

Seasonal variations in proximate composition of freshwater catfish *Mystus* species (Family: Bagaridae) from two different habitats.

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Abstract: The proximate biochemical composition of a species helps to assess its nutritional and edible value in terms of energy units compared to other species. A variation of the biochemical composition of fish flesh may also occur within the same species depending upon the fishing ground, fishing season, age and sex of the individual. In the present study the major biomolecules i.e., protein and lipids, ash, moisture content in the muscle tissue are studied with respect to different seasons in three *Mystus* species, *Mystus vittatus*, *Mystus gulio* and *Mystus cavasius*. The results of the present study suggest that the proximate composition of fish species greatly varies during different seasons. This might be due to physiological reasons and changes in environmental conditions.

Keywords: *Mystus vittatus*, *Mystus gulio*, *Mystus cavasius* Proximate composition, Seasonal variations.

INTRODUCTION

Biochemistry is the science concerned with various molecules and their chemical reactions that occur in living cells and organisms. In general, the biochemical composition of the whole body indicates the fish quality. Therefore, the proximate biochemical composition of a species helps to assess its nutritional and edible value in terms of energy units compared to other species. A variation of the biochemical composition of fish flesh may also occur within the same species depending upon the fishing ground, fishing season, age and sex of the individual and reproductive status. The spawning cycle and food supply are the main factors responsible for this variation Love (1980).

Analysis of biochemical composition including protein, fat and ash is very important to evaluate food value. Biochemical composition of fish varies from species to species and within the same species from one individual to another Stansby(1962b). Biochemical analysis is an index of nutritive value only because the

fractions it isolates are correlated with some of the properties people have no idea about the nutrient content of fish. Hence the present study was undertaken to investigate into the biochemical composition of some freshwater fishes namely *Mystus vittatus*, *Mystus gulio* and *Mystus cavasius*.

In the present study the major biomolecules i.e., protein and lipids, ash, moisture content in the muscle tissue are studied with respect to different seasons in three *Mystus* species, like pre-monsoon (includes March, April, May, June) Monsoon (includes July, August, September, October) post-monsoon (includes November, December, January and February). Biochemical aspects of the comparative levels of major biopolymers are investigated seasonal wise. These biochemical laboratory tests assist and encourage the use of biochemical investigations in relation to diseases, which reveals the cause and suggest rational and effective treatment. It also helps to make available screening tests for early diagnosis assist in monitoring progress and also helps in assessing response to therapy.

MATERIAL AND METHODS

Freshwater fishes of three *Mystus* species namely *Mystus vittatus*, *Mystus gulio*, *Mystus cavasius* were collected from two different stations Megadhrigedda Reservoir (Visakhapatnam) and Nagavali River (Srikakulam) and brought to the laboratory every month for one year from April 2011 to March 2012.

After collection of sample weight and length of the fish were measured. To prepare the sample for determination of proximate composition the fishes were washed thoroughly and transferred into plastic buckets, containing ice. They were thoroughly cleaned with the tap water by keeping the fish in slanting position in a tray and the excess water was removed with blotting paper.

The non-edible portions (Offal, bones and scales) were removed immediately to avoid decomposition. The edible protein (Muscle) was blended and aliquots weighed out for the various analyses. The muscle was kept in hot air oven at $95^{\circ} - 100^{\circ}\text{C}$ for about 24 hours to dry the material to the constant dry weight. The dry muscle was grained in to a fine powder in a porcelain mortar. The samples thus obtained were used for the determination of proximate composition (Moisture, Protein, Fat and Ash). Moisture, Fat

and Ash content were determined according to the AOAC (1970) and Protein by the method of Micro Kjeldahl by Gilchrist (1967).

RESULT

MOISTURE:

In Table no 1 shows the moisture content and moisture form the major component in the biochemical composition. With an annual mean and standard deviation values of moisture content throughout the year from two different places at Visakhapatnam and Srikakulam were 79.86 ± 1.14 , $79.58 \pm 1.13\%$ in *Mystus vittatus*, 78.61 ± 1.15 , $78.73 \pm 1.26\%$ in *Mystus gulio* and 79.67 ± 1.24 , $79.56 \pm 1.29\%$ in *Mystus cavasius* throughout the investigation period. There was a fall in moisture values from April -2011 to till June- 2011 to reach the lowest values 77.68 ± 1.14 , $77.52 \pm 1.13\%$ *Mystus vittatus*, 76.35 ± 1.15 , $76.12 \pm 1.26\%$ in *Mystus gulio* and 77.28 ± 1.24 , $76.32 \pm 1.29\%$ were noticed in *Mystus cavasius*. i.e pre-monsoon season. The moisture content increased until August-2011 reaches the highest values 81.84 ± 1.14 , $81.64 \pm 1.13\%$ in *Mystus vittatus*, 80.12 ± 1.15 , $80.34 \pm 1.26\%$ in *Mystus gulio* and 81.32 ± 1.24 , $81.23 \pm 1.29\%$ in *Mystus cavasius*. i.e in monsoon season followed by gradual decline until Jan-2012 and increase till March-2012. A positive correlation with significant variations were observed in moisture content of three *Mystus* species. The r and p values of *M. vittatus* ($r = 0.13$, $p = 0.074$), *M. gulio* ($r = 0.23$, $p = 0.026$) and in *M. cavasius* ($r = 0.59$, $p = 0.07$).

ASH:

In present study, ash in *Mystus vittatus* varies between 6.12% and 4.93%, *Mystus gulio* it varies between 5.94% and 4.86% and in *Mystus cavasius* it varies between 6.8% and 4.88% around different places, we observed in the Table no 2. The mean values with standard deviations in *Mystus vittatus* at two different places as 5.41 ± 0.29 in Visakhapatnam, $5.51 \pm 0.31\%$ in Srikakulam. Whereas in *Mystus gulio* $5.43 \pm 0.29\%$ in Visakhapatnam and $5.48 \pm 0.31\%$ in Srikakulam and *Mystus cavasius* $5.49 \pm 0.29\%$ in Visakhapatnam and $5.56 \pm 0.28\%$ in Srikakulam. Monthly variations of ash content in three species shown that increase from April-2011 to reach the maximum values in May-2011 as $6.03 \pm 0.29\%$; $6.12 \pm 0.31\%$ in *Mystus vittatus*, 5.92 ± 0.29 ; $5.94 \pm 0.31\%$ in *Mystus gulio* and 6.08 ± 0.29 ; $6.04 \pm 0.28\%$ in *Mystus cavasius*. Thereafter there was

a decline in ash values until August-2011 to reach lowest values were recorded as 4.93 ± 0.29 ; $4.98\pm 0.31\%$ in *Mystus vittatus*, 4.86 ± 0.29 ; $4.88\pm 0.31\%$ in *Mystus gulio* and 4.88 ± 0.29 ; $4.92\pm 0.28\%$ in *Mystus cavasius*. The abrupt increase was observed from October-2011 to January-2012 followed by a sudden fall till March-2012. In three species a positive correlation is observed. The r and p values of *M. vittatus* ($r=0.370$, $p=0.047$), *M. gulio* ($r=0.34$, $p=0.036$) and $r=0.29$, $p=0.028$ in *M. cavasius* with significant variations.

PROTEIN:

The protein content of three species of *Mystus* namely *Mystus vittatus*, *Mystus gulio*, and *Mystus cavasius* shown in Table no 3 and protein contents of *Mystus vittatus* from two different places varies between 20.53% - 14.26% in *Mystus gulio* varies between 18.95%- 14.16% and in *Mystus cavasius* varies between 17.82%-13.69%. The mean values with standard deviations of protein from two different places Visakhapatnam, Srikakulam are $17.88\pm 1.59\%$; $17.89\pm 1.49\%$ in *Mystus vittatus*, $17.06\pm 1.33\%$; $16.75\pm 1.33\%$ in *Mystus gulio* and $15.91\pm 1.12\%$; $15.47\pm 1.07\%$ in *Mystus cavasius*. There was a sudden decrease from April-2011 to May-2011 and sharp increase and reaches the maximum protein content in *Mystus* species from two different places $20.53\pm 1.59\%$; $20.48\pm 1.49\%$, in *Mystus vittatus*, $18.95\pm 1.33\%$; $18.82\pm 1.33\%$ in *Mystus gulio* and $17.82\pm 1.12\%$; $17.68\pm 1.07\%$ in *Mystus cavasius* from last month of pre-monsoon i.e. in June. There was a gradual decrease till August-2011 and the minimum values of protein are $14.26\pm 1.59\%$; $14.32\pm 1.49\%$ in *Mystus vittatus*, $14.60\pm 1.33\%$; $14.18\pm 1.33\%$ in *Mystus gulio* and $13.78\pm 1.12\%$; $13.69\pm 1.07\%$ in *Mystus cavasius* i.e. in monsoon. There was a gradual increase till January, it shows the second highest values followed by a slight decrease till March. Among the three *Mystus* species we observed maximum protein value in *Mystus vittatus* and minimum in *Mystus cavasius*. The seasonal variation in protein of *M. vittatus* between seasons is significant ($r=0.22$, $p=0.046$) as well as in *M. gulio* ($r=0.17$, $p=0.046$) and *M. cavasius* ($r=0.27$, $p=0.13$) is significant with positive correlation.

FAT:

The percentage composition of *Mystus* species has been determined and similar patterns of fluctuation to that of protein in three species *Mystus vittatus*, *Mystus gulio*, *Mystus cavasius* were observed in Table no 4. The overall mean and standard deviation values of fat content throughout the year from two different places of Visakhapatnam and Srikakulam were 5.43 ± 0.38 ; 5.44 ± 0.45 in *Mystus vittatus*,

5.85±0.45; 5.84±0.45 in *Mystusgوليو* and 5.18±0.54; 5.17±0.55 in *Mystuscavasius*. The result revealed that fat content increased in *Mystus* species in two places (6.16±0.38; 6.18±0.45% in *Mystusvittatus*, 6.82±0.45; 6.78±0.45% in *Mystusgوليو* and 5.98±0.54; 5.92±0.55% in *Mystuscavasius*) during post-monsoon season in January and reach to a minimum (4.82±0.38; 4.81±0.45% in *vittatus*, 5.22±0.45; 5.13±0.45 in *Mystusgوليو* and 4.34±0.54; 4.21±0.55% in *Mystuscavasius*) in monsoon season in September. Among three *Mystus* species maximum fat values observed in *Mystusgوليو* and minimum fat values are observed in *Mystuscavasius*. The seasonal variations in fat content of *M. vittatus* between seasons is significant ($r=0.0247$, $p=0.065$) and in *M. gوليو* ($r=0.47$, $p=0.06$) and *M. cavasius* ($r=0.24$, $p=0.003$) also significant with positive correlation.

DISCUSSION

MOISTURE:

Seasonal variations in the moisture content of the body muscles of *Mystus* species which showed the highest values of moisture were obtained in August i.e at spawning time. At spawning time, the fillets contained more moisture than any other time of the year. The moisture content was found to be low in *Mystusgوليو* and high in *Mystusvittatus*. The findings are more or less similar to other related fishes as well as other vertebrates due to maturation of gonads. The low values of moisture during certain seasons have been observed in several other fishes by various authors and attributed to the maturation of gonads. The moisture content was lower in post-monsoon season (Nov-Jan) which coincided with the increase in water salinity and higher in onset of monsoon (Jun-Aug). The same results are also found in Gobi fish.

The moisture is inversely related to lipid content in the present study. The inverse relationship has also been reported in freshwater fishes. *Mystusseenghala* Jafri (1968) and *Ophiocephalus punctatus* Jafri and Khawaja (1968) and marine fishes such as *Mugilcephalus* Das (1978); Sarda Sarda Zaboutkas et al., (2006); Ramaiyan et al., (1976) reported that generally when all content is higher the moisture content is low in *septipinnataty*, whereas, Shekhar et al., (2004) reported that moisture content did not significantly differ according to season in *Labeorohita* and was low when other constituents (fat and protein) were high. The

moisture content was high during the monsoon and part of post- monsoon when the fat content was low.

That can be ascribed to similar rapid fall in lipid content during spawning season.

It has been reported by Das (1978) that high values of moisture content in *Mugilcephalus* could be due to the decline in food intake during the monsoon months when the water would be highly turbid and heavily silt loaded. Similarly, in the present study high moisture was reported during the monsoon season. The result of the present study revealed that changes in moisture content in the muscles of *Mystus* species could be attributed to changes in lipid level directly and to spawning and feeding intensity indirectly.

The three *Mystus* species had a high moisture content in the range of (76.12%-81.84%). High moisture contents have been similarly reported in other fresh water species Abdullahi (1999 and 2001) Effiong and Tafa (2005) Effiong and Mohammed (2008). Differentiation in moisture and lipid content between dorsal and ventral portions of three farmed fish species has also been reported by Silvia et al., (2006). Nuray and Ozkan (2007) reported significant differences between moisture and ash contents in *Dicentrarchus labrax* and *Sparus aurata* respectively. There were no significant differences in the proximate composition of nutrients in both species. Kriton (2007) reported higher muscle moisture content in sea bream (*sparus aurata*) Mediterranean fish species. Fish flakes had a moisture content ranging from 24.94% to 26.34% results reported by Hui (2001).

However, El-Sayed (1979) explained the rising of moisture in fish muscles during the spawning period to be from endocrine source. Gonadotrophic hormones increase pre-spawning, therefore, it can be expected that the consequent increase in water content may be brought about during this period.

ASH:

Only gross measurements are made of ash. Ash concentrations increased marginally at maturity and markedly after spawning. At measurement the ash was light blue in colour

The ash content of *Mystus* species in this study is similar to that reported *Lucifer* species (11.9% of dry weight) by Omori (1969). Chitin content is also well within the range reported for planktonic decapods (3-6% dry weight) by Raymond et al., (1969) and for the genus *Aceies* (4% of dry weight) by Nair et al., (1975). Lower values of ash are observed in dry and wet samples of *Citharinus citharus*, *Clarias anguillaris*

and *Hemisynodontismembranaceus* were generally low(0.40%-1.35%) by Effiong and Mohammed (2008), Mumba and Jose (2005) and Abdullahi (2001), Ash content ranged between 1.86% and 2.25% in *A.boyeri*, *A.lagunae* and *A.therina* by Bouriga et al., (2010). Manzano et al., (2000) reported low ash in Black skipjack muscle in ice. The effect of natural antioxidant (*Thymus vulgaris*,*Linnaeus*) on flesh quality of tuna (*thunnusthynnus*,*Linnaeus*) during chilled storage was reported by Selmi and Sadok (2008). The fluctuation of ash content made difficult to show any relationship with the spawning season. In general, body composition of flesh seems to depend age, sex, season and diet.

Higher values of ash are observed in and by LaurenciajohnstoniiSetchell Gardner (38.3%), *Ulvasps.* (13-46%), *Hydroclaphrusclaphratus* (Bory) Howe (63.7%) and *Sargassumsinicola* (38.3%) Carrillo-Dominguez et al., (2002), *Macrocystispyrifera* (31-41%) Hernandez Carmona et al., (2000), *Eiseniaarborea* (19-29%) Hernandez Carmona et al., (2009). The high ash content is probably more related to the size of fish and the presence of bones in the samples.

PROTEIN:

In the present study protein content of three species of *Mystus* varied significantly over the year. The protein content was found to be high in *Mystusvittatus*. The highest percentage of protein in the muscle was noted in immature or maturing fishes. The protein cycle shows a strong correlation with spawning. Protein values remained fairly high as the fish advances towards peak maturity and the highest values were recorded when the fish is ripe. As we observed that these fish breed during June – July. The maximum values were observed during these months. A decrease in protein content in August the time during which spent once were observed indicates their spawning season. The variation occurred may be due to habitat, season, sex and or water quality.

The protein of some species found in the study was more or less similar to the result of Hossain et al., (1999), Kcukgulmez et al., (2010) and Kamal et al., (2007). It therefore, seems that the advancement in maturation is accompanied with a greater deposition of protein in the muscle. In fishes the lowest protein was recorded in spent or recovering fishes and highest during peak ripeness. This may because of a greater deposition of nucleoproteins in fish Jafri and Khawaja (1968).

Many other fishes have been found to store an excess protein in their ovaries during maturation Green (1921), Bruce (1924), Idler and Bitners (1960). The maximum values observed during early pre-monsoon months coincided with a period of intestine feeding on such organisms as fish which are rich in protein. A fall of protein value may likewise be attributed to a fall in that rate of feeding and the scarcity of fish in the gut. Variations in the protein with the consumption of protein- rich food have also been observed by Mc Cay and Tunsion (1936), in trout and by Jafri and Khawaja (1968).

An increase in the constituents during the post spawning months might be due to the recovery of the fish from the strenuous act of spawning. These observations agree with the findings of Bano (1977) in *Clariosbatrachus*. They also reported that the rise or fall of the biochemical constituents in different seasons appeared to coincide with high flow feeding activity of the fish. Shakoori et al., (1994) studied the effect of seasonal variation of the protein patterns of freshwater fish *Cirrhnamrigala*.

Al-Habbi et al., (1986) observed two peaks of protein cycles in *Barbusbarbulus*, one during June and second one during December which coincide with the present work. Protein levels coincide with slight increase occurring during the post-monsoon and a decline in March reaches a minimum value in April in the muscle of *Bib Trinsopterusluscus* Meryo (1996). In contrast to other investigations Eliassen and Vahl (1982) observed during Dec-Feb a maximum protein content and during Mar-Apr a minimum protein content in the muscle of *Gradusmorhua*.

Bano (1977) reported that low values recorded for a protein fraction during the spawning period, presumably indicates mobilization of these constituents towards gonad development. Dhawan et al (1989) stated that an increased trend of protein content was recorded by pre-spawning phase (particularly in flesh) they declined and minimum values were recorded during post spawning phase. But not much difference was recorded in protein content of the gonads during pre-spawning Jain et al., (1982) stated that the maximum and minimum protein content was recorded during pre-monsoon and monsoon respectively which coincide with present investigation.

Ravisankar and Aravind Kumar (1989) observed that protein values were high during pre-spawning period. The maximum protein values during pre-monsoon months (May, June and July) can attribute to the

fact that food material is very abundant in the monsoon and early pre-monsoon months and as such fish have a chance to feed more on the available portentous food. Maximum protein values recorded during the past-monsoon and pre-monsoon coincided with a period of intense feeding perhaps with more in the past-monsoon i.e. immediately after spawning as the fish while spawning increase energy expenditure along with loss of gradual elements and recovers to compensate the expenditure through various feeding activities. A fall of protein percentage may be attributed to a fall in the rate of feeding because of scarcity of food material due to turbidity and other ecological factors during those months.

Medford and Mackay (1978) that muscle protein of northern pike, *Esox Lucius* is high before spawning and low after spawning. This could be attributed that these constituents might have been utilized for spawning and gonadal development. Jafri (1968) also noticed such relationship in *Mystusseenghala*.

However, the isonitrogenous diets (approximately 40% protein level) in the present study were initially formulated according to the recommended protein requirement carnivorous species in Thailand, Van Weerd (1995) and Geoff et al., (2000). In addition a dietary protein level of 40% has been claimed to be optimal for satisfactory growth of tropical carnivorous species raised in “clear water” systems such as snakehead *Channa striata* fingerlings (12g individual size) Samantarayand Mohanty (1997), African catfish *Clarios macrocephalus* fingerlings Evangelista et al., (2005). However, protein requirements within the same species can vary with culture environment, fish size, dietary amino acids and protein-energy profiles Jauncey (1982) and Wilson (2002).

It has been reported that the protein content of fish meat varies across seasons, and that it is inversely proportional to the water content Hall and Ahmad (1997). Similarly, Haard (1990) stated that the decline in the protein content is related to the elevation in the muscle water content. In accordance with this finding, the water content of round herring was its lowest in the past-monsoon, the time when the protein content was at its highest.

Abdullahi (2001) reported that the protein content in fish might vary with the species due to certain factors such as the season of the year, effect of spawning and migration, food available etc. Furthermore, it

was reported that fish protein content changes very little with season Njinkoue et al., (2002) and Tzikas et al., (2007). The highest value of protein is observed by Hui (2001)

FAT:

Fat has a special importance to the animal body, which are primarily a source of energy in the diet. Fat also pad to keep different body organs in place. Moreover fats give the diet its particular flavor. The differences in season depending on the availability of food at different times of the year have a considerable effect on the tissue components particularly the fat. Changes in the reproductive cycle also have a marked effect on the body composition. Like other animals fish store fat to supply energy needed during food scarcity and reproductive phases. Reduction of the fat content during the spawning season has been recorded.

As for the as the nutritive value of the fish is concerned, as given in table that body muscle contains more fat before its spawning season. During mature stage the muscles contain less fat. Thus it is observed that fat content of muscle is less in the months (July-September) during spawning. The highest content of fat was during the post-monsoon season period (October- January). Almost all living beings shows low metabolic rate during this period due to low temperature hence the accumulation of energy mostly in the form of fats, also seems to coincide with the development and maturation of gonads resulting in high rates of feeding during this period. In these months the main constituent of the diet was fish Quayyum and Qasim (1964).

According to Ackman (1989),Cowey (1993) and Srivastava (1999) generally fish can be grouped in four categories according to their fat content ; Lean (<2%), low fat (2-4%), medium fat (4-8%) and high fat (>8%), in our study we observed that the three *Mystus* species are medium fat fishes. Additionally Huss (1995) categories fish has lean or fatty species depending on how they store fat for energy lean fish use the liver as their energy depot, while fatty species store fat in fat cells throughout the body. Moreover, the fat contents fillets from lean fish are low and stable whereas the fat contents in fillets of fatty species vary considerable and the accumulated amount is generally influenced by level of dietary fat that the fish consume Jorge et al ., (1993).

The greatest concentrations of fat may be found at the end of prolific feeding in pre-monsoon and the least in post-monsoon Love (1980). A rise in the content of mackerel muscles before spawning followed by a fall after spawning was observed by Chidambaram et al., (1952). Shreni (1981) observed maximum fat in June and lowest in December in *Heteropneustes fossilis* which is opposite to my case of study. Piska et al., (1989) showed that the muscle of *Samostromabacaila* contains high fat values during pre-spawning and low at the time of spawning. Jeong et al., (1998) observed the seasonal variation in lipid class composition of Korean fish.

The highly unsaturated nature of the fish fat is quickly in the process of oxidation, causing early onset of rancidity. Fat show considerable fluctuation during different seasons. Growth, maturity, stage of spawning and feeding habits are also have a pronounced effect on this muscle constituent. The mode of storage at fat in exterior and interior parts reduces the 'drag' during swimming.

In addition, fish fat is one of the very few natural food source vitamin D and contains important amounts of vitamins A and E (α -tocopherol) Bhuiyan et al., (1993) and Qyvind et al., (1994). Fats are high energy nutrient that can be utilized to partially spin (substitute for) protein in aquaculture feeds. Fats typically comprise about 15% of fish diet and serve as transporters for fat-soluble vitamins.

Red muscle is primarily for low-speed swimming and utilizes aerobic metabolism of fat as an energy source. While muscle is used for short burst or high – speed swimming and draws energy mainly for anaerobic metabolism of glycogen Bilinski (1974). In fish, there is a possibility that muscle fat reserves can be utilized directly, without participation of the blood stream Cowey and Sargent (1979). Fat release from storage depots is inhibited by increasing dietary energy intake.

Guner et al., (1998) reported that fat content of *shad* is 15.19% which is higher than what was found in my study. Fat content in fish varies according to season, species and geographical variations. Age variation and maturity in the same species may also contribute to the significant differences in the total lipid Piggot and Tucker (1990).

Rueda et al., (2001) reported that fat content of muscle, mesenteric and liver reared sharp snout sea bream *Diplodus puntazzo* were higher than of wild one. In general fish that are fed commercial diets do exhibit a greater body fat content than wild specimens Shearer (1994).

Bhuyan et al., (2003) and Shamsan and Ansari (2010) reported coincidence of intensive feeding with occurrence of high fat content in the muscle of fish. Balaswamy et al., (2007) and Prabhakararao et al., (2010) also reported fat content in *Rohu (labeorohita)* and *Murrel (channa striatus)*. Environmental factors are well known to affect the proximate analysis and conditions of white sea bream and other fish, especially the fat content George and Bhopal (1995) and Iverson et al., (2002). Love (1957) indicated that the availability of food at different time of the year has a considerable effect on the tissue component, particular fat.

Reduction of the fat content during the spawning season has been recorded for a mirror – carp and three spined stickleback reported by Habashy (1972).

SUMMARY

In the present study proximate composition and seasonal variations of protein, fat, moisture and ash in the muscle of three *Mystus* species *Mystus vittatus*, *M. gulio*, *M. cavasius* were estimated. Proteins were used for body building during different phases of maturation. Fat has been used for energy. *Mystus* species are an excellent source of proteins and a moderate amount of fat.

The results of the present study suggest that the proximate composition of fish species greatly varies during different seasons. This might be due to physiological reasons and changes in environmental conditions, i.e., spawning, migration and starvation or heavy feeding. Species – specific physiological characteristics might greatly affect the proximate composition. Sampling procedures also played important role in the differences of the findings. One of the possible factors was the representativeness of the samples. The different approach of sampling procedures which include the method of sample collection, different sample collection sites and differences in the inclusion criteria of samples with other previous studies, explained the slight differences in the proximate composition values.

The information on the proximate composition and seasonal variation of *Mystus* species was very limited. This study provides valuable information on variations in proximate composition of fish species studied in order to take necessary precautions in processing from a manufacturing point of view and to distinguish their nutritional value and make a choice based on that information from a consumer point of view.



Table No.1 - % of Moisture in <i>Mystusvittatus</i>, <i>Mystusgulio</i> and <i>Mystuscavasius</i> collected from different transects						
MONTH	<i>Mystusvittatus</i>		<i>Mystusgulio</i>		<i>Mystuscavasius</i>	
	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM
Apr-11	79.48	78.93	77.25	78.02	78.94	79.16
May-11	78.54	78.02	77.54	77.34	78.34	78.28
Jun-11	77.68	77.52	76.35	76.12	77.28	76.32
Jul-11	80.09	80.34	78.34	79.02	80.54	80.34
Aug-11	81.84	81.64	80.12	80.34	81.32	81.23
Sep-11	80.74	80.38	79.84	79.54	80.54	80.52
Oct-11	80.24	80.52	79.14	79.02	80.72	80.32
Nov-11	79.95	79.88	78.98	78.64	79.34	79.85
Dec-11	79.21	79.32	78.75	78.52	79.26	79.38
Jan-12	79.02	79.12	78.02	78.18	78.53	79.23
Feb-12	80.58	79.28	79.03	79.24	80.54	79.56
Mar-12	80.92	80.02	79.89	80.75	80.74	80.54
Mean	79.86	79.58	78.61	78.73	79.67	79.56
± SDV	1.14	1.13	1.15	1.26	1.24	1.29

Table No.2 - % of Ash in *Mystusvittatus*, *Mystusgulio* and *Mystuscavasius* collected from different transects

MONTH	<i>Mystusvittatus</i>		<i>Mystusgulio</i>		<i>Mystuscavasius</i>	
	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM
Apr-11	5.63	5.86	5.68	5.79	5.83	5.91
May-11	6.03	6.12	5.92	5.94	6.08	6.04
Jun-11	5.65	5.71	5.56	5.73	5.62	5.78
Jul-11	5.28	5.56	5.72	5.68	5.35	5.61
Aug-11	4.93	4.98	4.86	4.88	4.88	4.92
Sep-11	5.12	5.22	5.09	5.02	5.32	5.38
Oct-11	5.23	5.35	5.19	5.36	5.39	5.42
Nov-11	5.38	5.49	5.27	5.39	5.41	5.46
Dec-11	5.48	5.58	5.46	5.42	5.56	5.54
Jan-12	5.52	5.62	5.61	5.59	5.62	5.63
Feb-12	5.32	5.31	5.32	5.41	5.42	5.46
Mar-12	5.28	5.36	5.46	5.58	5.46	5.52
Mean	5.41	5.51	5.43	5.48	5.49	5.56
± SDV	0.29	0.31	0.29	0.31	0.29	0.28

Table No.3 - % of protein in *Mystusvittatus*, *Mystusgulio* and *Mystuscavasius* collected from different transects

MONTH	<i>Mystusvittatus</i>		<i>Mystusgulio</i>		<i>Mystuscavasius</i>	
	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM
Apr-11	19.12	19.06	18.21	18.18	17.15	16.06
May-11	16.58	17.21	16.68	16.52	15.89	14.88
Jun-11	20.53	20.48	18.95	18.82	17.82	17.68
Jul-11	18.56	18.32	17.27	17.28	16.29	16.14
Aug-11	14.26	14.32	14.16	14.18	13.78	13.69
Sep-11	16.72	16.81	15.79	15.12	14.98	14.52
Oct-11	17.32	17.56	16.18	15.98	15.58	15.62
Nov-11	17.82	17.98	16.63	16.12	15.63	15.73
Dec-11	18.23	17.69	18.32	17.21	15.89	15.82
Jan-12	19.28	19.19	18.43	18.22	17.28	16.22
Feb-12	18.22	18.29	17.16	16.98	15.56	14.98
Mar-12	17.91	17.78	16.92	16.39	14.98	14.26
Mean	17.88	17.89	17.06	16.75	15.91	15.47
± SDV	1.59	1.49	1.33	1.33	1.12	1.07

Table No.4 - % of Fat in *Mystusvittatus*, *Mystusgulio* and *Mystuscavasius* collected from different transects

MONTH	<i>Mystusvittatus</i>		<i>Mystusgulio</i>		<i>Mystuscavasius</i>	
	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM	VISAKHAPATNAM	SRIKAKULAM
Apr-11	5.57	5.48	6.02	6.12	5.65	5.82
May-11	5.64	5.31	5.98	5.89	5.49	5.46
Jun-11	5.39	5.26	5.86	5.79	4.98	4.96
Jul-11	5.26	5.19	5.56	5.53	4.74	4.73
Aug-11	5.12	4.98	5.38	5.42	4.52	4.56
Sep-11	4.82	4.81	5.22	5.13	4.34	4.21
Oct-11	4.98	4.96	5.25	5.32	4.78	4.76
Nov-11	5.49	5.61	5.92	5.93	4.96	4.96
Dec-11	5.68	5.94	6.13	6.21	5.24	5.32
Jan-12	6.16	6.28	6.82	6.78	5.98	5.92
Feb-12	5.87	5.98	6.15	6.12	5.81	5.78
Mar-12	5.18	5.52	5.96	5.92	5.72	5.52
Mean	5.43	5.44	5.85	5.84	5.18	5.17
± SDV	0.38	0.45	0.45	0.45	0.54	0.55

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