

PROXIMATE COMPOSITION OF SOME SELECTED MARINE FISHES



A Thesis

By

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PROXIMATE COMPOSITION OF SOME SELECTED MARINE FISHES

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Declaration

Proximate Composition of Some Selected Marine Fishes

The results presented in the project thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

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DEDICATED TO

MY BELOVED PARENTS

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Abstract

The knowledge of proximate composition of fishery species is fundamentally important for the application of different technological processes, the characteristics post-mortem of species, as an aspect of quality of raw material and giving an idea of sexual stage. Eleven marine fish species (*Johnius argentatus*, *Harpodon nehereus*, *Cynoglossus lingua*, *J. elongatus*, *Sillginopsis panijas*, *Pomadasys hasta*, *Setipinna phasa*, *Megalaspis cordyla*, *Rita rita*, *Gonialosa manmina* and *Scatophagus argus*), available at the local fish market in Khulna City, were considered in this study for the determination of proximate composition. Proximate composition (protein, lipid, moisture and ash) of fish from raw condition (as a whole), from different body parts (head, middle and tail) and from fish processed differently (boiled and dried) was determined. In whole body, protein lipid, moisture and ash were higher in *G. manmina*, *S. argus*, *H. nehereus*, and *S. argus*, respectively while lower in *H. nehereus*, *C. lingua*, *M. cordyla* and *R. rita*, respectively. Between the body parts, head part contained higher amount of protein followed by middle and tail parts whereas widely dissimilar patterns were observed for lipid, moisture and ash contents. Wide variations in protein content, 13.88–33.6%, between species and methods of cooking was observed. Fat content varied between species ranged from 0.39 to 4.1% in raw fish, 0.8 to 3.37% in boiled fish and 15.8 to 33.9% in fried fish. Frying of fish showed a considerable increase in fat values compared to raw fish (15.8–33.9% vs. 0.39–4.1%). Moisture content was much higher in raw (71.94 to 84.85%) and boiled fish (71 to 83%) than the fried fish (28.6 to 53.3%). The highest ash content was found in the fried *S. phasa* (9.1%). The present study is comprehensive in nature and can be used as reference in the formulation of feeds, and also to determine the health and nutritional status of commercially reared of these species.

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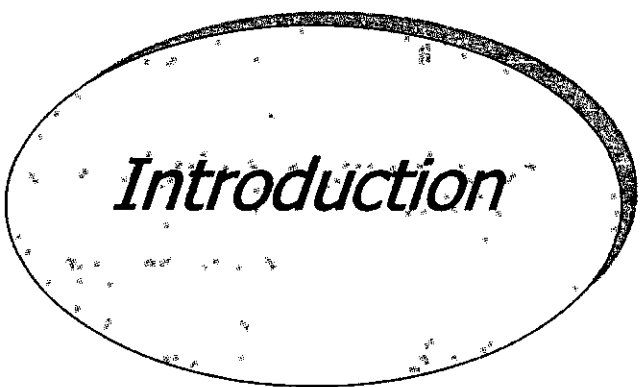
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C H A P T E R = 1



Introduction

1. Introduction

1.1 Background of the study

Fish has long been recognized as a valuable source of high-quality protein in the human diet. In recent years, fish lipids have also assumed great nutritional significance owing to their protective role against the development of cardiovascular diseases and rheumatoid arthritis (Shahidi and Botta, 1994). The gross composition of fish determines its nutritional value, functional properties, sensory attributes, processibility and storage stability (Sikorski, *et al.*, 1990). Knowledge of fish composition is therefore particularly important. Most fish are low in fat and cholesterol and a good source of protein, which makes them a good choice for a healthy diet. Our bodies require a certain amount of protein daily and the body does not store protein so we need to replenish it in our daily diet. All fish are a good source of B vitamins and oil-rich fish are a good source of vitamins A and D.

Fish is a major source of animal protein and it also contains minerals. Marine foods are very rich sources of mineral components. The total content of minerals in the raw flesh of marine fish and invertebrates is in the range of 0.6–1.5% wet weight. Mineral components such as sodium, potassium, magnesium, calcium, iron, phosphorus and iodine are important for human nutrition (Sikorski, *et al.* 1990).

Nutrition values of the most marine fishes (except for few commercial important) are not known. Knowledge of nutrient values for specific fish species is essential not only for their growth in captive condition (e.g., culturing) but also for the people those suffering from malnutrition. Most of the people in our country do not prefer marine fish as their contribution in human health is unknown. Moreover, poor people are unable to

reach fresh water fishes due to availability and costly. If poor people are aware about the nutrient values of marine fishes, their nutritional requirement could be satisfied.

Although Bangladesh is blessed with potential marine fisheries resources, people prefer freshwater fishes than marine water fishes due to the little knowledge about the nutritive value of marine fishes. Marine fish is widely consumed in many developed countries because of it has high protein content (Puwastien *et al.*, 1999), low saturated fat and rich in minerals known to support good health (Sikorski *et al.*, 1990). Marine fish, an excellent source of Omega-3 fatty acids that contributes to reduce the risks of heart attacks and blood pressure, make the blood flow easier through the body, reducing, help the heart beat steadier and reduce the chances of suffering from a stroke. Some experts think that it can help prevent cancer cells from developing to the tumor stage. It is also thought to reduce the inflammation in rheumatoid arthritis patients.

Bangladesh is populated and developing country. Majority people live in village and sub-urban areas and people of these localities are deprived from sufficient protein due to poverty. Presently, protein consumption per capita is 17.23 kg which is below than the standard level (18 kg) (DoF, 2009). Major protein sources for the people of Bangladesh derive from fish and animal husbandry. But these two items are costly for the poor people. The recent national wide declines in natural freshwater fish stocks, largely resulting from overexploitation and anthropogenic changes in the environment, have stirred renewed interest in the creation of alternative protein source for the poor people in Bangladesh. Marine fishes could be alternative protein source for the marginal people as these are relative cheap compared to commonly consumed freshwater fishes. In this regard, the present study was aimed to determine the nutritive value of some marine fishes those are available in Khulna district.

1.2 Objectives

Bangladesh is one of the resourceful countries with its wide range of marine aquatic bio-diversities. There are about 1093 marine aquatic organisms where 44.35% are finfish, 32.23% shellfish, 15.10% seaweeds and only 8.32% are other organisms including shrimps. Due to losses of freshwater fishes and the price of these species are high, marine fin fishes particularly small ones could be alternative source for protein for poor people in Bangladesh. But there is no scientific information available regarding the nutritive values of these small marine species. Therefore, the major objective of this study is to determine the proximate composition (protein, lipid, ash and moisture) of marine fishes those are available in Khulna district. Specific objectives of this study are:

- To determine the proximate composition (protein, lipid, moisture and ash) in whole fish.
- To determine the proximate composition in different body parts (head, middle and tail), and
- To determine the proximate composition in fish processed differently (boiled and dried).

CHAPTER - 2

*Literature
Review*



2. Literature review

It is essential to know the information about the previous related works to conduct an experiment. In Bangladesh some research works have been done about the proximate composition of freshwater fishes, but no works has been done to determine the nutritive value of marine fishes. A good number of works relating this topic has been done in other countries. The following information was reviewed in favor of the present study which was done around the world.

2.1 Works done in Bangladesh

Mazumder *et al.* (2008) studied on proximate composition of some small indigenous fish species (sis) in Bangladesh. In this study, the proximate biochemical composition of some small indigenous fish species i.e., Mola, Chapila, Punti, Chanda, Batashi and Kajuli were analyzed. Major nutrient compositions like protein, fat, moisture, ash in raw muscles were estimated. Proximate compositions were found to be varied among the species. Protein was estimated in mola (18.46 %), chapila (15.23 %), puti (14.08%), chanda (18.26%), batashi (15.84%) and Kajuli (16.99%). The fat content this study was between 5.41 – 1.53%. The highest level of moisture content was found in *C. nama* (78.62%) and the lowest was in *A. coila* (65.88%). The percentage of ash content was highest in *C. nama* (3.92%) and lowest in *G. chapra* (1.55%). This study concluded that nutrient contents of small indigenous fishes have higher or equal to those of larger fish species.

Nurullah *et al.* (2003) conducted a research on nutritional quality of some small indigenous fish species of Bangladesh. Proximate analysis of mola (*Amblypharyngodon mola*), dhela (*Osteobrama cotio*), chapila (*Gudusia chapra*), punti (*Puntius stigma*),

tengra (*Mystus tengra*) and kankila (*Xenentodon cancila*) showed that moisture content in freshly caught fish ranged from 72.97 to 76.36% with the highest moisture content in chapila and the lowest in punti. Protein content was in the range of 14.08 to 21.70% with highest value in kankila and a lowest in chapila, while lipid content was in the range of 2.82 to 6.28% with the highest value in tengra and lowest in kankila. Ash content ranged from 0.98 to 4.54%.

Das (2009) studied on effect of ambient temperature, icing and freezing on nutrient composition of rohu (*Labeo rohita*), grass carp (*Ctenopharyngodon idella*) and tilapia (*Oreochromis mossambica*). The study showed that if the fish preserved properly in ice (for short term) and in freeze (for long term) it can give optimum level of nutrients. The highest protein content was found in Tilapia, *Oreochromis mossambica* ($88.72 \pm 2.75\%$) at ambient temperature while the lowest protein content was found in Grass Carp, *Ctenopharyngodon idella* ($80.50 \pm 1.96\%$) in freezing.

2.2 Works done in other countries

Ali *et al.* (2005) studied on comparative study of body composition of different fish species from brackish water pond. Seven species of fish (*Catla catla*, *Cirrhinus mrigala*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Labeo rohita*, Mori-Rahu Hybrid and Thalla-Rahu Hybrid) were collected from a brackish water pond near Muzaffargarh, Pakistan for the comparison of body composition. All the seven species were found relatively well adapted to the saline environment though some of them showed significant differences in body composition. Results obtained did not show any adverse effect of salinity on these fish species. The mean values of body constituents, except for protein content (dry and wet body weight) differed significantly among various fish species. Minimum amount of water content and maximum amount of lipids, organic content and

condition factor were observed in *Cyprinus carpio* indicating that *Cyprinus carpio* show overall better growth in brackish water as compared to other species.

Belinsky *et al.* (1996) studied on composition of Fish Consumed by the James Bay Crees. They worked on five species of adult female fish those were harvested in autumn and collected from coastal and inland reservoir areas within the territory of the James Bay Crees of Quebec, Canada. Whitefish (*Coregonus clupeaformis*), cisco (*Coregonus artedii*), brook trout (*Salvelinus fontinalis*), lake trout (*Salvelinus namaycush*), and pike (*Esox lucius*) were harvested, portioned, and analyzed for proximate composition, heavy metals (Hg, Cd, As, Pb), nutritional minerals (Ca, Fe, Zn, Cu), and a complete profile of fatty acids.

Berg and Bremset (1998) conducted a research work on seasonal changes in the body composition of the young riverine Atlantic salmon and brown trout. In this study, the body composition of protein and fat in the Atlantic salmon *Salmo salar* and brown trout *Salmo trutta* before and after winter was investigated. Fat, protein and specific energy declined greatly in winter but were replenished rapidly in spring. Rates of decline were slower for the smallest fish, which also had the lowest specific content of fat, protein and energy, while the differences in absolute amounts were greatest for the larger fish. The mean specific fat content was reduced by 45-70% during winter, but a minor reduction in protein content was found during winter, with mean reductions of 6-10%.

Brown and Murphy (1991) studied on relationship of relative weight to Proximate Composition of Juvenile Striped Bass and Hybrid Striped Bass. In this study, it is showed that relative weight was correlated with percent crude fat, crude protein, ash, visceral fat and ash-free dry-weight gross energy.

Chukwu and Shaba (2009) conducted a research on effects of drying methods on proximate compositions of Catfish (*Clarias gariepinus*). They analyzed the effects of two different drying methods (smoking kiln and electric oven) on proximate compositions of catfish (*Clarias gariepinus*). Mean moisture, protein, lipid, ash, fibre, carbohydrate, vitamin A, Potassium and Phosphorus contents of raw fish were 71.85 ± 0.07 , 19.51 ± 0.18 , 14.28 ± 0.19 , 33.06 ± 0.04 , 0.98 ± 0.01 , 5.48 ± 0.02 , $3.6 \times 10^4 \pm 10^5$, $1.2 \times 10^4 \pm 10^5$ and $1.2 \times 10^4 \pm 10^5\%$, respectively. The changes in moisture, protein, lipids, energy value, vitamin A and phosphorus contents were found to be significant for the two drying methods. Ash, fibre, carbohydrate, vitamin C and potassium contents showed no significant differences for the two drying methods used in this study. The results indicate that drying methods have effects on the proximate compositions of catfish.

Erkan and Ozden (2007) conducted proximate composition and mineral contents in aqua cultured sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*) analyzed by ICP-MS. In this study, significant differences were observed between moisture, fat and ash contents of the two species. Sodium, potassium, calcium, magnesium, manganese, iron, zinc and iodine values for sea bass and sea bream were significantly different.

Jonsson and Jonsson (1998) carried out a research on body composition and energy allocation in life-history stages of brown trout. They reported that the lipid concentrations of parr in spring were not significantly different from those of similarly aged smolts. By contrast, the relative water content (%) decreased with age in parr in the autumn and increased with age in smolts, mean values being slightly higher in smolts (78%) than in parr (77%). Protein and carbohydrate concentrations did not vary with age in the immature fish, mean protein concentrations being 18.0, 17.5 and 16.8% in parr in the autumn and spring, and in smolts, respectively.

Krzynowek *et al.* (1989) conducted a research work on proximate composition and fatty Acid and cholesterol content of 22 species of Northwest Atlantic Finfish. In this research, the moisture, fat, ash, fatty acid profile, and cholesterol content was reported for cooked and raw fillets. All but nine species had 1% or less fat. Ocean perch and a spring sampling of mackerel and wolffish had about 2% fat, followed by yellowfin tuna, whiting, silver hake, butterfish, and a summer -sampling of mackerel and wolffish with a range of 3-7% fat. Herring had a range of 5-12% fat representing a winter sampling on the low end and summer sampling on the high end of the range. Bluefin tuna (a summer sampling) contained the most fat with a high of 23% fat. Omega-3 fatty acids were present in excess of omega-6 fatty acids. The fattier fish supplied the most omega-3 fatty acids per gram of tissue.

Puwastien *et al.* (1999) conducted a research on proximate composition of raw and cooked Thai freshwater and marine fish. In this study, proximate composition and non-protein nitrogen (NPN) were determined in eight freshwater and eight marine fish species which are commonly consumed in Thailand. Appropriate household cooking methods, i.e., boiling, steaming, roasting and frying were used for fish preparation. All fresh fish investigated were high in protein, 17–22 g/100 g. Wide variations in protein content, 16–32 g/100 g, between species and methods of cooking was observed. Fat content varied between species; freshwater fish, 0.6–14 g/100 g and marine fish, 0.5–9.2 g/100g. Comparatively, marine fish varieties had lower fat content than freshwater fish. Boiling and steaming did not alter the percentage fat of the cooked fish, 0.5–15.5 g/100 g, while roasting and frying showed a relative increase in fat values of the cooked products, 7–23 g/100 g.

Shearer *et al.* (1994) carried out a research work on whole body elemental and proximate composition of Atlantic salmon (*Salmo salar*) during the life cycle". They observed that the parameters changed in relation to life cycle stage and fish size, and were influenced by whether the fish were in salt or freshwater. In this study, it is observed that the protein concentration increased gradually with growth, increasing from 12 to approximately 18% when the fish had reached 125g. Percent lipid remained relatively constant during egg incubation but decreased between hatch and first feeding. Levels increased as the fish increased in size up to 125g, but decreased upon the entry into salt water. The level of lipid decreased during maturation. The ash level decreased by about 50% by the time the fish reached 250g, then increased prior to maturation.

Stirling (1972) worked for determining of moisture, protein ash and non-protein nitrogen in the white muscle, dark muscle liver and gonads of European bass from the Bay of Naples. He stated that the white muscle has a food value being rich in protein and low in lipid.

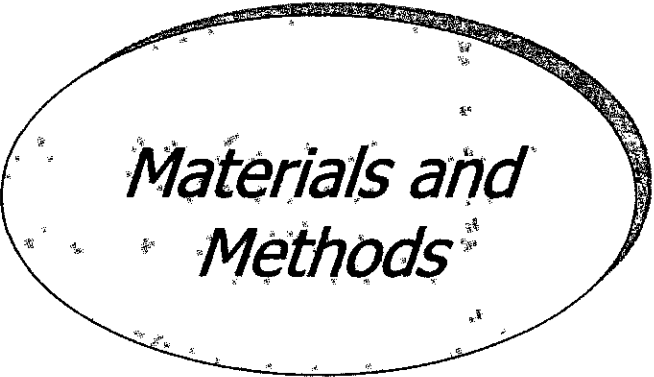
Suvanich *et al.* (1998) studied on prediction of proximate fish composition from ultrasonic properties: Catfish, Cod, Flounder, Mackerel and Salmon". In this study the ultrasonic velocity within Atlantic cod (*Gadus morhua*), Atlantic mackerel (*Scomber sombrus*), Atlantic salmon (*Salmo salar*), Channel catfish (*Ictalurus punctatus*), and Sole flounder (*Pseudopleuronectes americanus*) fillets was measured. The composition of the fish fillets, measured using standard techniques was compared. There was considerable variation in the fat (0.1-12%), protein (14-24%), and moisture content (69-81%) of the different types of fish, whilst the ash content remained fairly constant (0.9-1.3%).

Turan *et al.* (2007) studied on fatty acid profile and proximate composition of the thornback ray (*Raja clavata*, L. 1758) from the Sinop coast in the Black Sea. Proximate analyses of thornback ray were rich in protein (20.02%) and low in lipid (0.51%). The crude ash and moisture contents were found as 1.38% and 77.47%, respectively. The results of this study showed that thornback rays are good sources of protein.

Acc No - 1533.




C H A P T E R = 3



*Materials and
Methods*

3. Materials and Methods

3.1 Sample collection

In this study, eleven (11) marine fishes, available in local markets (Rupsa and Gollamari), were collected during the harvesting seasons (April to August, 2010). Immediate after collection, samples were kept in icing condition and returned to Fish Nutrition Laboratory, Khulna University. After collection, fishes were immediately transferred to the laboratory. After several washing with tap water, the fish was frozen at -18°C until laboratory analysis. Scientific, common and local names of the collected fish species are shown in Table 1. The total sizes of the experimental fishes were ranged between 250 to 500gm (marketable size).

Table 1. Marine fishes with local, common and scientific names

Local Name	Scientific Name	Common Name
1. Bishtara	<i>Scatophagus argus</i>	Spotted scat
2. Poa	<i>Johnius argentatus</i>	Silver croaker
3. Kauwa	<i>Megalaspis cordyla</i>	Torpedo scad
4. Chapila	<i>Gonialosa manmina</i>	Indian River Gizzard Shad
5. Loitta	<i>Harpodon nehereus</i>	Bombay duck
6. Phasa	<i>Setipinna phasa</i>	Gangetic Hairfin Ancovy
7. Rita	<i>Rita rita</i>	Rita
8. Sada Datina	<i>Pomadasys hasta</i>	Silver grunt
9. Tular dandi	<i>Sillginopsis panijas</i>	Gangetic sillago
10. Vola	<i>Johnius elongatus</i>	Spindle croaker
11. Bashpata	<i>Cynoglossus lingua</i>	Long Tongue sole

3.2 Research design

Samples were designed according to different parts for the raw fishes and also the different cooking conditions of the fishes. According to different body parts raw fishes were divided into three categories-

1. Below head: this was just after the head and above the lateral line.
2. The middle part and
3. The tail part

According to cooking condition those fishes were divided into-

1. Boiled fish and
2. Fried fish

3.3 Sample preparation

For raw fish sample preparation the fishes were cut into pieces by a sharp knife to collect muscles from three parts of the fish. Each part of the fish was kept in separate polythene bag for analysis. For preparing boiled fish samples, some part of the fishes was boiled with fresh tap water in the beaker. For preparing fried fish samples, some part of the fishes was fried with vegetable oil within the beaker. Fresh, boiled and fried samples were homogenized by mincing the fish samples in a mortar and kept at -18°C.

3.4 Determination of proximate composition

Proximate composition of collected fishes under various conditions was determined according to the standard protocols developed by AOAC, 1990. The detailed protocols for the determination of protein, lipid, moisture and ash were given below. Each experiment was conducted with the replication of three.

3.4.1 Determination of Moisture

For determining the moisture, at first crucibles were cleaned, dried and then the weight of the crucible was taken. Then 2-5g sample was placed in the crucible and weighted again. Difference between the two is the sample weight. Then the crucible with sample was put in a controlled oven and was dried at 105°C for about 24 hours until a constant weight was reached and cooled in desiccators and weighed several times till the constant weight was achieved. The percentage of the moisture content was calculated by the following equation:

$$\text{Percentage (\% of moisture)} = (\text{Weight loses/Original weight of sample}) \times 100$$

3.4.2 Determination of Protein

The protein content of the fish was determined by micro-kjeldahl method. It involves conversion of organic nitrogen to ammonium sulphate by digestion with concentrated sulphuric acid in a microkjeldahl flask. The digest was diluted with distilled water, made alkaline with sodium hydroxide and distilled. The liberated ammonia was collected in a boric acid solution and was determined titrametrically. The percentage of protein in the sample was calculated by the following equation (Pearson, 1976):

$$\text{Percentage (\% of total nitrogen (N))} = \frac{\text{Titrant (ml)} \times \text{Strength of titrant} \times 0.0014}{\text{Weight of sample (g)} \times 100}$$

$$\text{Percentage (\% of Crude protein)} = \text{Percentage (\% of total nitrogen (N))} \times 6.25$$

3.4.3 Determination of Lipid

Crude lipid of fish muscle was determined by extracting the sample (2-5g) with methanol and chloroform (1:2) solution. At first the sample was grinded by using mortar.

Then the sample was weighted and taken into a beaker and methanol-chloroform solution (100ml) was added. After that the sample is homogenized by using an electric homogenizer and passed through a filter paper. 50 ml water was added with the filtrated sample solution which turned into milky color and kept in separation funnel for 8 hours. Another beaker was dried in the oven and weighted and poured clear extracted solution which contain lipid. Beaker was then kept in the oven at 70°C until the evaporation of chloroform and methanol. The percentage of the lipid content was then calculated by the following formula:

$$\text{Percentage (\% of lipid)} = (\text{Weight of lipid extract} / \text{Weight of sample}) \times 100$$

3.4.4 Determination of Ash

The desired amount of fish muscle (2 – 5 gm) placed in cleaned and weighted crucible and transferred to the muffle furnace (at about 550-600°C) for the determination of ash. Sample when turned into white in color was then taken out and measured the ash content in the following equation:

$$\text{Percentage (\% of ash)} = (\text{Weight of ash} / \text{Weight of Sample}) \times 100$$

3.5 Data analysis

Graphical, tabular and statistical interpretation of collected data was performed by using Microsoft office excel and SPSS 12 statistical programme with five per cent level of significance. One-way ANOVA was performed to compare the variation of means within different fishes.

CHAPTER = 4



Results

4. Results

4.1 Proximate composition in whole fish

Mean protein, lipid, moisture and ash content among the raw fish species is given in Figure 1. Mean protein concentration vary significantly between different fishes ($P>0.05$). Considerable variation in protein was observed for raw fish, ranging from 13.88 to 17.5%. The maximum protein content was observed in Chapila (*Gonialosa manmina*) which was 17.51%, while the minimum was observed in Loitta (*Harpodon nehereus*) which was 13.88% (Figure 1a).

The lipid content varied significantly ($P>0.05$) among the raw fishes and ranged between 0.39 to 4.1% (Figure 1b). The lowest lipid concentration was observed in Bashpata (*Cynoglossus lingua*), while the highest lipid content was in the Kauwa (*Megalaspis cordyla*) fish.

The moisture content varied significantly ($P>0.05$) among the raw fishes and ranged between 71.94 to 84.85% fish (Figure 1c). The lowest moisture concentration was observed in Kauwa (*Megalaspis cordyla*), while the highest moisture content was in the Loitta (*Harpodon nehereus*) fish.

Mean ash content vary significantly among the raw fishes ($P>0.05$) and ranged between 1.05 to 3.76% of fishes (Figure 1d). The highest ash content was observed in the Bishtara (*Scatophagus argus*) and lowest content was in Rita (*Rita rita*).

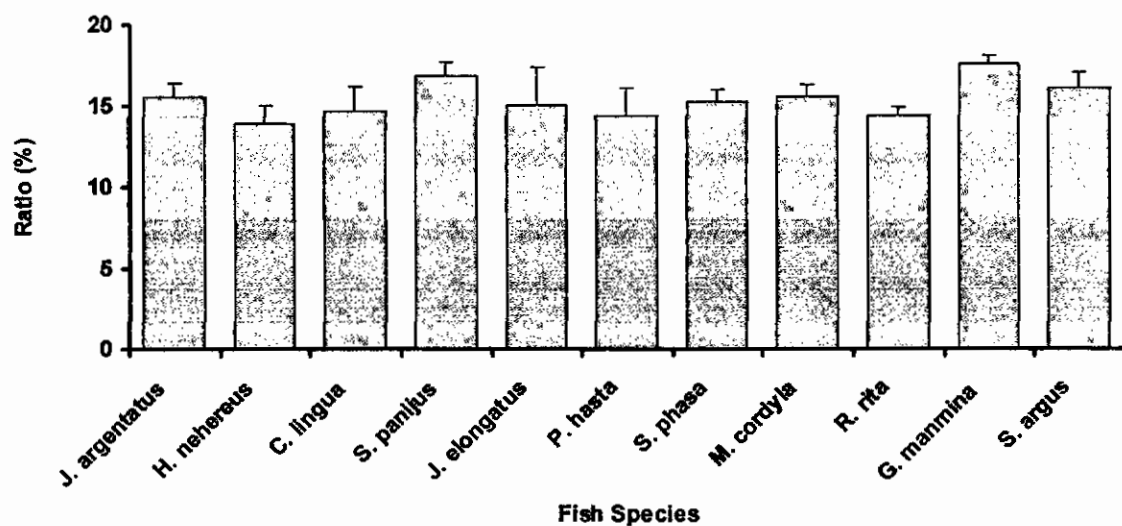


Figure 1a). Protein content in whole fish. Data shown as mean and SD of three replicates.

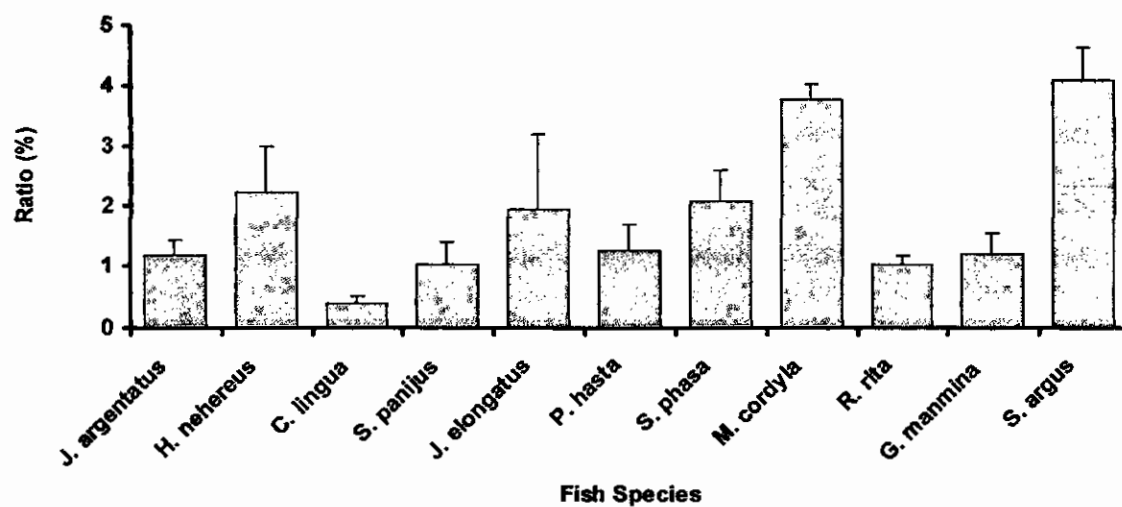


Figure 1b). Lipid content in whole fish. Data shown as mean and SD of three replicates.

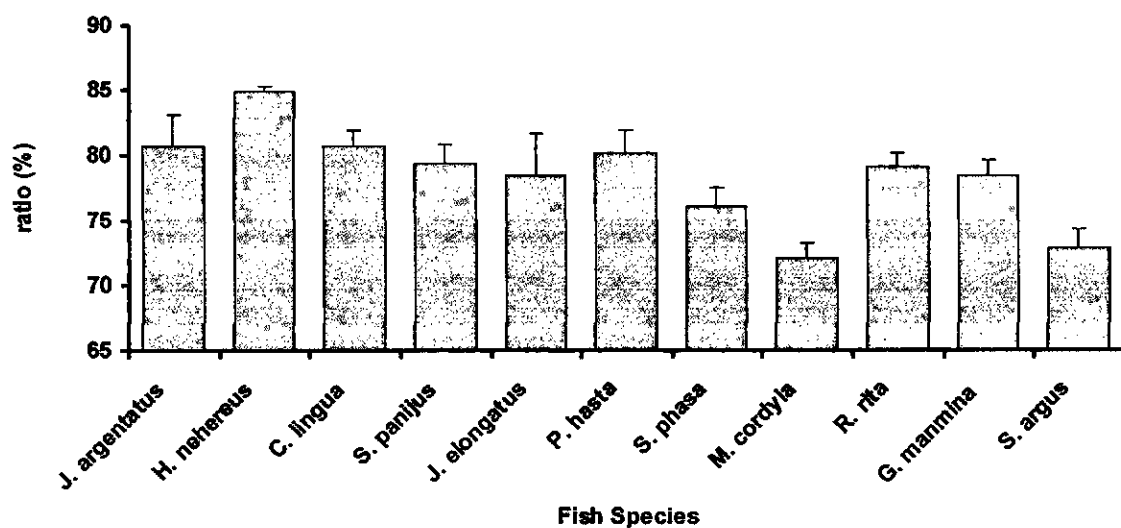


Figure 1c). Moisture content in whole fish. Data shown as mean and SD of three replicates.

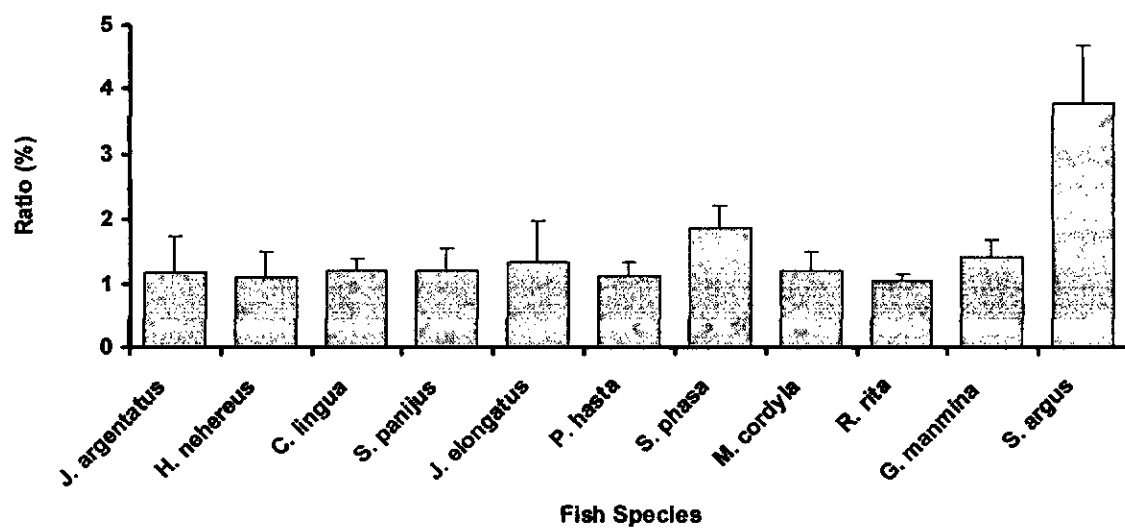


Figure 1d). Ash content in whole fish. Data shown as mean and SD of three replicates.

4.2 Proximate composition in different body parts

Proximate composition from different parts of the raw fish samples is given in figure 2. Protein varied within different parts of raw fishes from 12.55 to 18.05% (Figure 2a), moisture varied from 70.98 to 85.15% (Figure 2b), lipid varied from 0.34 to 4.54% (Figure 2c) and ash content varied from 0.65 to 4.4% (Figure 2d). The lowest amount of protein was found in the middle part of *Pomadasys hasta*, which was $(12.55\% \pm 1.36)$ and the highest amount was found below the head portion of Chapila (*Gonialosa manmina*), which was valued as $(18.05\% \pm 0.28)$. Lipid content was lower in the middle part of Bashpata (*Cynoglossus lingua*), $(0.34\% \pm 0.04)$ and higher in the middle part of Bishtara (*Scatophagus argus*), $(4.54\% \pm 0.44)$. The highest moisture was observed in the tail of Loitta (*Harpodon nehereus*) which was $85.15\% \pm 0.51$ and lowest in the tail of Kauwa (*Megalaspis cordyla*) which was $70.98\% \pm 0.57$. The middle portion of Loitta (*Harpodon nehereus*) contained $0.65\% \pm 0.02$ of ash which was the lowest amount and the highest ash content was found in the tail of Bishtara (*Scatophagus argus*), $(4.40\% \pm 0.64)$. Relatively smaller variation in protein, lipid, moisture and ash content was found in different part of each fish.

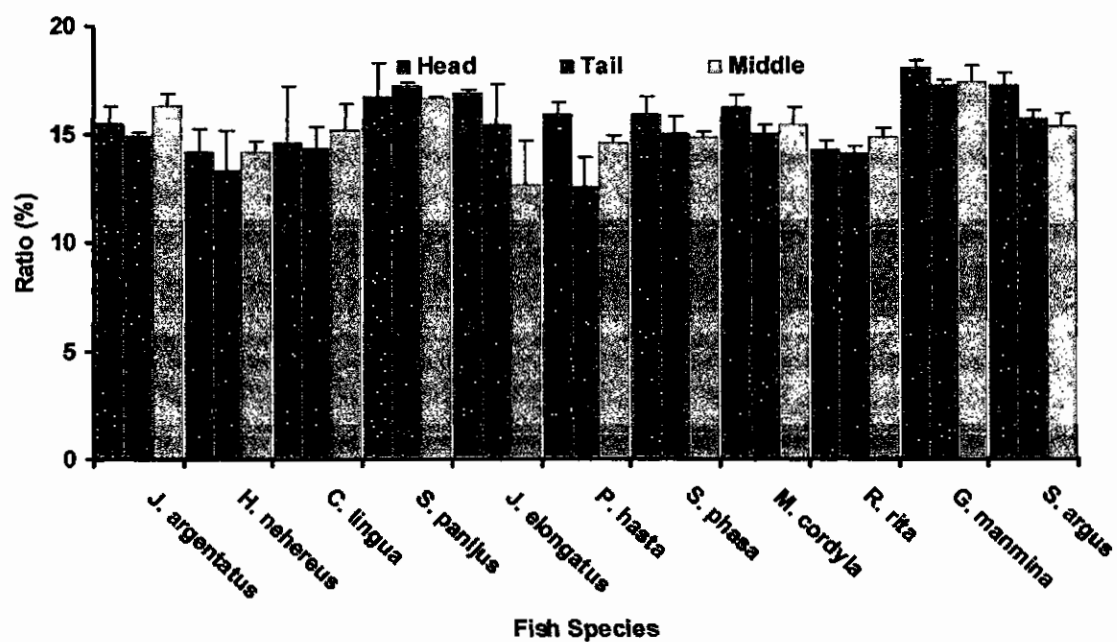


Figure 2a: Protein content in different body parts. Data shown as mean and SD of three replicates.

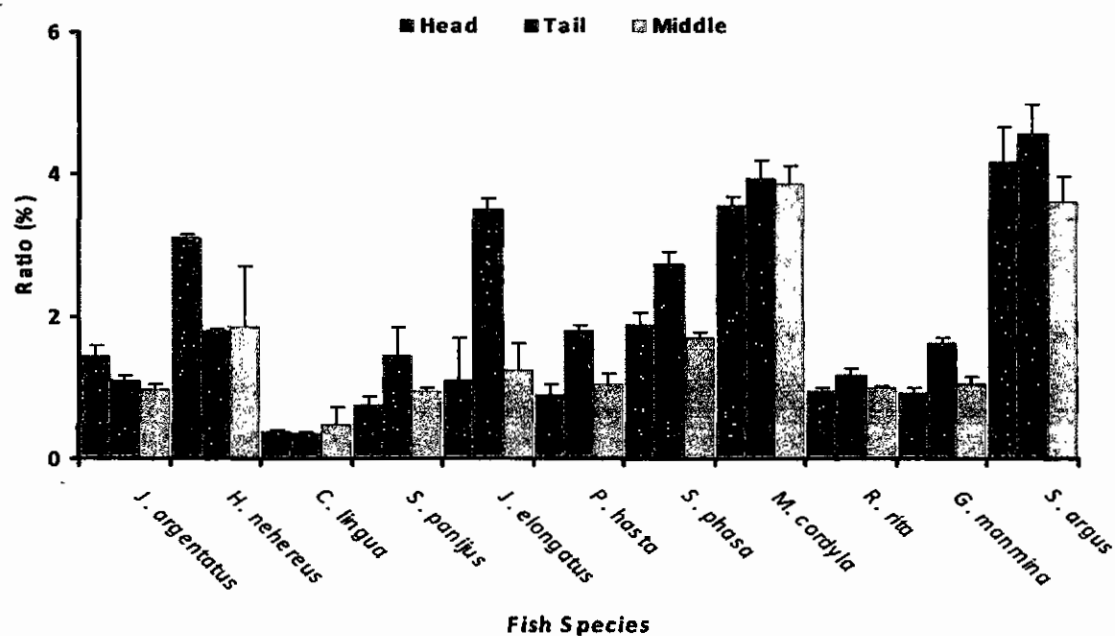


Figure 2b: Lipid content in different body parts. Data shown as mean and SD of three replicates.

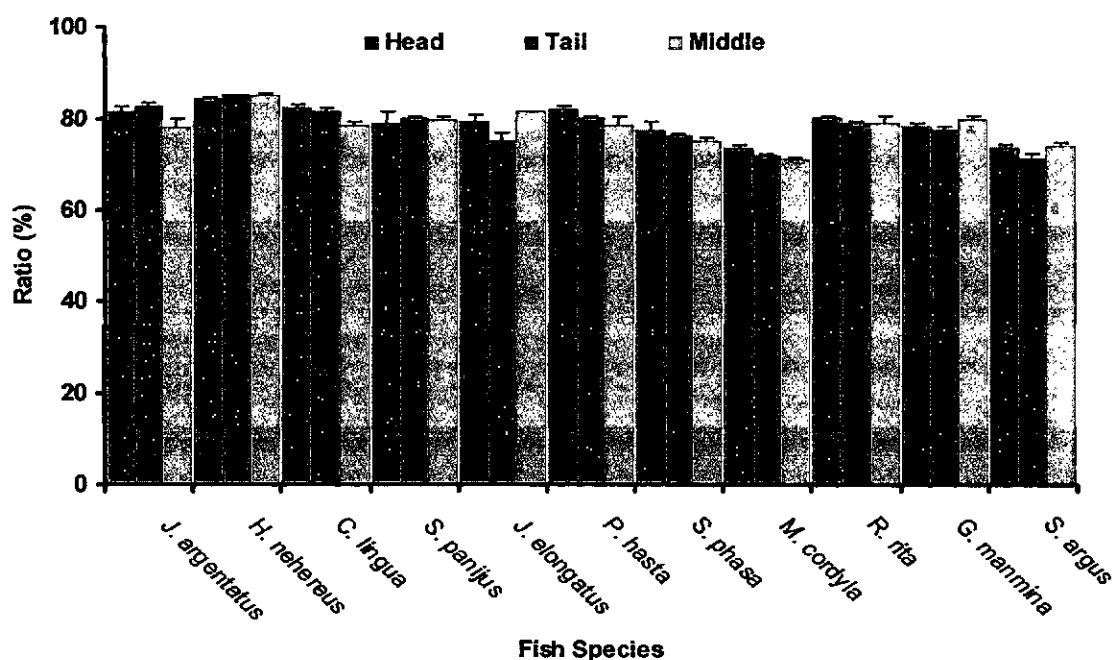


Figure 2c: Moisture content in different body parts. Data shown as mean and SD of three replicates.

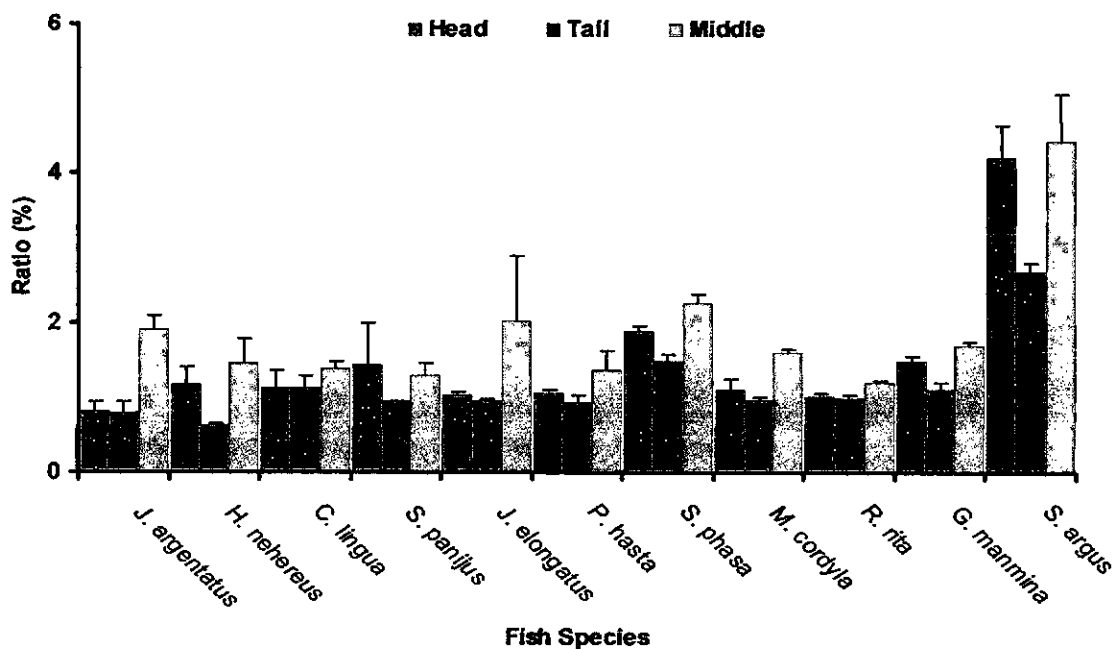


Figure 2d: Ash content in different body parts. Data shown as mean and SD of three replicates.

4.3 Proximate composition in boiled fish

Proximate composition of boiled fish was approximately similar as the raw fish, but the protein and lipid concentration is lower than the fried fish and the moisture content was higher than the fried fish.

Mean proximate composition (protein, lipid, moisture and ash) of boiled fish is given in Figure 3a, 3b, 3c and 3d. Mean protein concentration in boiled fish ranged from 14 to 21.68%, and varied significantly between different species ($P>0.05$). The lowest concentration of protein was for Loitta (*Harpodon nehereus*) and the highest concentration of protein was observed in Kauwa (*Megalaspis cordyla*) fish (Figure 3a).

The lipid content varied significantly ($P>0.05$) among the boiled fishes and ranged between 0.8 to 3.37% of fish (Figure 3b). The lowest lipid concentration was observed in Vola (*Johnius elongatus*), while the highest lipid content was in the Bishtara (*Scatophagus argus*).

The moisture content varied significantly ($P>0.05$) among the boiled fishes and ranged between 71 to 83% of fish (Figure 3c). The lowest moisture concentration was observed in Kauwa (*Megalaspis cordyla*), while the highest moisture content was in the Poa (*Johnius argentatus*) fish.

Mean ash content also varied significantly among the boiled fishes ($P>0.05$) and ranged between 0.51 to 3% of fishes (Figure 3d). The highest ash content was observed in the Bishtara (*Scatophagus argus*) and lowest content was in Vola (*Johnius elongatus*).

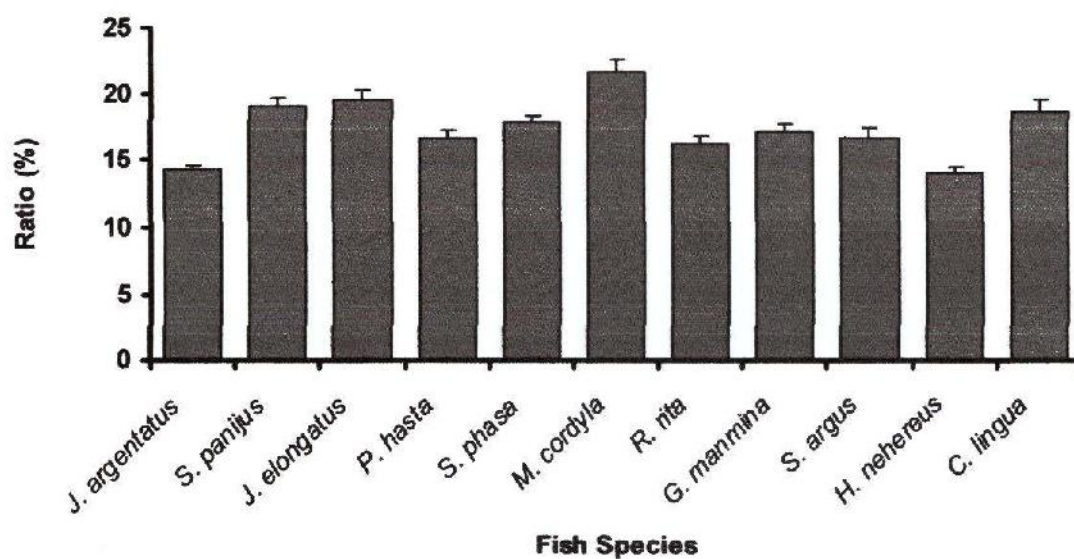


Figure 3a: Protein content in boiled fish. Data shown as mean and SD of three replicates.

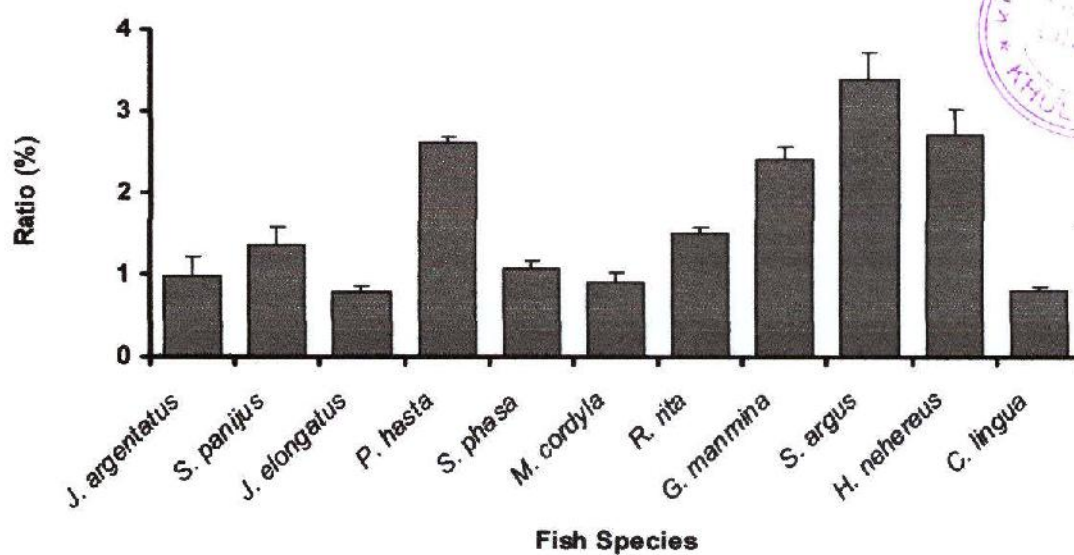


Figure 3b: Lipid content in boiled fish. Data shown as mean and SD of three replicates.

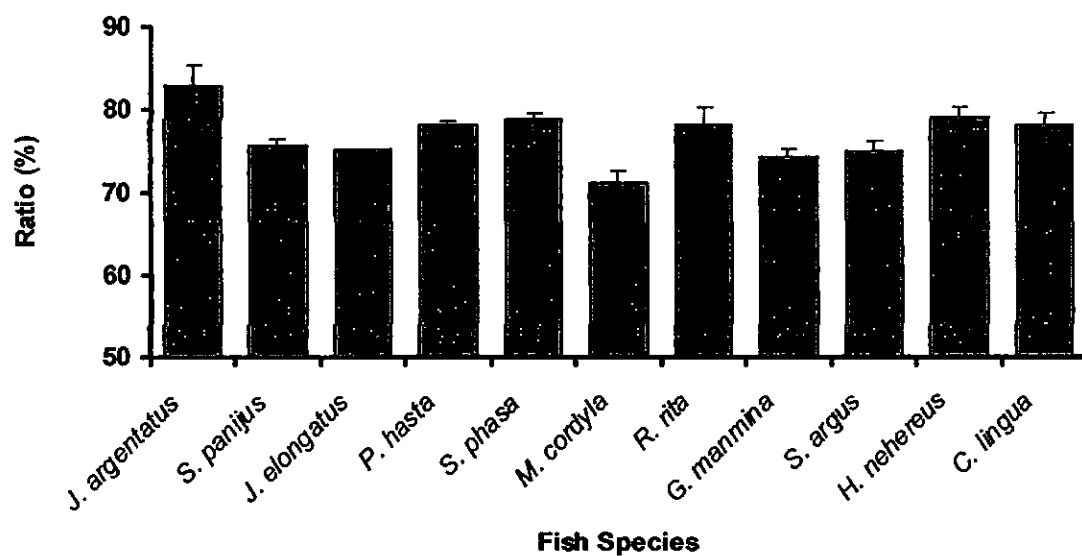


Figure 3c: Moisture content in boiled fish. Data shown as mean and SD of three replicates.

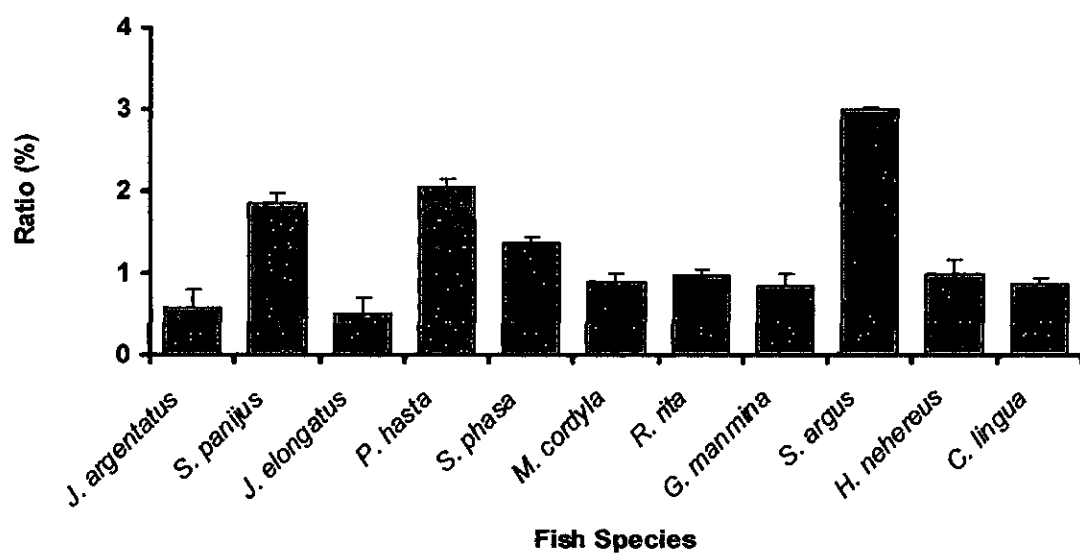


Figure 3d: Ash content in boiled fish. Data shown as mean and SD of three replicates.

4.4 Proximate composition in fried fish

Mean protein concentration in fried fish ranged from 19.2 to 33.6%, and varied significantly between different species ($P>0.05$). The lowest concentration of protein was for Loitta (*Harpodon nehereus*) and the highest concentration of protein was observed in Rita (*Rita rita*) (Figure 4a).

The lipid content varied significantly ($P>0.05$) among the fried fishes and ranged between 15.8 to 33.9% of fish (Figure 4b). The lowest lipid concentration was observed in Bishtara (*Scatophagus argus*), while the highest lipid content was in the Poa (*Johnius argentatus*) fish.

The moisture content varied significantly ($P>0.05$) among the fried fishes and ranged between 28.6 to 53.3% of fish (Figure 4c). The lowest moisture concentration was observed in Poa (*Johnius argentatus*), while the highest moisture content was found in Bishtara (*Scatophagus argus*).

Mean ash content also varied significantly among the fried fishes ($P>0.05$) and ranged between 1.7 to 9.1g/100g of fishes (Figure 4d). The highest ash content was observed in Phasa (*Setipina phasa*) and lowest content was in Bashpata (*Cynoglossus lingua*).

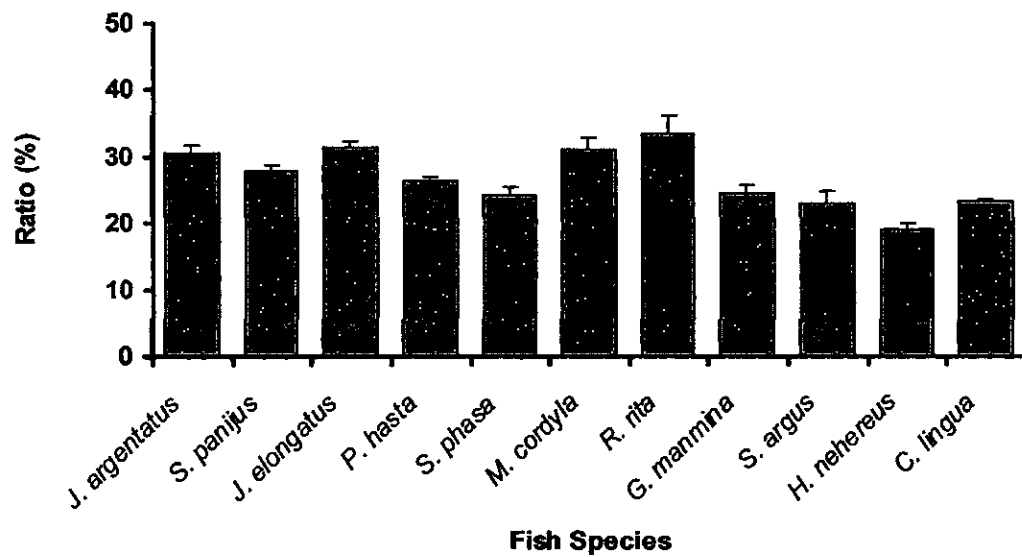


Figure 4a: Protein content in fried fish. Data shown as mean and SD of three replicates.

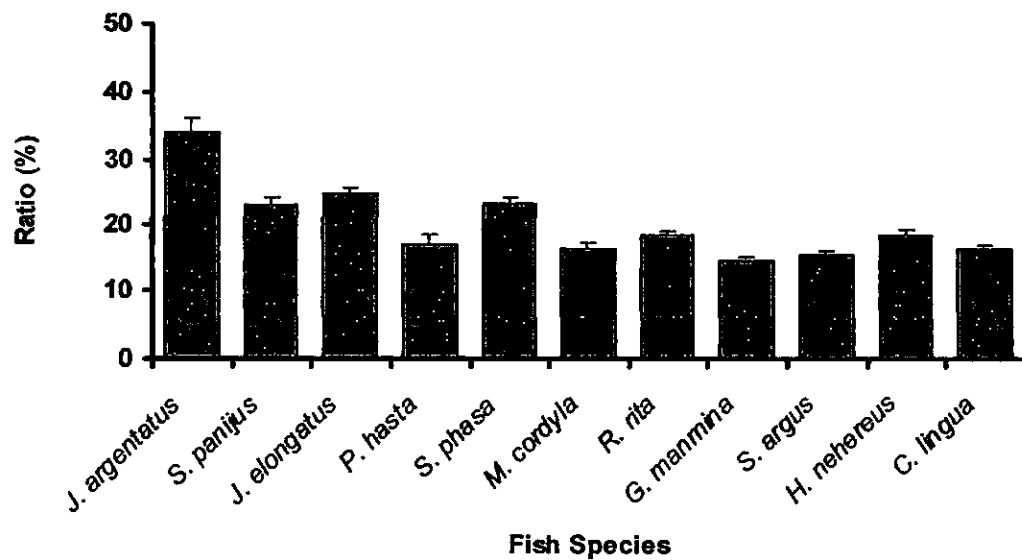


Figure 4b: Lipid content in fried fish. Data shown as mean and SD of three replicates.

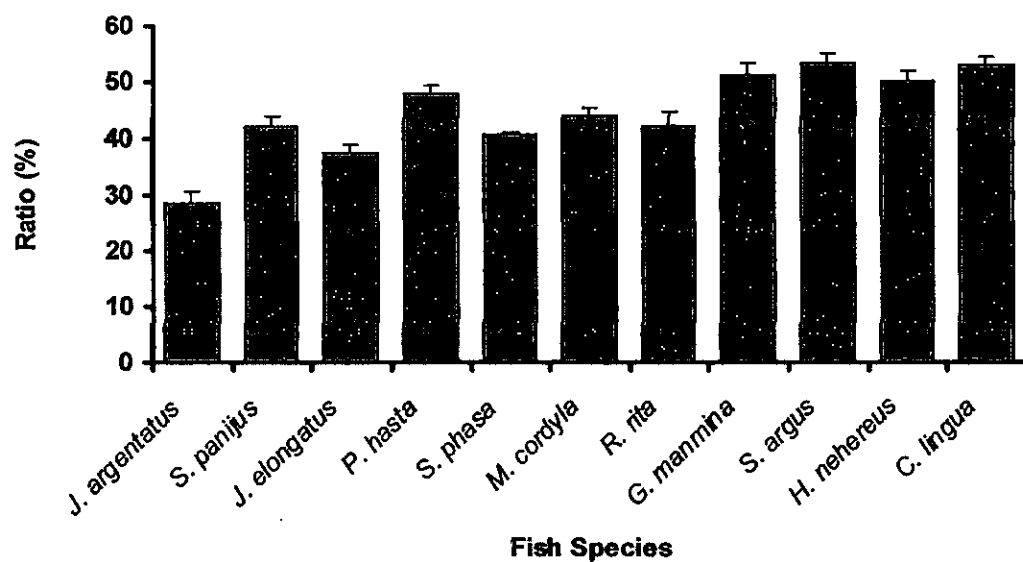


Figure 4c: Moisture content in fried fish. Data shown as mean and SD of three replicates.

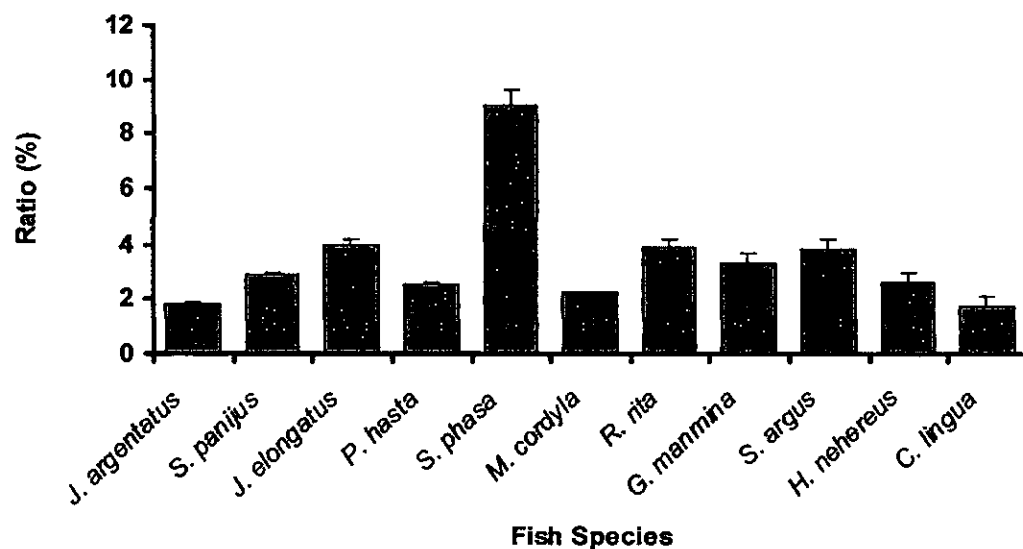


Figure 4d: Ash content in fried fish. Data shown as mean and SD of three replicates.

CHAPTER = 5



Discussion

5. Discussion

The objective of the present study was to measure the proximate composition of 11 marine fishes those are available in local market in various conditions like raw, boiled and fried condition. This study also determines the proximate composition from three parts (below head, middle and tail) of those fishes in raw condition. The observation indicates that the concentrations of the proximate composition at different parts of raw fishes showed small differences while relatively large changes was showed at different conditions of those fishes. It appears from the study that frying of the fish have significant effect on the proximate composition while boiling showed small difference of the proximate composition than the raw fishes. Major changes in proximate composition occurred due to frying. These events are associated with different cooking method and also with species to species. It is known that variations in the chemical composition of marine fishes are closely related to nutrition, living area, fish size, catching season, seasonal and sexual variations as well as other environmental conditions (Schormuller, 1968; Ludorff and Meyer, 1973).

5.1 Proximate composition in whole fish

The proximate composition of other species has previously been reported and the values stated for that fishes are more or less similar to the present studied fishes.

The present study showed that the protein content in raw condition of Poa (*Johnius argentatus*), Loitta (*Harpodon nehereus*), Bashpata (*Cynoglossus lingua*), Tular dandi (*Sillginopsis panijas*), Vola (*Johnius elongatus*), Datina (*Pomadasyss hasta*), Phasa (*Setipinna phasa*), Kauwa (*Megalaspis cordyla*), Rita (*Rita rita*), Chapila (*Gonialosa manmina*) and Bishtara (*Scatophagus argus*) were $15.51 \pm 0.79\%$, $13.88 \pm 1.03\%$,

14.63±1.45, 16.81±0.78%, 14.99±2.27%, 14.32±1.65, 15.20±0.75%, 15.51±0.73%, 14.33±0.48%, 17.51±0.57% and 16.04±0.96%, respectively.

Figure 1a states that the variation of protein contents among the studied fish is not so high and it ranged from 13.88%- 17.51%. It is due to mainly for species variation. This result is nearly similar to the findings of Mazumder *et al.* which was found for freshwater fishes. Mazumder *et al.* (2008) reported that Puti (*Puntius sarana*), Batashi, Kajuli (*Ailacoila*) and Chapila (*Gudusia chapra*) contain 14.08%, 15.84%, 16.99% and 15.23% protein. Puwastein *et al.* reported 17-20% protein for freshwater fishes and 18-22% for marine water fishes. This is slightly different from the present observation; it seems to occur due to keep the present studied fishes into freezing condition. Das, P. K. (2010) showed that protein content has inverse relationship with storage in freeze or ice. Shearer *et al.* (1994) reported that protein content in Atlantic salmon (*Salmo salar*) showed a gradual increase with growth, increasing from 12 to approximately 18% when the fish has reached 125g. There was considerable variation in protein (14-24%) of the different types of fish (Suvanich *et al.*, 1998).

The lipid content of the 11 marine fishes ranges from 0.39 to 4.1%. The lipid content varied significantly ($P>0.05$) among the raw fishes. The lowest lipid concentration was observed in Bashpata (*Cynoglossus lingua*), while the highest lipid content was in the Kauwa (*Megalaspis cordyla*). Mean lipid content in Poa (*J. argentatus*), Loitta (*H. nehereus*), Bashpata (*C. lingua*), Tular dandi (*S. panijas*), Vola (*J. elongatus*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*), Chapila (*G. manmina*) and Bishtara (*S. argus*) were 1.18±0.24%, 2.24±0.76%, 0.39±0.13%, 1.04±0.37%, 1.94±1.25%, 1.25±0.44%, 2.10±0.50%, 3.78±0.24%, 1.04±0.12%, 1.20±0.34% and 4.10±0.54%, respectively. The lipid content of these fishes

is much lower than the freshwater fishes. Mazumder *et al.* (2008) reported that the freshwater fishes like Puti (*Puntius sarana*), Batashi, Kajuli (*Aila coila*) and Chapila (*Gudusia chapra*) contain 3.05%, 2.24%, 3.53 and 5.41% lipid, which is comparatively higher than the present marine fishes. Nurullah *et al.* (2003) observed 2.82 to 6.28% lipid content in freshwater fishes. There was pronounced variation in lipid content between species of fish which is consistent with other studies. Berg and Bremest (1998) observed that lipid content varied indifferent sized Atlantic salmon and Brown trout from 0.91 to 1.63% and 0.98 to 2.0% in different season. Puwastein *et al.* (1999) reported a wide variation in fat content, from 2-4% in black pomfret and giant seaperch to 14.7% in walking catfish. Most of the marine fish had a lower fat content than freshwater fish. The fat content is found to be influenced by season and geographic location, with lower lipid content in fish from tropical waters (Ackman, 1990; Argen *et al.*, 1991). The low fat content in marine fish is also attributed to environmental factors such as food supply and dietary sources (Rao *et al.*, 1995).

Wide variation in moisture content was observed in raw fishes. The moisture content varied significantly ($P>0.05$) among the raw fishes and ranged between 71.94 to 84.85% of fish, which was found in Kauwa (*M. cordyla*) and Loitta (*H. nehereus*). The mean moisture content in Poa (*J. argentatus*), Loitta (*H. nehereus*), Bashpata (*C. lingua*), Tular dandi (*S. panijas*), Vola (*J. elongatus*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*), Chapila (*G. manmina*) and Bishtara (*S. argus*) were $80.66\pm2.51\%$, $84.85\pm0.46\%$, $80.76\pm1.20\%$, $79.39\pm1.45\%$, $78.50\pm3.13\%$, $80.21\pm1.78\%$, $76.07\pm1.47\%$, 71.94 ± 1.205 , 79.16 ± 0.985 , $78.39\pm1.26\%$ and $72.79\pm1.42\%$, respectively. The present findings represent higher moisture content in these fishes than the freshwater fishes. Mazumder *et al.* (2008) found the lowest moisture in freshwater *Aila coila* (Kajuli) was 65.88% and highest moisture content was found in *Chanda nama* (78.62%). 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 the lowest in Puntí. Puwastein *et al.* (1999) reported a wide variation in moisture content between species in raw freshwater fish, ranging from 65 to 80g/100g, while a smaller range was observed in marine fish, 71-80%, which is nearly similar to the present observation. Berg and Bremset (1998) stated that the specific water content has its highest value in spring for all stages of salmon and trout. The highest water content was found in the smallest salmon fry, with values of water content up to 86%. Suvanich *et al.* (1998) showed that considerable variation in moisture content (69-81%) was observed in different types of fish.

Among 11 marine fishes about all fishes showed nearly similar ash content (1-2%) except Bishtara (*Scatophagus argus*) which contain 3.76%, the highest ash content. The mean ash content was estimated as $1.18 \pm 0.57\%$, $1.09 \pm 0.40\%$, $1.20 \pm 0.20\%$, 1.21 ± 0.355 , $1.33 \pm 0.66\%$, 1.11 ± 0.24 , $1.86 \pm 0.36\%$, $1.21 \pm 0.30\%$, $1.05 \pm 0.11\%$, $1.41 \pm 0.28\%$ and $3.76 \pm 0.91\%$ in Poa (*J. argentatus*), Loitta (*H. nehereus*), Bashpata (*C. lingua*), Tular dandi (*S. panijas*), Vola (*J. elongatus*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*), Chapila (*G. manmina*) and Bishtara (*S. argus*), respectively. The lowest ash content was found in Rita. Proximate composition values (74.74% water, 1.53% ash, 18.80% protein and 6.53% fat) have been reported by Alasalvar *et al.* (2001) for sea bream. Puwastein *et al.* (1999) reported 1.0-1.6g/100g ash content in fresh fish, which is almost similar to the present findings. Suvanich *et al.* (1998) reported 0.9-1.3% ash content in different types of fishes, which was fairly constant.

5.2 Proximate composition in different body parts

Protein content varied within different parts of raw fishes from 12.55 to 18.05%, moisture varied from 70.98 to 85.15%, lipid varied from 0.34 to 4.54% and ash content

varied from 0.65 to 4.4%. The lowest amount of protein was found in the middle part of *Pomadasys hasta*, which was $(12.55\% \pm 1.36)$ and the highest amount was found below the head portion of Chapila (*Gonialosa manmina*), which was valued as $(18.05\% \pm 0.28)$. Lipid content was lower in the middle part of Bashpata (*Cynoglossus lingua*), $(0.34\% \pm 0.04)$ and higher in the middle part of Bishtara (*Scatophagus argus*), $(4.54\% \pm 0.44)$. The highest moisture was observed in the tail of Loitta (*Harpodon nehereus*) which was $85.15\% \pm 0.51$ and lowest in the tail of Kauwa (*Megalaspis cordyla*) which was $70.98\% \pm 0.57$. The middle portion of Loitta (*Harpodon nehereus*) contained $0.65\% \pm 0.02$ of ash which was the lowest amount and the highest ash content was found in the tail of Bishtara (*Scatophagus argus*), $(4.40\% \pm 0.64)$. Relatively smaller variation in protein, lipid, moisture and ash content was found in different part of each fish.

5.3 Proximate composition in boiled fish

Proximate composition of boiled fish was approximately similar as the raw fish, but the protein and lipid concentration is lower than the fried fish and the moisture content was higher than the fried fish. Mean proximate composition (protein, lipid, moisture and ash) of boiled fish is given in Figure 3a, 3b, 3c and 3d. There was significant difference of protein, lipid, moisture and lipid content in different boiled fishes ($P > 0.05$).

Boiled fish had protein content (14 to 21.68%) slightly higher to that of the fresh fish. This is associated with the findings of Puwastein *et al.* (1999). They reported that boiled Thai marine fish contained protein as 16-24g/100g. In the present study, among the boiled marine fishes Kauwa (*M. cordyla*) contain highest protein (21.68%) content and the lowest protein content (14%) was found in Loitta (*H. nehereus*). The mean protein content of the present studied boiled fishes was $14.3 \pm 0.4\%$, $19.1 \pm 0.70\%$, $19.6 \pm 0.8\%$,

16.68±0.67%, 18.0±0.34%, 21.68±1.0%, 16.27±0.57%, 17.2±0.57%, 16.7±0.71%, 14.0±0.46% and 18.68±1.0% in Poa (*J. argentatus*), Tular dandi (*S. panijas*), Vola (*J. elongatus*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*), Chapila (*G. manmina*), Bishtara (*S. argus*), Loitta (*H. nehereus*) and Bashpata (*C. lingua*), respectively.

The lipid content in boiled fish was nearly similar to that of the fresh fish, but lower variation was observed in boiled fish than the freshwater fish. The lipid content varied significantly ($P>0.05$) among the boiled fishes and ranged between 0.8 to 3.37% of fish. The lowest lipid concentration was observed in Vola (*J. elongatus*), while the highest lipid content was in the Bishtara (*S. argus*). The mean lipid content was 1.0±0.23%, 1.35±0.2%, 0.8±0.08%, 2.6±0.08, 1.07±0.09%, 0.88±0.41%, 1.49±0.07%, 2.42±0.14%, 3.37±0.34%, 2.71±0.30% and 0.81±0.04% in Poa (*J. argentatus*), Tular dandi (*S. panijas*), Vola (*J. elongatus*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*), Chapila (*G. manmina*), Bishtara (*S. argus*), Loitta (*H. nehereus*) and Bashpata (*C. lingua*), respectively. This finding is associated with the findings of Puwastein *et al.* (1999). They reported that various boiled and steamed fish contained the same range of fat as raw fish.

The moisture content in boiled fish ranged from 71 to 83% of fish. Almost all fishes showed the moisture content above 75% except Kauwa (71.1±1.43%) and Chapila (74.14±1.0%). The mean moisture content in other boiled fishes were 83.03±2.3%, 75.7±0.7%, 75.1±0.17%, 78.13±0.53%, 78.75±0.83%, 78.15±2.24%, 75.0±1.29%, 79.0±1.39% and 78.22±1.42% in Poa (*J. argentatus*), Tular dandi (*S. panijas*), Vola (*J. elongatus*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*),

Chapila (*G. manmina*), Bishtara (*S. argus*), Loitta (*H. nehereus*) and Bashpata (*C. lingua*), respectively.

Ash content also varied significantly in boiled fish species ($P>0.05$). Among all boiled fishes the lowest ash content was found in Vola (*J. elongatus*), which was 0.51% and the highest ash content was observed in the Bishtara (*S. argus*), which was 3g/100g. This variation range is nearly similar to that of the raw fishes. The mean ash content of rest of the boiled fishes was valued as $0.6\pm0.22\%$, $1.85\pm0.12\%$, $0.51\pm0.21\%$, $2.1\pm0.11\%$, $1.35\pm0.07\%$, $0.9\pm0.08\%$, $1.0\pm0.08\%$, $0.85\pm0.14\%$, $1.0\pm0.18\%$ and $0.87\pm0.08\%$ in Poa (*J. argentatus*), Tular dandi (*S. panijas*), Datina (*P. hasta*), Phasa (*S. phasa*), Kauwa (*M. cordyla*), Rita (*R. rita*), Chapila (*G. manmina*), Loitta (*H. nehereus*) and Bashpata (*C. lingua*), respectively.

5.4 Proximate composition in fried fish

A large change occurred in the proximate composition of fried fish. Protein and lipid content increased in higher amount, while the moisture content decreased. This was occurred due to loss in moisture during frying fish. Although the proximate composition changed, significant variation ($P>0.05$) in proximate composition was observed among the frying fishes.

Water losses occurring during frying resulted in higher protein content (19.2 to 33.6%) compared to that of the fresh fish. In this study the highest protein content in frying fish was observed in Rita (*R. rita*) and the lowest value was in Loitta (*H. nehereus*) (Figure 4a, 4b, 4c and 4d). Puwastein *et al.* (1999) reported that, frying of fish which is more commonly practiced in Thailand resulted in higher amount of protein, ranging from 25.5-32%. However in the present study wide variation in the different fried

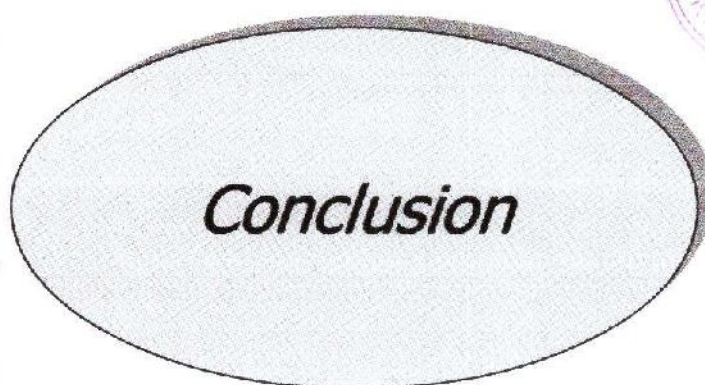
fish was observed. Gall et al. (1983) reported that, deep fried fish fillet had significantly higher protein than raw fillet.

Fried fish contained a higher level of fat compared to raw fish (15.8-33.9 % versus 0.39-4.1%) mainly due to absorption of cooking oil. It is noteworthy to mention that frying resulted in substantial fat absorption but it was proportionately than the water losses. This resulted in a concentration of nutrients as is observed in the protein content (14-21.68% in raw versus 19.2-33.6% in fried fish). Among fried fishes highest (33.9%) lipid content was found in Poa (*J. argentatus*), while Chapila (*G. manmina*) contain the lowest lipid (15.8) level. Puwastein *et al.* (1999) observed that fried fish contained a higher level of fat (8.5-22.7g/100g) which was higher compared to the raw fish (0.5-9.2g/100g). They also stated that it was occurred mainly due to absorption of cooking oil.

Fried fish contained a lower level of moisture compared to raw fish (28.6-53.3% versus 71.94-84.85%). This was occurred mainly due to loss of water from the fish during frying. It showed wide variation and varied significantly ($P>0.05$). This is in accordance with the findings of Puwastein *et al.* (1999) where water losses occurred during frying at about 17-54%.

Much higher ash content was found in fried fish compared to raw and boiled fish. The mean ash content varied significantly among different fried fishes ($P>0.05$). Among different fried fishes the highest ash content was observed in Phasa (*S. phasa*), $9.1\pm0.5\%$ and lowest content was in Bashpata (*C. lingua*), $1.7\pm0.4\%$. Almost all fried fishes contained ash in the range between 1.7-4.0% only except was Phasa (*S. phasa*) which contain much higher ash content than the other fishes. This may occur due to presence of intramuscular bone in higher amount.

CHAPTER - 6

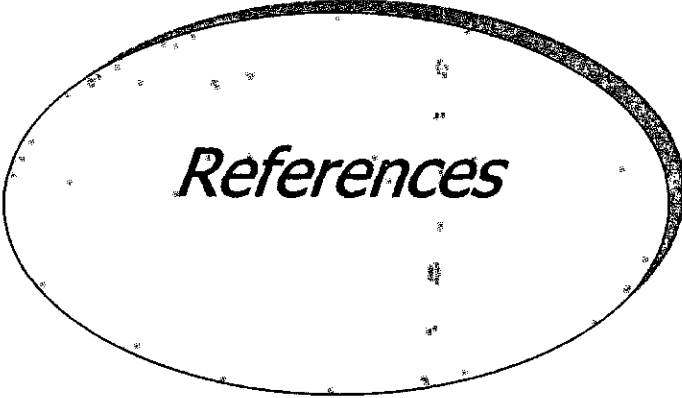


6. Conclusion

Fish is a very important source of animal protein in diets of man. Freshwater and marine fish supply protein equivalent to other animal meat but relatively low in fat content. Regular consumption of fish is therefore recommended for elderly and people with hypercholesterolemia and coronary heart disease. However, in Bangladesh, freshwater fish is costly and poor people are unable to get and therefore, they are suffering from malnutrition and various chronic diseases.

The present study was undertaken to determine the nutritive value of 11 marine fishes those are available in the local market. Wide variations in protein content, 13.88–33.6%, between species and methods of cooking was observed. Fat content varied between species ranged from 0.39 to 4.1% in raw fish, 0.8 to 3.37% in boiled fish and 15.8 to 33.9% in fried fish. The results of the study revealed that the highest protein and lipid was found in the fried fish while the raw and boiled fish contained almost similar amount. The ash content also differed among raw, boiled and fried fishes. Lowest moisture content was observed in fried fish (28.6 to 53.3%), while raw and boiled fishes showed higher moisture content (71 to 84.85%). This study, however, will provide basic information which can be added to the current Bangladeshi food composition tables on marine fish. The data can be used as a guideline for promoting marine fish consumption.

C H A P T E R = 7



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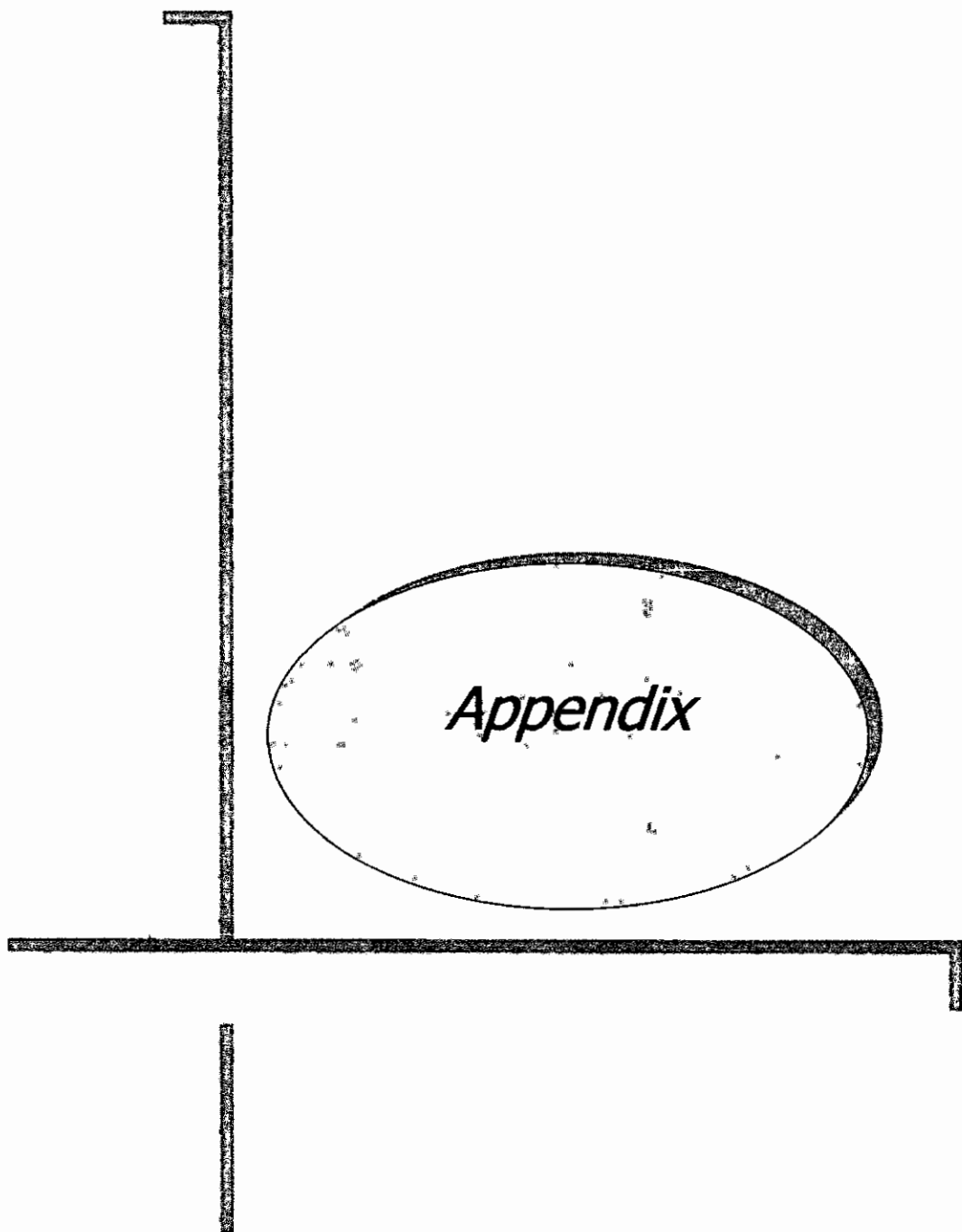
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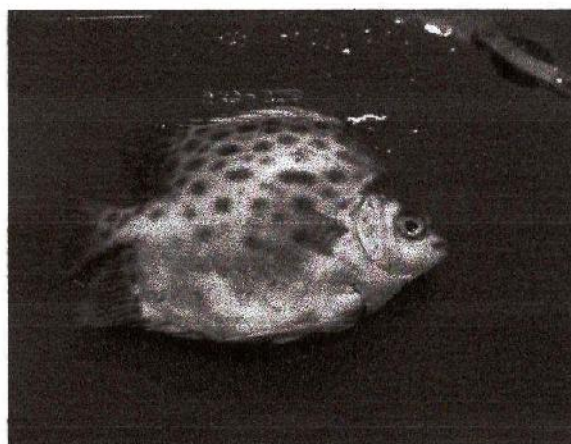
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Appendix

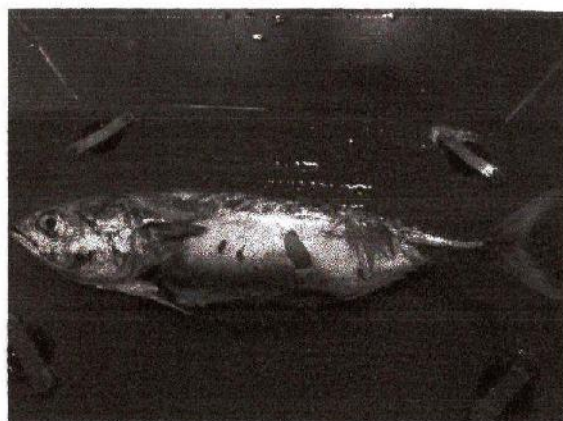
Photographs of the experimental fishes



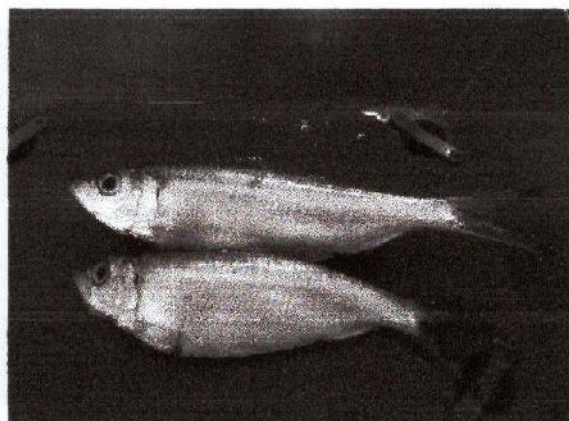
1. Bishtara



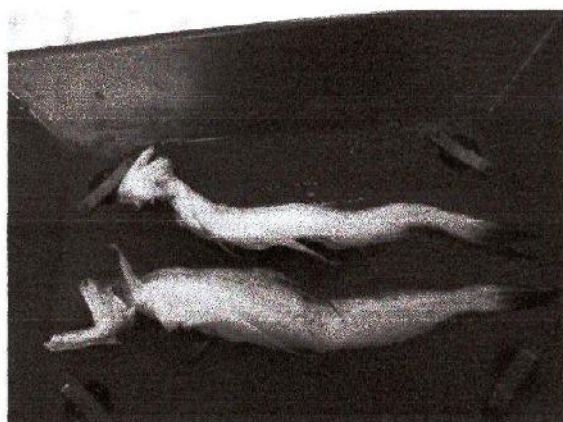
2. Poa



3. Kauwa



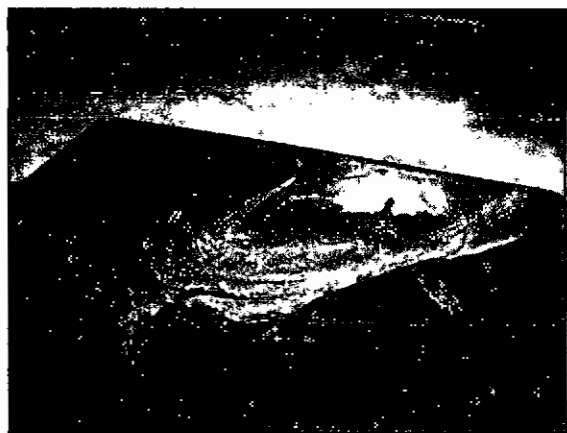
4. Chapila



5. Loitta



6. Phasa



7. Rita



8. Datina



9. Tular dandi



10. Vola



11. Bashpata

