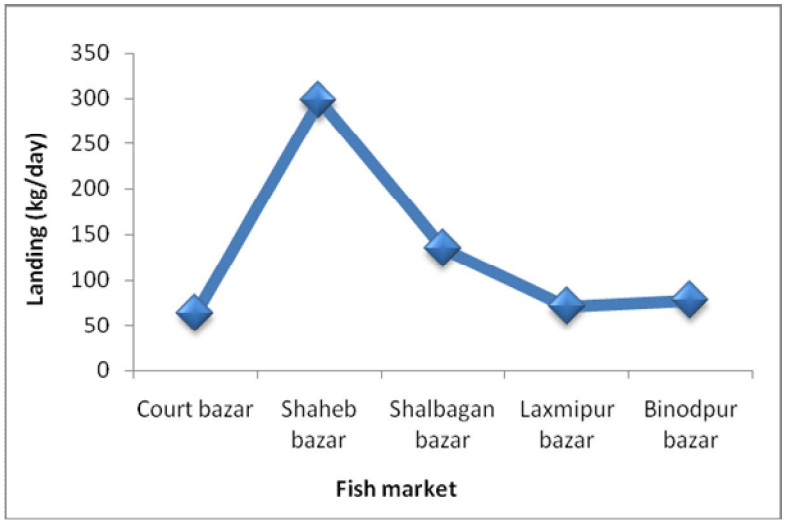


Fig. 4.1: Average landing of the studied species in five fish market

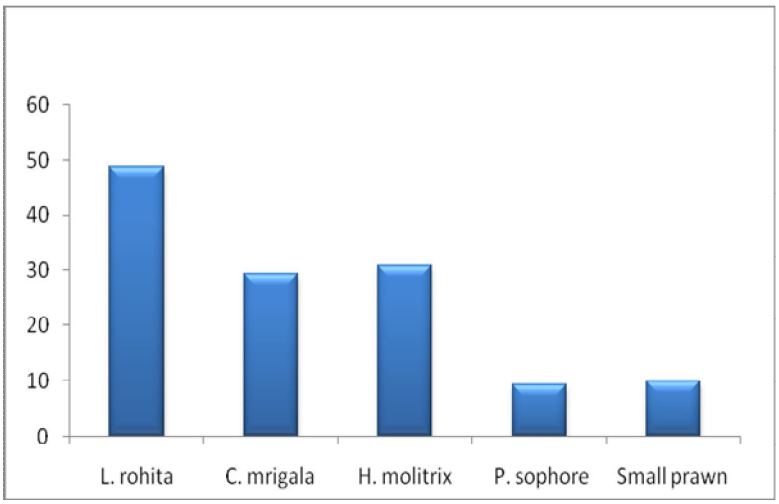


Fig. 4.2: Average landing of the fishes and small prawns

Price of the selected species

Price of the selected species presented in the Table-4.3 and Fig. 4.3. The average prices of *L. rohita*, in five fish market were BDT. 90.5, 90, 100, 98 and 95/kg. The average prices of *C. mrigala* were BDT. 75.5, 72.5, 80, 80.5 and 78.5/kg in Court bazar fish market, Shaheb bazar fish market, Shalbagan fish market, Laxmipur and Binodpur fish market. In five fish markets, the average prices of *H. molitrix* were BDT. 60, 55.5, 60,

65.5 and 65.5/kg. In case of *P. sophore* the average prices were BDT. 240, 280, 280, 250 and 250/kg, respectively. The average prices of small prawns were 235.5, 240.5, 230, 240.5 and 230/kg in Court bazar fish market, Shaheb bazar fish market, Shalbagan fish market, Laxmipur and Binodpur fish market, respectively. The average prices of the fishes and small prawns varied from BDT. 61.3 (*H. molitrix*) to 260/kg (*P. sophore*).

Table-4.3: Average price of studied fishes and small prawns in five fish market (Appendix table-14-18))

Fish market	***L. rohita* (BDT/kg)**	***C. mrigala* (BDT/kg)**	***H. molitrix* (BDT/kg)**	***P. sophore* (BDT/kg)**	**Small prawn (BDT/kg)**
Court bazar	90.5	75.5	60	240	235.5
Shaheb bazar	90	72.5	55.5	280	240.5
Shalbagan	100	80	60	280	230
Laxmipur	98	80.5	65.5	250	240.5
Binodpur	95	78.5	65.5	250	230
Mean±SD	94.7±0.63	77.4±6.00	61.3±1.17	260±6.00	235.3±5.33

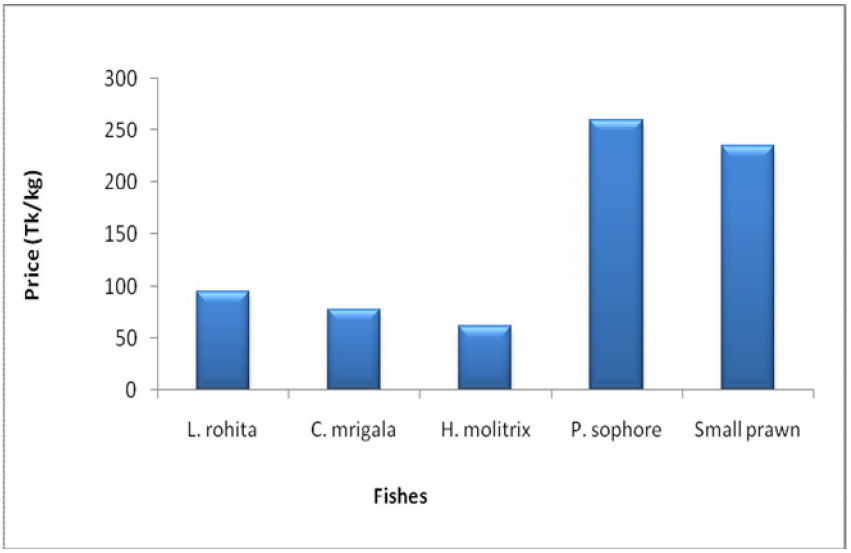


Fig. 4.3: Average price of fishes and small prawns

Discussion

In this chapter sources, landing and price of the selected species were analyzed. The selected species were collected from five fish market (Court bazar fish market, Shaheb bazar fish market, Shalbagan fish market, Laxmipur fish market and Binodpur fish market) under Rajshahi city corporation area. The selected fishes of the studied market were found to come from ponds, beels, ditches, canals and rivers of the nearer place of Rajshahi city.

Landing of the studied fishes and small prawns

The lowest landing of the studied species was observed 40kg/day (Court bazar) and highest was 500 kg/day (Shaheb bazar). The average landing of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 48.86, 29.29, 30.86, 9.34 and 10.02 kg/day, respectively in five fish market (Table-4.1, 4.2 and Fig. 4.1, 4.2). Asaduzzaman *et al.* (2010) observed that the landing of fishes in Binodpur bazar, Shaheb bazar and Court bazar fish market has been estimated as 1-2, 4-5 and 0.5-1 tones, respectively. Chowdhury (2008) also found that the average landing of Shaheb bazar, Binodpur, Laxmipur and Shalbagan fish market varied from 5000 to 12800 kg/season, 3500 to 7500 kg/day, 1500 to 5900 kg/season and 1050 to 5200 kg/season, respectively. Ahmed and Rahman (2005) stated that the daily supply of fish market in Gazipur sadar and Sripur was about 2 to 3 and 1 to1.5 metric-tones, respectively. In the present study, the low value of landing was found because it was the only amount of selected species. In Bangladesh, due to high population growth there is an ever increasing gap between supply and demand of fish. Narrowing the gap requires not only increasing production but also improvements at all aspects of marketing and distribution systems (ICLARM, 1991; SAARC, 1994).

Price of the studied fishes and small prawns

Price was analyzed for the determination of cost benefit ratio of processed snacks items with fish powder of selected species. The price of fish varies irregularly and more widely than other agricultural commodities.

The average price of the fishes and small prawns varied from BDT. 61.3 (*H. molitrix*) to 260/kg (*P. sophore*). The lowest average price of *L. rohita* was found BDT. 90/kg (Shaheb bazar) and highest was found BDT. 100/kg (Shalbagan). The highest average price of *C. mrigala* was observed BDT. 80.5/kg in laxmipur and lowest was observed BDT. 72.5/kg in Shaheb bazar fish market. In case of *H. molitrix* the average price varied from BDT. 55.5 (Shaheb bazar) to 65.5/kg (Laxmipur and Binodpur). The average lowest price of *P. sophore* was BDT. 240/kg in Court bazar and highest was BDT. 280/kg in Shaheb bazar and Shalbagan fish market. In case of small prawns the average lowest price was BDT. 230/kg (Shalbagan and binodpur) and highest was 240.5/kg (Shaheb bazar and Laxmipur) (Table and Fig. 4.3). Naturally, the price of carp depends on market structure, location, species, quality, size and weight. The price is also influenced by supply and demand and there are generally seasonal variations in prices with the highest in summer (March to May) and the lowest in winter (November to January), during the fish harvesting season (Rahman *et al*., 2009). Flowra *et al*. (2013c) also reported that the price of different fish groups was found to depend on market structure, species, quality, size and weight of fish. According to Nurullah *et al*. (2005) the price of fishes increases step by step and it is at the highest level when it reaches to the customer. Price also depends on several factors like day to day supply, demand and freshness of fish. There is a great seasonal and regional variation in the supply and type of fish all over the country (Khanam *et al*., 2003).

It is concluded that the selected species are collected from the different sources of freshwater. The species are available in all the biggest fish market of Rajshahi city.

CHAPTER-5

Utilization of Fish Powder

Introduction

In most Southeast Asian countries, fish is the main source of protein. Fish is one of the most versatile food commodities and can be utilized in a great variety of ways and product forms. Fish and fish products have a modern, healthy image. Due to increasing awareness of the consumers on health issues, consumption of fish and fishery products is increasing day by day. But fish is a limited raw material that is becoming scarcer and more expensive. In order to increase fish consumption, strategies are required to overcome or bypass certain limitations of commercialization and acceptability of fish. A key element to increase fish consumption is to provide processed and manufactured fish products preserving the high nutritional value of fish and meeting customer expectations (sensory attributes). So, it is need to developed special product concepts that will appeal to consumers, and cost-saving solutions that will add value to product lines.

Recent developments in fish processing technology are oriented towards technology up-gradation, diversification and quality assurance. Because, demands for fish protein ingredients including dried fish protein to develop functional food or ready-to-eat or ready-to-cook products are gradually growing in the world (Thorkelsson *et al.*, 2009). There are several factors, which have influenced this demand. One is the increasing affluence and the consequential changes that have influenced the eating habits, particularly in the western countries, which have resulted in the demand for diversely processed value added convenience products based on fish. There is also an increasing trend of eating away from home and this has triggered the growth of fast food trade serving value added fish based products (Maqsood *et al.*, 2015). In the recent years in Bangladesh also the preference of the consumers has significantly directed towards the fast food consumption since there has been a rapid urbanization and an increase in working women population. For that reason in the recent years, alternative ways and new technologies have emerging.

Now-a-days, consumers are becoming more educated about the nutritional value of foods and have start changing their food consumption life style. They are now choosing foods

rich in nutraceuticals, dietary fibers, natural colorants, minerals and vitamins, low in fat, and free of synthetic food additives (Saenz, 2000). In this aspects fish powder can be used as an ingredient in different foods for human beings. However, fish is an excellent source of protein, omega-3 fatty acids and key minerals and vitamins (Altschul, 1989). According to Neiva *et al*. (2011), fish is a high-protein, low-calorie food and an important source of omega-3 fatty acids and minerals, such as calcium and phosphorus.

Starchy snack products are widely consumed. They are usually low in protein and high in fat and carbohydrates (Ranhotra and Vetter, 1991; Rhee *et al.*, 1999, 2004). Snack is a portion of food often smaller than a regular meal, generally eaten between meals. Traditionally, snacks are prepared from ingredients commonly available in the home (Wikipedia, 2015d). Snack is a food of choice for school going children, adolescent girls and high mobility groups. Most of the snacks available in the market are mainly based of cereals which are high in calorie and low in protein contents. So, the incorporation of fish powder in these snacks is a good alteration in its nutritional value particularly high value protein.

Snacks items are also popular in Bangladesh. All types of peoples such as: new generation, students, young and old age people likes snacks items. The techniques for producing snacks including fish powder are very simple. Incorporation of functional ingredients into snack products can increase their nutritional value (Riaz, 2001; Rhee *et al.*, 2004; Veronica *et al*., 2006), and thereby make them more appropriate for the complementary feeding period. Addition of fish powder enhances the nutritional value of snacks in two ways: Firstly, by increasing fish intake (animal protein intake) and thereby increasing intake of nutrients such as calcium, iron, zinc, phosphorus, potassium and essential fatty acids proper growth and brain development in children are enabled. Secondly, the inclusion of fish in the diets of the target group increases the bioavailability of other nutrients in the meal. Fish helps the body to absorb the nutrients found from other foods in meal (Wahab, 2014).

Bangladesh is faced with serious protein energy malnutrition problem till now. Millions of people suffer from serious nutritional problem. Moreover, malnutrition is a serious

problem which is caused mainly due to animal protein deficit in the diet (Nuruzzaman, 1992). It is often argued that mothers and children of Bangladesh are generally the first victims of malnutrition. This protein deficiency can be minimized by supplying sufficient amount of fish instead of meat (Haq *et al.*, 2013). Children don't want to eat fish because of small bone. Snacks items with fish powder would be a great source of nutrition for children. Upon successful marketing of the tasty products (snacks) may contribute significantly towards protein supplementation in malnourished population. In spite all these facts, big processing industry like canning or large scale filleting is not yet developed in our country. For effective capacity utilization and potential production of diversified products, processing of the fishery products will bring immediate benefit to the existing fish processing industries of the country.

A good number of work have been conducted about the production and quality stability of the fishery fast food products including fish cake, fish crackers, fish balls, fish burgers, fish soup and shrimp crackers (Sipos *et al.*, 1979; Siaw *et al.*, 1985; Ihm *et al*., 1992a and 1992b; Khan and Nowsad, 2012; Rahman *et al*., 2012 and Haq *et* al., 2013). A few studies have demonstrated that is possible to develop snack foods fortified with fish flesh/protein powder (Maga and Reddy, 1985; Clayton and Miscourides, 1993; Choudhury, 1994; Mathews *et al.*, 2003; Shankar and Bandyopadhyay, 2005; Flowra, 2006; Kong *et al*., 2008; Pansawat *et al.*, 2008 and Dileep *et al.*, 2010). Snacks fortified with fish muscle/protein were accepted by American consumers (Kong *et al.*, 2008), Malaysian consumers (Huda *et al*., 2001), Indonesian consumers (Huda *et al*., 2000) and Indian consumers (Maga and Reddy, 1985). But no attempt has so far been taken to formulate any kind of snacks items (Fish khoi cake, fish vegetable cake, fish luci and vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom) with fish powder in Bangladesh. Considering the above facts, it was felt necessary to formulate snacks items including fish powder. So the present study was taken to prepare the protein enriched snacks items including fish powder of some freshwater fishes and small prawns. Obviously, in the days to come, these products, will share an important business in growing fast food industries and marketed locally or exported.

Materials and methods

In this chapter some snacks items using fish powder were prepared and organoleptic test were carried out for the acceptance of consumers. Ingredients, preparation methods of the snacks items and methods of organoleptic test are described below-

5.1: Fish khoi cake

Ingredients	Amount
1. Fish powder (*Labeo rohita*)	115.4g
2. Toasted paddy	750g
3. Rice flour	350g
4. Egg	8p
5. Ginger, garlic and cumin paste	50 g
6. Onion	250g
7. Green chilli	25g
8. Turmeric powder	25g
9. Salt	100g
10. Soyabean oil	750ml

Plate-5.1: Fish khoi Cake

Preparation method of fish khoi cake:

1. At first the toasted paddy are immersed in normal water for 5 minutes
2. The onions and green chilli are chopped
3. Grind ginger and garlic for making paste
4. Fish powder and rice flour mix with chopped onions
5. Add chopped chilli, turmeric powder and salt
6. Add ginger and garlic paste to whole mixture
7. Add the wet toasted paddy to the mixture and mix
8. Beat egg and add to the mixture
9. Keep the final mixture for 1 /2 hours in room temperature
10. Remove one piece at the time and fry in soyabean oil till brownish colour

5.2: Fish vegetable cake

Ingredients:	**Amount**
1. Fish powder (*Labeo rohita*)	**115.4g**
2. Basil leaf	**900g**
3. Rice flour	**250g**
4. Egg	**4p**
5. Ginger, garlic and cumin paste	**50g**
6. Onion	**250g**
7. Green chilli	**25g**
8. Turmeric powder	**25g**
9. Salt	**100g**
10. Soyabean oil	**750ml**

Plate-5.2: Fish vegetable cake

Preparation method of fish vegetable cake:

1. The onions and basil leafs are chopped finely and chilli are chopped thickly
2. Grind ginger, cumin and garlic for making paste
3. Fish powder and rice flour mix with onions
4. Add ginger, cumin and garlic paste
5. Add chopped chilli, turmeric powder and salt
6. Beat egg and add to the mixture
7. Then add the chopped basil leafs into the whole mixture
8. Remove one piece at the time and deep fry in soyabean oil till brownish colour

5.3: Fish luci and vegetable

Fish luci

Ingredients	**Amount**
1. Fish powder (*Labeo rohita*)	**115.4g**
2. Wheat flour	**1.1 kg**
3. Soyabean oil	**250ml**

Preparation method of fish luci:

1. Fish powder mix with wheat flour (maida) finely
2. Make dough of maida
3. Roll of small amount of dough in a roller for making round sized and cut into triangular shape.
4. Fry in hot soyabean oil till brownish colour appears

Plate-5.3: Fish luci and vegetable

Fish vegetable

Ingredients	**Amount**
1. Fish powder (*Labeo rohita*)	**115.4g**
2. Cabbage	**750g**
3. Tomato	**110g**
4. Potato	**250g**
5. Onion	**100g**
6. Green chilli	**25g**
7. Turmeric powder	**25g**
8. Salt	**50g**
9. Soyabean oil1	**150ml**

Preparation method of fish vegetable:

1. The Cabbage, potato and onion are chopped finely and green chilli chopped thickly.
2. Add all the ingredients and mix
3. Add water as per need
4. Cook in low flame for 20 minutes

5.4: Fish saaz pitha

Ingredients	**Amount**
1. Fish powder (*Labeo rohita*)	**115.4g**
2. Wheat flour	**1.15kg**
3. Kaligira	**10g**
4. Egg	**5p**
5. Sugar	**250g**
6. Soyabean oil	**500ml**

Plate-5.4: Fish saaz pitha

Preparation method of fish saaz pitha:

1. Fish powder mix with wheat flour (maida) finely
2. Add kaligira and sugar
3. Beat egg and mix with the mixture
4. Add soyabean oil slightly
5. Make dough of maida
6. Roll of small amount of dough in a roller for making round sized and cut into different shape and make different sized and shaped pitha
7. Deep fry in hot soyabean oil till brownish colour appears

5.5: Sweet fish cake

Ingredients	**Amount**
1. Fish powder (*Labeo rohita*)	**115.4g**
2. Wheat flour	**1.15kg**
3. Egg	**4p**
4. Sugar	**250g**
5. Soyabean oil	**500ml**

Plate-5.5: Sweet fish cake

Preparation method of sweet fish cake:

1. Fish powder mix with wheat flour (maida) finely
2. Add sugar and mix
3. Beat egg and mix with the mixture
4. Mix the whole mixture finely
5. Take one table spoon at the time and deep fry in hot soyabean oil in low flame till brownish colour appears.

5.6: Fish spicy cake

Ingredients	Amount
1. **Fish powder (*Labeo rohita*)**	**115.4g**
2. **Rice flour**	**1.15kg**
3. **Egg**	**4p**
4. **Ginger, garlic and cumin paste**	**20g**
5. **Onion**	**100g**
6. **Green chilli**	**25g**
7. **Turmeric powder**	**10g**
8. **Salt**	**100g**
9. **Soyabean oil**	**500ml**

Preparation method of fish spicy cake:

1. Onion is chopped finely and green chili is chopped thickly
2. Grind ginger, cumin and garlic for making paste
3. Fish powder mix with rice flour finely
4. Add chopped onion and chilli
5. Add salt, turmeric powder and ginger, garlic and cumin paste
6. Beat egg and mix with the mixture
7. Mix the whole mixture finely
8. Take one table spoon soyabean oil in the fry pan and heat
9. Take one big spoon mixture at the time and make round shape in the pan
10. Covered the pan with lid for 1 minute and turn upside down
11. Fry in low flame for 2 minutes

Plate-5.6: Fish spicy cake

5.7: Fish kabab shashlik

Ingredients	**Amount**
1. Chop of fish powder	**230p**
2. Onion	**1.5kg**
3. Capsicum	**6p**
4. Tomato	**1.5kg**
5. Cucumber	**1kg**
6. Bamboo stick (small size)	**115p**
7. Soyabean oil	**100ml**

Plate-5.7: Fish kabab shashlik

Preparation method of fish kabab shashlik:

1. Cut the chop of fish powder as cube shape
2. Cut onion, capsicum, tomato and cucumber as cube shape
3. Cube shaped chop, onion, capsicum, tomato and cucumber are string together into the bamboo stick
4. Put the fry pan and cover it with lid for 15 minutes

5.8: Fish papadom

Ingredients	**Amount**
1. Fish powder (*Labeo rohita*)	**115.4g**
2. Wheat flour	**1.15g**
3. Kaligira	**10g**
4. Egg	**4p**
5. Red chilli powder	**10g**
6. Salt	**50g**
7. Soyabean oil	**250ml**

Plate-5.8: Fish papadom

Preparation method of fish papadom:

1. Fish powder mix with wheat flour (maida) finely
2. Add kaligira and salt and red chilli powder
3. Beat egg and mix with the mixture
4. Add soyabean oil slightly
5. Make dough of maida
6. Roll of small amount of dough in a roller for making round sized and cut into round shape.
7. Deep fry in hot soyabean oil till brownish colour appears**.**

Methods for Organoleptic Analysis:

The organoleptic quality of snacks items including fish powder was assessed by adding 10% of the fish powder of the snacks items such as fish khoi cake, fish vegetable cake, fish luci and vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom with edible fish powder were prepared (Plate-5.1 to 5.8) and all the dishes were served to a taste panel of 8 members (22-40 years old students and teachers) and appearance, colour, odour, taste, texture, flavour and overall acceptability was determined by using hedonic scale of 1 to 9 and the dishes were rated as 9 for excellent 7 for good, 6 for acceptable and below 4 for poor or unacceptable.

Cost-profit analysis: A simple cost and profit analysis was done on the basis of market survey. Total cost and net profit of all the snacks items individually were calculated to identify the marketing feasibility of the product.

All the calculation was done by using computer software MS Excel.

Results and Observation

In this chapter some snacks items including fish powder were prepared and cost benefit ratio were analyzed. Amount of the product, Unit price of the product, net income, net profit and cost benefit ratio and result of organoleplic test are presented in Table 5.1, 5.2, 5.3, 5.4, 5.5 and 5.6.

In case of *L. rohita*, the production cost of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 536, 481, 269, 342, 351, 338, 458, 1122 and 334, respectively (Table-5.1 and Fig.5.1) by using 115.4 g fish powder (from 1kg fishes). The amount of produced snacks items were 230p, 157p, 90p, 1150g, 202p, 202p, 75p, 115p and 202p, respectively. Unit price of the prepared products were BDT. 4, 4, 5, 15, 4, 5, 10, 15 and 4, respectively. The net income of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 920, 628, 450, 432, 808, 1010, 750, 1725 and 808 whereas the net profit was BDT. 384, 147, 181, 90, 457, 672, 292, 603 and 474, respectively (Table-5.1 and Fig. 5.1).

Table-5.1: Cost benefit analysis of some snacks items including fish powder (from 1 kg raw *Labeo rohita*) (Appendix table 19, 24, 29, 34, 39, 44, 49, 54)

Processed product	Production cost (BDT)	Amount of the product	Unit Price (BDT/piece or amount)	Net Income (BDT)	Net profit (BDT)	Cost benefit ratio
Fish khoi cake	536	230p	4	920	384	1:0.71
Fish vegetable cake	481	157p	4	628	147	1:0.30
Fish luci	269	90p	5	450	181	1:0.67
Fish vegetable	342	1150g	15/40g	432	90	1:0.26
Fish saaz pitha	351	202p	4	808	457	1:1.30
Sweet fish cake	338	202p	5	1010	672	1:1.99
Fish spicy cake	458	75p	10	750	292	1:0.64
Fish kabab shashlik	1122	115p	15	1725	603	1:0.53
Fish papadom	334	202p	4	808	474	1:1.42

(P = Piece)

The cost benefit ratio for *Labeo rohita* in nine snacks items were 1:0.71, 1:0.30, 1:0.67, 1:0.26, 1:1.30, 1:1.99, 1:0.64, 1:0.53, and 1:1.42 respectively (Table-5.1).

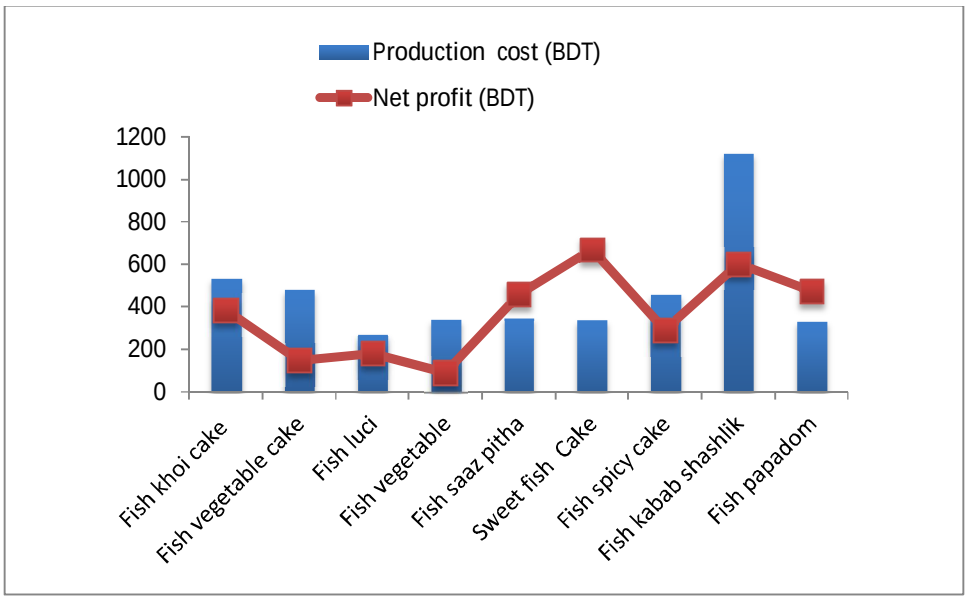


Fig. 5.1: Production cost and net profit of nine snacks items with fish powder of *L. rohita*

The production cost fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom of *C. mrigala* were BDT. 524, 470, 266, 329, 350, 335, 455, 1110 and 330, respectively by using 125.5 g fish powder (from 1kg fishes). The amount of produced snacks items were 250p, 155p, 100p, 1250g, 212p, 212p, 80p, 125p and 212p, respectively. Unit price of the prepared products were BDT. 4, 4, 5, 15, 4, 5, 10, 15 and 4, respectively. The net income of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 1000, 620, 500, 469, 880, 1060, 800, 1875 and 848 whereas the net profit of the same snacks items were BDT. 476, 150, 234, 140, 462, 725, 345, 765 and 518, respectively (Table-5.2, Fig. 5.2). The cost benefit ratio for *C. mrigala* in nine snacks items were 1:0.90, 1:0.32, 1:0.88, 1:0.43, 1:1.32, 1:2.16, 1:0.76, 1:0.67 and 1:1.60, respectively (Table-5.2).

Table-5.2: Cost benefit analysis of some snacks items including fish powder (from 1 kg *C. mrigala*) (Appendix table 20, 25, 30, 35, 40, 45, 50, 55)

Processed product	Production cost (BDT)	Amount of the product	Unit Price (BDT/piece or amount)	Net Income (BDT)	Net profit (BDT)	Cost benefit ratio
Fish khoi cake	524	250p	4	1000	476	1:0.90
Fish vegetable cake	470	155p	4	620	150	1:0.32
Fish luci	266	100p	5	500	234	1:0.88
Fish vegetable	329	1250g	15/40g	469	140	1:0.43
Fish saaz pitha	350	212p	4	880	462	1:1.32
Sweet fish cake	335	212p	5	1060	725	1:2.16
Fish spicy cake	455	80p	10	800	345	1:0.76
Fish kabab shashlik	1110	125p	15	1875	765	1:0.67
Fish papadom	330	212p	4	848	518	1:1.60

(P = Piece)

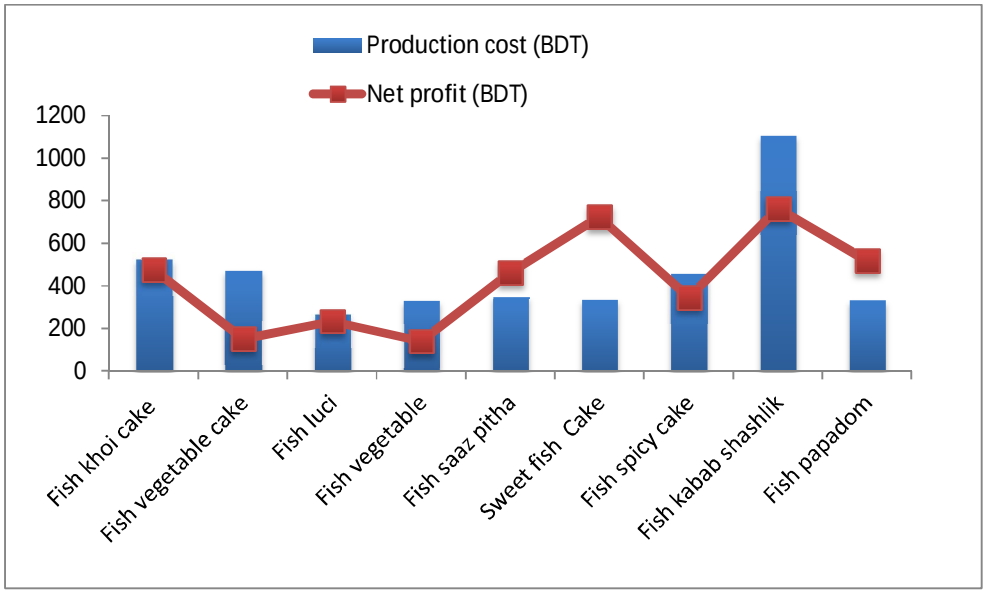


Fig. 5.2: Production cost and net profit of nine snacks items with fish powder of *C. mrigala*

In case of *H. molitrix* the production cost of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 501, 446, 246, 307, 345, 303, 419, 1093 and 229, respectively (Table-5.3, Fig. 5.3) by using 112.4 g fish powder (from 1kg fishes). The amount of produced snacks items were 224p, 175p, 90p, 1120g, 200p, 200p, 79p, 112p and 200p, respectively. Unit price of the fortified snacks items were also same as *L. rohita* that's are BDT. 4, 4, 5, 15, 4, 5, 10, 15 and 4, respectively. The net income of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 896, 700, 450, 420, 800, 1000, 790, 1680 and 800 whereas the net profit were BDT. 395, 256, 204, 113, 455, 697, 371, 587 and 571, respectively (Table-5.3, Fig.5.3). The cost benefit ratio were 1:0.79, 1:0.57, 1:0.83, 1:0.37, 1:1.31, 1:2.30, 1:0.89, 1:0.54 and 1:2.49, respectively.

Table-5.3: Cost benefit analysis of some snacks items including fish powder (from 1 kg *H. molitrix*) (Appendix table 21, 26, 31, 36, 41, 46, 51, 56)

Processed product	Production cost (BDT)	Amount of the product	Unit Price (BDT/piece or amount)	Net Income (BDT)	Net profit (BDT)	Cost benefit ratio
Fish khoi cake	501	224p	4	896	395	1:0.79
Fish vegetable cake	446	175p	4	700	256	1:0.57
Fish luci	246	90p	5	450	204	1:0.83
Fish vegetable	307	1120g	15/40g	420	113	1:0.37
Fish saaz pitha	345	200p	4	800	455	1:1.31
Sweet fish cake	303	200p	5	1000	697	1:2.30
Fish spicy cake	419	79p	10	790	371	1:0.89
Fish kabab shashlik	1093	112p	15	1680	587	1:0.54
Fish papadom	229	200p	4	800	571	1:2.49

(P = Piece)

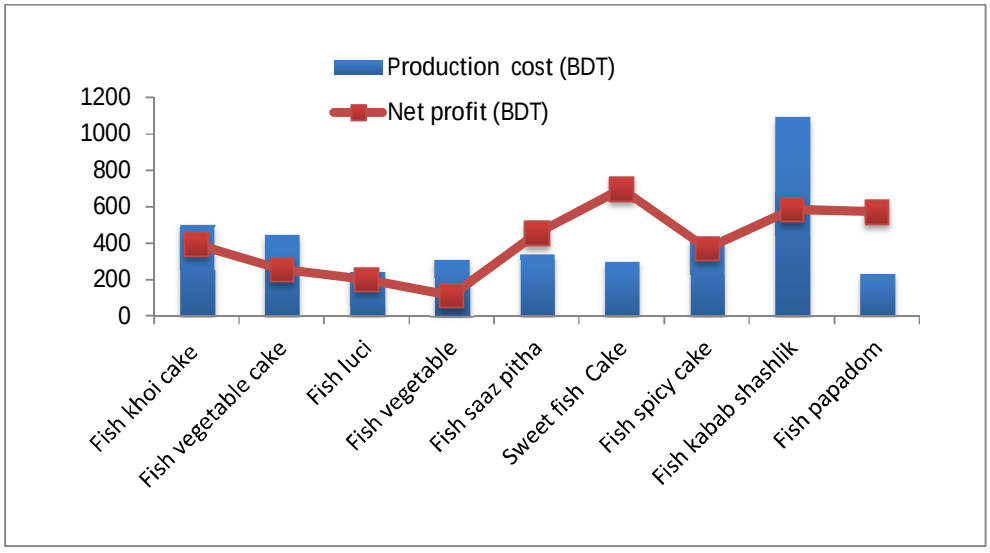


Fig. 5.3: Production cost and net profit of nine snacks items with fish powder of *H. molitrix*

The production cost of nine snacks items for *P. sophore* were BDT. 833, 724, 478, 591, 526, 637, 675, 1572 and 620, respectively (Table-5.4, Fig. 5.4) by using 180.5g fish powder (from 1kg fishes). The amount of produced snacks items were 360p, 252p, 141p, 1800g, 310p, 310p, 120p, 180p and 310p, respectively. Unit price of the fortified products were BDT. 4, 4, 5, 15, 4, 5, 10, 15 and 4, respectively. The net income of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 1440, 1008, 705, 1080, 1240, 1550, 1200, 2700 and 1240 whereas the net profit were BDT. 607, 284, 227, 675, 714, 913, 525, 1128 and 620, respectively (Table-5.4, Fig. 5.4). The cost benefit ratio for *P. sophore* in nine snacks items were 1:0.73, 1:0.39, 1:0.47, 1:1.14, 1:1.35, 1:1.43, 1:0.78, 1:0.72 and 1:1.00, respectively

Table-5.4: Cost benefit analysis of some snacks items including fish powder (from 1 kg *P. sophore*) (Appendix table 22, 27, 32, 37, 42, 47, 52, 57)

Processed product	Production cost (BDT)	Amount of the product	Unit Price (BDT/piece or amount)	Net Income (BDT)	Net profit (BDT)	Cost benefit ratio
Fish khoi cake	833	360p	4	1440	607	1:0.73
Fish vegetable cake	724	252p	4	1008	284	1:0.39
Fish luci	478	141p	5	705	227	1:0.47
Fish vegetable	591	1800g	15/40g	1080	675	1:1.14
Fish saaz pitha	526	310p	4	1240	714	1:1.35
Sweet fish cake	637	310p	5	1550	913	1:1.43
Fish spicy cake	675	120p	10	1200	525	1:0.78
Fish kabab shashlik	1572	180p	15	2700	1128	1:0.72
Fish papadom	620	310p	4	1240	620	1:1.00

(P = Piece)

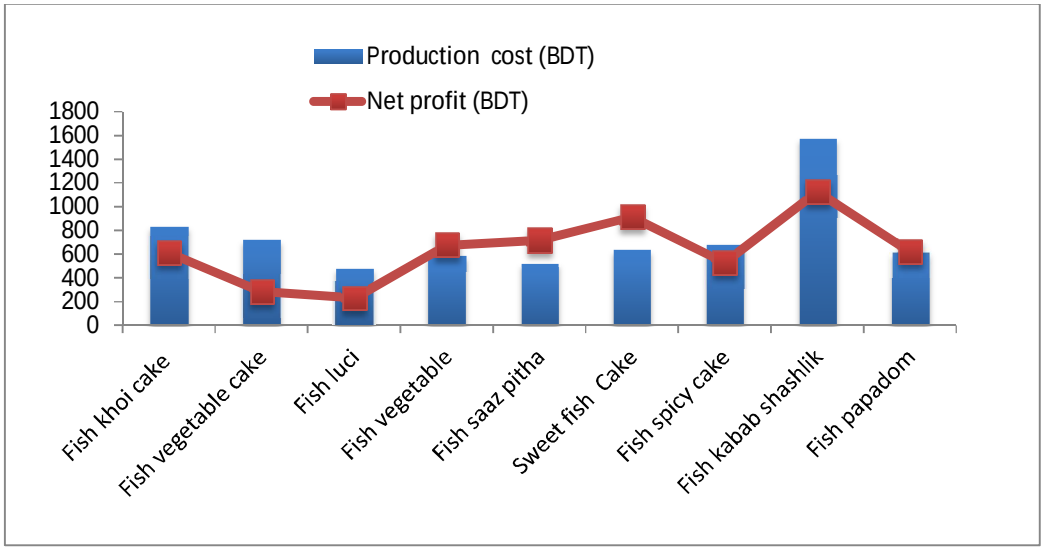


Fig. 5.4: Production cost and net profit of nine snacks items with fish powder of *P. sophore*

In case of small prawns, the total cost for fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 1122, 1045, 605, 529, 561, 715, 768, 2212 and 688, respectively (Table-5.5, Fig. 5.5) by using 268.5 g fish powder (from 1kg fishes). The produced snacks items were 540p, 367p, 210p, 2680g, 450p, 450p, 180p, 270p and 450p, respectively. Unit price of the prepared products were BDT. 4, 4, 5, 15, 4, 5, 10, 15 and 4, respectively. The net income of fish khoi cake, fish vegetable cake, fish luci, fish vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom were BDT. 2160, 1468, 1050, 1012, 1800, 2250, 1800, 4050, 1800 and net profit were BDT, 1038, 423, 445, 483, 1239, 1535, 1032, 1838 and 1112, respectively (Table-5.5, Fig. 5.5). The cost benefit ratio for small prawns in nine snacks items were 1:0.90, 1:0.40, 1:0.73, 1:0.91, 1:2.20, 1:2.15, 1:1.34, 1:0.83 and 1:1.62, respectively.

Table-5.5: Cost benefit analysis of some snacks items including fish powder (from 1 kg small prawn) (Appendix table 23, 28, 33, 38, 43, 48, 53, 58)

Processed product	Production cost (BDT)	Amount of the product	Unit Price (BDT/piece or amount)	Net income (BDT)	Net profit (BDT)	Cost benefit ratio
Fish khoi cake	1122	540p	4	2160	1038	1:0.90
Fish vegetable cake	1045	367p	4	1468	423	1:0.40
Fish luci	605	210p	5	1050	445	1:0.73
Fish vegetable	529	2680g	15/40g	1012	483	1:0.91
Fish saaz pitha	561	450p	4	1800	1239	1:2.20
Sweet fish cake	715	450p	5	2250	1535	1:2.15
Fish spicy cake	768	180p	10	1800	1032	1:1.34
Fish kabab shashlik	2212	270p	15	4050	1838	1:0.83
Fish papadom	688	450p	4	1800	1112	1:1.62

(P= Piece)

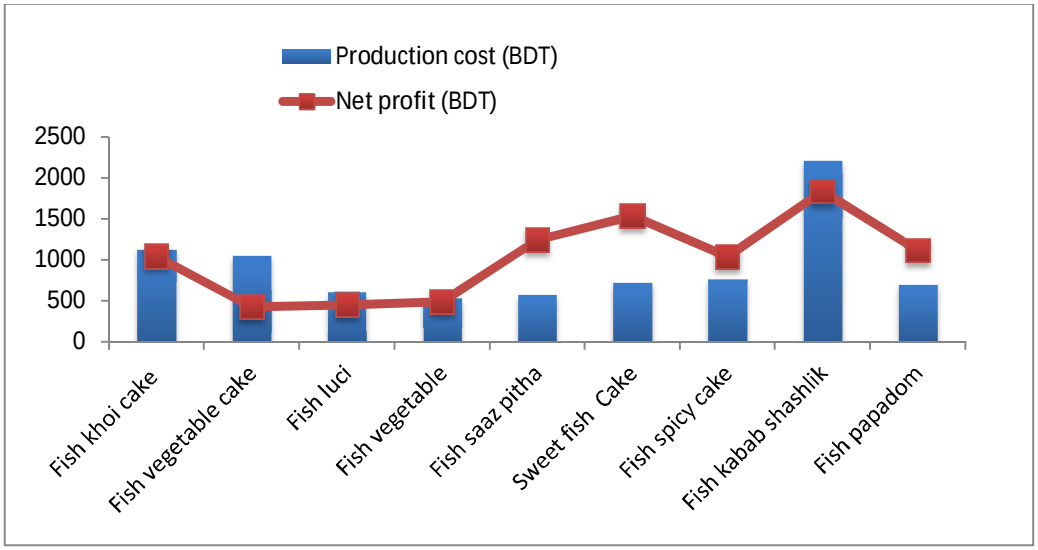


Fig. 5.5: Production cost and net profit of nine snacks items with fish powder of small prawn

Organoleptic evaluation: The physical and organoleptic qualities of the snacks items were evaluated on the basis of the colour, odour, test, texture, flavour and overall other quality aspects and the results are presented in Table-5.6. Average score of the organoleptic analysis of edible fish powder products are presented in Fig. 5.6 and 5.7**.** The Appearance of the experimented fish powder products obtained points were 7±0.92, 8.6±0.52, 8.2±0.84, 8.5±0.42, 8.3±0.70, 8.6±0.42, 8±0.46, 8.6±0.42, respectively and the obtained points of odour were 7±0.99, 8.6±0.52, 7.5±0.88, 8±0.80, 8.1±0.79, 8.5±0.46, 8±0.71 and 8.3±0.37 in fish khoi cake, fish vegetable cake, fish luci and vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom, respectively. The colours were 8±0.64, 7.9±0.83, 8±50, 8.1±0.58, 8.4±0.50, 7.7±0.53, 8.2±0.37 and 8.2±0.59 in snacks items which indicates that the appearance, odour and colour were described as excellent and good colour. The test of the processed snacks items were obtained from 8.8±0.46, 8.8±0.46, 7.6±56, 7.9±0.78, 8.3±0.37, 8.6±0.44, 8.2±0.26 and 7.8±0.59, respectively.

Table-5.6 : Average score of the organoleptic analysis of edible fish powder products (Appendix table 59-62)

Organoleptic parameters	Fish khoi cake	Fish vegetable cake	Fish luci and vegetable	Fish saaz pitha	Sweet fish Cake	Fish spicy cake	Fish kabab shashlik	Fish papadom
Appearance	7±0.92	8.6±0.52	8.2±0.84	8.5±0.42	8.3±0.70	8.6±0.42	8±0.46	8.6±0.42
Odour	7±0.99	8.6±0.52	7.5±0.88	8±0.80	8.1±0.79	8.5±0.46	8±0.71	8.3±0.37
Colour	8±0.64	7.9±0.83	8±50	8.1±0.58	8.4±0.50	7.7±0.53	8.2±0.37	8.2±0.59
Test	8.8±0.46	8.8±0.46	7.6±56	7.9±0.78	8.3±0.37	8.6±0.44	8.2±0.26	7.8±0.59
Texture	7.4±0.52	9±0.53	7.9±0.44	8±0.46	7.6±0.56	8.8±0.23	7.9±0.32	8.6±0.44
Flavour	7.5±0.93	8±0.64	7.3±0.37	8±0.46	7.9±0.58	8.2±0.46	8±0.38	8±0.37
Overall Acceptability	8.4±0.52	8.1±0.64	8.2±0.84	8.5±0.40	8.4±0.44	8.2±0.38	8.4±0.42	8.3±0.37

Scoring was >8= Excellent, 7= Good, 6= Acceptable, <4 = Reject.

The texture of the experimented snacks items ranged from 7.4±0.52 (Fish khoi cake) to 9±0.53 (Fish vegetable cake) which is considered as very soft and desirable by the

consumer. The flavour varied from 7.3±0.37 (Fish luci and vegetable) to 8.2±0.46 (fish spicy cake) and the overall acceptability ranged from 8.1±0.64 (fish vegetable cake) to 8.5±0.40 (fish saaz pitha). The flavour of the experimentally produced snacks items obtained points were 7.5±0.93, 8±0.64, 7.3±0.37, 8±0.46, 7.9±0.58, 8.2±0.46, 8±0.38 and 8±0.37 for flavour, which is considered excellent and good flavour.

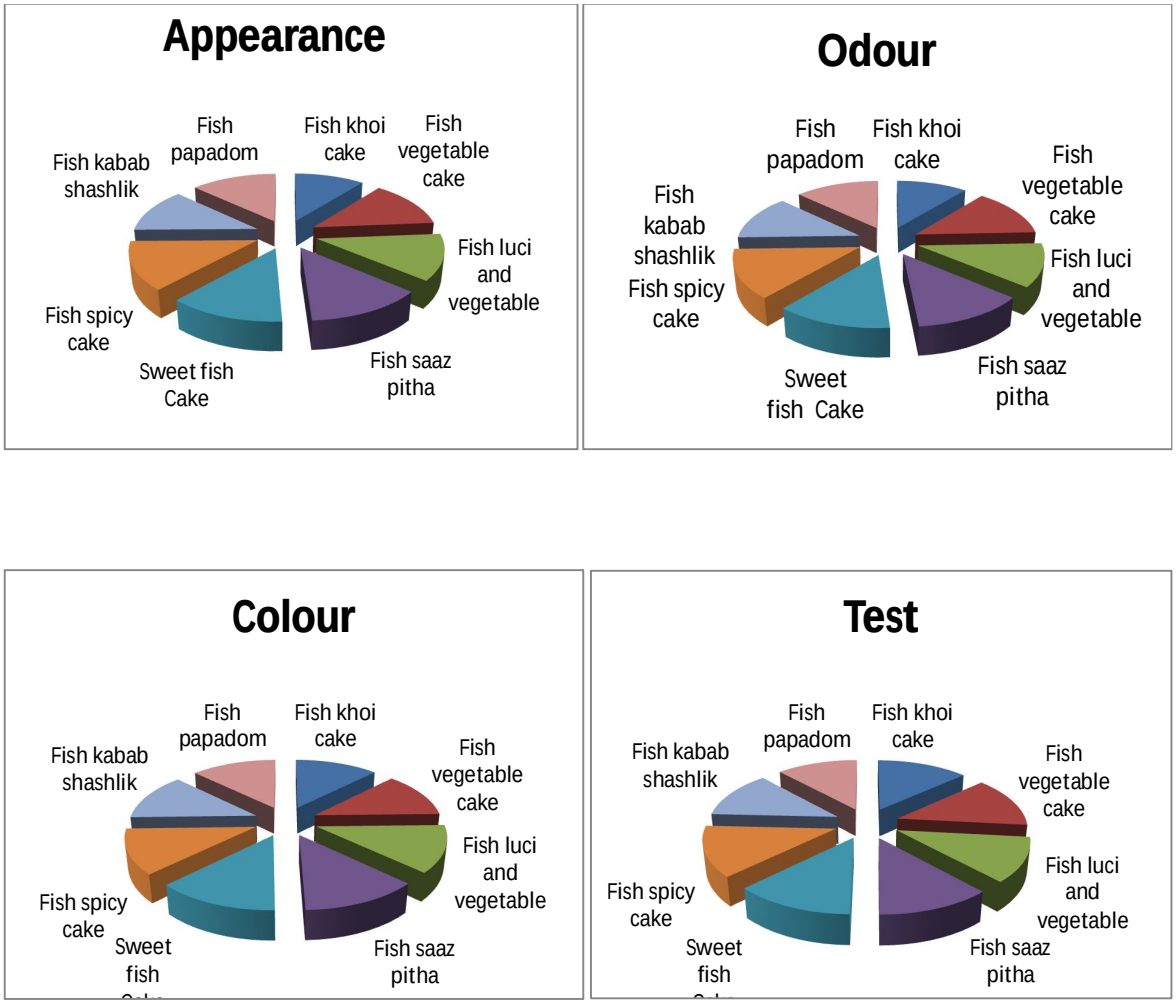


Fig. 5.6: Acceptable level of different quality parameters for the prepared snacks items

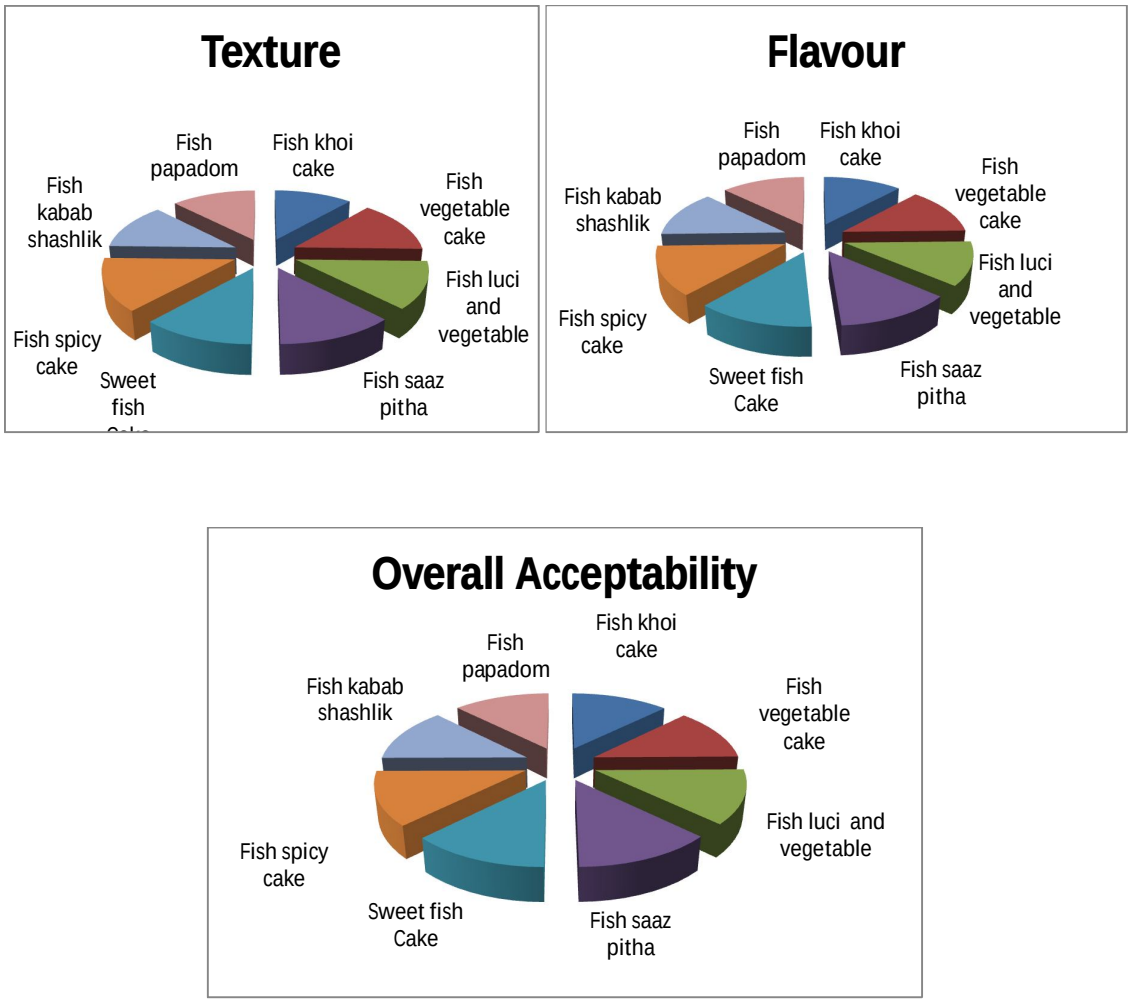


Fig. 5.7: Acceptable level of different quality parameters for the prepared snacks items

Discussion

In this chapter, the cost benefit ratios of the prepared snacks items were analyzed. The acceptance of consumer of the prepared snacks items was also experimented. In the previous chapter of processing and preservation, it was observed that the amount of each fresh species was 1 kg before drying and powdered. But after powdered it was 115.4g, 125.5g, 112.4g, 180.5g and 268.5g for *Labeo rohita, Cirrhinus mrigala, Hypophthalmichthys molitrix, Puntius sophore* and small prawns, respectively. The whole amount of powder from 1 kg fresh fishes and small prawns were used to prepare each snacks items. Total cost mentions the sum of the price of 1 kg fishes and small prawns, price of ingredients, labour cost and fuel cost.

Cost- profit analysis: A simple cost and profit analysis was done (Table-5.1 to 5.5). In the present study it was observed that 115.4g (*L. rohita*), 125.5g *(C. mrigala*, 112.4g (*H. molitrix*), 180.5g (*P. sophore*) and 268.5g (small prawns) powder were obtained from 1 kg fishes. The retail price of the produced snacks items varied from BDT. 4 to15. The retail price was set based on total production cost and the retail price of other snacks items which already exist in market. A net profit varied from BDT. 90 (fish vegetable of *L. rohita*) to BDT. 1838 (fish kabab shashlik of small prawn) in different fishes and small prawns depends on the production cost and amount of product. In the present study it was observed that the production cost and net profit of same items also varied from species to species. The cost benefit ratio of the snacks items in different species varied from 1:0.26 (fish vegetable of *L. rohita*) to 1: 2.49 (fish papadom of *H. molitrix*). It was obtained from the analysis that the production cost and net income of fish kabab shashlik was higher than other processed product but sweet fish cake was more profitable than other snacks items. Because the production cost of sweet fish cake was comparatively low but amount of product was comparatively high. In the present study fish powder was incorporated as a supplement to nine food items preparation for human being and it was highly acceptable.

Organoleptic evaluation*:* A final organoleptic evaluation was made by a group of 08 untrained judges (22-40 years old students and teachers) who were invited to evaluate the

product on the basis of hedonic ratings. The physical and organoleptic qualities of the snacks items were evaluated on the basis of the colour, odour, test, texture, flavour and overall other quality aspects. The appearance and odour of the processed snacks items with fish powder varied from 7±0.92 (fish khoi cake) to 8.6±0.52 (fish vegetable cake) and 7±0.99 (fish khoi cake) to 8.6±0.52 (fish vegetable cake) (Table-5.6), which indicates excellent and good appearance and odour**.** The colour of the experimented snacks items with fish powder varied from 7.7±0.53 (fish spicy cake) to 8.4±0.50 (sweet fish cake) (Table-5.6). Ejaz (2008) reported the colour points were 6.49±0.08, 7.10±0.10, 8.37±0.2, 8.28±0.02, and 8.41±0.03 in Pangus burger produced adding 0, 10, 15, 20 and 25% mashed potato respectively. The present study more or less agreed with the colour test of the above report. The experimentally produced snacks items flavour obtained points varied from 7.3±0.37 (fish luci and vegetable) to 8.2±0.46 (fish spicy cake) for flavour which is considered excellent and good flavour (Table-5.6). Ejaz (2008) reported the flavour points were 4.48±0.07, 6.51±0.08, 7.03±0.15, 8.15±0.05 and 8.87±0.15 in Pangus burger produced adding 0, 10, 15, 20 and 25% mashed potato respectively. The present study more or less agreed with the flavour cost of the above report. The texture of the experimented snacks items obtained points ranged from 7.4±0.52 (fish khoi cake) to 9±0.53 (fish vegetable cake) which is considered as very soft and desirable by the consumer. This excellent texture may be due to addition of the recommended ingredients with fish powder (Table-5.6). Ejaz (2008) reported the softness points were 3.58±0.27, 5.37±0.21, 6.22±0.12, 7.46±0.04 and 8.35±0.05% in Pangus burger produced adding 0, 10, 15, 20 and 25% mashed potato respectively. The present study of fish burger agreed with the softness test of the above report. The test of the processed products varied from 7.6±56 to 8.8±0.46. The overall acceptability ranged from 8.1±0.64 (fish vegetable cake) to 8.5±0.40 (fish saaz pitha) which indicates excellent and good quality (Table-5.6).

The appearance of the processed product scored more or less 8 except fish khoi cake (7±0.92). The odour, colour, test, texture, flavour and overall acceptability of the entire processed product scored more or less 8 except few cases. All the products are having excellent characters and all are accepted favorably by the consumers (Fig. 5.6 and 5.7).

CHAPTER-6

Biochemical Analysis of Fish Powder

Introduction

Fish and shellfish are the primary sources of animal protein and valuable in the diet because they provide a good quantity (usually 70 per cent or more) of protein of high biological value, particularly sulphur containing amino acids (Latham, 1997). Fish is one of the main food constituents in our diet as it contains essential fatty acids, amino acids and some of the principal vitamins and minerals in sufficient amounts for healthy living (Borgstrom, 1961). It is quite different from the other animal food sources, because they provide low energy and have high-level proteins, which contain all essential amino acids. So they are beneficial nutrition sources (Weatherley and Gill, 1998). Stansby (1954) has established that information on the chemical composition of fish in respect to the nutritive value is important to compare with other source of animal protein foods such as meat and poultry products.

Moisture, fat, protein and minerals are the main components of the fish muscle which are referred as 'proximate composition' (Love, 1970). Proximate composition generally means percentage composition of basic constituents such as water, protein, lipids, carbohydrate and minerals (Kumaran *et al.*, 2012). Fish flesh contains up to 15-25% protein, 80% water and 1- 2% mineral matter (CSIR, 1962). According to FAO (1991), fishes contain 72% water, 19% protein and 5% calcium. Love (1980) and Ali *et al*. (2005) reported that most of fish usually consists of water 70-80%, protein 20-30% and 2-12% of lipid. The proximate composition of fish varies widely from species to species and also depends on the season, habitat, temperature, pressure and the type of food consumed by the fish. There is also individual variation in the same species. The distribution of these components among the various organs and tissues of the body may also show considerable difference (Weatherley and Gill, 1987).

The fish protein is relatively high digestible compared to other protein source. It comprises of all the ten essential amino acids in desirable quantity for human consumption. All these properties bring the fish flesh to be in the same class as chicken protein and are superior to milk, beef protein and egg albumen (Srivastava, 1999). Lipid,

also have a high calorific value and stored in muscles, liver, intestine and gonads. Fish meat contains significantly low lipids and higher water than beef or chicken and is favored over other white or red meats (Nestel, 2000). An increasing amount of evidences suggest that, fish meat and oil contains high amount of polyunsaturated fatty acid that are valuable in decreasing the serum cholesterol to prevent a number of coronary heart diseases (Turkmen *et al*., 2005).

Carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis (Cui and Wotton, 1988; Love, 1980). The consumption of fish and fish products is recommended as a means of preventing cardiovascular and other diseases and greatly increased over recent decades in many European countries (Cahu *et al*., 2004). Besides, this fishes are good source which possess immense antimicrobial peptide in defending against dreadful human pathogens (Ravichandran *et al*., 2011). Fish is also a good source of fluorine and iodine, which are needed for the development of strong teeth and the prevention of goiter in man (enlargement of the thyroid gland situated in the neck) (Andrew, 2001). Protein, fat and water content of fish is important to consumers, scientists and manufacturer for nutritional value, seasonal variations and considerations regarding processing (Murray and Burt, 2008). Ingesting fish thus can reduce the risk of heart diseases and lower the risk of developing dementia, including Alzheimer's diseases (Grant, 1997).

Fish is also a vitamin and mineral rich food for young as well as old age people (Edem, 2009). Regular consumption of fish can promote the defense mechanism for protection against invasion of human pathogens because fish food has antimicrobial peptide (Ravichandran *et al*., 2011). Fish muscle does not have a uniform colour. Some muscles are white while others have a reddish or brown colour. This dark colour is usually observed just under the skin. The proportion of dark to white muscle differs continually from head to tail. The proportion also varies between species, increasing with the swimming activity of the fish and sometimes approaching 48 percent of the body weight. There are often differences in the chemical composition of dark and white muscles with respect to protein and lipid contents. The dark muscle has greater concentrations of

hemoglobin and myoglobin than the white muscle. The presence of dark muscle is related to the activity of the fish.

Fish have a significant role in nutrition, income, employment and foreign exchange earning of the country. Frozen fish and fisheries products contribute to nearly 5% of the country's foreign exchange earnings of Bangladesh (Ahmed, 2003). In Bangladesh, as most of the fishermen have no proper preservation facilities, drying is suitable preservation method for them. Dry fish is very popular in Bangladeshi people. According to Basu and Gupta (2004), fish specially dry fish is a rich source of protein, lipid, calcium, iron and zinc. In spite of huge amount of fish protein consumption, there are a few reports on the nutritive or caloric values of dried fish and small prawns. As a result, peoples are confused to take required amount of calorie from dry fishes. Fish powder is a new approach in Bangladesh. Fish powder is an excellent dietary supplement which can be added to a diverse range of products to provide a healthy source of easily digested protein. Fish powder can be added to lose weight and supplement protein and can benefit the heart by lowering blood pressure and plasma total cholesterol. In any area of the food chain where protein is a requirement for health and nutrition, as well as for all animal feed products, Fish powder can be used as a protein base.

Biochemical studies of fish tissue are of considerable interest for their specificity in relation to the food values of the fish and for the evaluation of their physiological needs at different periods of life. It is also necessary to have the data on the composition of fish in order to make the best use of it as food and also to develop the technology of processing fish and fish products. It has long been recognized that marked changes occur in many species of fish during the normal sexual cycle, but in comparison with mere observation, actual chemical studies have not been plentiful. Therefore, knowledge of chemical composition is essential in order to compare its value as food with other protein foods. It is also necessary to have data on the composition of fish powder in order to make the best use of them as food and in order to develop the technology of processing fish and other fisheries items.

A good number of works on biochemical composition of freshwater fishes of Bangladesh have been done by different researchers *viz.,* Kamaluddin *et al.* (1977), Gheyasuddin *et al.* (1979), Rubbi *et al.* (1987), Mollah *et al.* (2000), Azam *et al.* (2003), Islam *et al.* (2003), Nurullah *et al.* (2003), Naser *et al.* (2007), Mazumder *et al.* (2008), Sultana *et al.* (2011), Begum and Minar (2012), Mahfuz *et al.* (2012) and Flowra and Bhuiyan (2013). Rubbi *et al.* (1987) mentioned proximate composition of some commercial species of freshwater fish. Naser *et al.* (2007) stated the proximate composition of shellfish (prawn and shrimp) in Bangladesh. Sultana *et al.* (2011) mentioned the proximate composition of some SIS fishes. But there is no such work about biochemical composition of fish powder of the selected species. Therefore, the present study is undertaken to estimate the amount of total protein, fat, moisture, carbohydrate, ash, phosphorus, iron, and calcium content in fish powder of some carp fishes and small prawns in order to make the consumers more attentive on the nutritional content of fish powder. This information will be useful to help consumers in choosing fish powder based on their nutrient values.

Materials and Methods

In this chapter bio-chemical composition such as moisture, ash, protein, lipid, carbohydrate, phosphorus, calcium and iron has been estimated to assess the quality of fish powder.

Collection of samples

Fish powder were packed tightly species wise in polyethylene bags and brought into the BCSIR (Bangladesh Council for Scientific and Industrial Research) laboratory, Rajshahi, Bangladesh and the Central science Laboratory, University of Rajshahi, Bangladesh, for the determination of biochemical composition and minerals.

Biochemical analysis of fish powder

Triplicate determinations were carried out on each chemical analysis. According to Stansby (1954) and Salam *et al*. (1995), variation in proximate composition of fish flesh may vary with species variation, season, age and feeding habit of the fish (Islam and Joadder, 2005). Generally moisture content shows inverse relationship with lipid content. Compositions of fish powder were determined by the following method.

Estimation of protein:

Protein in the sample was determined by Micro-Kjeldahl distillation method (AOAC, 1990).

Materials:

1. Kjeldahl digestion flasks: 250ml capacity
2. Ditilation apparatus
3. 100ml beaker
4. 50ml conical flask
5. 50ml burette
6. 100ml volumetric flask

Procedure:

The samples were digested by heating with concentrated sulphuric acid (H_2SO_4) in the presence of digestion mixture, Potassium sulphate (K_2SO_4) and copper sulphate ($CuSO_4$). The mixture was then made alkaline with 40 % NaOH. Ammonium sulphate thus formed, released ammonia which was collected in 4% boric acid solution and titrated against standard HCl.

Calculation:

The percentage of nitrogen content of the sample was calculated by the formula given below. Total protein was calculated by multiplying the amount of percent nitrogen with appropriate factor (6.25).

$$\% N = \frac{1.4 \text{ X (mL HCl - mL blank) X Conc. of HCl}}{\text{Weight of sample (g)}}$$

% Protein = % N X Factor (6.25)

Estimation of Lipid:

Lipid determination is one of the key analyses used for food labeling and quality control. Lipid content in the fish powder was determined by petroleum ether extraction followed by soxhelt apparatus (Jinadasa, 2010).

Materials:

1. Soxhelt apparatus
2. Round bottom flask
3. Flask containing pumice chips
4. Oven

Procedure:

For the present study 5 g of finely ground sample was taken in a motor and anhydrous sodium sulphate of twice the weight of the sample was added into it. Then the mixture was ground until a free flowing powder was obtained. Then the powder was transferred to

a thimble and sealed the end. Extraction thimble with the sample was placed in the soxhelt apparatus and fixed a previously dried and weighed round bottom flask. 200 ml of extracting solvent (petroleum ether) was added to the flask containing pumice chips. Then the Flask and the condenser were connected to the soxhelt extractor. Sample was allowed to reflux for about five hours. After the extraction flask was removed from the apparatus and kept in the water bath and then in the oven. Then the flask was cooled and weight was taken.

Calculation:

Percent crude lipid was calculated using the following formula.

% Crude lipid=(X-F)×100/W

Where, X – Weight of the flask with lipid and chips, F – Weight of the flask and chips, W- Weight of the sample

Determination of moisture content:

Moisture content was determined by standard IUPAC method (1977).

Materials:

1. Porcelain crucible
2. Electrical oven
3. Electrical balance
4. Desiccators

Procedure:

2 gm of fish powder were weighed in a porcelain crucible (which was previously cleaned, heated to 105^0C cooled and weighed). The crucible with the sample was heated in an electrical oven for about six hours at 105^0C. It was then cooled in desiccators and weighed again.

Calculation:

The percentage moisture in the fish powder was calculated from the formula:

Moisture = $100(W_1- W_2)/W_2$ %, where W_1 = Original weight of the sample before drying; W_2 = Weight of the sample after drying.

Determination of ash content:

Ash content was determined as described by AOAC (1955).

Materials:

1. Porcelain crucible
2. Muffle furnace
3. Electrical balance
4. Desiccators

Procedure:

About 2 gm of fish powder samples were weighed in a porcelain crucible (which was previously cleaned, heated to about 100^0C, cooled and weighed). The crucible with its content was placed in a muffle furnace for about four hours at about 600^0C. It then cooled in desiccators and weighed. To ensure completion of ashing, the crucible was again heated in the muffle furnace for half an hour, cooled and weighed again. This was repeated till two consecutive weights were the same and the ash was almost white in colour.

Calculation:

The percentage of ash content in the fish powder was calculated from the formula (g per 100g of experimented samples):

Ash = $100(W_1/W_2)$, where W_1 = Weight of the ash obtained; W_2 = Weight of the experimental sample

Carbohydrate:

Fish muscle normally contains only traces of carbohydrates, in the form of sugars, sugar phosphates and glycogen. Some other tissues such as liver contains larger amounts as glycogen, and most molluscan shellfishes also contain a fair amount of glycogen. There is no single method suitable for determining total carbohydrate in all tissues and, apart from the indirect infrared method mentioned earlier under protein, the methods are not straightforward. For these reasons it is common to estimate carbohydrate (C) by difference.

The following equation was used to de-terming the amount of carbohydrate:

% carbohydrate = 100% – (% of protein + lipid + moisture + ash) (Pearson, 1976; Nurnadia *et al.,* 2011)

Because of possible accumulation of errors in the four separate analyses, the accuracy of such an estimate may be low, especially if the amount is small.

Estimation of Minerals:

Estimation of phosphorous:

Determination of phosphorus from fish powder samples by following the Vanadomolybdate yellow colour method was applied (Bhargava and Raghupathi, 2005). A 0.5gm of oven dried and grind sample less than 40 mesh + 7ml conc. nitric acid + 3ml perchloric acid in 30ml micro-Kjeldhal digestion flask. The sample was digested on digestion unit till the content becomes clear. The acid extract was diluted with distilled water in 100ml volumetric flask. The acid extract was used for phosphorus content of plant samples. 10 ml aliquot of plant extract was pipetted out into 50 ml volumetric flask. Then 10ml vanadomolybdate reagent was added, dilute to 50 ml with DW, mix well and the intensity of the yellow colour was read at 470 nm on spectrometer. For the preparation of standard curve standard orthophosphate solution measuring 0, 0.5, 1.0, 1.5, 2.0, and 2.5 ml was taken separately in 50 ml volumetric flask, and it was followed by the addition of 10 ml of the ammonium molybdate-vanadate reagent. The content were diluted to 50 ml with distilled water and mixed well. The absorbance was measured after 30 min. at 470

nm on spectrophotometer and the graph was prepared. The amount of phosphorus was calculated from standard graph of phosphorous.

Estimation of Calcium:

Preparation of standard sample:

The ash obtained as earlier was moistered with a small amount of distilled water (0.5-1) and then 5ml of concentrated HCL was added to it. The mixture was evaporated to dryness on a boiling water bath. Another 5ml of concentrated HCL was added again to the precipitate and the solution was evaporated to dryness as before. Then 4ml of concentrated HCL and a few warmed on a boiling water bath. The warmed solution was then filtered into a 100ml volumetric flask using Whatman no-41 filter paper.

Procedure:

After preparing the standard solution of appropriate concentration, 1 ml from 1000 ppm standard calcium (ca) solution is taken in 100 ml volumetric flask to prepare 10 ppm solution with deionized water. 10 ml from 10 ppm is pipetted in 100 ml volumetric flask to produce 1000 ppb solution. Then 5ml, 10ml, 20ml, have been taken from 1000 ppb solution in 100ml volumetric flask to prepare 0.5, 1 and 2 ppb solution respectively. The calcium was measured by flame method by using flame atomic absorption spectrophotometric procedure (Perkin-Elmer, 1982) using atomic spectrophotometer (Model 372).

Estimation of Iron:

Sample preparation:

Nitric acid, perchloric acid decomposition:

First grained and air dry 2-5gm of sample and place in a conical beaker. Wet with water, add 25ml of HNO_3 and after mixing set aside. Next, gently heat to start a sample reaction. After cooling add 10ml of $Hclo_4$ and gently heat to concentrate. Midway, if the contained material becomes dark, add 2-3 ml portions of HNO_3 and continue heating. When the

contained materials turn yellowish or colorless, the decomposition is complete. After cooling add 2ml of HCL and use water to prepare fixed volume of measurement solution.

Procedure:

After the preparation of sample, the iron concentration was measured by flame atomic absorption spectrophotometric procedure (Perkin-Elmer, 1982) using atomic spectrophotometer (Model 372).

Results and Observation

This chapter deals with the compositional variation of protein, lipid, moisture, ash, carbohydrate and minerals (phosphorus, calcium and iron) of sun dried fish powder of the studied species.

Protein content: The protein content was estimated as 66.90%, 68.47%, 62.18%, 54.31% and 68.50% in *L. rohita, C. mrigala, H. molitrix, P. sophore* and in small prawns, respectively. The highest value was found in small prawns (68.50%) and lowest value was recorded in *P. sophore* (54.31%) (Table-6.1 and Fig. 6.1, 6.2).

Lipid Content: The highest value of lipid content was recorded in *L. rohita* (19.33%) and the lowest was in *P. sophore* (13.33%). The lipid content of *C. mrigala, H. molitrix* and small prawns were 15.71%, 18.66% and 13.64%, respectively (Table-6.1, Fig. 6.1 and 6.2).

Moisture: The highest moisture content was found in *H. molitrix* (13.95%) and lowest was found in *L. rohita* (11.55%). The value of moisture in *C. mrigala, P. sophore* and small prawns were recorded as 13.63%, 12.85% and 12.30%, respectively (Table-6.1, Fig. 6.1 and 6.2).

Table-6.1: The nutritional composition of fish species and small prawns

Specimens	**Proximate composition**				**Minerals**			**Carbohydrate (%)**
	Protein (%)	**Lipid (%)**	**Moisture (%)**	**Ash (%)**	**P (g/kg)**	**Ca (g/kg)**	**Fe (g/kg)**	
L. rohita	66.90	19.33	11.55	0.24	0.95	2.49	0.79	1.75
C. mrigala	68.47	15.71	13.63	0.44	1.78	2.51	1.85	4.85
H. molitrix	62.18	18.66	13.95	0.36	1.32	2.52	0.43	1.98
P. sophore	54.31	13.33	12.85	0.28	1.91	2.51	0.43	19.23
Small prawns	68.50	13.64	12.30	0.16	1.68	2.55	0.94	5.4

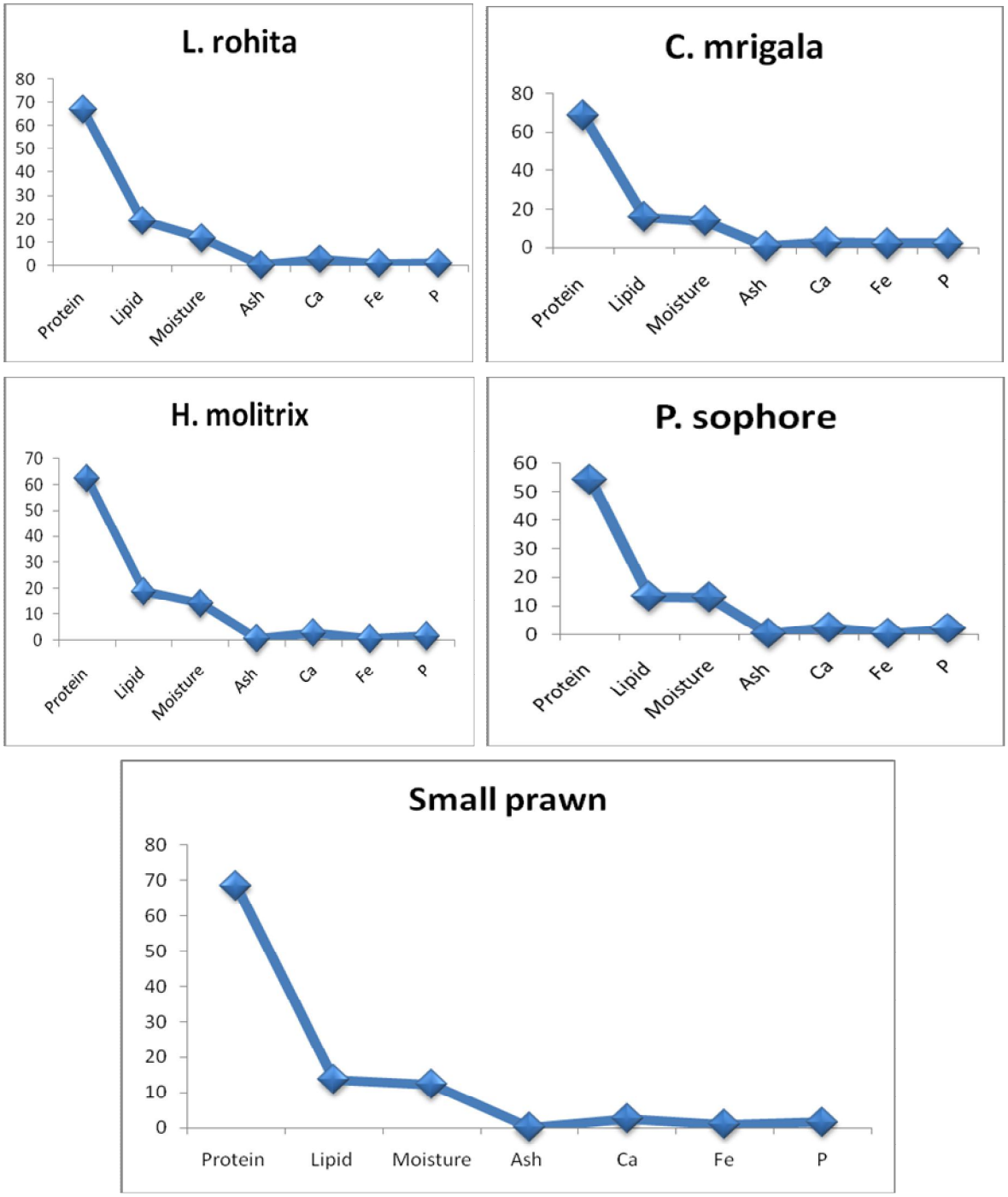


Fig. 6.1: Biochemical composition of the studied species

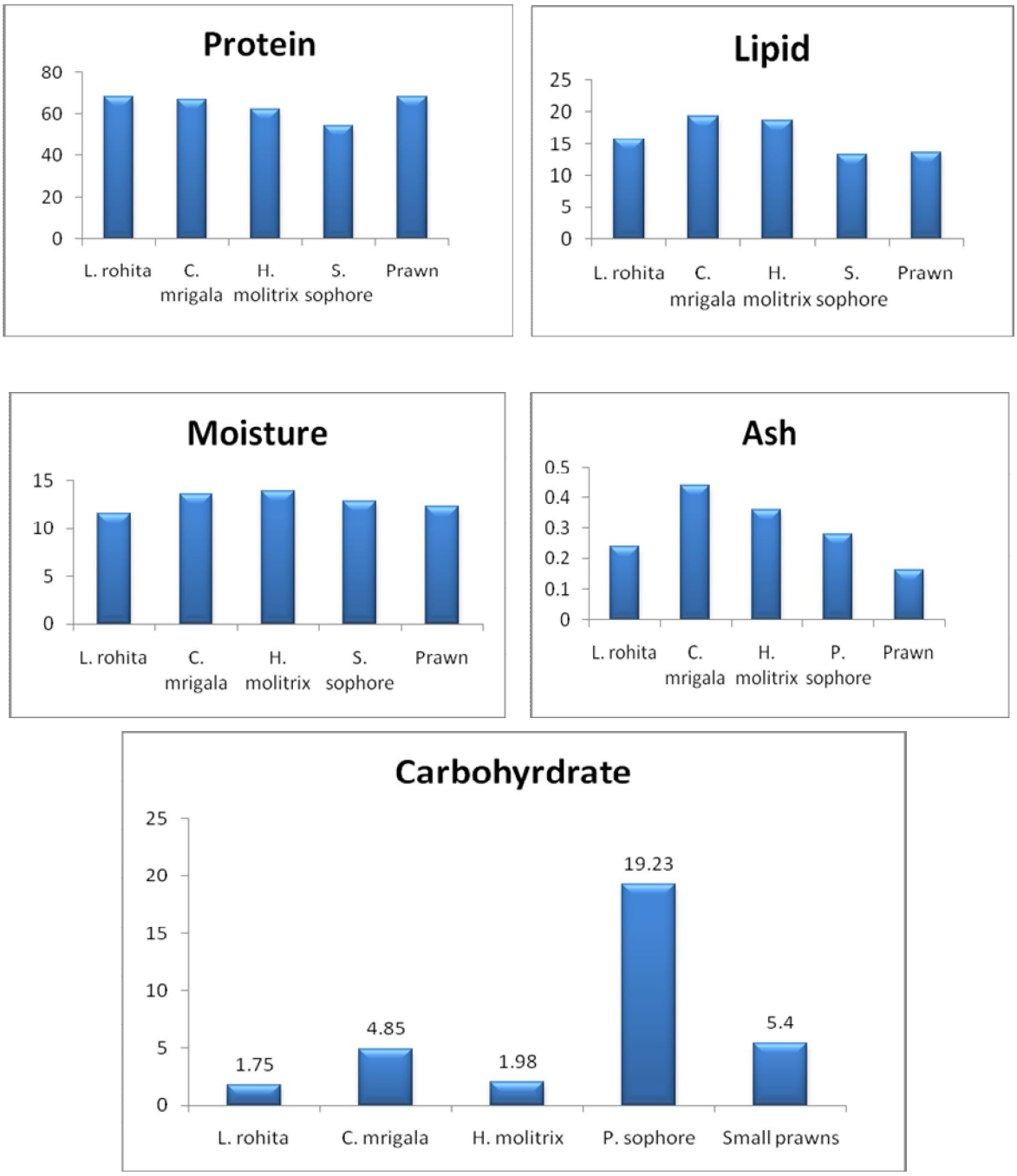


Fig. 6.2: Nutrient compositions of different fish species and prawns

Ash content: The highest ash content was found in *C. mrigala* (0.44%) and lowest was found in small prawns (0.16%). The values of ash in *L. rohita, H. molitrix* and in *P. sophore* were recorded as 0.24%, 0.36% and 0.28%, respectively (Table-6.1, Fig.6.1 and 6.2).

Carbohydrate:

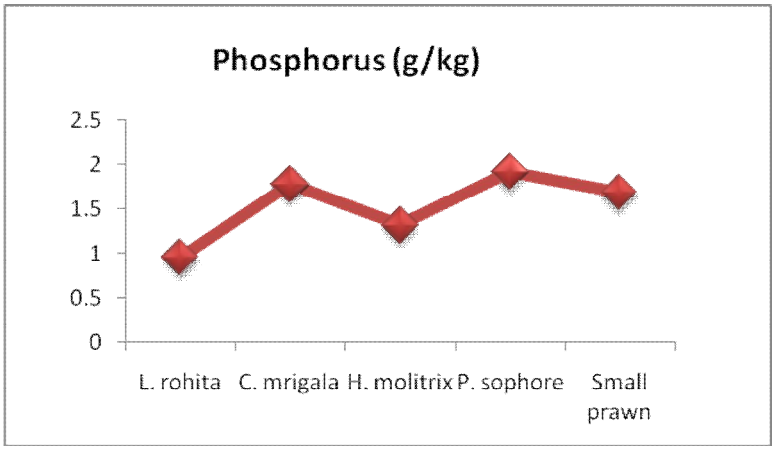
The highest carbohydrate content was observed in *P. sophore* (19.23%) and lowest was found in *L. rohita* (1.75%). The values of carbohydrate in *C. mrigala, H. molitrix* and in small prawns were recorded as 4.85%, 1.98 % and 5.4 %, respectively ((Table-6.1, Fig. 6.2).

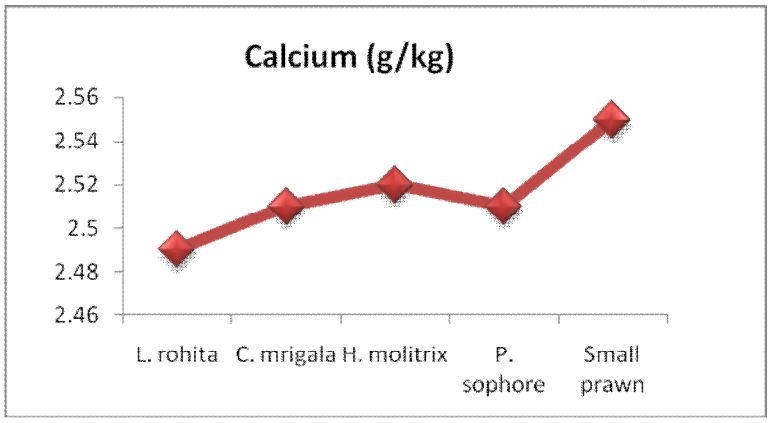
Minerals of freshwater fishes and small prawns

Phosphorus content: The highest phosphorus content was found in *P. sophore* (1.91g/kg) and lowest was found in *L. rohita* (0.95g/kg). The values of phosphorus in *C. mrigala, H. molitrix* and in small prawns were recorded as 1.78 g/kg, 1.32g/kg and 1.68 g/kg, respectively ((Table-6.1, Fig. 6.3).

Calcium content: The highest calcium content was found in small prawns (2.55g/kg) and lowest was found in *L. rohita* (2.49g/kg). The value of calcium in, *C. mrigala, H. molitrix,* and *P. sophore* were recorded as 2.51g/kg, 2.52g/kg and 2.51g/kg, respectively (Table-6.1 and Fig. 6.3).

Iron content: The highest iron content was found in *C. mrigala* (1.85g/kg) and lowest was found in *H. molitrix* and *P. sophore* (0.43g/kg). The value of iron in *L. rohita* and small prawns was recorded as 0.79g/kg and 0.94g/kg ((Table-6.1, Fig. 6.3).





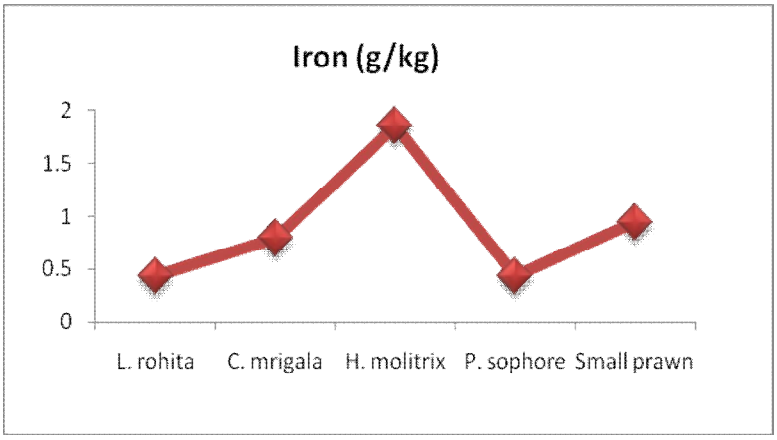


Fig. 6.3: Mineral contents of different fish species and small prawn

Discussion

The protein content was estimated as 66.90%, 68.47%, 62.18%, 54.31% and 68.50% in *L. rohita, C. mrigala, H. molitrix, P. sophore* and in small prawns, respectively. The highest value was found in small prawns (68.50%) and lowest value was recorded in *P. sophore* (54.31%) (Table-6.1 and Fig.6.1 and 6.2). These findings are more or less similar with Sultana *et al*. (2011) who reported that protein content ranged from 52.66 to 72.45% in seven dried fishes. Hoq (2004) concluded that normally the sun-dried fishes contain 60 to 80% protein. Azam *et al*. (2003) also found that the protein content varying between 40.69 to 66.52% in fourteen selected dried fish species. Hussain *et al*. (1992) reported that protein content widely varied from 17.2 to 78% in 23 different dried species. Effiong, (2005) reported that the protein content in fish might vary with species to species due to certain factors such as the season of the year, effect of spawning and migration, food availability etc.

Lipid contents in different fish species and small prawns are shown in the (Table-6.1 and Fig. 6.1, 6.2). The highest value of lipid content was recorded in *L. rohita* (19.33%) and the lowest was in *P. sophore* (13.33%). The lipid content was also recorded in *C. mrigala* (15.71%), *H. molitrix* (18.66%) and in small prwans (13.64%). Flowra *et. al.* (2012a) observed 15.86 % lipid content in *Wallago attu*. These findings are more or less similar with the present study in case of larger fishes. According to Islam *et al.* (2013), lipid content was found 14.03% in *Amblypharyngodon mola* (Mola) which was more or less similar with the present study incase of small fish such as *P. sophore* and small prawns. Hussain *et al.* (1992) obtained that 3.7 to 17.8% fat in 23 sun-dried fish species. Lipid content also varies from species to species such as Mollah *et al.* (1998) reported that dried *Rita rita* contains 13.92% lipid. In the present study the high content of lipid could be due to the larger size of fish.

The highest moisture content found in *H. molitrix* (13.95%) and lowest was found in *L. rohita* (11.55%). The value of moisture in *C. mrigala, P. sophore* and small prawns were recorded as 13.63%, 12.85% and 12.30%, respectively (Table-6.1 and Fig. 6.1, 6.2).

Sultana *et al*. (2011) reported that moisture content ranged from 11.65-13.50% in seven dried fishes. The present findings are strongly agreed with the referred values. Hoq (2004) also reported that normally the sun-dried fishes contain an average of 10 to 20% moisture which was also agreed with the present study. Islam (1982) reported that the moisture content of traditionally dried rui fish was 9.07%. Humayun (1985) stated that sun-dried Rohu fish contained 10.30% moisture which was lower than the present study. But according to Minar *et al*. (2012), the percentage of moisture may also vary according to size, sex and season of the year. From the report of Valsan *et al.* (1985), non-penaeid prawn of Bombay markets that high moisture of 24.3% for unsalted sun-dried fish products promotes the growth of microorganism and accelerates the rate of spoilage. In the present findings salt were not used before dried. Saha (1999) also reported that sun-dried SIS fishes contained 36.50 to 82.80% moisture in thirteen sun dried fishes which were much higher than the present study. Hussain *et al.* (1992) stated that the moisture content varied over a large range from 12.3%-54%. Azam *et al.* (2003) studied biochemical assessment of fourteen selected dried fish and observed that moisture content ranging from 18.23-23.61%. According to Kucukgulmez *et al.* (2010) and Younis *et al.* (2011), the moisture content of fish can vary greatly.

The highest ash content was found in *C. mrigala* (0.44%) and lowest was found in small prawns (0.16%). The values of ash in *L. rohita, H. molitrix* and *P. sophore* were recorded as 0.24%, 0.36% and 0.28%, respectively (Table 6.1 and Fig. 6.1, 6.2). Islam *et al.* (2003) reported that the ash content of *Cirrhina reba* was 1.7% which is higher than the present study. Chukwu and Shaba (2009) also found higher amount of ash content in *C. gariepinus* (3.06%) which is more higher than the studied fish species and small prawns wherever Devadsan *et al*. (1978) found in his experiment, lower amount of ash content in six freshwater fishes such as *L. rohita* (1.31%), *Catla catla* (0.93%), *C. cirrhosus* (1.40%), *L. calabasu* (1.02%), *Mystus seenghala* (0.91%) and *Wallago attu* (0.72) which is more or less similar with the present study. The main cause of change of the percentage of ash is due to amount and quality of food it eats along with its movement (Minar *et al*., 2012).

The highest carbohydrate content observed in *P. sophore* (19.23%) and lowest was found in *L. rohita* (1.75%). The values of carbohydrate in *C. mrigala, H. molitrix* and in small prawns were recorded as 4.85%, 1.98% and 5.4%, respectively (Table-6.1, Fig. 6.2). Bhuiyan (1992) observed 0.2-0.88% carbohydrate in dried bombay duck Sin croaker samples. Stirling (1972) found 1.0-12.5% carbohydrate in the liver of dried fish samples.

The concentration of minerals in fish species can vary depending on age, feeding behavior, environment, ecosystem, as well as many other factors such as time and region of sampling (Zeynali *et al.*, 2009, Falah *et al.*, 2010, Burger *et al*., 2011). The highest phosphorus content was found in *P. sophore* (1.91g/kg) and lowest was found in *L. rohita* (0.95g/kg). The values of phosphorus in *C. mrigala, H. molitrix* and in small prawns were recorded as 1.78 g/kg, 1.32g/kg and 1.68 g/kg, respectively (Table-6.1 and Fig. 6.3). Windom *et al.* (1987) observed such variations in the concentrations of minerals elements among different fish species due to the chemical forms of the elements and their concentrations in the local environment. The concentrations of phosphorus are low due to the separating of bone during processing.

The highest calcium content was found in small prawns (2.55g/kg) and lowest was found in *L. rohita,* (2.49g/kg). The values of calcium in *C. mrigala, H. molitrix*, and *P. sophore* were recorded as 2.51g/kg, 2.52g/kg and 2.51g/kg, respectively (Table-6.1 and Fig. 6.3). Calcium plays essential role in human body for the formation of bones muscle tone and nervous impulse (Mollah *et al*., 1998). It has been reported that *Cirrhina reba* contains 822 mg calcium/100g of fish (Islam *et al*., 2003).

The highest iron content was found in *C. mrigala* (1.85g/kg) and lowest was found in *H. molitrix* and *P. sophore* (0.43g/kg). The values of iron in *L. rohita* and small prawns were recorded as 0.79g/kg and 0.94g/kg (Table-6.1 and Fig. 6.3). Sultana *et al.* (2011) reported that the iron ranging from 16.85 mg/100g in different dried fish. Nurullah *et al*. (2003) reported that iron was present at a range from 14.50 to 42.20 mg/100g of raw fish. These findings were true as shellfish were usually high in minerals such as iron and copper compared to fish (Oksuz *et al*., 2009). However, most of the samples (except black pomfret and silver pomfret) showed lower concentrations of iron when compared with

previous data reported in the Nutrient Composition of Malaysian Foods (Tee *et al*., 1997). This discrepancy could be due to factors affecting the iron content; such as species, individuals, sampling period (Yilmaz *et al*., 2010). The concentrations of iron are low due to the separating of bone during processing.

Biochemical composition of fish varies from one species to another, depending on a number of factors including age, fishing grounds, fishing season, sex of the fish, feed intake and migratory swimming (Lall, 1994). Therefore the results obtained must be interpreted with caution. Nonetheless, fish and fishery products contain water, protein, fat, ash, carbohydrates, minerals and vitamins (Nunes *et al*., 1992 and Lall, 1994).

CHAPTER-7

Shelflife Assessment of Fish Powder

Introduction

Shelf life is the length of time that a commodity may be stored without becoming unfit for use or consumption. It is the recommended maximum time for which products or fresh (harvested) fish can be stored, during which the defined quality of a specified proportion of the goods remains acceptable under expected (or specified) conditions of distribution, storage and display. In another view, shelf life is a guide for the consumer of the period of time that food can be kept before it starts to deteriorate, provided any stated storage conditions have been followed. Its length depends on many factors including the types of ingredients, manufacturing process, type of packaging and how the food is stored. It is indicated by labeling the product with a date mark. For food, shelf life is different from expiration date: the former refers to food quality, the latter to food safety. A product that has passed its shelf life might still be safe, but quality is no longer guaranteed. Most often "quality" refers to the aesthetic appearance and freshness or degree of spoilage which the fish has undergone. It may also involve safety aspects such as being free from harmful bacteria, parasites or chemicals. It is important to remember that "quality" implies different things to different people and is a term which must be defined in association with an individual product type (Wikipedia, 2015c).

Fish is a highly protein content food consumed by a larger percentage of populace because of its availability and palatability (Foran *et al.*, 2005). For that reason all over the world, a number of methods are used to preserve fish. Processing of fish involves primarily the application of preservation techniques in order to retain quality and increase shelf life. It may also mean adding value to produce a wide variety of products. To prolong the shelf life of fish, some preservation techniques are followed based on temperature control, using ice, refrigeration or freezing; others on the control of water activity that includes drying, salting, smoking and freeze-drying. Fish drying is one of the important methods of preserving fish throughout the world. It is still a vital method in the developing regions of the world specially in Bangladesh. Every year a sizeable quantity of fish is preserved by sun drying in Bangladesh from inland water fish as well as from

marine fish. Domestic consumers as well as the ethnic community in developed countries eat dried fish. Traditionally, dried fish represents a low cost source of high quality protein. Bangladesh earns a good quantity of foreign exchange by exporting dried fish every year. The food value of dried fish is well established by the scientists (Cutting, 1962; Qudrat-I-Khuda *et al*., 1962; De, 1967; Bhattacharya *et al*., 1985; Humayun, 1985).

There are many people of Bangladesh who do not like dried fish as for strong odour. So, fish powder would be a great source of high protein, lipid, ash, minerals and carbohydrate. Because incorporation of fish powder in any human food is a good alteration in nutritional value particularly high value animal protein. Fish powder describes a food grade powder product designated primarily for human consumption applications. Fish powders have various sanitary processing, purity and functional characteristics which establish them as human food ingredients.

In order to get fresh and hygiene fish powder, freshness of the raw materials is an important factor which affects quality and shelf life of fish powder. Generally, the quality of the fish powder depends on the quality and chemical composition of raw fish. According to Haruna (2003) fish is a low-acid food that supports the growth of pathogens if not carefully handled and rapidly processed after harvesting. There are so many incidents of fish spoilage across the world, particularly in the tropics, which facilitate microbial activities and chemical changes, with a resultant deterioration and spoilage. Ugwumba (1992) states that the changes are characterized by a series of biochemical changes such as glycolysis caused by enzyme action, rigor mortising the muscle (stiffening of muscle), muscle tendering by post-rigor, autolysis caused by the action of proteinases (muscle protein enzymes) and finally, spoilage due to microbial action and release of mucus. Spoilage is the result of whole series of complicated deteriorative changes brought about in dead fish tissue by its own enzyme, by bacteria and by chemical action (Shewan, 1976). Enzymes from spoilage microorganisms can metabolize the amino acids of the fish muscle producing a wide variety of volatile compounds resulting off-flavors and odors. The combined total amount of ammonia (NH3), dimethylamine (DMA) and trimethylamine (TMA) in fish is called the total volatile base (TVB) nitrogen content

of the fish and is commonly used as an estimate of spoilage. Total volatile nitrogen has been widely used as an index for freshness of fish (Stansby *et al.*, 1944).

In order to get quality product, fish must be dried quickly and hygienically in plenty of sunlight and moving air. This protects from insects and dirt because of getting quality dried fish. Dry fish naturally content different types of microorganisms. Because, Fish is a reservoir of large number of microorganisms; one of the major factors contributing to poor quality of the fish in retail trade is unhygienic handling and storage leading to off smell, physical damage and contamination with dirt and objectionable microorganisms. The majority of these microorganisms are non pathogenic causing only spoilage to fish but some are pathogenic and causes food poisoning. The quality deterioration of foods during processing, storage and distribution is mainly caused by microorganisms. A major problem associated with sun drying of fish in Bangladesh is the infestation of the product by fly and insect larvae during drying and storage (Ahmed *et al.*, 1978; Nowsad, 2007; Nowsad *et al.*, 2010, Flowra *et al*., 2013a). Quality fish powder is highly desirable due to increasing awareness of the consumers on health issues. So it is highly desirable that, the requirement of a safe dried fish powder should be available to all those who are concerned with the expansion and development of fish processing and preservation and the people of Bangladesh can get high protein without any trouble through the preparing of different human food items (snacks) including fish powder.

Microbiological quality and shelf life assessments of fish powder are necessary to ensure the food safety of any processed products with fish powder. In Bangladesh, there are no such work has been done on the microbiological quality and shelf life assessment of fish powder. The aim of shelf life assessment of fish powder is to evaluate the tolerable range of bacteria or other organisms in public health. Besides, it had a view to observe whether the microbial load in fish powder of some freshwater fishes and small prawns were within the acceptable limits (1x105 cfu/g)for total viable bacteria, <100 MPN/g for total coliform as recommended by International Commission of Microbiological Specifications for Foods (ICMSF) and European Union(EU).

Different studies were conducted on the quality assessment of dry fish in different region in Bangladesh such as: Azam *et al*. (2003), Hassan *et al.* (2013), Islam *et al.* (2013), Farid *et al.* (2014), Latifa *et al*. (2014) and Mansur (2014). But no work has been carried out on the shelflife assessment of fish powder of the selected species in Bangladesh. Therefore, this study is undertaken to assess the shelf life of fish powder of some freshwater fishes and small prawns for raising food safety concern to promote international trade. Shelf life assessment was carried out on fish powder stored at room temperature and refrigerated temperature for different time periods. The methods for evaluation of fresh fish quality may be conveniently divided into three categories: sensory, biological and chemical. Biological and chemical methods were applied in the present study for the assessment of shelf life of fish powder of some fishes and small prawns.

Materials and Methods

In this chapter bacterial load and TVB-N value were determined for the assessment of Shelf life of the preserved fish powder. The fish powder was preserved in the normal room temperature and refrigerated temperature for different period.

Collection of sample:

The part of the samples (fish powder) were packed tightly species wise in polyethylene bags and brought into the IBSc (Institute of Biological Sciences) laboratory, University of Rajshahi, Bangladesh and BCSIR (Bangladesh Council for Scientific and Industrial Research) laboratory, Rajshahi, Bangladesh, for the determination of bacterial load and TVB-N value. The rest of the samples were kept in separate plastic container and preserved at normal room temperature and refrigerated temperature during study period. The following methods were used for the determination of bacterial load and TVB-N value.

Preparation of peptone physiological saline (PPS) solution

The recommended quantities of ingredients were weighed by an electric balance and then dissolved in required amount of distilled water (Table-7a). Then the mixture was shaking so that the ingredients mix properly. The mixture was then sterilized in an autoclave (Clover, china) for 15 minutes at 121^{o}C under 15 lbs per sq inch pressure.

Table-7a: The composition of the PPS solution (1 Liter)

Ingredients	**Quantity**
Peptone	**1 g**
Nacl	**8.5 g**
Distilled water	**Up to 1000ml**

Preparation of Media

Different ingredients of recommended quantity for media (Agar) preparation were weighed by an electric balance (Table-7b). These ingredients were dissolved in prescribed amount of distilled water. Then the mixture was boiled and stirring with a stick so that the ingredients mix thoroughly. The media were then sterilized before using them in order to kill any microorganism and if their spores present in the media or in the glassware containing them. Sterilization was accomplished by placing the media in an autoclave for 15 minutes at 121^{o}C under 15 lbs per sq inch pressure. Then the media was ready to use for the purpose of bacteria culture.

Table-7b: The composition of the media (Plate count agar) of 1Liter

Ingredients	**Quantity**
Peptone	**5 g**
Meat extract/Yeast extract	**2.5 g**
Nacl	**1 g**
Bacterial agar	**15 g**
Distilled water	**Up to 1000 ml**

Preparation of the sample

At first the fish powder was weighed (20-30g). Then, a sample of 1:10 dilution was obtained. One ml of dilute sample was transferred with a sterile pipette to a test tube containing 9.0 ml of PPS solution and the test tube was shaken thoroughly. Using similar process, several ten-fold dilutions were made up to desired level.

Aerobic plate count (APC) of Bacteria

Total aerobic plate count expressed as colony forming units (CFU/g) of the representative samples were determined by standard plate count method on plate count agar following the serial dilution technique described by Seeley and Vandemark (1972).

At first, 0.1 ml of prepared, well shaked diluted sample was transferred to prepared agar plates using micropipette. Samples were pipetted out and transferred aseptically to the plates by raising the upper lids sufficiently enough to admit the tip of the pipette. The pipetted samples were spread over the whole surface of the media by using L-shaped glass rods until the samples were dried completely. All the plates were inoculated in duplicate. Then the plates were incubated at 30°C in an inverted position in an incubator (Binder, Germany). After 48 hrs of incubation, colonics were developed. After 48 hrs of incubation, colonies developed only the plates and the colonies were counted by a digital colony counter (Labtronics, India). The result is performed from following formula-

$$\text{No of bacteria (CFU/g)} = \text{No of Colony} \times \text{Dilution Factor}$$

Determination of Total volatile base-Nitrogen (TVB-N)

TVB-N has been used as an index for the determination of freshness of fish. Volatile nitrogenous bases increase in concentration during the spoilage of fish. TVB-N was determined according to the methods given in AOAC (1980) with certain modification.

Reagents required

1. Perchloric acid (6%)
2. NaoH (20%)
3. Standard HCL 0.01N
4. Boric acid (H_3BO_3.3%)
5. Mixed indicator
6. Phenolphthalin indicator

Equipment required

1. Conical flask
2. Distillation unit
3. Kjeldahl flask
4. Weighing machine
5. Some glass beds

Extract Preparation

10gm of ground sample were weighed and mixed with 90ml of 6% perchloric acid and homogenized for two minute with a blender under cooled condition.

Steam distillation and titration

100ml of extract with 4-6 drop of phenolphthalein were put in a kjeldahl flask. Some glass beds were added to prevent bumping. 10ml of 20% NaOH was added to the flask after placing on the distillation unit. Distillation should be continued for more or less than 15 minutes. The distillate was collected in conical flask containing 50ml of 3% Boric acid (H_3Bo_3). Then one drop of mixed indicator was added. Distillation was set at 70˚C and continued through changing the colour of mixed indicator i.e; violet to greenish. After distillation the collected distillate was titrated with 0.01N HCL and regaining the violet colour of mixed indicator confirmed the end.

The results were expressed as mg of TVB-N/100g sample.

Finally TVB-N was calculated by the following formula-

TVB-N (mg/100g of sample) = $ml\ of\ titrant \times 0.14 \times \frac{100}{sample\ weight}$

Here

Titrant = Final reading-Initial reading

Results and Observations

TPC and TVB-N of the fish powder were calculated during the present study. The bacteriological and chemical analyses showed variations among the samples. The total aerobic plate count expressed as colony forming unit in one gram of sample (CFU/g). The fish powder of different freshwater fishes and small prawns were preserved in normal room temperature and in normal home refrigerator. The changes in enumeration of total viable bacteria (Total Plate Count, TPC) and Total volatile based Nitrogen (TVB-N) of some freshwater fishes and small prawns were assessed and the results are given in Table-7.1, 7. 2, 7.3 and Fig. 7.1, 7. 2.

In normal room temperature

In the storage period of the microbiological analyses showed variations among the samples in different time period. In the study period the bacterial load and TVB-N value was high after six months in normal room temperature. Total bacterial load varied from 1.5×10^2 (small prawns) to 4.4×10^6CFU/g (*P. sophore*) and the TVB-N value of different fresh water fishes and small prawns were varied from 4.18 (small prawns) to 36.65 mg N/100g (*P. sophore*).

Estimation of Bacterial load

In room temperature after one month the TPC values of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 3.6×10^2, 2.3×10^2, 2.3×10^3, 9.4×10^3 and 1.5×10^2 CFU/g. After three months the values were 4.1×10^5, 3.3×10^5, 3.5×10^5, 9.8×10^5 and 1.5×10^3 CFU/g, respectively. After six months the TPC values of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 3.6×10^6, 2.3×10^6, 2.5×10^6, 4.4×10^6 and 1.7×10^5 CFU/g, respectively (Table -7.1)

Estimation of TVB-N

TVB-N is one of the most widely used parameter to evaluate fish quality. It represents the sum of ammonia, DMA, TMA and others basic nitrogenous compounds volatile under the

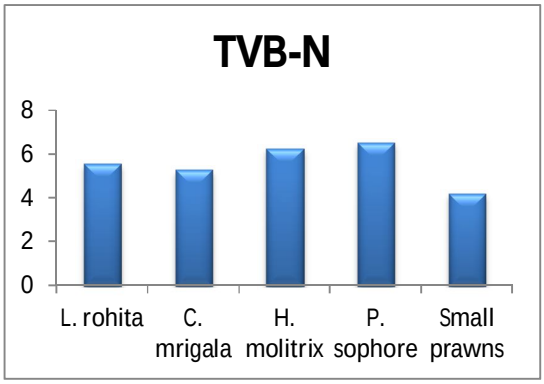
analysis conditions. TVB-N expresses the degree of bacterial spoilage during processing in other word the degree of freshness.

Table-7.1: Microbial load of fish powder in normal room temperature after different times

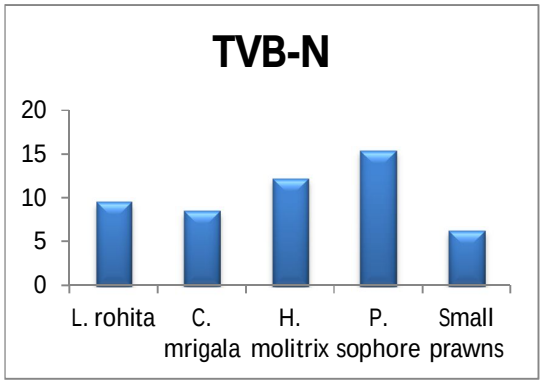
Fish species	After one month	After three month	After six month
	TPC (CFU/g)	TPC (CFU/g)	TPC (CFU/g)
L. rohita	3.6×10^2	4.1×10^5	3.6×10^6
C. mrigala	2.3×10^2	3.3×10^5	2.3×10^6
H. molitrix	2.3×10^3	3.5×10^5	2.5×10^6
P. sophore	9.4×10^3	9.8×10^5	4.4×10^6
Small prawns	1.5×10^2	1.5×10^3	1.7×10^5

Table-7.2: TVB-N values of fish powder in normal room temperature after different times

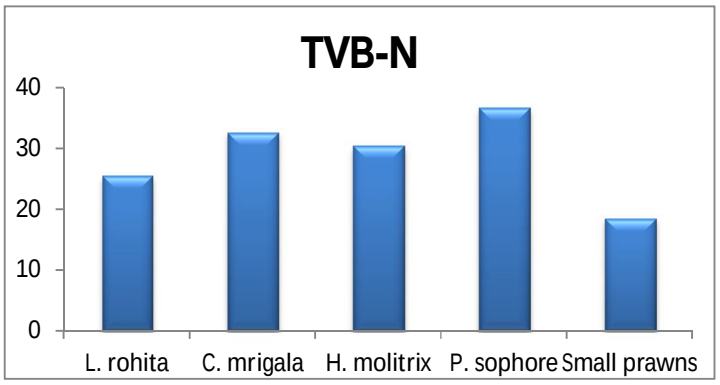
Fish species	After one month	After three month	After six month
	TVB-N (mg N/100g)	TVB-N (mg N/100g)	TVB-N (mg N/100g)
L. rohita	5.54	9.54	25.40
C. mrigala	5.24	8.44	32.55
H. molitrix	6.25	12.25	30.35
P. sophore	6.52	15.42	36.65
Small prawns	4.18	6.28	18.43



a = (after one month)



b = (after three month)



c = (after six month)

Fig. 7.1: TVB-N values of fish powder in normal room temperature (a) after one month, (b) three month and (c) six month

After one month TVB-N values of *L. rohita, C. mrigala, H. molitrix, P. sophore* and small prawns were 5.54, 5.24, 6.25, 6.52 and 4.18 mg N/100g, respectively. After three months the values were 9.54, 8.44, 12.25, 15.42 and 6.28 mg N/100g, respectively and after six months the TVB-N values of *H. molitrix, L. rohita, C. mrigala, P. sophore* and small prawns were 25.40, 32.55, 30.35, 36.65 and 18.43 mg N/100g, respectively (Table-7.2 and Fig. 7.1).

In refrigerated temperature: During the storage period in normal room temperature, total volatile base nitrogen value (TVB-N) increased. But in the storage of refrigerator total bacterial count was not detected after one month, six month and one year of the

storage period but after two years low amount of TVB-N value were observed. In refrigerated temperature the TVB-N values was varied from 0.16 to 0.74 mg N/100g. After two years of the storage period. The TVB-N values of *L. rohita*, *C. mrigala*, *H. molitrix*, *P. sophore* and small prawns were 0.74, 0.52, 0.18, 0.63 and 0.16 mg N/100g, respectively (Table-7.3 and Fig. 7.2).

Table-7.3: Microbial load and TVB-N values of fish powder in refrigerated temperature after different times

Fish species	After one months		After six months		After one year		After two year	
	TPC (CFU/g)	TVB-N (mg N/100g)	TPC (CFU/g)	TVB-N (mg N/100g)	TPC (CFU/g)	TVB-N (mg N/100g)	TPC (CFU/g)	TVB-N (mg N/100g)
L. rohita	-	-	-	-	-	-	-	0.74
C. mrigala	-	-	-	-	-	-	-	0.52
H. molitrix	-	-	-	-	-	-	-	0.18
P. sophore	-	-	-	-	-	-	-	0.63
Small prawns	-	-	-	-	-	-	-	0.16

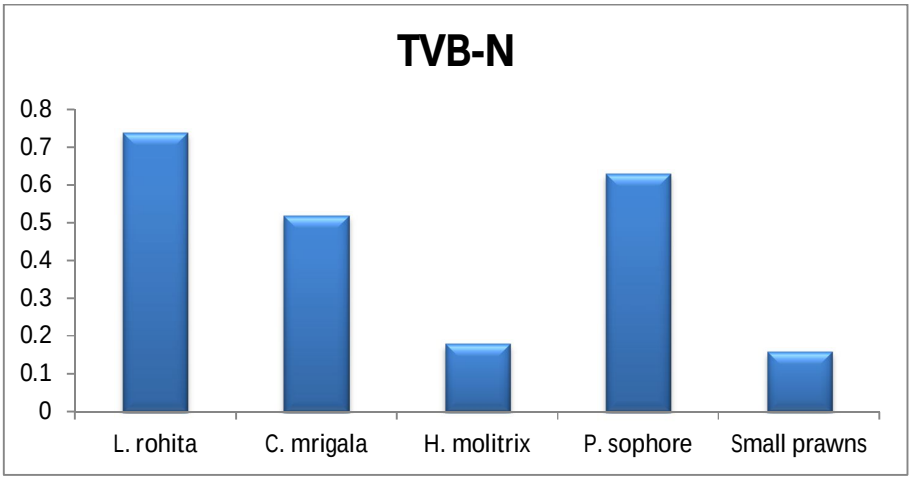


Fig. 7.2: TVB-N values of fish powder after two years in refrigerated temperature

Discussion

All the values of the fish powder highly varied among the species probably indicating the different degrees of spoilage by bacteria. The fish powder of different freshwater fishes and small prawns were preserved in normal room temperature and in normal home refrigerator.

In normal room temperature

Bacterial load

In the preservation of the study period in normal room temperature after one month the bacterial load of fish powder varied from1.5×10^2 (Small prawn) to 9.4×10^3CFU/g (*P. sophore*) and after three months it ranged from 1.5×10^3 (Small prawn) to 9.8×10^5CFU/g (*P. sophore*). After six months it was observed that the lowest value of bacterial load was 1.7×10^5 (Small prawn) and the highest value was 4.4×10^6 (*P. sophore*) (Table-7.1). Islam *et al*. (2013) observed that the total bacterial count of dried puti, mola and Bele were 2.3×10^5, 2.5×10^5 and 9.5×10^5, but in Taki it was 3.6×10^7. Mansur (1989) determined the total bacterial count of some traditionally dried SIS ranged from 1.0×10^5 to 1.5×10^6cfu/g which is more or less similar with the present study. Surendran *et al*. (2006) recommended that the acceptable limit of bacterial count for dried fish is 1×10^5 at 37˚C. Sanjeev (1997) also observed that in Cochin market the bacterial count in dried fishes was less than 10^7g-1. Adesiyan *et al*. (1992) also observed in Nigerian market that the total bacterial count of dried beef and dried fish sample was 10^5 and 10^9. According to the mentioned references it was observed that after one month and after three months the values of bacterial load was accepted to the consumption of human being but after six months the values were going to be higher than the acceptable limit. All the mentioned references are more or less similar with the present study.

According to Sen *et al.* (1961), bacterial growth is inhibited in fish samples with moisture content lower 25%, whereas with less than 15% moisture content mold growth inhibited as well.

The low value of bacterial load after one and after three month would be due to the low concentration of moisture. Low concentration of moisture is helpful to make the long shelf life of any dried product. In the previous chapter it was observed that the moisture content of the different species varied from 11.55 to 13.95%. There is a close relationship between the moisture content and bacterial load in food products. Fish is an ideal substrate for the growth and multiplication of microorganisms. Various factors are responsible for this. Suitable moisture content is one of them. The heat applied during drying cause considerable reduction of microorganisms of various types. Drying by heat usually destroys all yeasts and most of the bacteria, but spores of some bacteria and molds usually survive. Bacteria, yeast and mold do not grow with moisture content below 18%, 20% and 16% respectively. So, if the drying process and storage conditions are adequate, there will be no growth of microorganism in dried fish. But in practical, it is about impossible to control moisture and growth of microbes during processing and storage of dried fish. Especially during improper storage and exposed condition in the retail market, dried products absorb a considerable amount of moisture. Sen *et al*. (1961) reported that, when water content of the fish fall below 25% of the wet weight, bacterial activity stops; when the water content is further reduced to 15% mould ceases to grow. This indicates that, moisture level of 20% was quite unsuitable for the growth of bacteria. It is of little use of insisting production of sun-dried fish with water content below 20% when there is no option but to store it even in a climate of 90% humidity. Sen *et al*. (1961) also reported, when water content of fish fell below 25% of wet weight, bacterial action stopped and when the water content further reduced to 15%, mold ceased to grow. Frazier and Westhoff (1978) reported that, generally no microbe (yeast, mold and bacteria) can grow in a product with moisture content below 15%.

TVB-N values

TVB-N values indicate the freshness of the fish (Beatty and Gibbons, 1936). These spoilage indicators levels in fish muscles have been used as indices of spoilage having good correlation with bacterial growth. TVB-N is accepted universally as an indicator of quality that uses ammonia. But, Reilly *et al.* (1985) stated that TVB-N is not reliable as indices of quality. While Castell and Triggs (1955) have expressed that there is a wide variation in critical values suggested for individual species. TVB- N analyses reflect only stages of advanced spoilage of fish, they are considered unreliable for the evaluation of

the fish freshness in the early stage of storage and they don't reflect the mode of spoilage, bacterial or autolitic (Oehlenschläger, 1992, 1997a, b; Nunes*et al.,* 1992; Huss, 1995; Baixas-Nogueras *et al*., 2002).

TVB-N cannot replace the organoleptic examination, because for most fish species their content in the flesh are relatively low during the edible storage period and after the bacterial population has grown, in the later phase of spoilage, when the fish is near to rejection, increasing amounts of TVB-N are found. They cannot be used as universal quality indicators with a specific set of criteria and standards applicable to all fish species (Ababouch *et al*., 1996). Nevertheless, it may help the spoilage determination of some fish species and it is still the best chemical indicator that is simple to analyze.

The TVB-N values of fish powder of different freshwater fishes and small prawns varied from 4.18 (Small prawn) to 36.65 mg N/100g (*P. sophore*) (Table-7.2) in room temperature. In the storage of normal room temperature, after one month the TVB-N values varied from 4.18 (Small prawn) to 6.52mg N/100g (*P. sophore*) among the different species. After three months the estimated TVB-N values varied from 6.28(Small prawn) to15.42 mg N/100g (*P. sophore*). In the present study it was observed that after six months the TVB-N values ranged from 18.43 (Small prawn) to 36.65 N/100g (*P. sophore*) (Table-7.2 and Fig. 7.1).

Different scientist recommended different ranges of the acceptable limit of TVB-N. As for example, Pearson (1982) recommended that the limit of acceptability of fish is 20-30 mgN per 100g. While Kirk and Sawyer (1991) suggested that a value of 30-40mg N/100g as the upper limit of TVB-N whereas Kimura and Kiamakura (1934) recommended that the acceptability level of TVB-N in dried fish is 35 - 40 mg/100 g as the upper limit and above that level fishery products are considered unfit for human consumption. This is higher than the present observed values. According to Ali *et al.* (2010), the acceptable amount of TVB-N in the previous study showed that 6.72±.18mgN/100g is highly acceptable; 6.81±.17 to 13.57±.36 mgN/100g is acceptable; 20.03±.02 mgN/100g to 33.50±.44 mgN/100g is moderately acceptable; 39.55±.47mgN/100g is just acceptable; 46.57±.37mgN/100g to 91.43±.49 mgN/100g is unacceptable. All the mentioned references are more or less similar with the present study.

Iyer *et al.* (1986) also reported that TVB-N level of fish in retail market was as high as 98 mg/100 g. TVB-N level of dried fishes in Tuticorin market were 30 -18.4, 18.95 – 14.81, 9.31 – 14.14 mg/100 g in monsoon, post monsoon and summer season, respectively (Sinduja *et al.*, 2011). After discussion of TVB-N value of the present study with references, it was observed that after one month and three months the values of TVB-N was highly acceptable or moderately acceptable but after six months it was just acceptable and the values were going to be high for unacceptable.

In the storage of Refrigerator

In the storage period of refrigerator, it was observed that the TVB-N value ranged from 0.16 (Small prawn) to 0.74 mg N/100g (*L. rohita*) (Table-7.3 and Fig. 7.2). The value was much lower than the recommended value. It is known that, the main components of TVB-N are TMA and ammonia. TMA is produced by many spoilage micro-organisms and the ammonia is mainly produced by bacterial attack on proteins and also by attack on amino acids (particularly arginine in crustacea) and on urea in cartilaginous species. Though, it was observed that in the storage period of after one month, six months and also one year no microbes were observed so the TVB-N values would be low. Freezing effectively stops microbial growth. Shewan (1954) found that freezing caused initial reduction in bacterial numbers in fish by 60–90%. Further gradual declining in the flora during storage occurred, with the highest levels of destruction taking place at temperature between 0˚-10˚C.

So, it was proved that the shelf life of fish powder was much longer in the storage of refrigerator than the storage of room temperature.

It is concluded that in normal room temperature the values of bacterial load and TVB-N shows that the fish powder is highly acceptable up to three months and after six months it was acceptable but started to be contaminated with microbes specially bacteria highly. But in refrigerated temperature the bacteria cannot grow up to two years. There was also variation among the different species (fish powder). Such as in case of small prawns the upper limit of bacterial load and TVB-N was lower than other species. But in case of puti the upper limit is very higher than the other species.

CHAPTER-8

Problems

Recommendations

Conclusion

Problems and Recommendation

The problems of preservation are common problem in Bangladesh because preservation of dried fish was found to be performed in a tent generally made of thin plastic sheet and bamboo splits. So, the traditionally dried fishes are contaminated with sand, dirt, mud and other things and they also use a huge quantity of salt which reduce the test and flavor of dry fish. In the present study salt was not used in processing and the dry fishes were kept into plastic container before making powder and the powder were also preserved at normal room temperature and in refrigerator also. During study period the following problems are observed.

Problems

1. In room temperature, the powder products are contaminated quickly with bacteria and other microbes after 30 days.
2. Moisture of air can easily mix with the processed dried fisheries product.
3. In refrigerated condition, the growths of microbes are controlled but the smell of the product slowly fall off.

Recommendation

- The problems can be minimized when the preservation system will be changed. Because during study period, the fish powder were put in the normal plastic container but when airtight container will be used the growth of microbes will be stopped or slow.

- Special care should be taken in processing and preservation of fish before placing sale to the consumers.

- Government (GO) and Non Governmental Organizations (NGOs) should therefore take effective steps and programmes to develop fish processing and preservation system. If proper step is taken, it will be fruitful to ensure food safety and protein demand.

Conclusion

In the present study it is concluded that small sized fishes are more appropriate than that of large sized fishes for getting large amount of fish powder. This might be due to low oil content and small sized bones of small fishes. For the preservation of fish powder, airtight plastic containers have to be used for maintaining the normal test and flavour of fish powder and preventing contamination. The results of the present study revealed the information that the processed dried fisheries product (fish powder) is equally nutritive and possesses good quality as it is in fresh condition. The powder is acceptable for human consumption up to six months in normal room temperature and two years in refrigerator. The powder of fishes and small prawns are used for the preparation of different snacks items such as fish khoi cake, fish vegetable cake, fish luci and vegetable, fish saaz pitha, sweet fish cake, fish spicy cake, fish kabab shashlik and fish papadom. The odour, colour, test, texture, flavour and overall acceptability of the entire processed products showed excellent characters and found to be accepted favorably by the consumers. This powder is easy to use, nutritious and will be very helpful to the busy people who have no time for processing fish and also helpful for the fulfilment of the protein requirment of the children who don’t want to eat fish for bone. It may be also concluded that the unemployed people can also be involved with the preparation process of most accepted tasty snacks items including fish powder as a small entrepreneurs and promote it in the market and can contribute to reduce the poverty and malnutrition as well as play a vital role to the national economy of Bangladesh.

CHAPTER-9

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Appendices

Appendix

AppendixTable-1: Temperature during drying period

Days	*L. rohita*	*C. mrigala*	*H. molitrix*	*P. sophore*	Small prawn
1	33.35	34.4	31.6	34.45	34.25
2	32	26.65	26	26.65	26.55
3	28	32	28	33	30.5
4	26.3	29.7	23.63	26.72	
5	33	32	28	32	
6	26.3	28	28.3		
Mean±SD	29.8±3.32	30.5±2.88	27.6±2.65	30.6±3.65	30.4±3.85

AppendixTable-2: Humidity of air during drying period

Days	*L. rohita*	*C. mrigala*	*H. molitrix*	*P. sophore*	Small prawn
1	84.5	85.5	85.5	84	86
2	84	84	86	83.5	84
3	84.5	84.5	87	84	86.5
4	85	85	86.5	83.5	-
5	86	86	86	85	-
6	84.5	85	86.5	-	-
Mean±SD	84.75±0.69	85±0.70	86.25±0.52	84±0.61	85.5±1.32

Appendix Table-3: Total length and standard length of *L. rohita*

No. of experiment	Total length (cm)	Standard length (cm)
1	19.5	16
2	19.8	16.1
3	19.2	15.8
4	19.5	15.7
5	17.1	13.7
6	18	14.1
7	22.1	17.2
8	19.4	15.1
9	19.3	15.2
10	19.2	15
Mean±SD	19.31±1.27	15.39±0.96

Appendix Table-4: Total length and standard length of *C. mrigala*

No. of experiment	Total length (cm)	Standard length (cm)
1	25.2	20.5
2	25.7	20
3	26	21
4	25.4	20.2
5	25.2	20.2
6	25.8	21.1
Mean±SD	25.55±0.33	20.5±0.41

Appendix Table-5: Total length and standard length of *H. molitrix*

No. of experiment	Total length (cm)	Standard length (cm)
1	28.4	23.2
2	28.5	23.3
3	27.7	22.8
4	29.5	24.4
Mean±SD	28.54±0.74	23.44±0.68

Appendix Table-6: Total length and standard length of *P. sophore*

No. of experiment	Total length (cm)	Standard length (cm)
1	5.5	3.9
2	5.3	4.1
3	4.5	3.6
4	3.8	3.1
5	4.4	3.9
6	5.5	4.2
7	5.4	4.2
8	4.5	4.4
9	6.4	5.3
10	5.7	5.3
Mean±SD	5.1±0.77	4.2±0.68

Appendix Table-7: Total length and standard length of small prawn

No. of experiment	Total length (cm)	Standard length (cm)
1	4.3	3.9
2	4.2	3.9
3	5	4.1
4	4.8	3.7
5	6.9	5.2
6	6.7	5.1
7	5.2	4.3
8	3.5	2.9
9	4.7	4.3
10	3.6	3.1
Mean±SD	4.89±1.15	4.02±0.74

Appendix Table-8: Monthwise landing of studied species in five fish market

Month	Court bazar (kg/day)	Shaheb bazar (kg/day)	Shalbagan (kg/day)	Laxmipur bazar (kg/day)	Binodpur (kg/day)
1st	80	230	181	81	93
2nd	72	355	198	77	70
3rd	40	170	194	50	101
4th	55	185	98	65	95
5th	66	250	96	62	56
6th	45	280	96	53	50
7th	65	300	92	67	62
8th	77	500	216	77	95
9th	58	240	83	81	120
10th	71	285	112	76	50
11th	64	365	139	73	35
12th	61	406	107	86	98
Mean±SD	62.83±0.54	297.16±95.41	134.33±49.00	70.67±11.27	77.08±26.46

Appendix Table-9: Monthwise landing of studied species in Court bazar fish market

Months	*L. rohita* (kg/day)	*C. mrigala* (kg/day)	*H. molitrix* (kg/day)	*P. sophore* (kg/day)	Small prawn (kg/day)	Total landing (kg)/month
1th	30	20	25	2	3	80
2th	25	18	22	3	4	72
3th	15	10	12	2	1	40
4th	18	13	15	4	5	55
5th	26	15	15	5	5	66
6th	16	10	14	3	2	45
7th	24	15	16	5	5	65
8th	30	13	20	6	8	77
9th	21	11	14	5	7	58
10th	24	14	18	7	8	71
11th	20	15	15	7	7	64
12th	18	12	18	6	7	61
Mean±SD	22.25±5.06	13.83±3.04	17±3.76	4.58±1.78	5.16±2.32	62.83±0.53

Appendix Table-10: Monthwise landing of studied species in Shaheb bazar fish market

Months	*L. rohita* (kg/day)	*C. mrigala* (kg/day)	*H. molitrix* (kg/day)	*P. sophore* (kg/day)	Small prawn (kg/day)	Total landing (kg)/month
1th	90	55	60	10	15	230
2th	130	70	125	15	15	355
3th	65	45	34	14	12	170
4th	65	45	48	15	12	185
5th	90	65	70	10	15	250
6th	100	65	90	10	15	280
7th	120	80	75	12	13	300
8th	230	115	80	40	35	500
9th	90	30	60	30	30	240
10th	100	50	80	30	25	285
11th	135	100	50	35	45	365
12th	160	100	70	36	40	406
Mean±SD	114.58±45.95	68.33±25.96	70.16±23.71	21.41±11.70	22.66±11.93	297.16±95.41

Appendix Table-11: Monthwise landing of studied species in Shalbagan fish market

Months	*L. rohita* (kg/day)	*C. mrigala* (kg/day)	*H. molitrix* (kg/day)	*P. sophore* (kg/day)	Small prawn (kg/day)	Total landing (kg)/month
1th	70	45	50	8	8	181
2th	80	50	50	10	8	198
3th	80	50	46	11	7	194
4th	40	24	25	4	5	98
5th	40	30	15	6	5	96
6th	45	25	20	3	3	96
7th	35	22	24	5	6	92
8th	80	45	36	30	25	216
9th	35	22	14	5	7	83
10th	30	22	25	17	18	112
11th	40	30	30	19	20	139
12th	35	26	18	12	16	107
Mean±SD	50.83±20.20	32.58±11.43	29.41±13.13	10.83±7.87	10.66±7.13	134.33±49.00

Appendix Table-12: Monthwise landing of studied species in Laxipur fish market

Months	*L. rohita* (kg/day)	*C. mrigala* (kg/day)	*H. molitrix* (kg/day)	*P. sophore* (kg/day)	Small prawn (kg/day)	Total landing (kg)/month
1th	30	20	26	2	3	81
2th	26	18	22	5	6	77
3th	20	10	12	4	4	50
4th	22	16	18	4	5	65
5th	22	15	15	5	5	62
6th	20	12	14	3	4	53
7th	24	17	16	5	5	67
8th	30	13	20	6	8	77
9th	28	15	16	10	12	81
10th	24	14	18	10	10	76
11th	22	15	18	8	10	73
12th	26	18	20	10	12	86
Mean±SD	24.5±3.52	15.25±2.80	17.91±3.87	6±2.82	7±3.24	70.67±11.27

Appendix Table-13: Monthwise landing of studied species in Binodpur fish market

Months	*L. rohita* (kg/day)	*C. mrigala* (kg/day)	*H. molitrix* (kg/day)	*P. sophore* (kg/day)	Small prawn (kg/day)	Total landing (kg)/month
1th	43	20	25	2	3	93
2th	30	15	17	3	5	70
3th	50	20	28	2	1	101
4th	35	26	25	4	5	95
5th	22	13	14	3	4	56
6th	20	10	15	3	2	50
7th	24	15	14	4	5	62
8th	45	17	20	6	7	95
9th	55	22	26	7	10	120
10th	15	12	14	5	4	50
11th	12	8	10	2	3	35
12th	35	20	30	6	7	98
Mean±SD	32.16±14.01	16.5±5.30	19.83±6.68	3.91±1.72	4.66±2.46	77.08±26.46

Appendix Table-14: Monthwise price of *L. rohita* in Different markets

Month	Court bazar BDT/kg	Shahebbazar BDT/kg	Shalbagan BDT/kg	Laxmipur BDT/kg	Binodpur BDT/kg
1st	85	95	100	96	100
2nd	95	90	105	100	95
3rd	90	85	95	100	90
4th	85	90	110	105	95
5th	90	95	95	95	105
6th	95	95	95	95	90
7th	100	90	110	100	90
8th	80	85	95	90	85
9th	95	80	90	90	95
10th	90	100	95	100	105
11th	90	90	105	100	95
12th	85	85	105	105	95
Mean±SD	90.5	90	100	98	95

Appendix Table-15: Monthwise price of *C. mrigala* in Different markets

Month	Court bazar BDT/kg	Shaheb bazar BDT/kg	Shalbagan BDT/kg	Laxmipur BDT/kg	Binodpur BDT/kg
1st	80	76	85	90	82
2nd	80	78	80	80	82
3rd	75	75	85	85	85
4th	75	75	80	80	75
5th	80	72	85	82	80
6th	70	70	85	85	70
7th	76	72	80	80	76
8th	72	72	75	76	82
9th	70	66	75	75	75
10th	75	75	80	80	80
11th	75	65	75	75	75
12th	78	77	75	78	80
Mean±SD	75.5	72.5	80	80.5	78.5

Appendix Table-16: Monthwise price of *H. molitrix* in Different markets

Month	Court bazar BDT/kg	Shaheb bazar BDT/kg	Shalbagan BDT/kg	Laxmipur BDT/kg	Binodpur BDT/kg
1st	60	55	62	65	65
2nd	62	58	62	66	66
3rd	64	56	60	68	68
4th	60	57	58	66	66
5th	60	58	64	67	67
6th	55	55	55	68	68
7th	64	58	60	70	70
8th	58	54	58	60	60
9th	55	50	55	55	55
10th	64	52	64	65	65
11th	60	55	60	70	70
12th	58	58	62	66	66
Mean±SD	60	55.5	60	65.5	65.5

Appendix Table-17: Monthwise price of *P. sophore* in Different markets

Month	Court bazar BDT/kg	Shaheb bazar BDT/kg	Shalbagan BDT/kg	Laxmipur BDT/kg	Binodpur BDT/kg
1st	248	296	300	260	260
2nd	240	300	300	240	248
3rd	232	280	296	260	280
4th	248	280	288	248	248
5th	248	280	296	248	240
6th	244	280	280	244	244
7th	260	300	280	300	260
8th	220	260	260	220	240
9th	228	248	240	228	228
10th	240	260	260	240	260
11th	232	280	280	232	232
12th	240	296	280	280	260
Mean±SD	240	280	280	250	250

Appendix Table-18: Monthwise price of small prawns in Different markets

Month	Court bazar BDT/kg	Shaheb bazar BDT/kg	Shalbagan BDT/kg	Laxmipur BDT/kg	Binodpur BDT/kg
1st	232	240	232	236	236
2nd	240	244	236	248	236
3rd	232	260	232	256	232
4th	235	240	230	240	228
5th	240	244	232	240	232
6th	244	228	236	232	232
7th	248	246	232	246	236
8th	224	228	224	232	218
9th	228	232	218	232	220
10th	236	248	228	248	232
11th	232	240	232	236	228
12th	235	236	228	240	230
Mean±SD	235.5	240.5	230	240.5	230

Appendix Table-19: Cost for fish khoi cake of *L. rohita*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	115.4g	95
2	Toasted paddy	750g	37
3	Rice flour	350g	21
4	Egg	8p	56
5	Ginger, garlic and cumin paste	50g	20
6	Onion	250g	7
7	Green chilli	25g	2
8	Turmeric powder	25g	6
9	Salt	100g	2
10	Soyabean oil	0.75 litre	90
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		536

Appendix Table 20: Cost for fish khoi cake of *C. mrigala*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	125.5g	80
2	Toasted paddy	750g	37
3	Rice flour	450g	24
4	Egg	8p	56
5	Ginger, garlic and cumin paste	50g	20
6	Onion	250g	7
7	Green chilli	25g	2
8	Turmeric powder	25g	6
9	Salt	100g	2
10	Soyabean oil	0.75litre	90
11	Labour cost	-	100
12	Other cost		100
13	Total cost		524

Appendix Table 21: Cost for fish khoi cake of *H. molitrix*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	112.4g	60
2	Toasted paddy	750g	37
3	Rice flour	350g	21
4	Egg	8p	56
5	Ginger, garlic and cumin paste	50 g	20
6	Onion	250g	7
7	Green chilli	25g	2
8	Turmeric powder	25g	6
9	Salt	100g	2
10	Soyabean oil	0.75 litre	90
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		501

Appendix Table-22: Cost for fish khoi cake of *P. sophore*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	180.5g	260
2	Toasted paddy	1.4kg	70
3	Rice flour	400g	24
4	Egg	10p	70
5	Ginger, garlic and cumin paste	75g	30
6	Onion	400g	12
7	Green chilli	40g	4
8	Turmeric powder	35g	8
9	Salt	150g	5
10	Soyabean oil	1.25 litre	150
11	Labour cost	-	100
12	Others	-	100
13	Total cost		833

Appendix Table-23: Cost for fish khoi cake of small prawns

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	268.5g	240
2	Toasted paddy	2 kg	100
3	Rice flour	700g	42
4	Egg	12p	84
5	Ginger, garlic and cumin paste	100g	40
6	Onion	500g	14
7	Green chilli	50g	5
8	Turmeric powder	50g	12
9	Salt	250g	5
10	Soyabean oil	1.5 litre	180
11	Labour cost	-	200
12	Others	-	200
13	Total cost		1122

Appendix Table-24: Cost for fish vegetable cake of *L. rohita*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	115.4g	95
2	Basil leaf	900g	18
3	Rice flour	250g	15
4	Egg	4p	28
5	Ginger, garlic and cumin paste	50g	20
6	Onion	250g	7
7	Green chilli	25g	2
8	Turmeric powder	25g	6
9	Salt	100g	2
10	Soyabean oil	750ml	90
11	Labour cost	-	100
12	Others	-	100
13	Total cost		483

Appendix Table-25: Cost for fish vegetable cake of *C. mrigala*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	125.5g	80
2	Basil leaf	1kg	20
3	Rice flour	250g	15
4	Egg	4p	28
5	Ginger, garlic and cumin paste	50g	20
6	Onion	250g	7
7	Green chilli	25g	2
8	Turmeric powder	25g	6
9	Salt	100g	2
10	Soyabean oil	750ml	90
11	Labour cost	-	100
12	Others	-	100
13	Total cost		470

Appendix Table-26: Cost for fish vegetable cake of *H. molitrix*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	112.4g	60
2	Basil leaf	900 kg	18
3	Rice flour	220g	13
4	Egg	4p	28
5	Ginger, garlic and cumin paste	50g	20
6	Onion	250g	7
7	Green chilli	25g	2
8	Turmeric powder	25g	6
9	Salt	100g	2
10	Soyabean oil	750ml	90
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		446

Appendix Table-27: Cost for fish vegetable cake of *P. sophore*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	180.5g	260
2	Basil leaf	1.5 kg	30
3	Rice flour	350g	21
4	Egg	6p	42
5	Ginger, garlic and cumin paste	50g	20
6	Onion	250g	7
7	Green chilli	50g	5
8	Turmeric powder	25g	6
9	Salt	125g	3
10	Soyabean oil	1.25 litre	130
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		724

Appendix Table -28: Cost for fish vegetable cake of small prawns

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	268.5g	260
2	Basil leaf	2.2 kg	44
3	Rice flour	500g	30
4	Egg	10p	70
5	Ginger, garlic and cumin paste	100g	40
6	Onion	250g	7
7	Green chilli	50g	5
8	Turmeric powder	25g	6
9	Salt	125g	3
10	Soyabean oil	1.5 litre	180
11	Labour cost	-	200
12	Other cost	-	200
13	Total cost		1045

Appendix Table-29: Cost for fish luci and vegetable of *L. rohita*

Luci			
Sl. No.	**Ingredients**	**Amount**	**Cost (BDT)**
1	**Fish powder**	**115.4g**	**95**
2	**Wheat flour**	**1.1 kg**	**44**
3	**Soyabean oil**	**250ml**	**30**
4	**Labour cost**	**-**	**50**
5	**Other cost**	**-**	**50**
6	**Total cost**	**-**	**269**
Vegetable			
2	**Fish powder**	**115.4g**	**95**
3	**Cabbage**	**750g**	**9**
4	**Tomato**	**110g**	**3**
5	**Potato**	**250g**	**5**
6	**Onion**	**100g**	**3**
7	**Green chilli**	**25g**	**2**
8	**Turmeric powder**	**25g**	**6**
9	**Salt**	**50g**	**1**
10	**Soyabean**	**150ml**	**18**
11	**Labour cost**	**-**	**100**
12	**Other cost**	**-**	**100**
13	**Total cost**	**-**	**342**

Appendix Table-30: Cost for fish luci and vegetable of *C. mrigala*

Luci			
Sl. No.	**Ingredients**	**Amount**	**Cost (BDT)**
1	**Fish powder**	**125.4g**	**80**
2	**Wheat flour**	**1.25 kg**	**50**
3	**Soyabean oil**	**300ml**	**36**
4	**Labour cost**	**-**	**50**
5	**Other cost**	**-**	**50**
6	**Total cost**		**266**
Vegetable			
2	**Fish powder**	**125.4g**	**80**
3	**Cabbage**	**1 kg**	**12**
4	**Tomato**	**100g**	**3**
5	**Potato**	**150g**	**3**
6	**Onion**	**150g**	**4**
7	**Green chilli**	**25g**	**2**
8	**Turmeric powder**	**25g**	**6**
9	**Salt**	**50g**	**1**
10	**Soyabean oil**	**150ml**	**18**
11	**Labour cost**	**-**	**100**
12	**Other cost**	**-**	**100**
13	**Total cost**	**-**	**329**

Appendix Table-31: Cost for fish luci and vegetable of *H. molitrix*

Luci			
Sl. No.	**Ingredients**	**Amount**	**Cost (BDT)**
1	**Fish powder**	**112.4g**	**60**
2	**Wheat flour**	**1.1 kg**	**50**
3	**Soyabean oil**	**300ml**	**36**
4	**Labour cost**	**-**	**50**
5	**Other cost**	**-**	**50**
6	**Total cost**	**-**	**246**
Vegetable			
2	**Fish powder**	**112.4g**	**60**
3	**Cabbage**	**750g**	**9**
4	**Tomato**	**110g**	**3**
5	**Potato**	**250g**	**5**
6	**Onion**	**100g**	**3**
7	**Green chilli**	**25g**	**2**
8	**Turmeric powder**	**25g**	**6**
9	**Salt**	**50g**	**1**
10	**Soyabean oil**	**150ml**	**18**
11	**Labour cost**	**-**	**100**
12	**Other cost**	**-**	**100**
13	**Total cost**	**-**	**307**

Appendix Table-32: Cost for fish luci and vegetable of *P. sophore*

Luci			
Sl. No.	**Ingredients**	**Amount**	**Cost (BDT)**
1	**Fish powder**	**180.5 g**	**260**
2	**Wheat flour**	**1.8 kg**	**58**
3	**Soyabean oil**	**500ml**	**60**
4	**Labour cost**	**-**	**50**
5	**Other cost**	**-**	**50**
6	**Total cost**	**-**	**478**
Vegetable			
2	**Fish powder**	**180.5g**	**260**
3	**Cabbage**	**1.4kg**	**16**
4	**Tomato**	**200g**	**6**
5	**Potato**	**200g**	**4**
6	**Onion**	**200g**	**5**
7	**Green chilli**	**25g**	**2**
8	**Turmeric powder**	**25g**	**6**
9	**Salt**	**75g**	**2**
10	**Soyabean oil**	**300ml**	**90**
11	**Labour cost**	**-**	**100**
12	**Other cost**	**-**	**100**
13	**Total cost**	**-**	**591**

Appendix Table-33: Cost for fish luci and vegetable of small prawn

Luci			
Sl. No.	**Ingredients**	**Amount**	**Cost (BDT)**
1	**Fish powder**	**268.5g**	**240**
2	**Wheat flour**	**2 .6kg**	**105**
3	**Soyabean oil**	**500ml**	**60**
4	**Labour cost**	**-**	**100**
5	**Other cost**	**-**	**100**
6	**Total cost**	**-**	**605**
Vegetable			
2	**Fish powder**	**268.4g**	**240**
3	**Cabbage**	**2.2kg**	**25**
4	**Tomato**	**250g**	**7**
5	**Potato**	**250g**	**5**
6	**Onion**	**250g**	**7**
7	**Green chilli**	**25g**	**2**
8	**Turmeric powder**	**25g**	**6**
9	**Salt**	**100g**	**1**
10	**Soyabean oil**	**300ml**	**36**
11	**Labour cost**	**-**	**100**
12	**Other cost**	**-**	**100**
13	**Total cost**	**-**	**529**

Appendix Table-34: Cost for fish saaz pitha of *L. rohita*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	115.4g	95
2	Wheat flour	1.15 kg	46
3	Kaligira	10g	5
4	Egg	5 p	35
5	Sugar	250g	10
6	Soyabean oil	500ml	60
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	351

Appendix Table-35: Cost for fish saaz pitha of *C. mrigala*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	125.4g	80
2	Wheat flour	1.25 kg	60
3	Kaligira	10g	5
4	Egg	5 p	35
5	Sugar	250g	10
6	Soyabean oil	500ml	60
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	350

Appendix Table-36: Cost for fish saaz pitha of *H. molitrix*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	112.4g	60
2	Wheat flour	1.12 kg	45
3	Kaligira	10g	5
4	Egg	5 p	35
5	Sugar	250g	10
6	Soyabean oil	500ml	90
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	345

Appendix Table-37: Cost for fish saaz pitha of *P. sophore*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	180.5g	260
2	Wheat flour	1.8 kg	72
3	Kaligira	15g	7
4	Egg	5 p	35
5	Sugar	250g	10
6	Soyabean oil	600ml	72
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	556

Appendix Table-38: Cost for fish saaz pithaof small prawns

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	268.4g	240
2	Wheat flour	2.6 kg	105
3	Kaligira	20g	10
4	Egg	8p	56
5	Sugar	500g	20
6	Soyabean oil	1 litre	120
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	561

Appendix Table-39: Cost for sweet fish cake of *L. rohita*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	115.4g	95
2	Wheat flour	1.15 kg	45
4	Egg	4 p	28
5	Sugar	250g	10
6	Soyabean oil	500ml	60
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	338

Appendix Table-40: Cost for sweet fish cake of *C. mrigala*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	125.4g	80
2	Wheat flour	1.25kg	50
4	Egg	5 p	35
5	Sugar	250g	10
6	Soyabean oil	500ml	60
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	335

Appendix Table-41: Cost for sweet fish cake of *H. molitrix*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	112.4g	60
2	Wheat flour	1.12 kg	45
4	Egg	4 p	28
5	Sugar	250g	10
6	Soyabean oil	500ml	60
7	Labour cost	-	50
8	Other cost	-	50
9	Total cost	-	303

Appendix Table-42: Cost for sweet fish cake of *P. sophore*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	180.5g	260
2	Wheat flour	1.8 kg	60
4	Egg	5 p	35
5	Sugar	250g	10
6	Soyabean oil	600ml	72
7	Labour cost	-	100
8	Other cost	-	100
9	Total cost	-	637

Appendix Table-43: Cost for sweet fish cake of small prawns

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	268.4g	240
2	Wheat flour	2.6 kg	105
4	Egg	8p	40
5	Sugar	500g	10
6	Soyabean oil	1 litre	120
7	Labour cost	-	100
8	Other cost	-	100
9	Total cost	-	715

Appendix Table-44: Cost for fish spicy cake of *L. rohita*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	115.4g	95
3	Rice flour	1.15kg	58
4	Egg	4p	28
5	Ginger, garlic and cumin paste	20g	8
6	Onion	100g	3
7	Green chilli	25g	2
8	Turmeric powder	10g	2
9	Salt	100g	2
10	Soyabean oil	500ml	60
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		458

Appendix Table-45: Cost for fish spicy cake of *C. mrigala*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	125.4g	80
3	Rice flour	1.25kg	63
4	Egg	5p	35
5	Ginger, garlic and cumin paste	20g	8
6	Onion	100g	3
7	Green chilli	25g	2
8	Turmeric powder	10 g	2
9	Salt	100g	2
10	Soyabean oil	500ml	60
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		455

Appendix Table-46: Cost for fish spicy cake of *H. molitrix*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	112.4g	60
3	Rice flour	1.12kg	45
4	Egg	5p	35
5	Ginger, garlic and cumin paste	20g	10
6	Onion	100g	3
7	Green chilli	25g	2
8	Turmeric powder	10 g	2
9	Salt	100g	2
10	Soyabean oil	500ml	60
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		419

Appendix Table-47: Cost for fish spicy cake of *P. sophore*

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	180.5g	260
3	Rice flour	1.8kg	72
4	Egg	7p	49
5	Ginger, garlic and cumin paste	25g	10
6	Onion	150g	5
7	Green chilli	25g	2
8	Turmeric powder	15g	3
9	Salt	100g	2
10	Soyabean oil	600ml	72
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		675

Appendix Table-48: Cost for fish spicy cake of small prawn

Sl.No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	268g	240
3	Rice flour	2.7kg	128
4	Egg	8p	56
5	Ginger, garlic and cumin paste	30g	12
6	Onion	200g	5
7	Green chilli	25g	2
8	Turmeric powder	25g	3
9	Salt	100g	2
10	Soyabean oil	1 litre	120
11	Labour cost	-	100
12	Other cost	-	100
13	Total cost		768

Appendix Table-49: Cost for fish kabab shashlik of *L. rohita*

Sl. No.	Ingredients	Amount	Cost
1	Chop of fish powder	230(2 piece of chops were use in each shashlik)	134
2	Onion	1.5 kg	42
3	Capsicum	6 piece	240
4	Tomato	1.5 kg	42
5	Cucumber	1 kg	20
6	Bamboo stick (small size)	115p	30
7	Soyabean oil	100g	12
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	1022

Appendix Table-50: Cost for fish kabab shashlik of *C. mrigala*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Chop of fish powder	250(2 piece of chops were use in each shashlik)	524
2	Onion	1.5 kg	42
3	Capsicum	6 piece	240
4	Tomato	1.5 kg	42
5	Cucumber	1 kg	20
6	Bamboo stick (small size)	112p	30
7	Soyabean oil	100g	12
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	1110

Appendix Table-51: Cost for fish kabab shashlik of *H. molitrix*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Chop of fish powder	224(2 piece of chops were use in each shashlik)	501
2	Onion	1.6kg	45
3	Capsicum	6 piece	240
4	Tomato	1.6 kg	45
5	Cucumber	1.1 kg	20
6	Bamboo stick (small size)	112p	30
7	Soyabean oil	100g	12
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	1093

Appendix Table-52: Cost for fish kabab shashlik of *P. sophore*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Chop of fish powder	360(2 piece of chops were use in each shashlik)	833
2	Onion	2.5 kg	70
3	Capsicum	10 piece	400
4	Tomato	2.5 kg	70
5	Cucumber	1.5 kg	30
6	Bamboo stick (small size)	180p	45
7	Soyabean oil	200g	24
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	1572

Appendix Table-53: Cost for fish kabab shashlik of small prawn

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Chop of fish powder	540(2 piece of chops were use in each shashlik)	1122
2	Onion	2.5 kg	70
3	Capsicum	15 piece	600
4	Tomato	3 kg	84
5	Cucumber	2 kg	40
6	Bamboo stick (small size)	270p	60
7	Soyabean oil	300g	36
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	2212

Appendix Table-54: Cost for fish papadom of *L. rohita*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	115.4g	95
2	Wheat flour	1.1kg	44
3	Kaligira	10g	3
4	Egg	4 p	28
5	Red chilli powder	10g	3
6	Salt	50g	1
7	Soyabean oil	250 ml	60
8	Labour cost	-	50
9	Other cost	-	50
10	Total cost	-	334

Appendix Table-55: Cost for fish papadom of *C. mrigala*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	125.5g	80
2	Wheat flour	1.2kg	48
3	Kaligira	10g	3
4	Egg	5p	35
5	Red chilli powder	10g	3
6	Salt	50g	1
7	Soyabean oil	250 ml	60
8	Labour cost	-	50
9	Other cost	-	50
10	Total cost	-	330

Appendix Table-56: Cost for fish papadom of *H. molitrix*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	112.4g	60
2	Wheat flour	1.1kg	44
3	Kaligira	10g	3
4	Egg	4 p	28
5	Red chilli powder	10g	3
6	Salt	50g	1
7	Soyabean oil	250 ml	60
8	Labour	-	50
9	Other cost	-	50
10	Total cost	-	229

Appendix Table-57: Cost for fish papadom of *P. sophore*

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	180.5g	260
2	Wheat flour	1.8kg	72
3	Kaligira	15g	5
4	Egg	6p	42
5	Red chilli powder	10g	3
6	Salt	70g	2
7	Soyabean oil	300 ml	36
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	620

Appendix Table-58: Cost for fish papadom of small prawns

Sl. No.	Ingredients	Amount	Cost (BDT)
1	Fish powder	268.5g	240
2	Wheat flour	2.6kg	104
3	Kaligira	20g	6
4	Egg	10p	70
5	Red chilli powder	20g	6
6	Salt	100g	2
7	Soyabean oil	500 ml	60
8	Labour cost	-	100
9	Other cost	-	100
10	Total cost	-	688

Appendix Table-59: Organoleptic analysis of snacks items with edible fish powder products

Organoleptic parameters	Fish khoi cake								Fish vegetable cake							
Appearance	9	8	7	7	9	9	8	7	9	8	8	9	9	9	8	9
Odour	8	9	9	9	7	7	7	7	9	9	8	8	9	9	9	8
Colour	9	8	8	8	8	7	7	8	8	9	7	7	8	8	9	7
Test	9	9	9	9	8	8	9	9	9	9	9	8	8	9	9	9
Texture	7	7	8	8	7	7	7	8	9	8	9	8	8	8	9	9
Flavour	9	8	8	7	7	6	8	7	8	8	9	7	8	9	8	8
Overall Acceptability	9	8	8	9	8	8	8	9	7	8	8	8	8	8	9	9

Appendix Table-60: Organoleptic analysis of snacks items with edible fish powder products

Organoleptic parameters	Fish luci and vegetable								Fish saaz pitha							
Appearance	8	8.5	9	9	9	7	8	7	8	8.5	8.5	9	9	9	8	8.5
Odour	7	9	7	9	7	7	7.5	7.5	7	7	8.5	8.5	7	9	7.5	8
Colour	9	9	9	8	8.5	9	8	8	8	9	7.5	7.5	8	8	9	8
Test	8	7.5	7	7.5	8	8.5	7	7	8	9	8	7.5	8	7	9	7
Texture	8	7	8	8.5	7.5	8	8	8	7.5	8	8	8.5	8	8.5	9	8
Flavour	7	8	7	7.5	7	7.5	7	7	7.5	8	8	7.5	8	9	8	8
Overall Acceptability	9	8	7	9	8	8.5	8	8.5	7.5	8.5	8	8	8.5	8	8	8

Appendix Table-61: Organoleptic analysis of snacks items with edible fish powder products

Organoleptic parameters	Sweet fish cake								Fish spicy cake							
Appearance	9	8.5	8	8	9	9	8	7	8	8.5	8.5	9	9	9	8	8.5
Odour	8	9	9	9	8	7	7.5	7.5	9	8	8.5	8.5	9	8	9	8
Colour	9	8	8	8	8.5	9	9	8	8.5	7	7.5	7.5	8	8	8	7
Test	9	8.5	8	8.5	8	8.5	8	8	8	9	9	8.5	8	9	8.5	9
Texture	7.5	7	8	8.5	7.5	7	7	8	8.5	9	9	8.5	9	8.5	9	9
Flavour	8	8	8.5	8	7	8	8.5	7	8	8.5	8	7.5	8	9	8	8.5
Overall Acceptability	9	8	8	9	8	8.5	8	8.5	8.5	8	8	8	8.5	8	9	8

Appendix Table-62: Organoleptic analysis of snacks items with fish powder products

Organoleptic parameters	Fish kabab shashlik								Fish papadom							
Appearance	9	8.5	9	9	9	9	8	8	8	8.5	8.5	9	9	9	8	8.5
Odour	8	9	8	9	7	8	7.5	7.5	8	8	8.5	8.5	8	8.5	9	8
Colour	9	8	8	8	8.5	8	8	8	8.5	9	7.5	7.5	8	8	9	8
Test	8	8.5	8	8.5	8	8.5	8	8	8	8	8.5	8.5	8	7.5	7	7
Texture	7.5	8	8	8.5	7.5	8	8	8	9	8	9	8.5	8	8.5	9	9
Flavour	8	8	8.5	7.5	8	7.5	8.5	8	8	8.5	8	7.5	8	7.5	8	8.5
Overall Acceptability	9	8	8.5	9	8	8.5	8	8.5	8.5	8	8	8	8.5	8	9	8