Studies on the Biochemical Composition of Some Selected Freshwater Fishes of Kashmir Valley

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CERTIFICATE

This is to certify that the Dissertation entitled **'Studies on the biochemical composition of some selected freshwater fishes of Kashmir Valley'** has been completed under my supervision by **Mr. Reyaz Ahmad Ganie.** The work is original and independently pursued by the candidate. It embodies some interesting observations contributing to the existing knowledge on the subject.

The candidate is permit to submit the work for the award of degree of **Master of Philosophy** in **Zoology** of the University of Kashmir, Hazratbal, Srinagar (J&K) India.

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CHAPTER -1

Introduction

Introduction

The world's demand for aquatic source of foods is on the rise not only because of its growing population, but also because of a preference for healthier foods for human beings (Abimorad and Carneiro, 2007). Over 800 million people in the world are chronically malnourished as per the united nation's statistics. Of this one fourth are children under the age of five, who suffer from acute or chronic protein energy malnutrition (PEM). Although in the past three decades, the food production has increased at a greater rate than the population but this fact holds true only for the developed nations. The irony in the developing world remains that only one out of five people can get enough food to meet their daily needs. To ensure food security for everyone, it is essential to create shift in the way people think about the food system. Because food security for everyone can only be achieved by enhancing global food production in terms of proteins. This will also help to overcome the problem of protein malnutrition. To ensure nutritional security, increased availability of divers types of foods of animal origin such as milk, meat and fish besides cereals are essential.

It has been estimated that about ten million people die every year in the world either through starvation or malnutrition (FAO, 1995). As the world population increases, the demand for fish in the world also grows (FAO, 2000). Inspite of high preferences for fish and fishery products, the per-capita consumption of fish in India is still very low. A decline in fish availability will have a detrimental effect on the nutritional status of man as fish contributes significantly to the protein intake of people in most Asian countries.

Globally, fish and shellfish account for about 16% of animal protein consumed (Mba et al., 2011). In some countries figure is as high as 50%. Protein content of raw fish flesh is 18-22%. Therefore, aquatic food can in some ways be the medical food of 21st centaury. It not only does the functions of food but also contributes a lot to meet the requirements of basic nutrition and also plays a vital role in fulfilling the vitamin and mineral deficiencies besides driving away the diet related diseases.

Importance of fish as a source of high quality, balanced and easily digestible protein as well as several other nutrients is well understood. Fish provides the most of the gross and essential protein, fat, minerals, vitamins and essential amino acids. It is excellent for growth and development of human body and prevents several nutritional deficiency diseases. Apart from this fish is one of the most important sources of animal protein and has widely accepted as a good source of protein and other elements for the maintenance of healthy body (Andrew, 2001; Agusa, 2007).

Fish proteins are rich in all the essential amino acids in contrast to most proteins from plant sources, which lack adequate amounts of one or more essential amino acids. As compared to red meat, fish protein is considered slightly superior than any other land animal proteins and is nutritionally equivalent. The enhanced digestibility is mainly because of the fact that most fish muscles are devoid of strong collagenous fibers and tendons common in any other land animals. Fish is highly nutritious food, containing higher amount of protein with high biochemical value for humans. In addition, it is very good source of polyunsaturated fatty acid (PUFA). Fish also contain micronutrients such as iodine, selenium and fat-soluble vitamins that have positive effects on human health. In many developing countries of the world, small fish are eaten as whole and thus contribute calcium, phosphorus and iron to the human diet. It is not only the ‘brain-food’ but is excellent for growth and development of human body and prevents several nutritional deficiencies namely protein energy malnutrition (PEM).

Good and adequate nutrition plays a pivotal role in the expression of mental, physical and intellectual qualities in humans. To ensure access the nutritionally adequate food for the improvement in the quality of diet of a poor person in the society, fish is the only medium, which can serve the very purpose. It is estimated that around 60% of people in many developing countries depend on fish for over 30% of their animal protein supplies. While almost 80% in most developed countries obtain less than 20% of their animal protein from fish. However, with the increased awareness of the health benefits of eating fish and the ensuring rise in fish prices, these figures are rapidly changing. Fish also contains significant amount of all essential amino acids, particularly lysine and methionine which is relatively poor in cereals. Fish protein can be used therefore to complement the amino acids pattern and improve the overall protein quality of a mixed diet (FAO, 2005).

Despite the fact that fish protein is one of the most important nutrient for human health, the fish muscles also have a good source of n-3 PUFA that are considered to be most important in human nutrition due to their therapeutic role in reducing certain cardiovascular disorders (Lands, 1986; Stickney and Hardy, 1989). An increasing amount of evidence suggests that due to its high content of PUFA fish flesh and fish oil are beneficial in reducing the serum cholesterol (Stansby, 1985). With the possibility of enhancing n-3 or n-6 fatty acids in edible portion of farm raised fish by dietary modification (Hardy et al., 1987). Today it is known that Omega-3 fatty acids or a balanced Omega-3/ omega-6 ratio in the diet are essential for normal growth and development and may play an important role in the prevention and treatment of coronary artery diseases, diabetes, hypertension and cancer. They also effect neurodevelopment in infants, fat glycemic control, learning ability and visual function (Kinsella et al., 1990). Recent studies have shown that an increased intake of long chain polyunsaturated fatty acids during pregnancy increases the length of gestation and birth size. This suggests that maternal long chain polyunsaturated fatty acids status may be critical in the development of the fetus (Muskiet et al., 2006). Major depression is associated with lowered omega-3 PUFA levels (Hibbeln, 1998; Maes et al., 1999).

Benefits from dietary long chain n-3 fatty acids in promoting human health has been long recognized through clinical, pathological, observational and case studies (Breslow, 2006). These fatty acids are essential for normal growth and development. It is recommended by cardiologists to use generous quantities of fish in food to obtain adequate, protein without taking in excessive fatty acids and lipids (Dyerberg, 1986; Kinsella, 1991). Fish oil is also most important natural source of PUFA including eicosapentanoic acid (EPA) and docosahexanoic acid (DHA), which have been proven to have useful effects on human health (Rafflenbeul, 2001; Saoud et al., 2008). Diets deficient in these fatty acids can result in impairments in functions of several systems including cardiovascular, nervous, immune, and skin (Edirisinghe, 1998). It is now technically possible to produce fish of good nutritional quality with tailor made total n-3/n-6 composition in it body, thus meeting the human health requirements. Therefore, the consumption of fish provides an important nutrient to a large number of people world wide and thus make a very significant contribution to human nutrition.

Fishes besides being a good source of above nutrients also is an excellent source of vitamins particularly vitamin A and D. Fish fat is one of the very few natural food sources of vitamin D and contains important amounts of vitamin A and vitamin E (Bhuiyan et al., 1993; Qyvind et al., 1994).

Due to an ever-increasing awareness about health foods, fish is finding more acceptances because of its special nutritional qualities. Fish is one of the most important components of feed for animals and human beings, because of their excellent nutritional profile and easily digestible characteristics.

Thus fish makes a vital contribution to the survival and health of a significant portion of the world's population. Fish is especially important in developing world. Fish is often referred as 'rich food for poor people', as it provides essential nourishment, especially quality proteins, fats, vitamins and minerals. On a global scale, fish and fish products are the most important source of protein in human diet. Fish flesh is in the same class as chicken protein and are superior to milk, beef protein and egg albumin (Srivastava, 1999).

The whole body of fish is often used as an indicator of fish quality. The value of any food product, including fish is a function of its taste and nutritional properties. The nutritive value of a product depends mainly on the quantity of organic substances (Proteins, fats, vitamins, carbohydrates etc) and mineral present. Biochemical composition of fishes have important implications in the study of fish bioenergetics (Craig, 1977; Van Pelt et al., 1997) as well as the study of contaminants, given the propensity of many compounds related to lipid levels (Lanno et al., 1989). Further the quantity of fat also have importance in aquaculture and food technology, whereby the fish grading, fish quality and value are linked to fat levels in the tissue (Rasmussen, 2001).

Moisture, protein, fat and ash are the main components of fish meat and the analysis of the same is referred to as 'proximate composition' (Love, 1970). Like any other meat, the moisture, protein, fat, and ash (mainly minerals) constitute the four basic constituents of fish meat. Carbohydrates and non-protein compounds are also important constituents but are present in small amounts and are usually ignored during analysis (Love, 1980; Cui and Wootton, 1988; Wootton, 1990). The live weight of majority of fish usually consists of about 70-80% moisture, 20-30% protein and 2-12% fat (Love, 1980). However these values may vary considerably within and between species and also with size, sex, feeding, season and physical conditions/activity. The distribution of these substances among the various organs and tissues of body may also show considerable difference (Weatherley and Gill, 1987).

Generally the proximate composition is traditionally used as an indicator of nutritional value of food materials (Vlieg and Head, 1988; Rasmussen, 2001; Suleiman and Abdullahi, 2009), and it has also been reported that the principal components of fish are moisture, protein, fat, ash and minute quantities of carbohydrates (Hus, 1995). Other constituents also include vitamins and minerals (Mumba and Jose, 2005). There may be considerable variations in fish tissues concentration of these compounds within species, sex and sexual conditions. These components have also been shown to fluctuate even amongst fishes of different ecological systems (Reinitz et al., 1979; Hus, 1995).

In short, proximate body composition is the moisture, protein, fat, and ash contents of the fishes. Therefore, the precise information about these biochemical constituents of fishes are necessary for the formulation of animal feed, fish feed, fish industry, human health, nutritionists, pharmaceuticals, chemists etc.

Moisture: The percentage of moisture in the composition of fish is a good indicator of the relative energy, protein and fat contents (Aberoumad and Pourshafi, 2010; Barua et al., 2012). The proportion of moisture in fish varies widely between 65-90%, although it is normally in the range of 70-75%. The existence of inverse relationship between moisture and fat contents have been reported by several workers in the past especially in smaller fish species and reported that low moisture content is usually associated with relatively high fat content and vice-versa. It means determining the relative amount of moisture content in the fish one can obtain relative estimates of energy and fat contents (Salam et al., 1993; Salam and Davies, 1994., Jonsson and Jonsson, 1998). After moisture content the next important constituent in fish body is protein.

Protein: Proteins are complex molecules and the molecular weight of proteins range from less than 5000 Dalton to several thousand Daltons. Proteins are generally classified based on the shape, solubility and chemical structure. Based on solubility in salt solution proteins are classified into three groups viz (i) Sarcoplasmic proteins (albumin and globulin) which constitute about 25-30% of protein (ii) Myofibrillar protein (actin, myosin, tropomyosin and troponin) are structural protein and constitute about 65-70% of total protein; (iii) Stroma or connective tissue proteins (called collagin) constitute about 3% of the protein in teleosts and about 10% in elasmobranches. Fish protein is easily digestible protein of high biological value and contains all the essential amino acids in required proportion. In addition to above the fish protein is also rich in non-protein amino acid taurine, which has unique role in neurotransmission. The protein content of fish muscle ranges between 16-21% and the protein content < 15% in the body of fish signifies low protein.

Fat: Fish fat provides much of energy and the essential body fatty acids (Gatlin, 2010). Fats are heterogeneous group of compounds extracted with solvent of low polarity. Glycerides, fatty acids phosphoglycerides, sphingolipids, aliphatic alcohols and waxes, steroids and several lipoproteins are important components belonging to this group. The term fat or oil is often used to represent this group of compounds. In terms of quantity, fat is the third major constituent in fish muscle. Fat content varies between species to species and also between different organs within the species. As far as the type of fat in fish muscle is concerned, triacyl glycerol and phosphoglycerides both containing long chain fatty acids are the major components. Squaline and wax esters are other component found usually in high concentrations in a few fish species. Based on variations in fat content fishes are broadly classified as lean and fatty fish.

The fat content present in a teleost fish species may be divided into two major groups viz. the phospholipids (structural lipids) and tryglycerides (depot fat). Among the saturated acids, palmitic and stearic acids are important ones and in mono unsaturated group, palmitoleic and oleic acid are major constituents. Whereas among the polyunsaturated acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the major components. Many workers reported the importance of total fat and fatty acid compositions of some food fishes (Ackman and Takeuchi, 1986; Suzuki et al., 1986; Bieniarz et al., 2000).

Ash: After moisture, protein and fat contents the next constituent in the fish body is ash. It is the material or white residue left after ashing the fish sample. The ash content of fish also varies from 0.5-5%. Fish is good source of minerals and the total mineral content in wet fish meat ranges from 0.6 to 1.5%. The minerals present in fish include iron, calcium, zinc, iodine (from marine fish), phosphorous, selenium and fluorine. These minerals are highly ‘bio available’ meaning that they are easily absorbed by the body.

It is evident that fish contribute more to people’s diet. Fish should therefore be an integral component of the diet, preventing malnutrition by making these micro and macro-nutrients readily available to the body. Fish is used in paste and powdered form to feed young children. It is estimated by WHO (2009) that people living with HIV survive eight year longer if they have good, balanced diet including fish. Fish is the source of nutrition, income, employment and foreign exchange. Increase in demand for fish in driven by population growth. With the increase in population of world, there is greater awareness among people to use every type of possible food.

As for as the use of fish in human food is concerned the fishes have been exploited as a source of animal protein from the time immemorial. Although marine waters are the major contributors of the total fish catch of the world, the fresh water ecosystem also play a significant role as source of fish protein in world including Kashmir valley. Fish is one of the main food constituents in our diet as it includes essential fatty acids, amino acids, and some of principle vitamins and minerals in sufficient amounts for healthy living (Borgstrom, 1961).

The Valley of Kashmir has a great potential of fresh water habitats of both lentic (flowing) and lotic (stagnant) nature. These aquatic resources are inhabited by a number of fish species, endemic as well as exotic. Among the endemic fish species the most important genus which is exploited for the commercial purpose on large scale throughout the valley is Schizothorax, which has reported 16 species by Heckel (1838), 13 species by Mishra (1949), 10 species by Das and Subla (1970), and recently 5 species by Nyman et al. (1998). Among the exotic species large numbers of carp species are also exploited for commercial scale.

The above endemic and exotic species of fishes are tremendously used as source of protein in the Valley of Kashmir but unluckily less attention have been paid towards the ecology of these fishes which are good source of protein, in the valley. A very less attention regarding the culture of these fishes has been paid so for. Till date nobody has worked on the biochemical composition or proximate analysis of these fishes, due to this peoples are not fully aware about the nutritional profile, importance of these fishes as natural source of food and to understand which fish could provide more protein and other essential nutrients for the betterment of human health.

Therefore, the present research work was conducted to analyze the biochemical composition of the commercially important food fishes of

Kashmir valley for determination of their nutritive values, caloric content, and to assess their nutritional edible values in terms of the nutrient contents. The present study related to the biochemical composition of some selected fresh water food fishes of Kashmir valley would provide valuable information about the biochemical composition of these fishes to distinguish their nutritional value and provide a choice based information from a consumer point of view.

Native fish Schizothorax is called as 'Kashir gaad' in local and also called as snow trout. The genus Schizothorax inhabits the streams, rivers and lakes of the Kashmir valley. The genus is believed to have migrated into the water bodies of Kashmir valley from Central Asiatic water sheds bordered by inner and southern slopes of Hindu-Kush, Korakoram and the inner ends of North Western Himalays and Sulaiman range. These fishes got isolated in the Kashmir region by land upheavals and evolved into the large number of species endemic in the valley. Although earlier a number of fishes belong to the genus Schizothorax have been reported in Kashmir water. However, presently only five species from this genus are mostly found in the water bodies of Kashmir region. The detailed of these fishes are as under:

Schizothorax niger

It is locally known as 'Aale gaad' and it inhabits lentic water bodies of valley, found mostly in Dal lake. Das and Jan (1971) suggested that this fish as typical herbivore which feeds mainly on fine microphytes and planktonic algae and fish have selective mode of feeding and ingest planktonic algae, zooplankton and fine microphytes having taste of adult insects.

Schizothorax curvifrons

It is locally known as ‘Satter gaad’. It inhabits the lakes, streams and rivers of the valley. The fish is the column feeder herbivore and is planktophagus with definite preference towards macrophages and planktonic algae and other plant matter. The animal food consumed up to 25-30% is rotifers, crustaceans, insect larvae etc.

Schizothorax esocinus

The fish is locally known as ‘Chirru’ and inhabits streams and rivers of valley. The fish is column feeder although some authors called it surface feeder. It feeds mostly on aquatic subtratal vegetation, both on sides and bottom of water bodies (Subla, 1967). Das and Subla (1970) suggested that this fish is herbivore and consumed 65-75% of annual feed consisting of planktonic and benthic plants chiefly microphytes and macrophytes. While 30-35% of animal food consists mainly of aquatic invertebrates such as insect larvae, crustaceans and oligochaetes.

Schizothorax plagiostomus

It is locally known as ‘Khont’. The fish inhabits the snow fed, streams and rivers of the valley. The fish is herbivorous and mostly feeds on phyto-macroplanktons, bottom algae and bottom invertebrates (Subla, 1967). The fish is typical bottom feeding herbivore and taking 70-75% of plant food. Its gut has 10% sand which is characteristic of bottom feeder and about 25-30% of animal food consists of bottom invertebrates such as rotifers, crustacians, insect larvae and molluscus (Das and Subla, 1970).

Schizothorax labiatus

The fish is locally called ‘Chush’ found mostly in rivers of valley. The fish is column feeder herbivore with preference towards plant food which is small microphytes and macrophytes. The animal food consists of rotifers, crustaceans and insect larvae.

Carps

Carp is locally called as ‘Punjabi gaad’. The two varieties of common carp viz mirror and scale carp was first time introduced in 1956 in the Kashmir valley. These carps feed voraciously on phytoplankton and other plant matter. These two varieties of carp have got established in all low lying lakes of valley including Dal and rivers of the valley. Fotedar and Qadri (1974) reported that *Cyprinus carpio* contributes 70-75% of the total catch in Kashmir valley. The predominance of this fish is due to higher fecundity, endless feeding grounds and availability of luxuriant vegetation for spawners to stick their adhesive eggs on it.

Cyprinus carpio specularis (Mirror Carp)

The fish is capable of filter feeding which is usual mode of feeding in young stages. The fish is detritus feeder feeding on decaying organic matter. This fish is herbivorous eating almost 80-85% plant food. It is column feeder (Subla, 1967). The plant food consists of microphytes and macrophytes besides planktonic organisms. 15-20% of animal food consists of rotifers, annelids, crustaceans and insect larvae (Das and Subla, 1970). It is prolific breeder and has attained phenomenal population in all the lakes and rivers except for fast running cold hill streams. Almost 50% of fish population in valley lakes is mirror carp (Fotedar and Qadri, 1974).

Cyprinus carpio communis (Scale carp)

This fish is a voracious herbivore feeding on coarse macrophytes and insect adults besides plankton algae, zooplankton (rotifers) and dissolved organic matter which is ingested in large quantity by sucking from the bottom. The fish is able to take any sort of food available besides broken maize and cooked rice (Jan and Das, 1971).

CHAPTER – 2

Review of Literature

Review of Literature

Fish is known to be the best and cheapest source of animal protein of very high digestibility and nutritive value. In general the biochemical composition of the whole body indicates the fish quality. Therefore, knowledge on biochemical composition of fish finds application in several areas. Due to an ever-increasing awareness about health foods, fish is finding more acceptance because of its special nutritional qualities. Fish is one of the most important components of feed for animals and human beings, because of their excellent nutritional profile and easily digestible characteristics. Precise information on the biochemical composition of fishes is necessary not only for the purpose of formulating fish feed of animals, but also for the purpose of processing and preservation of fish and fishery products for their export and other important means for human food, medicine and for industries.

Biochemical studies on fish muscles have drawn attention of several researchers as muscles are the major source of protein, lipids and carbohydrates (Joshi et al., 1979) and being the main energy reserves. The importance of such studies is to express the food value in terms of energy units (Qasim, 1972).

The most exhaustive work on biochemical composition of fish has appeared from many countries of the world. Most notable references are those of Atwater (1888), his work covered about 53 species of American food fishes, since then considerable use of his work have been reported. It has been used by chemists and biologists. Second notable work related to the fish biochemical composition was of Clark and Almy (1918), who analyzed large number of fishes at Atlantic coast. They reported for the variation seen in the biochemical composition of fish with seasons. Love and Wood (1937) work on fat metabolism of Herring. Love later revealed the chemistry of fish in his two books namely, 'Chemical Biology of Fish (1970-1980)'. On the basis of this Love is regarded as father of Fish Biochemistry.

Although several studies on the biochemical composition of many commercially important fishes have been reported from many countries of the world including India such as Atwater, 1888; Clark and Almy, 1918; Basu and De, 1938; Idler and Bitners, 1958; Love et al., 1959; Natarajan and Sreenivasan, 1961; Parulekar,1964; Qasim, 1964 and 1972; Jafri and Qasim, 1965, 1966; Love, 1970; Jany, 1976; Bano, 1977; Marais and Erasmus, 1977; Joshi et al., 1979; Dawson and Grimm, 1980; Hofer et al., 1982; Saleem et al., 1983; Sinha and Pal, 1990; Jyotsna et al., 1995; Salam et al., 1995; Venkalah and Lakshipathi, 2000; Dorucu, 2000; Chiou et al., 2001; Das and Sahu, 2001; Schreckenbach et al., 2001; Salam et al., 2002; Basade et al., 2006; Atanasova et al., 2008; Mazunder et al., 2008; Ozden and Erkan, 2008. However no systematic investigation had so far been made on the nutritive values and biochemical composition of the fresh water fishes from the Kashmir valley.

Pearse (1925) attempts to contribute to this general field by describing the variations in composition of two common fresh water fishes, the yellow perch and the brook trout at various ages, seasons, and tinder varying conditions of nutrition. The observations described by Pearse give a general idea of the gross chemical changes that take place in trout and perch during development and adult life. He mentioned that after the eggs are laid they absorb water. During the growth dependent on the utilization of stores of nourishment in the eggs, fat and nitrogen are used up, ash remains fairly constant, and the proportion of water increases. However, when young fish begins to feed, its nitrogen increases somewhat, then remains more or less constant throughout adolescence and adult life. Fat also increases for a time being but after the first year undergoes periodic seasonal fluctuations. As fat increases water decreases and vice versa.

Jafri and Qasim (1965) conducted a detailed biochemical composition of some freshwater fishes and reported that the biochemical composition of 24 species of freshwater fishes varied significantly. They also reported that among all species murrels possessed highest fat content compared to carps and catfishes while protein content was slightly high in some catfishes e.g., *Rita rita* and *Calaries magur* etc.

Jafri (1974) studies a fat- water relationship in the liver of the Indian major carp, *Cirrhinuss mrigala* and reported that an inverse relationship has been observed between fat and water contents in the liver of *C. mrigala*.

Kalpana et al. (1978) have analyzed the biochemical constituents such as moisture, protein, fat and ash content in the muscles of freshwater catfish, *Heteropneustes fossils* and reported that the ventral part of the body showed more accumulation of fat and ash than the dorsal part, while this dorso-ventral gradation was not marked in case of protein content.

Mustafa and Jafri (1978) studied the biochemical constituents and the calorific values of different regions of the body musculature of murrel, *Channa punctatus* and reported that various biochemical constituents were not distributed homogenously in the body musculature with the exception of water which showed inverse relationship with fat. While the constituents were found more concentrated in the muscles at the tail end.

De Silva and Rangoda (1979) reported some interesting information on some chemical characteristics of fresh and salt dried product of *Tilapia mossambica*.

Mustafa and Jafri (1981) have shown relationship of fat and glycogen concentration in the flesh of *H. fossils* as indicator of living condition and suggested that the precise information about fat and glycogen contents of fishes could possibly be used as indicators of growth in weight for a particular length, nutritional status of fish and as indices of the relative fitness of different environment.

Zeitler et al. (1984) in their studies found a decreasing trend in water and protein contents of *Cyprinus carpio,* while fat and energy contents showed a significant increase.

Javaid et al. (1992) suggested that changes in moisture, protein and phosphorous are function of body weight and may be simultaneously affected by lipid contents of the diet

Biochemical and mineral composition of three Nigerian fresh waster fishes was analyzed by Otitologbon et al., (1997). It was found that the *Oreochromis niloticus, Clarias lazera* and *Mormyrus rume* are classified as being in the low fat containing fishes. Among these fishes *O. niloticus* has the highest mineral content, while *M. rume* has the highest amount of protein, lipid and phosphorus contents, where as *C. lazera* is reported to have the highest amount of potassium, iron, nickel, chromium and copper.

Ali et al. (2001) studied the biochemical composition of *Channa punctatus* and reported that protein content which is a vital constituent of living cells tends to vary relatively little in healthy fish unless drawn upon during particular demands of reproduction or during food deprivation periods.

Bhuyan et al. (2003) studies on the biochemical parameters of *Cynoglossids* in Kutuboha Channel, Bangladesh and reported that higher protein and fat contents were observed ripe and gravid fish where as low level of protein and fat was recorded in spent and young fish.

Chandrashekar et al. (2004) studied the changes in muscle biochemical composition of *Labeo rohita* in relation to seasons and reported that moisture content was low when other constituents (fat, protein and carbohydrate) were high in *L. rohita.*

Ali et al. (2005) conducted a detailed comparative study of body composition of different carp fish species from brakish water pond in Pakistan and reported that the body composition varied significantly among the various carp fish species in brakish water pond. The maximum moisture content was observed in *Labeo rohita* while minimum was observed in *Cyprinus carpio*. The inverse trend in body fat content was reported among these fish species where a maximum fat was reported in *C. carpio* compere to that of *L. rohita.*

Islam and Razzaq (2005) reported the seasonal variations of the biochemical composition of freshwater Gobi, *Glossogobius giuris* from the river Padma. They suggested that the proximate composition of the fish generally depend on season, but also to a great extent in reaction to sex and reproductive cycle. It was mentioned that *G. giuris* is a 'low fat-high protein' fish. The female fish contained more moisture and fat content than those of male fish.

Comparative study of body composition of four fish species in relation to pond depth was carried out by Ali et al. (2006). It was found that significant differences among body composition were observed among the fish species related to pond depth. They reported that body composition like moisture, protein, fat and ash contents varied significantly among four fish species namely Indian major carps *Labeo rohita, Cirrhanus mrigala,Catla catla,* and grass carp, *Hypothalmicthys molitrix* in pond.

Nargis (2006) studied on the seasonal variation in the biochemical composition of muscles of koi, *Anabas testudineus*. They reported that the composition varied seasonally in relation to reproductive cycle of the fish. The protein content found to be higher in medium sized fishes and gradually decreased with the increase of age. Fat content was higher in large sized male than that of females. Carbohydrate content was slightly higher in male than the female.

Fawole et al. (2007) have studied the proximate and mineral composition of some food fish species and observed that food fishes are good in mineral composition.

Kamal et al. (2007) studied the biochemical composition of seven small indigenous fresh water fishes namely magur, *C. batrachus*; shingi, *H. fossilis*; koi, *A. testudineus*; foli, *Notopterus notopterus*; royna, *N. nandas*; taki, *C. punctatus* and tangra, *Mystus vittatus* from the Mouri river Khulna, Bangladesh. They reported that all the species are rich in food value.

Breck (2008) reported that the moisture content in fish is directly related to protein and fat contents with fat replacing water in more robust fishes.

Hartman and Margraf (2008) studied the common relationships among proximate composition components in fishes. They examined the relationships between the various body proximate components and dry matter for five species of fishes such as chum salmon, *Oncorhynchus keta*, chinook salmon, *Oncorhychus tshawytscha*, brook trout, *Salvelinus fontionalis*, bluefish, *promatomus saltatrix* and striped bass, *Morone saxatilis*. Finally they suggested that all the fishes showed a strong relationship between dry matter percentage and other body components such as fat, protein and ash. The dry matter content of these fish species can be used to reliably predict the percent composition of other components.

Mazumder et al. (2008) studied the biochemical composition of some small indigenous fish species i.e. mola, *Amblypharyngodon mola*; chapila, *Gudusia chapra*; punti, *Puntius chola*; chanda, C*handa nama;* batashi, *Pseudeutroptus atherinoides* and kajuli, *Ailia coila*. Their findings revealed that the highest protein content was recorded in *A. mola* (18.46%) but the fat was highest in *G. chapra* (5.41%). However they recommended that the overall nutrient content of these small indigenous fish species were observed as higher or equal to those of larger fish species.

Ozden and Erkan (2008) studies a comparison of biochemical composition of three cultured fish species and reported that cultured fish may provide an alternative source of protein, fat and mineral for human beings. Because cultured fish species is a good source of PUFA's and mineral contents.

Oduor-Odote and Kazungu (2008) studies the body composition of low value fish and their preparation into a higher value snack food. They assessed the feasibility of increasing the value of this by catch by testing it suitability to the production of snack foods which was prepared with locally available flour from rice, wheat and maize.

Duran and Tales (2009) studied the biochemical changes and sensory assessment on tissue of carp, *Cyprinus carpio*, during sale conditions. It was found that storage temperature and time are the most important factor that affects the quality of fish during sales.

Osibona et al. (2009) studied proximate composition and fatty acid profile of the African catfish *Clarias gariepinus* and reported the proximate compositions of *C. gariepinus* were: moisture 76.71%, protein 19.64%, fat 1.15% and ash 1.23%. There were no seasonal changes (P>0.05) in the mean monthly proximate composition of the fish over two years period was reported. A total of twenty seven different fatty acids were obtained in the muscle. The fish belonged to high protein low oil category. Palmitic and oleic acids were the main saturated and monounsaturated fatty acids, respectively. They recommended that the principal acids in the polyunsaturated group were linoleic, eicosapentaenoic and decosahexanoic acids. *C. gariepinus* thus constitute a source of high protein and polyunsaturated fatty acids as well as an ideal dietetic fish food.

Aberoumad and Pourshafi (2010) conducted a detailed biochemical composition of some important fish species such as skip jack tuna, yellow fin tuna and long tail tuna. These workers suggested that lower the percentage of moisture, the greater the fat and protein contents and higher resulted energy value and reported that skip jack tuna contains lowest moisture content and maximum protein content and highest energy value. Therefore, skip jack tuna was the best quality fish from the point of view of high biological value of protein and fat contents and finally the nutritional values.

Bouriga et al. (2010) studied the biochemical composition of three Tunsian silverside fish populations caught in open sea, lagoon and island coasts. Fatty acid and amino acid profiles were determined in three fish species such as *Atherina boyeri, Atherina lagunae* and *Atherina species* and reported biochemical variation among these fishes.

Seasonal changes on total fatty acid composition of carp, *Cyprinus carpio* in Ivriz Dam lake, Turkey was carried out by Kalyoncu et al. (2010). A total of 38 different fatty acids were determined from the common carps and reported a quantitative differences between fatty acids in muscles depending on season. While the percentage of omega-3 fatty acids was higher than those of omega-6 fatty acids.

The analysis of biochemical composition and caloric content in sand whiting, *Silago sihama* from Zuari estuary, Goa was carried out by Shamsan and Ansari (2010). Fish conditions and the seasonal variation in biochemical composition (moisture, protein, fat and carbohydrate) of *S. sihama* were monitored over fifteen month’s period on dry weight basis. They reported that moisture content was high when fat was low during the peak spawning and indicated a significant inverse relationship between the two components. Highest protein values were recorded in November, when the fat content was lowest. Finally they concluded that seasonal changes in biochemical composition of the muscle are generally associated with feeding, reproductive cycle, storage and utilization of reserves.

Ashraf et al. (2011) determined the proximate composition and amino acid profile of farmed and wild silver carp, *Hypothalmicthyes molitrix* and grass carp, *Ctenopharyngodon idella* to identify nutritional differences due to habitat changes and finally concluded that *C. idella* showed significantly higher protein and fat contents and lower moisture level than *H. moltrix* and farmed fish is nutritionally better than wild irrespective of the species studied.

Boran and Karacam (2011) studied seasonal changes in proximate composition of some fish species from the black sea and reported variation in biochemical constituents among the species especially protein and fat contents of the four species of fishes i.e. horse mackerel, *Trachurrus trachurus*; garfish, *Belone belone*; golden mullet, *Mugel auratus* and shad, *Alosa fallax.*

Comparative Evaluation of the chemical composition of Fillets from two fresh water *Alestes nurse* and *Oreochromis gallilaeu*s and two Brakish water *Scomberomorous tritor* and *Pseudotolithus elongates* fish species were carried out by Mba et al. (2011) by using AOAC methods.

Sutharshiny and Sivashanthini (2011) studied the major nutrient compositions of raw muscle like moisture, protein, fat, carbohydrate and reported that proximate compositions were found to be varied among the three fish species analyzed. It was recommended that among the three fish species, (*Scomberoides commersonianus, S. lysan* and *S. tol)* the *S. commersonianus* is an ideal fish for human food.

Barua et al. (2012) have studied the biochemical composition of some commercial marine fish species and found that *Dasyatis americana* contains highest protein, fat and ash concentrations while *Dasyatis pastinaca* hold highest moisture content and lowest value of protein and fat contents. Whereas *Dasyatis Zugei* registered lowest concentration of moisture and ash contents.

Siddique et al. (2012) determined the proximate composition of three available marine dry fishes namely Bombay duck, *Harpodon nehereus*; Sin croaker, *Johnius dussumieri* and Ribbon fish, *Lepturacanthus savala*. Major nutrient compositions like moisture, protein, fat, ash and carbohydrates were estimated in two different seasons, winter and monsoon, respectively. Their study revealed that the marine dry fishes have very good nutritional value. Higher amount of protein and fat content of dry fishes make it highly nutritious than fresh fishes and finally they suggested that marine dry fishes are highly nutritive and could be a substitute of other protein sources such as fresh fish, chicken, beef etc.

Abasi and Ogar (2013) studies the proximate composition of snakehead fish, *Parachanna obscura* and revealed that although the protein content of *P. Obscura* is relatively comparable with other members of the family channidae. However, the fat content was exceptionally high, making this species a good healing and recuperating agent for post natal and post operation patients.

CHAPTER-3

Materials and Methods

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Materials and Methods

The main objective of the present study was to analyze the major biochemical constituents such as moisture, protein, fat, ash and nitrogen free extract (NEF) of some locally important food fish species by using following methodology:

Source of fishes

Live fishes were obtained from the local fish markets in early hours of morning. Care was taken to ensure that all fishes used for analysis were in fresh condition. The fishes were brought to Fish Nutrition Research Laboratory in live condition in plastic containers. The specimens were first properly cleaned in the laboratory and the total length and weight of each fish was determined (Table 1). After careful examination, each individual was first wrapped in cloth for complete dryness. The following fishes were selected during the proposed study: *Schizothorax niger* (Aale gaad), *Schizothorax curvifrons* (Satter gaad), *Schizothorax esocinus* (Chirru), *Schizothorax plagiostomus* (Khont), *Schizothorax labiatus* (Chush), *Cyprinus carpio* communis (Scale carp), *Cyprinus carpio* specularis (Mirror carp).

Table 1. Showing average length, weight and condition factor of seven different fish species

Fishes species	Fish (*n*)	Weight (grams)	Length (cm)	Condition factor (K)
Shizothorax niger	10	240	27.6	1.1414
Shizothorax curvifrons	10	253	28	1.1446
Shizothorax esocinus	10	200	24.9	1.3299
Shizothorax plagiostomus	10	223	27.6	1.1283
Shizothorax labiatus	10	196	26.1	1.1421
C. carpio communis	10	250	25.2	1.5246
C. carpio specularis	10	220	24.7	1.4226

Schizothorax niger (Aale gaad)

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Sub-Family	Schizothoracinae
Genus	*Schizothorax*
Species	*niger*

Diagnostic features:

- Elongate, fusiform and short blunt and slightly prognathous upper jaw.
- Lips thick but not expanded into wide fold.
- Differ from others in having short snout, few gill rackers and thick lips but not expanded into wide folds. Only fish is having 6-dorsal fin rays.

Schizothorax curvifrons (Satter gaad)

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Sub-Family	Schizothoracinae
Genus	*Schizothorax*
Species	*curvifrons*

Diagnostic features:

- Elongate, fusiform, with short, blunt and slightly prognathous Upper jaw.
- Lips thin, Gill racker number is highest (21-28)
- A series of enlarged scales along the anal fin base.

Schizothorax esocinus (Chirru)

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Sub-Family	Schizothoracinae
Genus	*Schizothorax*
Species	*esocinus*

Diagnostic features:

- Elongate, fusiform with long snout, jaws equal.
- Lower gill racker number (8-15).
- Much longer jaw, light ground colour and contrasting black spots in most specimens.

Schizothorax plagiostomus (Khont)

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Sub-Family	Schizothoracinae
Genus	*Schizothorax*
Species	*plagiostomus*

Diagnostic features:

- Elongate, fusiform with projecting snout.
- Possess wider, almost transverse mouth.
- Lower jaw short and with sharp keratinized anterio-ventral cutting edge.
- Lower lip fold expanded and papillose.

Schizothorax labiatus (Chush)

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Sub-Family	Schizothoracinae
Genus	*Schizothorax*
Species	*labiatus*

Diagnostic features:

- Elongate, fusiform with a prognathus upper jaw.
- Lower jaw rounded with wide lip of folds usually separated by a distinct raised pad.
- Longer lower jaw and narrower mouth.

Cyprinus carpio communis

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Division	Cyprini
Genus	*Cyprinus*
Species	*carpio* communis

Diagnostic features:

- It has a deep body form and a heavy appearance.
- Fully scaled all over the body.
- Distinctive features include a short head, a rounded snout, a single long dorsal fin, a forked tail.
- Two pairs of fleshy barbels on either side of its mouth.

Cyprinus carpio specularis

Classification:

Phylum	Chordata
Class	Teliostomi
Super-Order	Ostariophysia
Order	Cypriniformes
Family	Cyprinidae
Division	Cyprini
Genus	*Cyprinus*
Species	*carpio* specularis

Diagnostic features:

- It has a deep body form and a heavy appearance.
- Partially largely scaled along the sides.
- Distinctive features include a short head, a rounded snout, a single long dorsal fin, a forked tail.
- Two pairs of fleshy barbels on either side of its mouth.

The following parameters were determined for above mentioned fishes which include moisture, protein, fat, ash and NFE by using the standard methods (AOAC, 1995).

Methods used for determination of moisture content

For determining the moisture content of fishes, the body of each fish was divided into two horizontal regions along the lateral line i.e. dorsal and ventral parts and samples were taken. Simultaneously the uniform proportion of the sample was also collected from all the parts of the individual fish for the determination of whole body moisture content of the fishes. The wet samples were put in pre-weight dry petri dishes and then weighted again. The petri-dishes with wet samples were kept in digital hot air oven for drying at 105^0C for about 24 hours or until the constant weight was obtained. Then dry samples were taken out from oven and put in desiccators, after 30 minutes the weight was taken, the difference in weight (wet and dry sample) was calculated and expressed as percentage moisture content of the sample.

The percentage of moisture content was calculated by using the following formulae:

$$\textbf{Moisture (\%)} = \frac{\text{Wet weight of sample (g) - Dry weight of sample (g)}}{\text{Wet weight of sample (g)}} \times 100$$

The moisture free dried fish samples were grinded and finely powdered with the help of mortar and pestle for converting samples into fine powder which was used for the analysis of other parameters.

Protein

The technique employed for the estimation of crude protein content was based on slightly modifying micro-Kjeldahl’s method (Jafri et al., 1964) 0.1–0.5 gram of sample was digested with 1:1 sulphuric acid in presence of potassium persulphate as an oxidizing agent. After complete digestion the sample was transferred in 50 ml volumetric flask and raised the volume upto 50 ml by adding double distilled water. 0.5 ml of aliquot was then taken in a test tube with Nesseler's reagent, after 10 minutes the colour developed was read on spectrophotometer at 480nm. The optical density (OD) obtained is used for estimating the crude protein (N×6.25) content of the sample.

Fat

Crude fat content of sample was determined by using solvent extraction technique with petroleum ether (B.P=40-60 ^{0}C) by using Soxtec (Foss Avanti Automatic 2050, Swedan). Briefly 1-5 gm of dried fined powdered sample is placed in Whatman Thimble and defatted cotton is plugged on the top of the thimbles. These thimbles then put into the thimble holder and placed inside the machine i.e. attached with condenser. The aluminum made extraction cups were first dried and weighted. Then added 60-70ml of petroleum ether and finally attached with thimbles already placed inside the machine. After full programming the extraction process gets started and then completing the whole extraction process, the equipment display a message that extraction is completed. Then the extraction cup containing fat content was removed from the extraction unit and placed in digital oven for about 60 minutes at 50-60 ^{0}C for the complete evaporation of petroleum ether, later on the aluminum cups containing samples were placed in desiccators for complete coolness and finally the weight was taken.

The total fat was calculated by using following formulae:

$$\textbf{Total fat (\%)} = \frac{\text{Weight of fat (g)}}{\text{Weight of sample (g)}} \times 100$$

Weight of fat= Weight of extraction cup with fat- Weight of empty extraction cup.

Total Ash

The ash content of the sample is the residue left after complete ashing. The fine powdered moisture free samples were taken in clean pre-weighted silica crucibles and weighted again along with samples. The crucibles containing samples was then placed in a muffle furnace at 650 ^{0}C for about 4-6 hours or till the residue became completely white. The samples were then allowed to cool in desiccators for about 20-30 minutes, reweighted and the amount of ash was calculated as the difference in weight.

The percentage of ash was obtained by using the following formulae:

$$\textbf{Total ash (\%)} = \frac{\text{Weight of ash (g)}}{\text{Weight of sample (g)}} \times 100$$

Weight of ash= weight of crucible with ashed sample -weight of empty crucible.

NFE

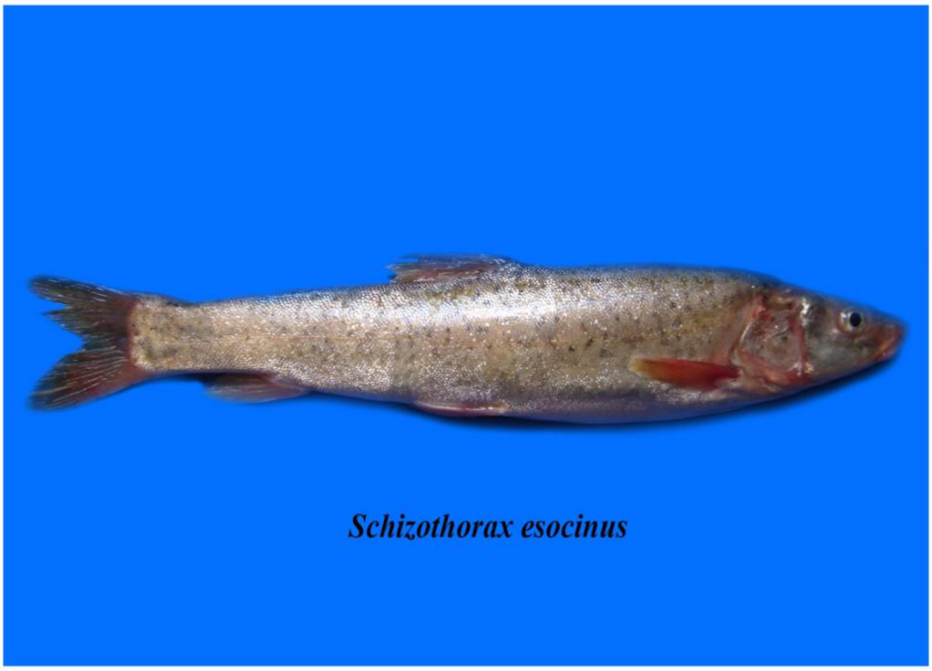
Nitrogen free extract was computed by taking the sum of values for moisture, protein, fat and ash contents and subtracted this from 100 (AOAC, 1995).

Statistical Analysis

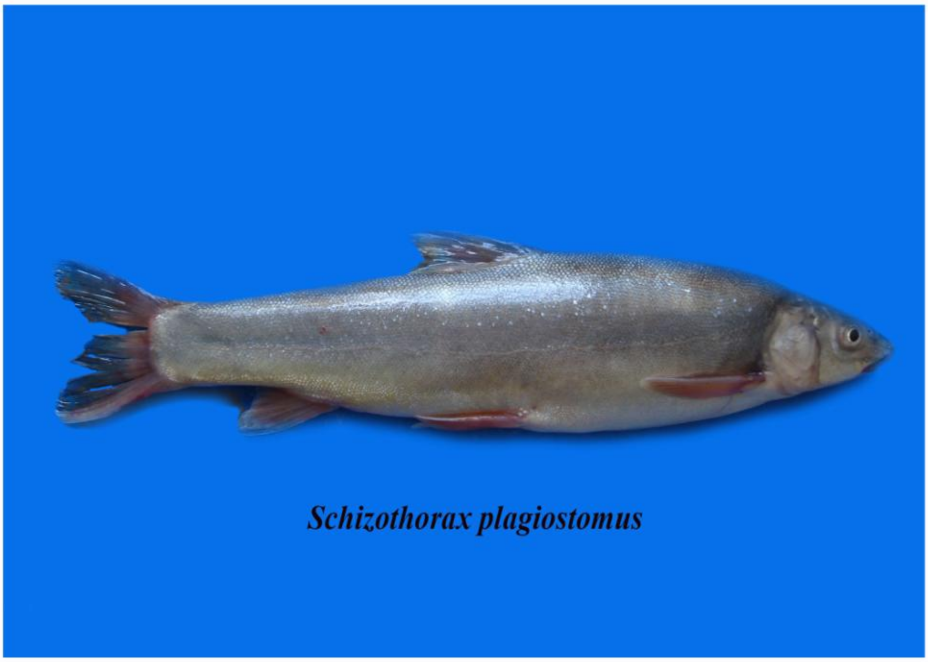
The whole body moisture, protein, fat, ash and NFE data were subjected to one-way analysis of variance (Snedecor and Cohran, 1967; Sokal and Rohlf, 1981). To determine significant differences (P< 0.05) among the fishes, means, Dunan's Multiple Range Test (Duncan, 1955) was employed. The values are presented as mean ± standard error of the mean (SEM).

Schizothorax niger

Schizothorax curvifrons



Schizothorax esocinus



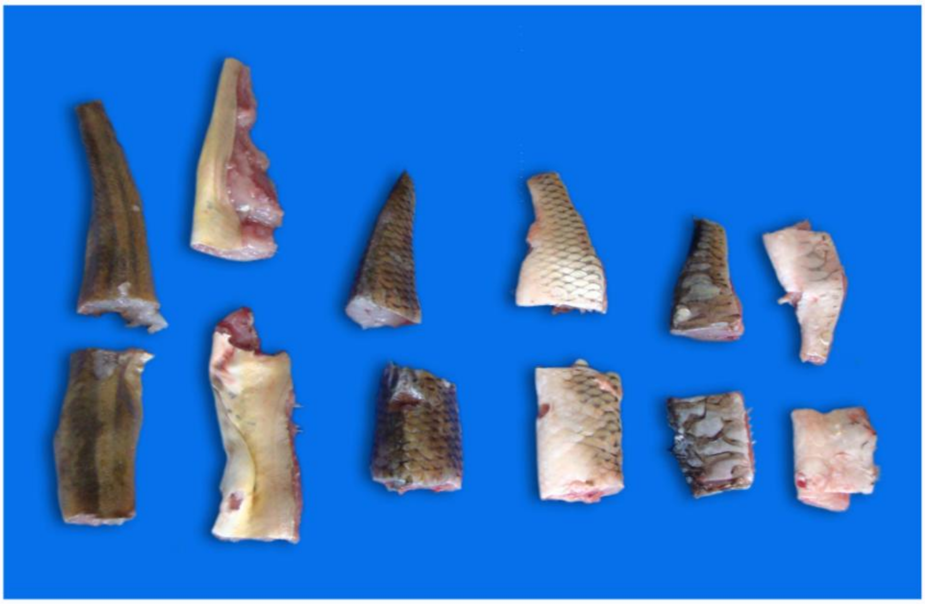
Schizothorax plagiostomus

Schizothorax labiatus

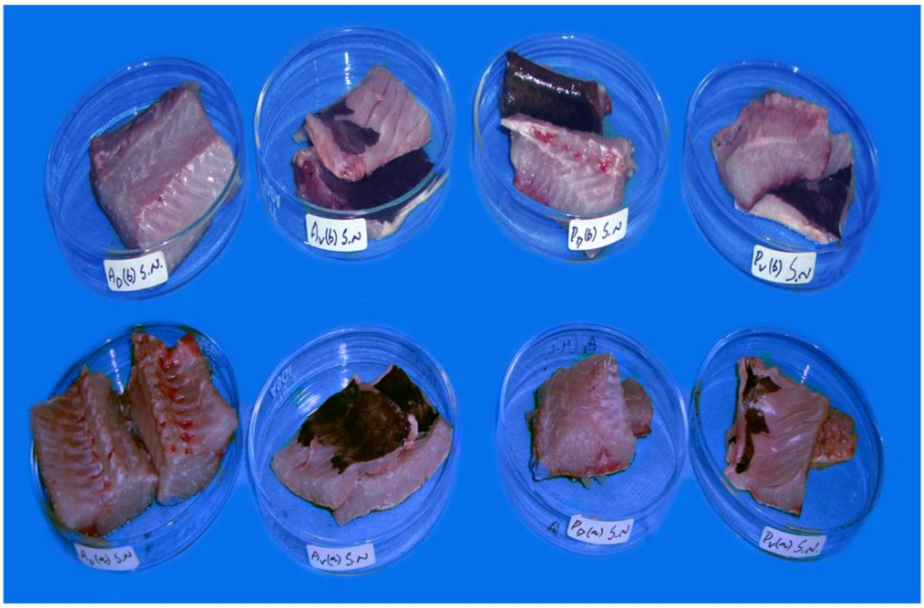
Cyprinus carpio communis

Cyprinus carpio specularis

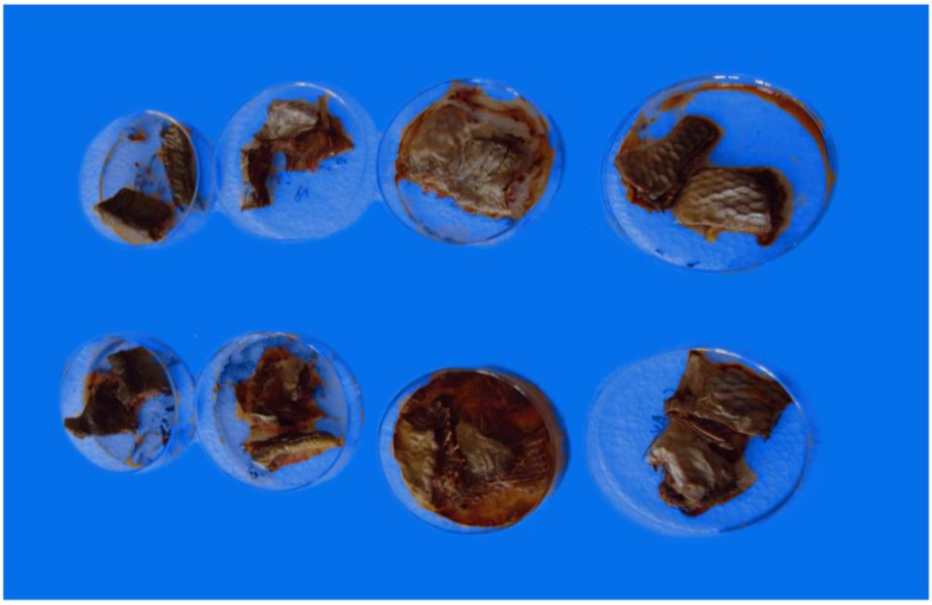
Dorsal and Ventral pieces of sample



Pieces of Fish Sample



Sample before Drying

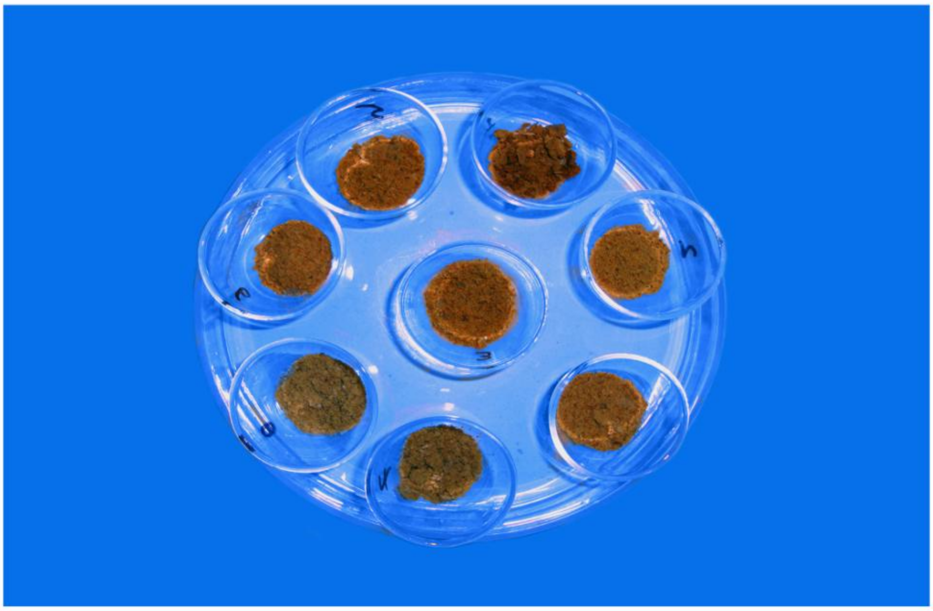


Sample after Drying

Reagents for Protien analysis

Soxtec Automatic Fat analyser

Extraction cups containing fat



Sample before ashing

Sample after ashing

CHAPTER – 4

Results

Results

The data obtained from the whole body composition of different fish species are present in table 2. Results in the present study clearly indicate the wide variations in the major biochemical constituents among fish species (Fig.1, 2, 3, 4 and 5). The maximum moisture content 79.58% was found in *Schizothorax curvifrons* which was significantly (*P*<0.05) higher among all the fish species. Whereas the significantly (*P*<0.05) lowest moisture content 71.51% was noted in *S. niger*. Among other fish species *S. plagiostomus* was also reported significantly lower moisture content 74.27% which was next to *S. niger.* After *S. curvifrons* the highest moisture content 77.84% was recorded in *S. esocinus* which was not significantly (*P*>0.05) different to the value obtained from *Cyprinus carpio* specularis 77.46% while *S. labiatus* 76.52% and *C. carpio* communis 76.14% produced insignificant (*P*>0.05) intermediate values of their moisture content among each other.

The protein content was found to be significantly (*P*<0.05) higher in *S. plagiostomus* 17.51% followed by *S. labiatus* 17.22% which was not significantly different from each other. After that the *S. niger* 16.43% and *C. carpio* communis 16.60% produced insignificant (*P*>0.05) intermediate protein values. Whereas *S. esocinus* represent 15.88% protein content followed by *C. carpio* specularis 14.63%. However, among all the fish species a significantly (*P*<0.05) lowest protein content 14.10% was noted in *S. curvifrons* in the present study.

The whole body fat content of different fish species produced differences among each other significantly (*P*<0.05) highest fat content 7.43% was noticed in *S. niger* followed by *S. plagiostomus* 4.33% whereas significantly (*P*<0.05) lowest whole body fat content was estimated in *S. labiatus* 1.88% which was not significantly different (*P*>0.05) from *S.*

esocinus 2.09%. The remaining fish species also produced significant differences in the whole body fat content among each other.

Ash content of the whole body of all fish species could not produce any significant differences among each other and generally represent low ash contents, excepting *S. esocinus* 2.60% and *S. niger* 2.29% where significantly ($P<0.05$) higher ash content was recorded.

The nitrogen free extract (NFE) of the whole body of different fish species were calculated and significantly ($P<0.05$) higher NFE content 2.41% was reported in *S. labiatus* followed by *S. niger* 2.29%. Whereas intermediate different values of NFE contents were recorded among other fish species, excepting *S. curviforns* where a significantly ($P>0.05$) lower value of NFE content was reported (Table 2).

In addition to the whole body composition, the distribution of moisture, protein, fat, ash and NFE contents of fish muscle from different body regions of various fish species were also analyzed in the present study and results are presented in table 3, which indicates an interesting distributional pattern in the muscles obtained from different body regions of each fish individual (Fig.1, 2, 3, 4 and 5).

Table 2. Showing the whole body biochemical composition of seven commercially important fresh water fishes of Kashmir valley*

Body constituents	*Schizothorax niger*	*Schizothorax curvifrons*	*Schizothorax esocinus*	*Schizothorax plagiostomus*	*Schizothorax labiatus*	*Cyprinus carpio* communis	*Cyprinus carpro* specularis
Moisture (%)	71.58 ± 0.42^{e}	79.48 ± 0.38^{a}	77.84 ± 0.38^{b}	74.27 ± 0.75^{d}	$76.5.+2\pm0.60^{c}$	76.14 ± 0.61^{c}	77.46 ± 0.47^{b}
Protein (%)	16.43 ± 0.46^{b}	14.10 ± 0.72^{e}	15.88 ± 0.61^{c}	17.51 ± 0.69^{a}	$17.22\pm0.^{63a}$	$16.60\pm0.^{53b}$	14.63 ± 0.50^{d}
Fat (%)	7.42 ± 0.33^{a}	3.08 ± 0.21^{e}	2.09 ± 0.05^{f}	4.33 ± 0.27^{b}	1.88 ± 0.20^{f}	3.58 ± 0.26^{d}	3.80 ± 0.33^{c}
Ash (%)	2.28 ± 0.20^{b}	1.86 ± 0.11^{d}	2.60 ± 0.17^{a}	2.20 ± 0.22^{b}	1.97 ± 0.16^{cd}	2.10 ± 0.07^{c}	2.02 ± 0.24^{c}
NFE (%)	2.29 ± 0.50^{b}	1.48 ± 0.45^{e}	2.02 ± 0.59^{c}	1.69 ± 0.34^{d}	2.41 ± 0.42^{a}	1.54 ± 0.55^{de}	2.10 ± 0.14^{c}

*Values are mean ± SEM (n=10). Mean values sharing the same superscript letter are not significantly different (P>0.05)

Table 3. Moisture, protein, fat, ash and NFE contents of the muscle from various body region and whole body of seven commercially important fresh water fishes of Kashmir valley*

Constituents	Region of body	*Schizothorax niger*	*Schizothorax curvifrons*	*Schizothorax esocinus*	*Schizothorax plagiostomus*	*Schizothorax labiatus*	*C. carpio* communis	*C. carpro* specularis
Moisture (%)	Dorsal	71.07±0.71	78.78±0.42	77.15±0.28	73.58±0.56	75.46±0.35	75.16±0.55	76.81±0.67
	Ventral	72.08±0.46	80.18±0.18	78.53±0.26	76.04±0.97	77.57±0.78	76.18±0.21	78.11±0.56
Protein (%)	Dorsal	17.48±0.58	15.38±0.57	17.46±0.35	18.82±0.42	15.09±0.60	16.22±0.52	15.77±0.40
	Ventral	13.37±0.11	12.89±0.18	14.31±0.13	14.87±0.51	17.76±0.78	17.23±0.41	13.49±0.44
Fat (%)	Dorsal	6.83±0.21	2.90±0.33	2.15±0.03	4.13±0.32	2.25±0.11	3.35±0.11	3.27±0.36
	Ventral	8.01±0.23	3.52±0.18	2.33±0.04	4.92±0.34	1.51±0.10	4.36±0.30	4.34±0.33
Ash (%)	Dorsal	2.48±0.11	1.69±0.11	2.42±0.08	2.55±0.05	2.31±0.02	2.21±0.07	2.43±0.25
	Ventral	1.69±0.11	1.67±0.10	1.89±0.15	1.84±0.34	1.64±0.06	1.98±0.08	1.57±0.16
NFE (%)	Dorsal	1.80±0.35	1.34±0.45	1.00±0.67	0.98±0.27	3.53±.0.81	2.66±0.32	2.15±0.23
	Ventral	2.74±0.08	1.62±0.04	3.04±0.16	2.40±0.38	1.30±0.45	0.53±0.17	2.53±0.20

*Values are mean ± SEM (*n*=10).

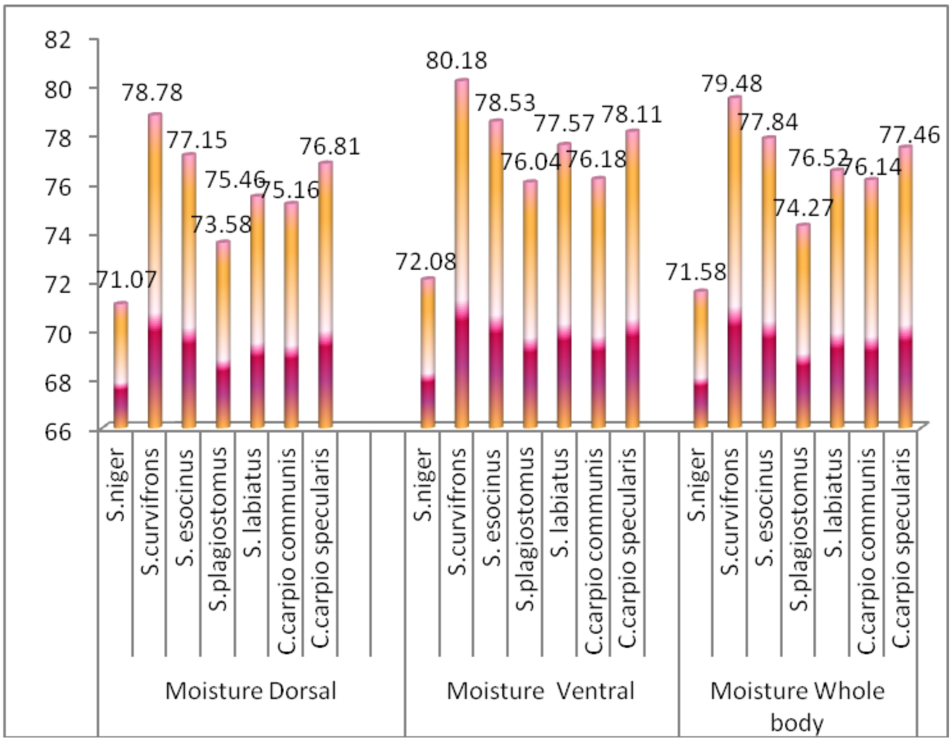


Fig.1: Showing variation of moisture

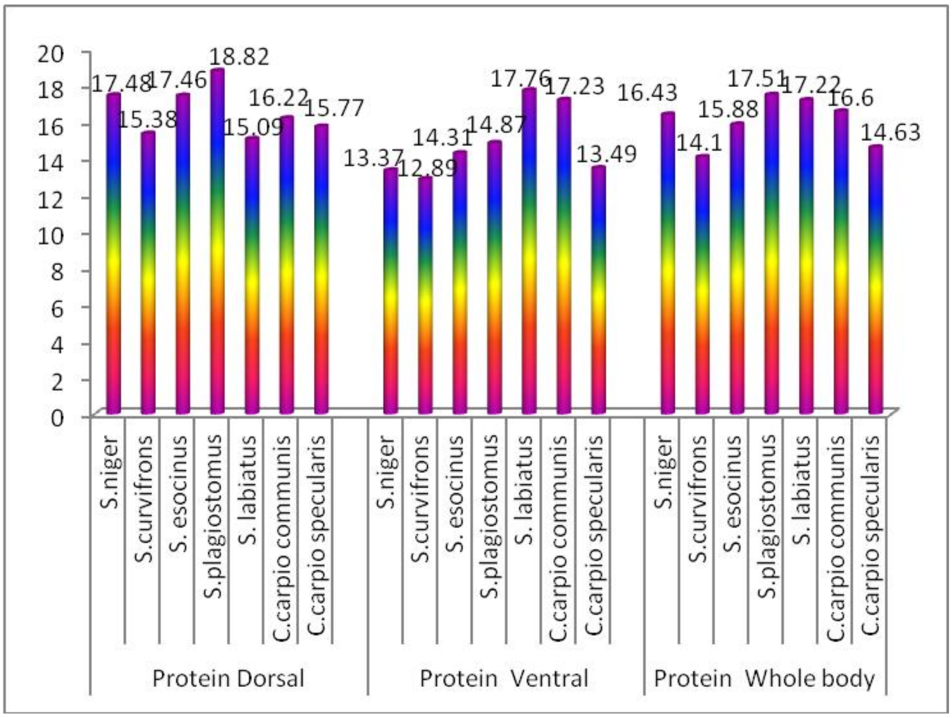


Fig.2: Showing variation of protein

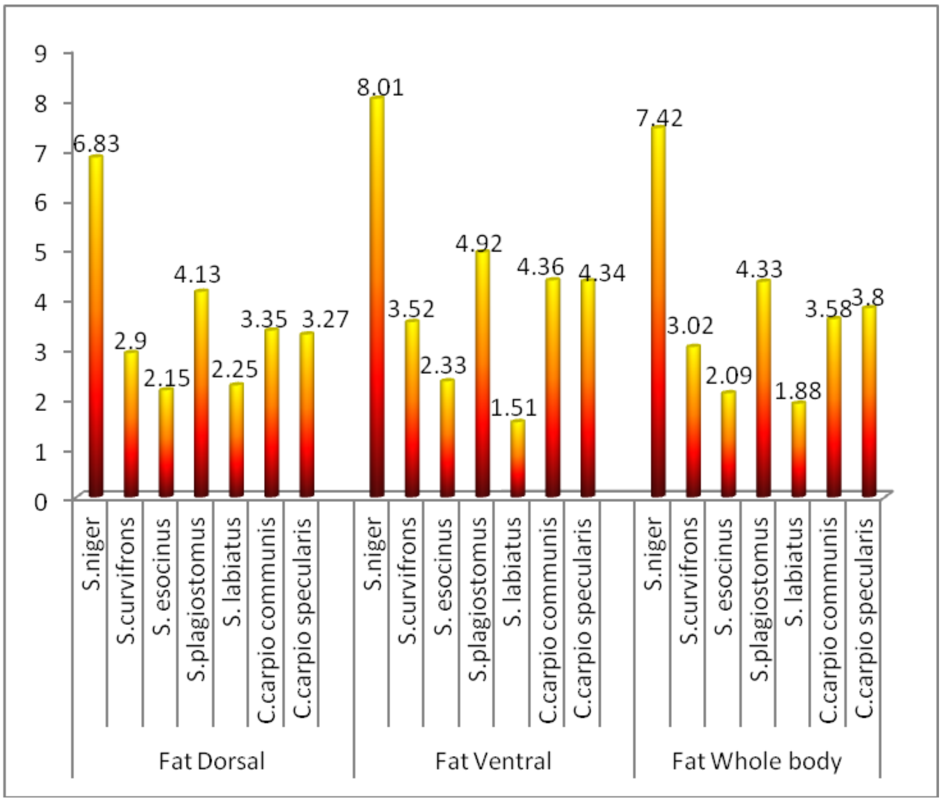


Fig. 3: Showing variation of fat

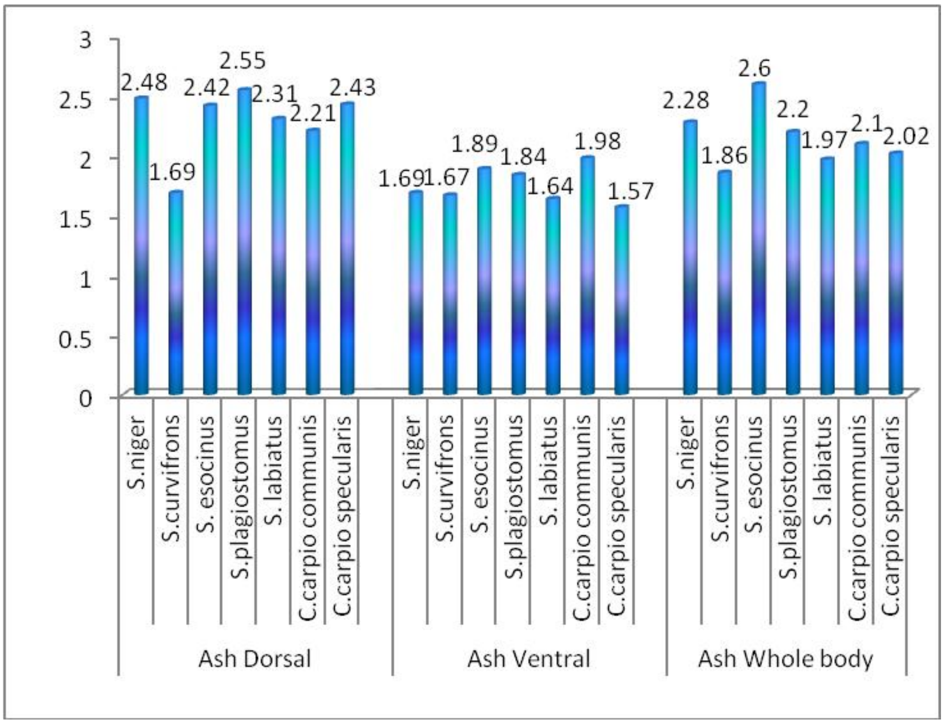


Fig.4: Showing variation of ash

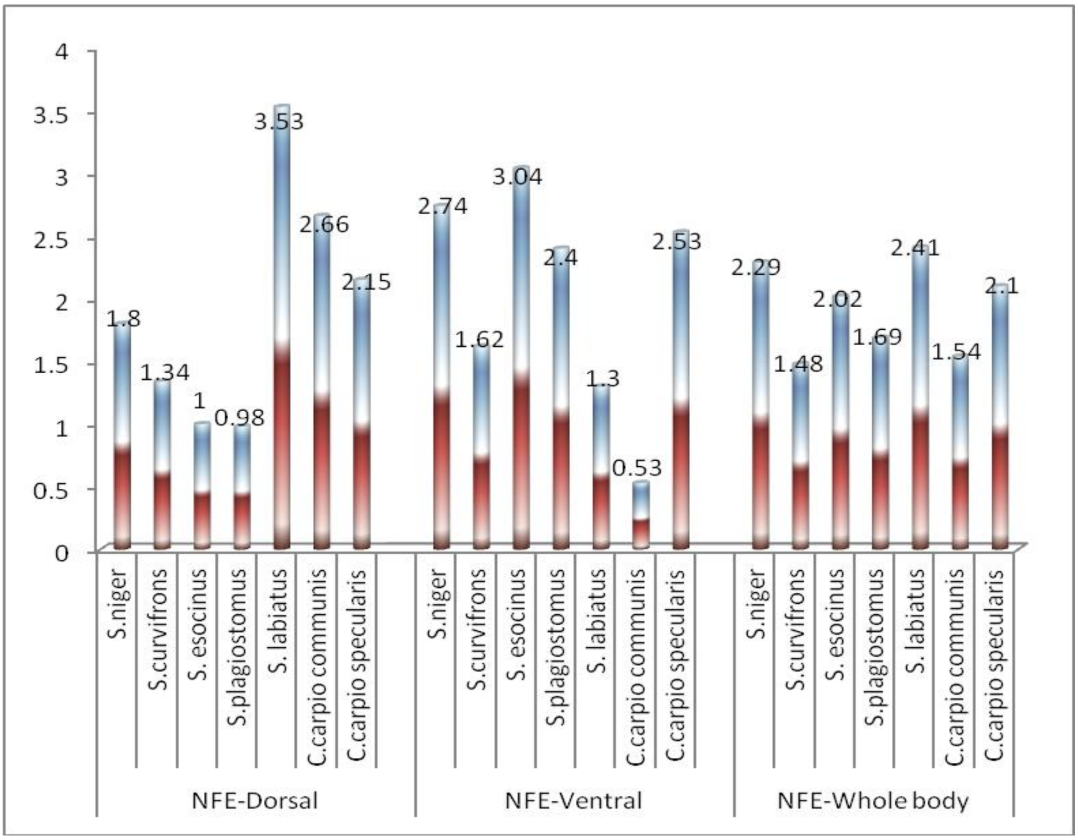


Fig.5: Showing variation of NFE

The distributional patterns of moisture, protein, fat, ash and NFE contents of fish muscle from different body regions of individual fish species were also analyzed in the present study, beside their whole body composition. The results related to the different body aspects of each fish species was separately presented as:

Schizothorax niger

The biochemical composition of *S. niger* is presented in table 4. The moisture content was slightly low in dorsal aspects 71.07$\pm$0.71% as compared to the ventral aspects where numerically higher moisture content 72.08$\pm$0.46% was noted. The protein content of *S. niger* was reported higher 17.48$\pm$0.50% on dorsal region whereas low protein content 13.77$\pm$0.11% was recorded on ventral region. Similarly the result related to fat content was also varied among both region, representing higher value of fat content on ventral region 8.01$\pm$0.23% compared to the dorsal region, where slightly lower fat content 6.83$\pm$0.21% was reported. A definite dorso-ventral graduation in the ash content of the body of *S. niger* is also indicated in the present study where higher ash content 2.48$\pm$0.11% was registered on dorsal region whereas low ash content 1.69$\pm$0.11% was reported on ventral region. Similarly the wide variation in nitrogen free extract (NFE) was also noted, with highest NFE was obtained in ventral aspects of *S. niger* compared to the dorsal aspects. The overall whole body moisture and fat of *S. niger* did not showed much variation with both aspects, however, the protein and ash contents produce wide variation among dorsal and ventral regions of the fish. The graphical distributional pattern of the important biochemical constituents of *S. niger* are presented in pie chart **(Fig. 6).**

Schizothorax curviforns

In case of *S. curvifrons* the body distributional pattern of moisture, protein, fat, ash and NFE are presented in table 5. The highest moisture content 80.18±0.18% was noted on dorsal aspect of the fish which is slightly higher than those reported at the ventral region 78.78±0.42%. The protein content of *S. niger* also indicated higher value 15.38±0.57% on dorsal region compared to the ventral region where only 12.89±0.18% protein content was recorded. Similarly the ventral regions of *S. curvifrons* produced higher value of body fat content 3.52±0.18% in comparison of dorsal region 2.90±0.33% where lower value of body fat content was noticed. However, *S. curvifrons* could not produce any significant variation in the body ash content in both regions, with the values 1.67± 0.10% and 1.69±0.11% on ventral and dorsal regions, respectively. The NFE content was also reported higher 1.62±0.04% in ventral region compared to dorsal region where slightly lower NFE content 1.34±0.45% was reported. The graphical representation of the whole body composition of the important constituents of fish is represented in pie chart **(Fig.7).**

Schizothorax esocinus

The results obtained for the distributional pattern of moisture, protein, fat, ash and NFE and of *S. esocinus* are presented in table 6. Although not much variation had been seen in the body moisture content of the both regions but a slight numerically higher body moisture content 78.53±0.26% was noticed on ventral region of the fish, while dorsal region registered 77.15±0.28% moisture content which was slightly lower than that found in ventral region of the fish. The maximum protein content 17.46±0.35% was reported on dorsal region of the fish while minimum protein content 14.31±0.13% was obtained on the ventral region of the fish. The distributional pattern of fat content did not showed any significant wide variation within the both regions. However, a numerical lower fat content 2.15±0.03% percent was reported on dorsal region where as ventral region produced 2.33±0.04% percent fat content. A marked increase in ash content was reported in dorsal region of the fish i.e. 2.42±0.08%, whereas ventral region registered only 1.89±0.15% percent ash content. The highest percentage of NFE 3.04±0.16% was found on the ventral region compare to the dorsal region where only 1.00±0.67% of NFE was found. The overall distribution patterns of important constituents of the whole body of the fish are presented in the form of pie chart **(Fig.8).**

Schizothorax plagiostomus

It would be evident in table 7, that the distribution of moisture, protein, fat, ash and NFE were characteristically associated with various regions, showing wide variations in their presence with different body regions of the fish. The maximum moisture content 76.04±0.97% was recorded on ventral region of *S. plagiostomus,* while lower body moisture content 73.58±0.56% was noted on the ventral region of the fish, likewise the presence of protein in the body of *S. plagiostomus* also showed considerable variations with the maximum protein content 18.82±0.42% obtained on the dorsal aspects of the fish, while only 14.87±0.51% protein content was noticed on the ventral region of *S. plagiostomus*. The body fat content also showed difference in both the regions with maximum fat content reported on ventral region 4.92±0.34% as compared to the dorsal region where slightly lower fat content 4.13±0.32% was reported. Similarly the body ash content of the fish also produced slightly higher ash content in the dorsal region 2.55±0.05%, while ventral region produced only 1.84±0.34% ash content. The NFE was found maximum on ventral region 2.40±0.38%, while dorsal region showed minimum NFE content 0.98±0.27%. The whole body distribution pattern of

S. plagiostomus can be best described in the form of graphical representation as pie chart **(Fig.9)** which showed detail about the contribution of important constituents as whole body composition of the fish.

Schizothorax labiatus

The marked changes in the body moisture, protein, fat, ash and NFE contents of *S. labiatus* with different regions of the fish body are well shown in table 8. The table shows that the slightly lower value of body moisture content 75.46±0.35% was noted on the dorsal region of the fish, while maximum moisture content 77.57±0.78% was obtained on the ventral region of the fish. The protein content of *S. labiatus* also produced somewhat similar results to that of the moisture content, with minimum protein content 15.09±0.60% reported on dorsal region of the fish, whereas ventral region contributed higher protein content 17.76±0.78%. Inverse results were obtained in the body fat content of the fish. The highest fat content 2.25±0.11% was recorded on dorsal region as compared to the ventral region where only 1.51±0.10% fat content was noted. Similar trends in the body ash content was also reported with maximum ash content 2.31±0.02% reported on dorsal region, while minimum ash content obtained on ventral region 1.64±0.06. The variation of NFE in *S. labiatus* was also noticed in the present study where maximum NFE was calculated on dorsal region 3.53±0.81% and minimum NFE on ventral region 1.30±0.45%. The whole body distributional pattern of important body constituents of fish are shown in the pie chart **(Fig.10)** which depict their percent values of occurrence in fish body in combination in best possible way.

Cyprinus carpio communis (Scale carp)

The body compositions of different regions of scale carp analyzed in the present study are presented in table 9. Moisture content of scale carp of the both dorsal and ventral regions showed slight numerical differences with higher moisture content 76.18±0.21% recorded on ventral region whereas dorsal region produced comparatively low moisture content 75.16±0.55%. The protein content of both regions showed inverse results. The higher protein content 17.23±0.41% was reported on ventral region, while dorsal region showed 16.22±0.52% protein content. The dorsal region of scale carp also produced lower fat value 3.35±0.11% as compared to the ventral region where higher value of body fat content 4.36±0.30% was recorded. The higher value of body ash content 2.21±0.07% was noted on dorsal region with respect to ventral region, where slight lower ash content 1.98±0.08% was observed. Similar trends were also reported in NFE values of scale carp from both the regions. The overall whole body composition of scale carp in relation to their total contribution in the body of fish is best presented in the pie chart **(Fig. 11).** Here it can be clearly seen that the maximum of the fish body is being occupied by moisture followed by protein, fat, ash and NFE, respectively.

Cyprinus carpio specularis (Mirror carp)

The data obtained in the present study for the distribution of moisture, protein, fat ash and NFE content of the body of the mirror carp is presented in table 10. Like scale carp the moisture content of mirror carp also produced somewhat similar results. The highest moisture content 78.11±0.56% was noted on ventral region of the body of mirror carp while dorsal region produced slightly lower value of moisture content, 76.81±0.67%. The protein content was found to be maximum 15.77±0.40%

in dorsal region as compared to ventral region with only 13.49$\pm$0.44% protein content. The body fat content produced inverse results to that of protein content. The fat content was reported minimum 3.27$\pm$0.36% on dorsal region and maximum fat content 4.34$\pm$0.33% was reported on ventral region. The body ash content also showed an inverse result to that of the protein content, where maximum ash content 2.43$\pm$0.25% was found in dorsal region and minimum ash content 1.57$\pm$0.16% was reported in ventral region. The NFE was calculated maximum in ventral region and minimum in dorsal region. The overall body composition of mirror carp is presented in the form of pie chart **(Fig.12).** The whole body moisture, protein, fat, ash and NFE contents were presented in the figure, which clearly depict their percentage in overall whole body composition.

Table 4. Moisture, protein, fat, ash and NFE contents of the muscle from various body regions and whole body of *S. niger**

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	71.07±0.71	72.08±0.46	71.58±0.42
Protein (%)	17.48±0.58	13.37±0.11	16.43±0.46
Fat (%)	6.83±0.21	8.01±0.23	7.42±0.33
Ash (%)	2.48±0.11	1.691±0.11	2.28±0.20
NFE (%)	1.80±0.35	2.74±0.08	2.29±0.50

*Values are mean ± SEM (*n*=10).

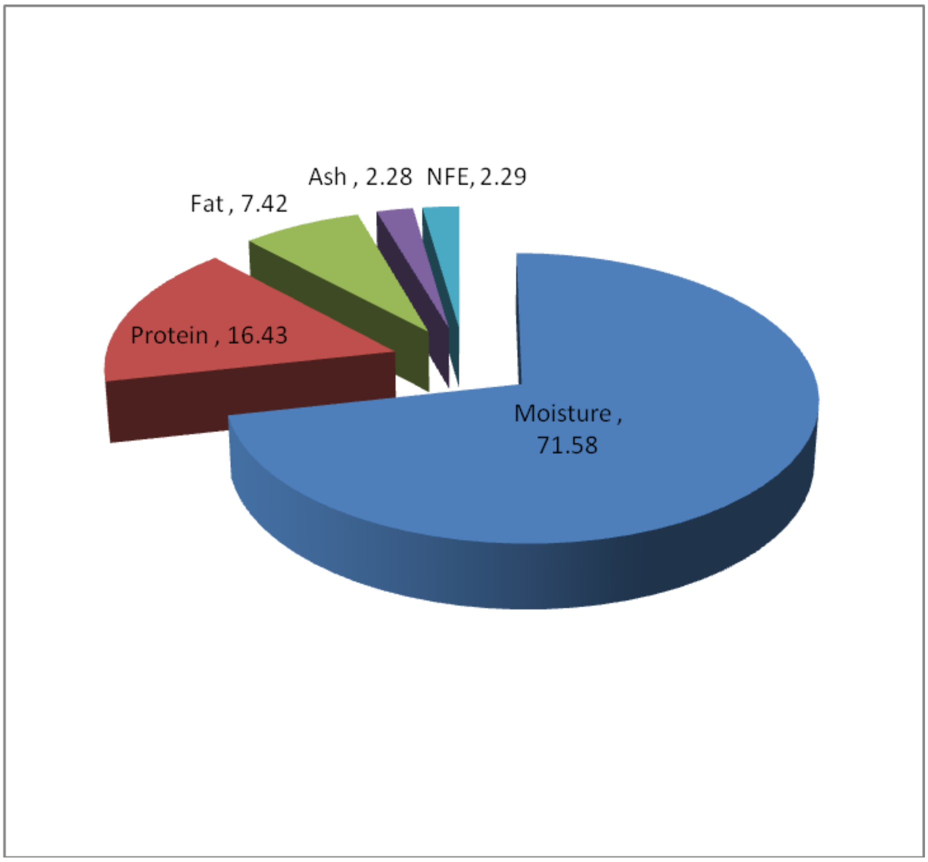


Fig.6. Whole body biochemical composition (%) of *S. niger*

Table 5. Moisture, protein, fat, ash and NFE contents of the muscle from various body regions and whole body of *S. curvifrons**

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	78.78±0.42	80.18±0.18	79.58±0.42
Protein (%)	15.38±0.57	12.89±0.18	14.10±0.72
Fat (%)	2.90±0.33	3.52±0.18	3.08±0.21
Ash (%)	2.50±0.06	1.67±0.110	1.86±0.11
NFE (%)	1.34±0.45	1.62±0.04	1.48±0.45

*Values are mean ± SEM (*n*=10).

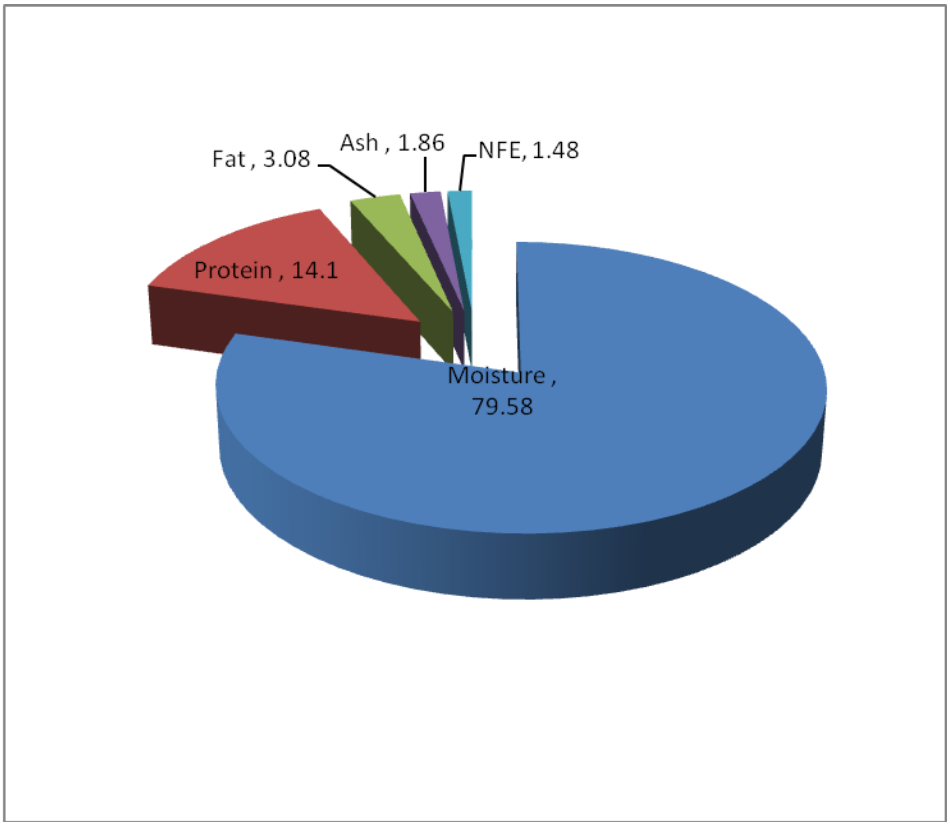


Fig.7. Whole body biochemical composition (%) of *S. curvifrons*

Table 6. Moisture, protein, fat, ash and NFE contents of the muscle from various body regions and whole body of *S. esocinus**

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	77.15±0.28	78.53±0.26	77.84±0.37
Protein (%)	17.46±0.35	14.31±0.13	15.88±0.61
Fat (%)	2.15±0.03	2.33±0.04	2.09±0.05
Ash (%)	2.42±0.08	1.89±0.14	2.16±0.17
NFE (%)	1.00±0.67	3.04±0.16	2.02±0.59

*Values are mean ± SEM (*n*=10).

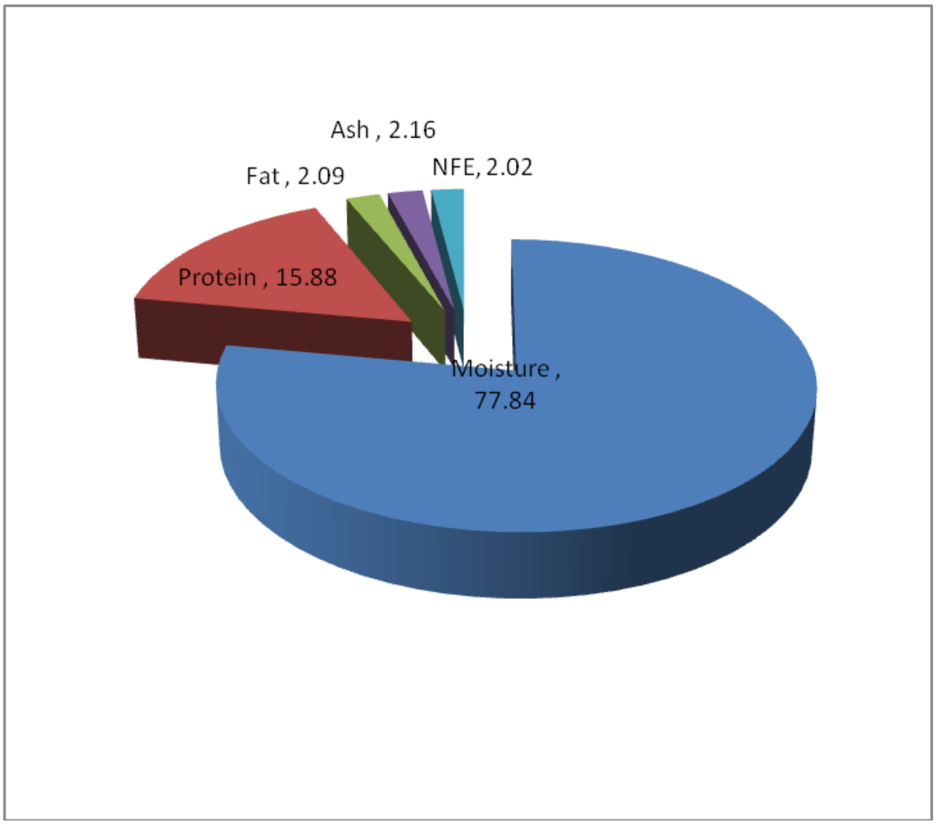


Fig.8. Whole body biochemical composition (%) of *S. esocinus*

Table 7. Moisture, protein, fat,ash and NFE contents of the muscle from various body regions and whole body of *S. plagiostomus**

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	73.58±0.56	76.04±0.97	74.27±0.75
Protein (%)	18.82±0.42	14.87±0.51	17.51±0.69
Fat (%)	4.13±0.31	4.92±0.33	4.13±0.27
Ash (%)	2.55±0.05	1.84±0.34	2.20±0.22
NFE (%)	0.98±0.27	2.40±0.38	1.69±0.34

*Values are mean ± SEM (*n*=10).

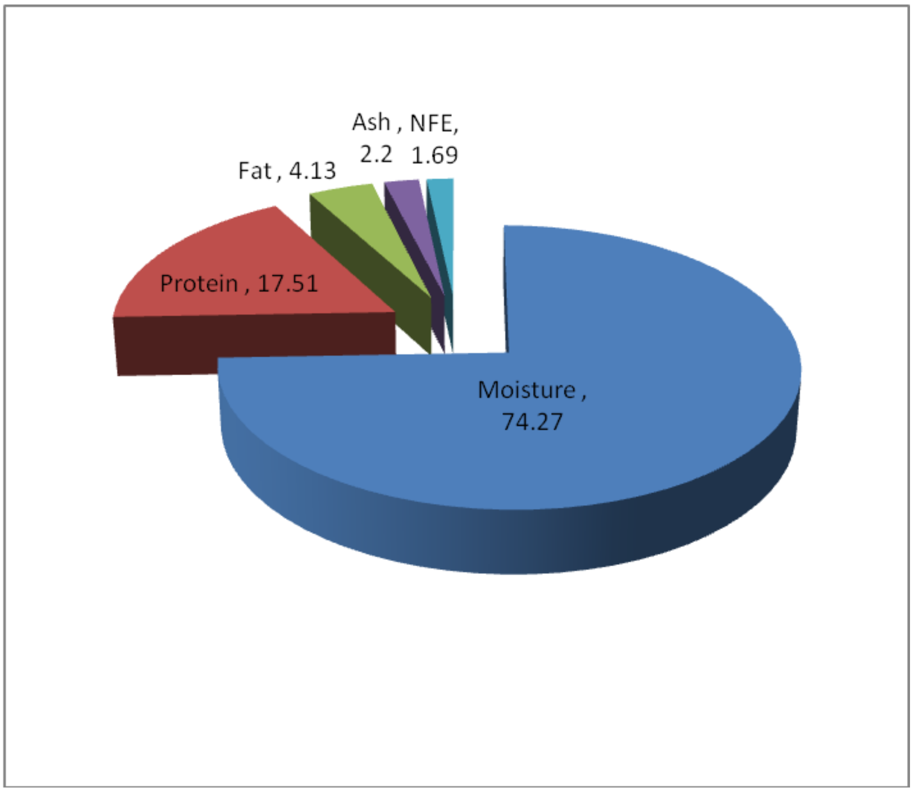


Fig.9. Whole body biochemical composition (%) of *S. plagiostomus*

Table 8. Moisture, protein, fat, ash and NFE contents of the muscle from various body regions and whole body of *S. labiatus**

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	75.64±0.35	77.57±0.78	76.52±0.60
Protein (%)	15.09±0.60	17.76±0.78	17.22±0.63
Fat (%)	2.25±0.11	1.51±0.10	1.88±0.20
Ash (%)	2.31±0.02	1.64±0.06	1.97±0.16
NFE (%)	3.53±0.81	1.30±0.45	2.41±0.42

*Values are mean ± SEM (*n*=10).

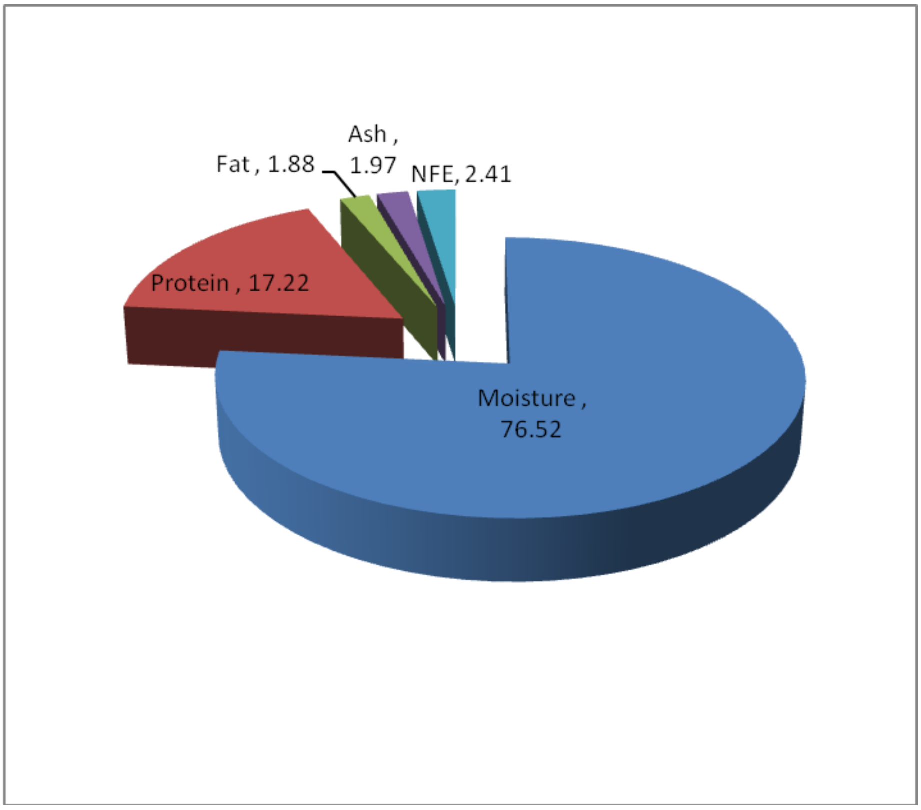


Fig.10. Whole body biochemical composition (%) of *S. labiatus*

Table 9. Moisture, protein, fat, ash and NFE contents of the muscle from various body regions and whole body of *C. carpio* communis*

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	75.16±0.55	76.18±0.22	76.14±0.61
Protein (%)	16.22±0.51	17.23±0.41	16.60±0.53
Fat (%)	3.35±0.12	4.36±0.30	3.58±0.28
Ash (%)	2.21±0.07	1.98±0.07	2.10±0.07
NFE (%)	2.66±0.32	0.53±0.17	1.54±0.55

*Values are mean ± SEM (*n*=10).

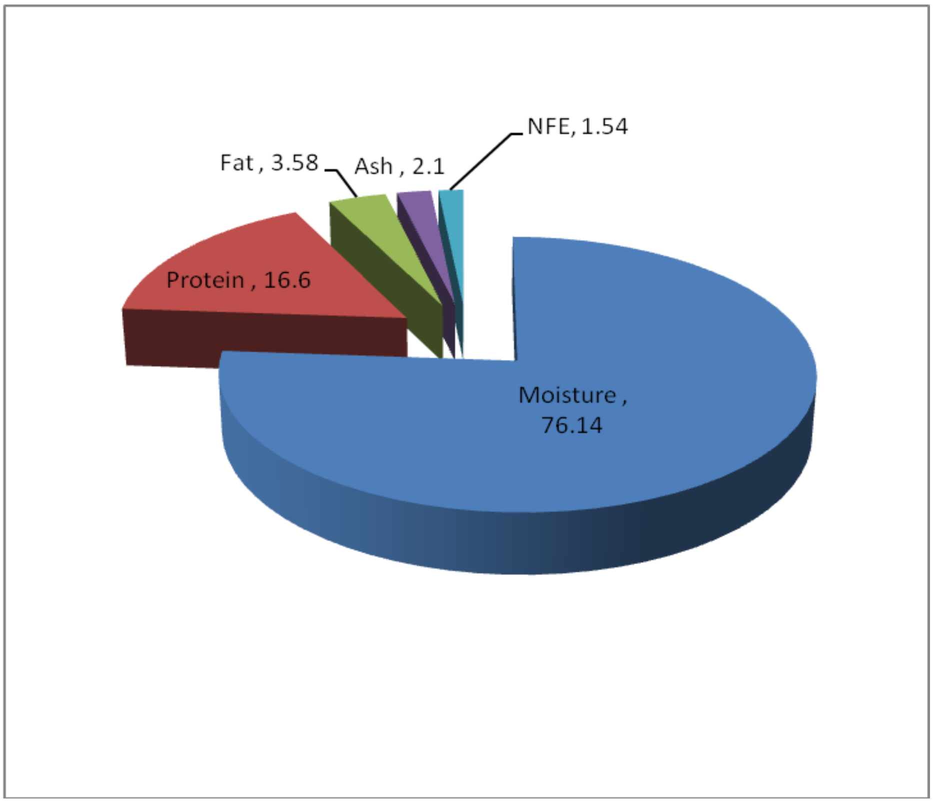


Fig.11. Whole body biochemical composition (%) of *C. carpio* communis

Table 10. Moisture, protein, fat, ash and NFE contents of the muscle from various body regions and whole body of *C. carpio specularis**

Body constituents	Dorsal side	Ventral side	Whole body
Moisture (%)	76.81±0.67	78.11±056	77.46±0.47
Protein (%)	15.77±0.40	13.49±0.44	14.63±0.50
Fat (%)	3.27±0.36	4.34±0.33	3.80±0.33
Ash (%)	2.43±0.25	1.57±0.16	2.20±0.24
NFE (%)	2.15±0.23	2.53±0.20	2.10±0.14

*Values are mean ± SEM (*n*=10).

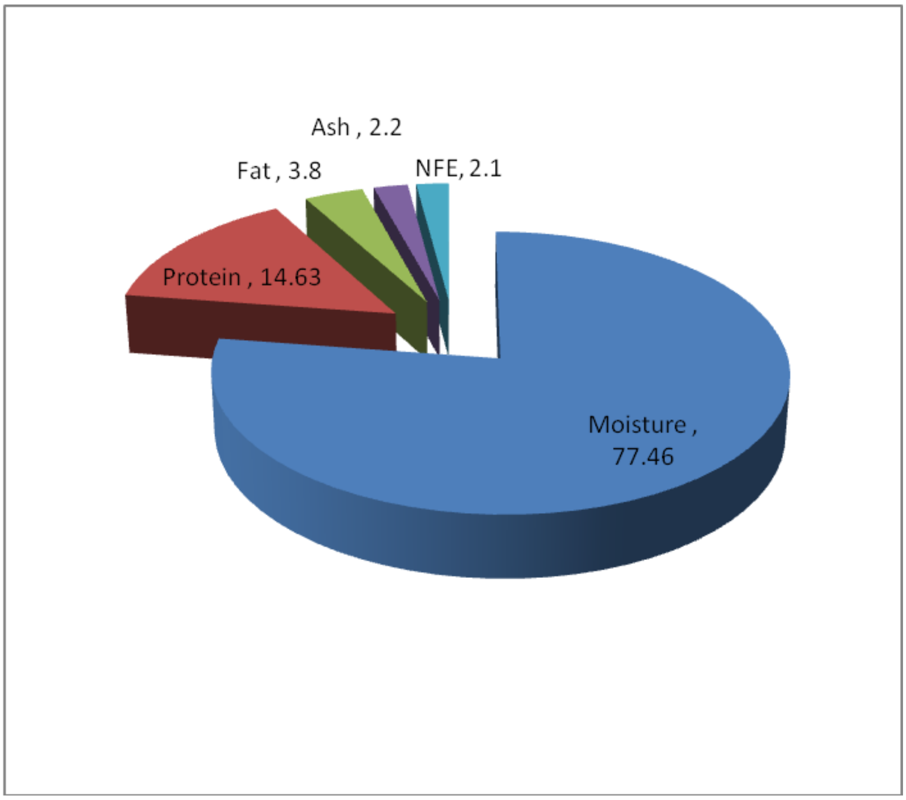


Fig.12. Whole body biochemical composition (%) of *C. carpio* specularis

CHAPTER - 5

Discussion

Discussion

The biochemical composition of the fish muscle generally indicates the fish quality. Therefore, proximate biochemical composition of a species helps to assess its nutritional and edible values. An increasing amount of evidences suggests that due to the high content of polyunsaturated fatty acid, fish flesh and fish oil are beneficial in reducing the serum cholesterol level (Stansby, 1985). In addition to that, the special type of fatty acid, the omega-3 PUFA, recognized as an important nutritive supplement to prevent a number of coronary heart diseases (Edirisinghe, 1998) is also present in fishes.

Although several studies dealing with the proximate composition of biochemical components of many commercially important food fishes have been reported in the past but no work on similar lines has been carried out in fishes from Kashmir valley. Therefore, the present study was undertaken to elucidate the dynamics of biochemical composition of muscles of different food fishes of the valley.

The fishes are very heterogeneous and highly specialized group evolved through biochemical adaptation and evolution, consisting approximately of 24000 species, shown extreme variation in biochemical composition. The chemical composition of fish muscles varies greatly from one species to other species (Love, 1980; FAO, 2002) and from one individual to another individual depending on age, sex, environment and season etc. (Balogun and Talabi, 1985; Nettleton et al., 1990; Silva and Chamul, 2000; FAO, 2002). It has been well established that in many fishes, both from fresh water and marine environment shows variations in the biochemical composition of whole body and different tissues are related to many factors including season, feeding, growth, maturation and spawning etc. Taking the above factors into the consideration the present study was conducted in almost uniform season in order to avoid any seasonal discrepancies among the species related to their major chemical constituents.

The four major constituents in the edible portion of the fish are moisture, protein, fat and ash. The analysis of these four basic constituents of fish is often referred as proximate analysis (Love, 1970). The distributional patterns of major biochemical constituents in the muscles obtained from different regions of the fishes as well as their whole body composition were analyzed, which showed that wide variation not only existing among the different fish species in their whole body biochemical composition, but also provides valuable information about the variation in the biochemical constituents in the individual fish species in different regions of their body. Although the objective of the present work was to analyze the major biochemical constituents of the different fish species, however, the analysis was also carried out to generate the more precise information related to the individual distributional pattern of these biochemical constituents in the different body regions of the individual group of fishes and the results were presented in result section as whole body as well as regions wise of each fish species.

Quantitative analysis of primary body constituents of fish have been reported for numerous marine fish (Vinogradov, 1953) and freshwater species (Jacquot, 1961). Generally, live weight, whole body composition of fish contained 70-80% water, 20-30% protein and 2-12% fat; however, extreme values for these components may fall well outside these ranges (Weatherly and Gill, 1987). Several studies have shown significant changes in whole body composition or in the composition of the specific organs or muscle tissues due to age, diet, feeding, frequency, migration, ration, seasons, sex, starvation and temperature (Chang and Idler, 1960; Bret et al., 1969; Groves, 1970, Savitz, 1971; Niimi, 1972; Elliot, 1976; Criag, 1977; Grayton and Beamish, 1977; Millikin, 1982; Weatherly and Gill, 1983).

The four major constituents, moisture, protein, fat and ash contents of the different fish species have been analyzed during present study which were separately discussed as:

Moisture: Among all the four major constituents studied the moisture (water) is a major constituent in the body of fish, which is essential for all living systems. The body fluids act as median of transport for nutrients, metabolites etc. Atwater (1892) reported that moisture is one of the most difficult components in the fish body to determine accurately and is very difficult to compare moisture content of different fish species because of different methodology especially by the setting of temperature. Brandes and Dietrich (1953) reported variation in the moisture content of the some fish species when setting two different temperatures and found that the difference upto 1.57% between determination done at 60 ^{0}C and those done at 96 ^{0}C. Therefore, in the present study the moisture content of the fish species were determined at constant temperature (105 ^{0}C) for 24 hours which is a standard protocol as recommended by AOAC (1995). The whole body moisture content of different fish species shows wide variation among each other in the present study and the values are reported within the range of 71% to 80%.

In the present study the significant variation in moisture content among different fish species have been reported with minimum moisture content 71.58% was obtained in the whole body of *S. niger*, while maximum moisture content 79.48% was recorded in *S. curvifrons*. While intermediate different values of moisture contents were recorded among other fish species. Interestingly the fish obtained from Dal Lake showed minimum content of moisture and maximum quantity of fat content in their whole body as compared to all those fish species which were collected from other sources like river Jhelum etc. However, the same fish also provides a good quantity of protein content in their body. *S. plagiostomus* also showed significantly low moisture content 74.27% as compared to all other fish species except *S. niger* which showed significantly lowest moisture content. Among all the Schizothorax fish species and two varieties of common carp i.e. *C. carpio* communis (Scale carp) and *C. carpio* specularis (Mirror carp), during the present study produced a significant difference in their body moisture contents.

The variation in the moisture content among all the fish species can be best described in the graphical presentation shown in fig.13. In several earlier investigations it had been pointed out that the moisture has an inverse relationship with the fat content (Brandes and Dietrich, 1958) which was clearly seen in the present study in some species especially *S. niger*, *S. plagiostomus*, *S. esocinus* etc. The overall results related to the moisture content of various fish species obtained in the present study are in accordance with findings of other workers (Marias and Erasmas, 1977; Nabi and Hossain, 1989; Salam et al., 1995; Mazumder et al. 2008).

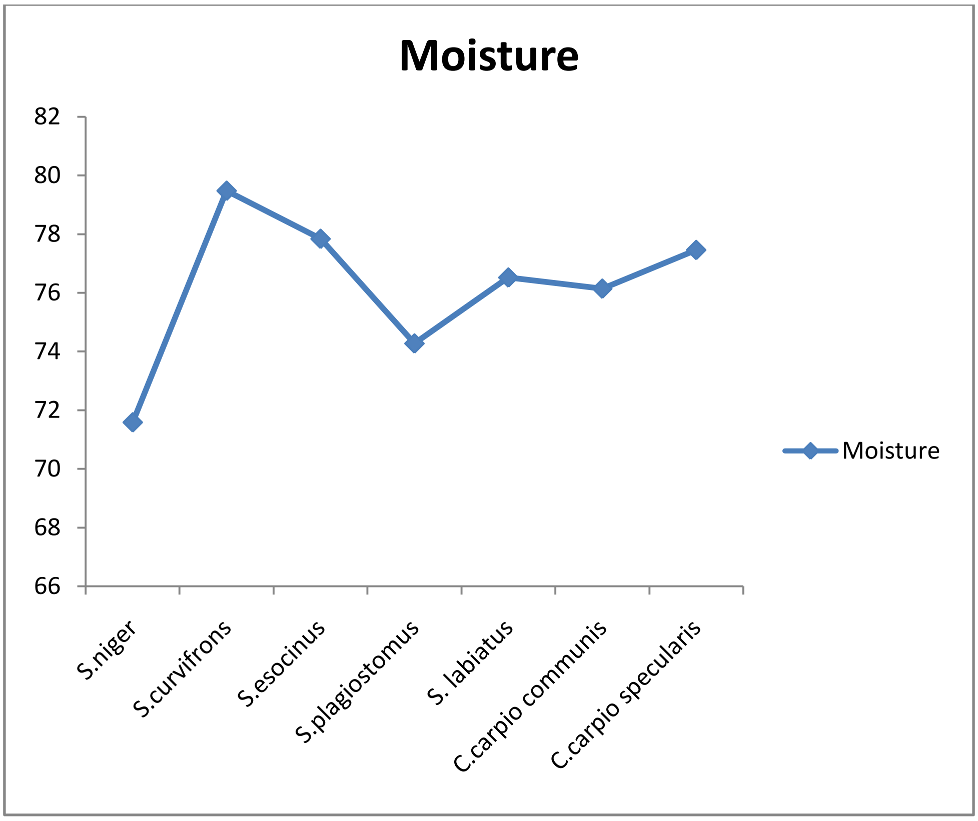


Fig.13. Variation of moisture contents (%) in different fish species

Protein: Protein which is next to the moisture content or second major component in the muscle tissue of the fish and is generally reported in the range of 12-20% in fresh water fish species. The protein content of all the species in the present study varied from 14.10-17.51% as shown in fig. 14. Among all the species analyzed in the present study the *S. plagiostomus* had the highest protein content 17.51% which was significantly higher among all the fish species except *S. labiatus* where an insignificant difference in protein content 17.21% was noted. Whereas *S. curvifrons* registered significantly lowest protein content 14.10% in the whole body followed by *C.carpio* specularis 14.63%. However, intermediate values of protein contents have been reported in other fish species with following order, *C. carpio* communis 16.60%, *S. niger* 16.43%, *S. esocinus* 15.88%, respectively.

Results clearly indicated a marked fluctuation of protein in all the seven fish species. The highest percentage of protein was observed in *S. plagiostomus* and was minimum in *S. curviforns*. The variation of protein might be influenced by their feeding and breeding capabilities (Islam and Razzaq, 2005). Borgstrom (1961) observed that the protein and fat contents in fishes depend on some factors such as size, age, sex, seasonal change and habitat. Similar observation was also reported by in different fish species in Brackish water pond (Ali et al., 2005), *Glossogobius giuris* (Islam and Razaak, 2005), in small indigenous fish species of Bangladesh (Mazumdar et al., 2008), and in some fish species from black sea (Borane and Karacam, 2011).

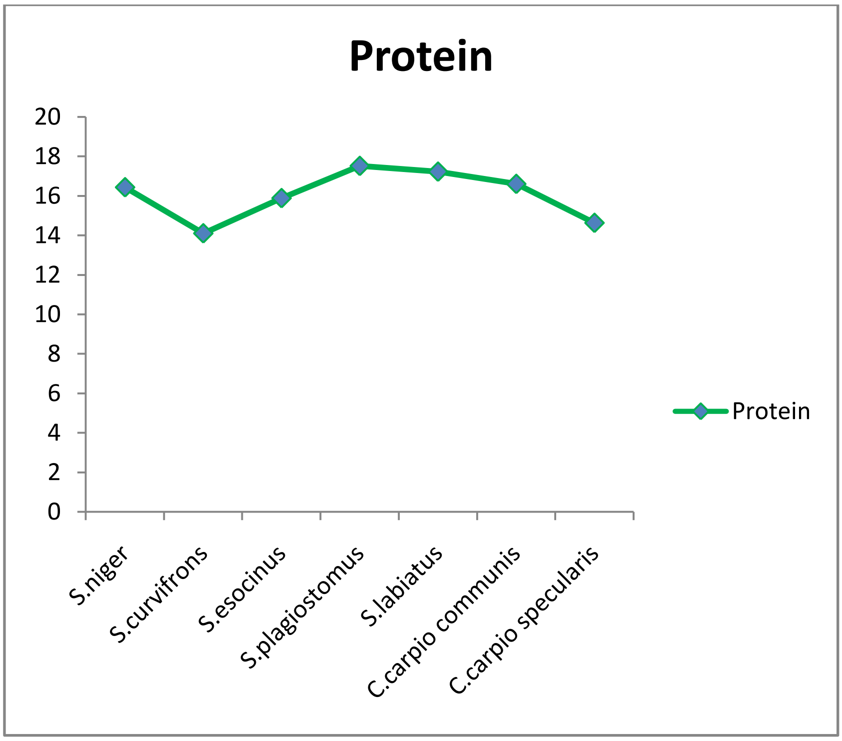


Fig.14. Variation of protein contents (%) in different fish species

Fat: In the present study the fat content of different fish species also varied considerably and reported within the range of 1.88-7.42% among different fish species. The fish obtained from Dal Lake, *S. niger* had reported significantly highest fat content 7.42% among all the species followed by *S. plagiostomus* 4.33% from Jhelum river. Whereas significantly lowest fat content values 1.88% and 2.09% were obtained from *S. labiatus* and *S. esocinus* respectively, which were not significantly different among each other. The remaining fish species also showed intermediate differences in their fat values. In the present study the variation in the fat contents among different fish species were much wider than that in the protein contents. Idlers and Wood (1965) reported that the fat content of herring, *Elupea pallasi*, varies between 4-20% with different season. The present result related to the fat content is in accordance with the above study. The Fishes were generally classified on the basis of their fat content (Silva and Chamul, 2000; Tzikas et al., 2007), which means that fat content is one of the most important constituent in the body of fish and its quantity will determine the quality of the fish. Fig. 15 showed the variation of fat contents among the different fish species which is not generally so high in majority of species because of their common behavior. However, some species showed the variation of fat content much wider, because of the different habitats. Salam (2002) reported the variation of fat content of different fish species from 3.25% in *H. fossils* to 5.41% in *G. Chapra*. The present results are in good agreement with the above study in respect to the variation in fat content among different fish species. Although the inverse relationship between fat and moisture have been reported in earlier studies. However, during the present study the inverse relationship between fat and moisture has been reported only in some species. Pillay and Nair (1973) marked an inverse relationship between fat and moisture content in some prawn species.

Marked fluctuation in the fat constituent in some fish species indicated in the present study might be due to dependence on some factors (Borgstrom, 1961). The table 2 shows that fat content is less in *S. labiatus*

1.88% and the highest percentage of fat was in *S. niger* 7.42%. This is due to the availability of food and habitat which has considerable effect on the tissue component particularly fat. The other factor could be the inverse relationship between moisture and fat (Shamsan and Ansari, 2010). Bumb (1992) reported coincidence of intensive feeding with occurrence of high fat content. Similar observation was reported by Mazumdar et al. (2008) in some indeginous fish species of Bangladesh, Bouriga et al. (2010) in three fish species i.e. *Atherina boyeri, A. lagunae, A. species.*

Ash: Mostly both marine and freshwater fish species have reported similar amount of ash contents in the whole body usually 1-3%. The highest ash content 2.60% was found in *S. esocinus* which was significantly higher among all the groups followed by *S. niger* 2.28% and *S. plagiostomus* 2.20% as shown in fig. 16. The values obtained for the ash content in the body of different fish species varied within the range of 1.86%-2.60% and fall in accordance with the values reported earlier by Natrajan and Sreenivasan, 1961; Habashy, 1972; Nabi and Hossain, 1989 and Salam, 2002. The similar observations were also made by Mazumder et al., 2008 in some indigenous fish species of Bangladesh.

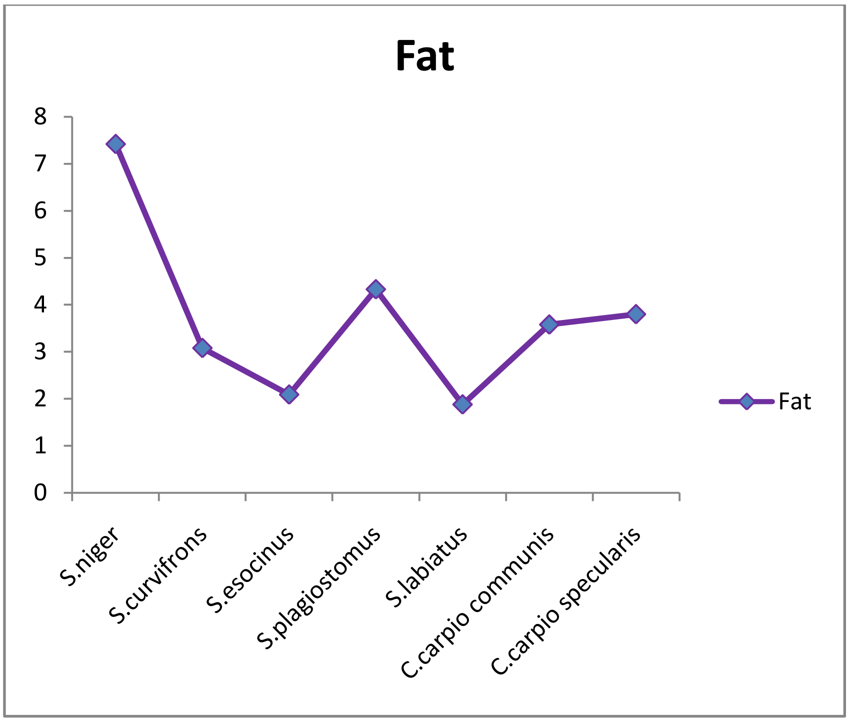


Fig.15. Variation of fat contents (%) in different fish species

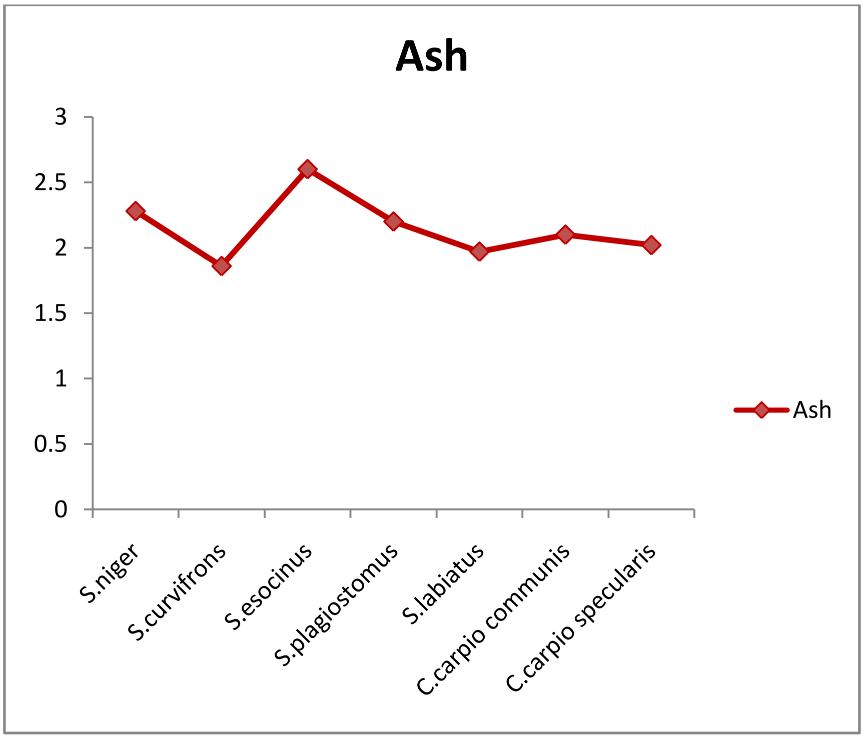


Fig.16. Variation of ash contents (%) in different fish species

NFE: The nitrogen free extract calculated in the present study were reported within the range of 1.48-2.41% among all the species. The significant differences in NFE content among different fish species have also been found in the present study. In *S. labiatus* significantly higher NFE values 2.41% was calculated followed by *S. niger* 2.29%. While other fish species provided intermediate different NFE values. The variation of NFE content of different fish species has clearly been seen among some fish species as shown in figure 17. Similar observations related to the NFE contents have also been made by Mba et al. (2011) in two fresh water and two brackish water fishes.

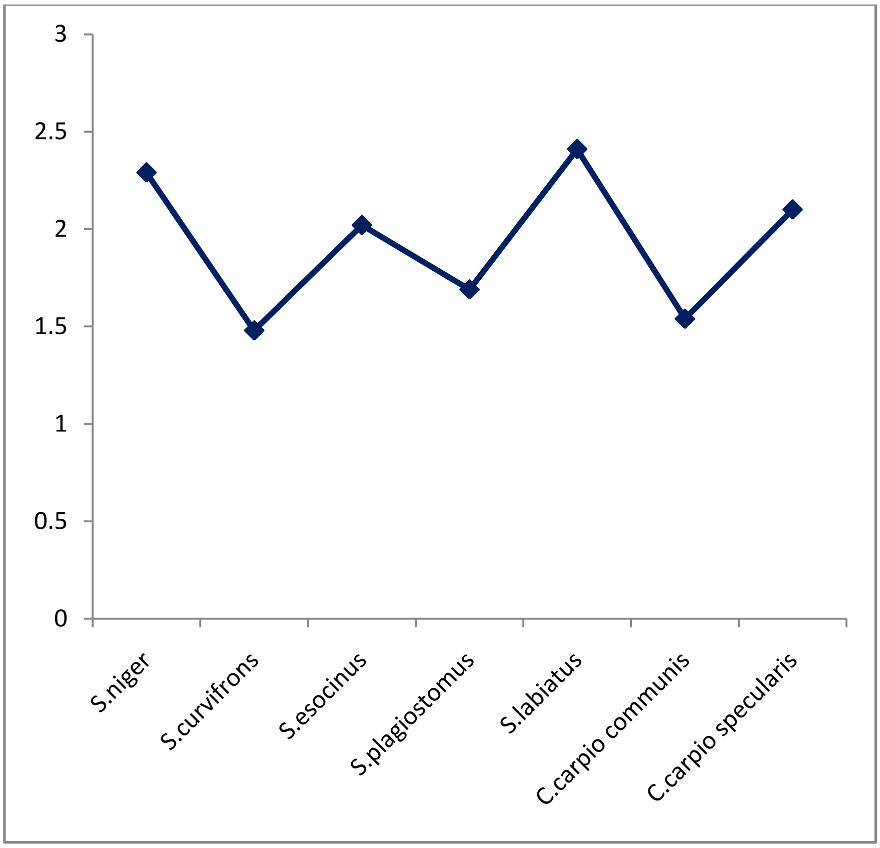


Fig.17. Variation of nitrogen free extract (%) in different fish species

CHAPTER - 6

Summary and Conclusion

Summary and conclusion

The dissertation incorporates results of the study on the whole body biochemical composition of some selected freshwater fish species of Kashmir valley. It also present data on distributional patterns of biochemical composition of these fish species and attempts to establish baseline information about moisture, protein, fat, ash and Nitrogen free extract (NFE). The seven different fish species belonging to freshwaters of valley have been analysed for their moisture, protein, fat, ash and NFE contents. The standard methods were used for the determination of above parameters. Briefly for moisture analysis the samples were dried at 105 ^{0}C for about 24 hours, for protein using micro-Kjeldahl method, Soxtec extraction technique for fat analysis and ash analysis was done by oven incineration in muffle furnace at 650 ^{0}C. The moisture content were found in the range of 71-79%, protein content was found in the range of 14-17.50%, fat content 1.88-7.42%, ash 1.80-2.60% and NFE 1.48-2.41%, respectively. In addition to the whole body composition of seven fish species, the individual distributional patterns of major constituents of the fish species has been analyzed and the results related to the major constituents like moisture, protein, fat and ash contents of each fish on region wise distribution such as dorsal and ventral region were reported in the present study. Overall the highest whole body protein content was found in *S. plagiostomus* 17.51% followed by *S. labiatus* 17.22%, where as the lowest protein content 14.10% was recorded in *S. curvifrons,* while intermediate protein values have been reported in other fish species. The lowest moisture content was reported in *S. niger* 71.58% and the highest was reported in *S. curvifrons.* The inverse relationship in body fat and moisture contents was obtained in some fish species where the fish showed significantly (P<0.05) highest fat content and significantly (P<0.05) lowest moisture content and vice versa. The fat content of the whole body of the fish *S. niger* was reported highest 7.42%, while lowest fat content 1.88% was reported in *S. labiatus.* The ash also produced significant difference amon each other. In *S. esocinus* significantly (P<0.05) highest ash content 2.60% was noted. While the rest of the fish group represent the ash values within the range of 1.86-2.28%. The overall NFE was found to be significantly (P<0.05) different among fish species with the highest value of NFE was reported in *S. labiatus* 2.41% and lowest in *S. curviforns* 1.48%. The data obtain the present study would be useful for further research and also provides valuable baseline information for conducting micro level biochemical analysis of these fish species.

The information obtained on moisture, proteins, fats and ash (minerals) contents and how they vary from species to species are important for the fish used as food by consumers. It also facilitates the selection of most appropriate species having higher protein contents for human consumption.

The work based on nutritional status of fishes of Kashmir valley have been carried out in different patterns i.e. dorso-ventrally and whole body composition in seven fish species to elucidate the biochemical assessment for the benefit of the people of the valley. The results from the current study indicated that body composition varied among the various fish species in fresh waters of Kashmir valley.

The fish is becoming a main food of the world and the Kashmir valley due to its excellent nutritional potential including protein, amino acids, vitamins and minerals, besides fish oil as health food and therapeutic substance. The need for analyzing fish is becoming increasingly important, because proximate analysis is used as an indicator of nutritional value of food material (fishes). It can be concluded that the whole body composition of the selected fishes in the present study is falling well within nutritional ranged required by human beings. It was found that the seven different food fishes species of Kashmir valley contain good amount of nutrients particularly protein to cope up the nutritional requirements of peoples. All the fish species were found to have in good nutritional condition to facilitate for the body health and functions. The results obtained from present study would be useful:

1. To assess the nutritional status of different aspects of the edible portion of important food fish species.
2. To provide reliable information about the nutrient content of different fish species to those exports who are concerned with fish and fishery related products.
3. The data on the biochemical composition of local fishes will be essential for nutritionists for the purpose of formulating feed of animals.
4. This study provides valuable information about biochemical composition of local food fishes to distinguish their nutritional value and make a choice based on that information from consumer point of view.
5. To establish baseline information about the major nutrient contents of these fishes, which would be useful for the further micro analysis of these fish species.

It is recommended that the fishes have to continue to provide valuable protein food in terms of amino acids in appreciable quantities, therefore, some form of intensification of micro analysis will have to occur, with a focus on promising fish species of Kashmir valley. These measures can also only be effective if a holistic approach to fishes of Kashmir for biochemical analysis is adopted.

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