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Full Length Research Paper

Sexual maturity linked variations in proximate composition and mineral content of female *scomberomorus commerson* (narrow banded mackerel) in south east coast of India

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Monthly variations in the proximate composition and the mineral content of *Scomberomorus commerson (narrow banded mackerel)* were investigated. The proximate composition and mineral contents significantly varied (P < 0.05) among the months (P < 0.05). Moisture content was high in May (74.84 ± 0.18 %) %), followed by protein in June (20.52 ± 0.27), lipid in December (12.35 ± 0.28%), glycogen in June (1.26 ± 0.01) and ash in March (1.42 ±0.37%). Minerals such as calcium (Ca) was maximum in June (344.59 ± 0.25), followed by phosphorus (P) in April (1878.58 ± 0.12) and iron (Fe) in October (9.83 ± 0.25). Results showed that the proximate composition and mineral content in female *S. commerson* were directly related to the sexual maturity of fish.

Key words: Narrow banded mackerel, proximate composition, mineral content, sexual maturity.

INTRODUCTION

Fish is a major source of protein food and it occupies an important part in human nutrition. It is high digestibility, biological and growth promoting value. Marine and freshwater fish constitute majority of the aquatic ecosystems and these products are an important part of animal source food for human consumption. Fishes are quite different from other animal source food, because they provide low energy and high protein, which contains all essential amino acids and other elements for the maintenance of a healthy body (Arannilewa et al*.,* 2005). Cardiologists recommend the use of generous quantities of fish in food to obtain adequate protein without taking in excessive fatty acids and lipids (Dyerberg, 1986 and Kinsella, 1991) so they are the beneficial nutritional sources of food (Weatherley and Gill, 1998).

The importance of chemical analysis in marine fish, expresses the food value in terms of energy units (Qasim, 1972). Works on chemical composition of different fishes are well documented in Bangladesh (Ahmed, 1977; Khuda et al., 1964; Nabi and Hossain,, 1989; Muslemuddin et al., 1991). The nutritive value of fishes is recognized all over the world, so, the nutritional quality of fish is important since it is used as food for humans. Related studies reveals that the variation on biochemical composition of fish lined to sexual maturity has not received adequate attention.

In general, the biochemical composition of the whole body of fish indicates its quality. Therefore, proximate biochemical composition of a species helps to assess its nutritional and edible value in terms of energy units compared to other species. Variation of biochemical composition of fish fleshy parts may also occur within the same species depending on 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). Knowledge of biochemical composition of *S. commerson*, is of great importance in evaluating its nutritive value but also helps in quality assessment and optimum utilization of this natural resource. This in turn, can help in processing the fish into products and other value added products without wastage or loss of constituents such as free amino acids, proteins and fats. Biochemical

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investigations on fish help to evaluate the impact of environment. The composition of several fish species varies from season to season due to its natural cycle, sexual maturity stage, geographic location, etc. (Aro et al., 2000; Bandarra et al., 2001). Seasonal changes in water, lipids and proteins content of muscle and liver are known to occur in several fish species including gadoids, and these changes have been related to the growth of gonads and other processes associated with sexual maturity (Love, 1970).

However, no information is available on the sexual maturity linked to biochemical composition of *S. commerson*. They are otherwise known as Narrow banded Mackerel, Spanish mackerel and King fish and locally known as "cheela". Spanish mackerel are commercially important fish of India. King fish, *S. commerson* belongs to epipelagic species available throughout the coastal tropical waters of the Indo pacific region (Mc pherson, 1992). This fish comes under the family of *Scombridae* which has 15 genera and 49 species (Collette and Nauen, 1983). This fish is considered the most important commercial pelagic species (Al-Hosni and Siddeek, 1999). Few studies have been done in *S. commerson* in Indian Ocean (Siddeek, 1993) and in Saudi Arabia, Oman and South African coastal waters (Bertignac and Yesaki 1993; Kedidi, 1993; Govender, 1993). Some studies were carried out by Hosseini (2000); Shojaei et al. (2007) and Taghavi et al. (2008) in the coastal waters of Iran.

Although, several studies deal with the proximate composition of many commercially important fishes (Das and Sahu, 2001; Parulekar, 1964; Ramaiyan et al., 1976; Sinha and Pal, 1990), however, no work on similar line has been carried out in *S. commerson* particularly from Tuticorin waters. Therefore, the present study was undertaken to elucidate the dynamics of biochemical composition on the muscle tissue of *S. commerson* with reference to their sexual maturity.

MATERIALS AND METHODS

Sample collection

Samples of female fishes, *S. commerson* were procured in 2013 from January to December from Thirespuram, landing center (Lat 08 48'957'N and Long 078 09 795'E) of Tuticorin located in Tamil Nadu, India. Analysis was done with one fish per month; the fishes had almost the same body weight (BW) and total length (TL) of 3.20 kg and 125 cm respectively. The collected fishes were brought to the laboratory using ice box and it was washed in potable water several times to remove the dirt and debris on the surface. Then it was used for proximate analysis. The proximate compositions of the samples were analyzed in replicates.

Proximate composition analysis

Moisture content was determined by drying the sample in hot air oven at 105°C for 24 h (AOAC, 1975). Crude proteins and lipids of the collected samples were determined by the method of micro-kjeldahl (Rangama, 1979; Bligh and Dyer, 1989). The amount of glycogen (carbohydrate) present in the sample was estimated by phenol-sulphuric acid method (Dubois et al., 1956).

Mineral content analysis

Calcium and iron content were determined quantitatively using an Atomic Absorption Spectrophotometer (AOAC, 1999). Phosphorus was determined with ammonium molybdate and sodium chloride using a spectrophotometer (AOAC, 1999).

Statistical analysis

Data's were analyzed using the Excel XP 2007 software. In doing this, descriptive statistics such as means and standard deviations were computed. Two way analysis of variance (ANOVA) and correlation Co-efficient was used to test the significant difference and correlation in monthly variation of proximate composition.

RESULT

Moisture being the most important constituent contributes maximum to the chemical composition in fish tissues and may show high degree of variations. Percentage changes of water content in female *S. commerson*is are shown in Figure 1. Water forms the major component of the biochemical composition with an annual average value of 73.56 ± 1.42 % throughout the study period. The percentage of water varied from 70.33 ± 0.49 % (December) to 74.84 ± 0.58% (May) and water level was observed to be high during March to July (74.08 ± 1.05 % - 74.36 ± 0.75 %) followed by gradual decline until December (70.33 ± 0.49 %). From January to February, there was a slight increase from 73.42 ± 1.06 % - 73.18 ± 0.34. It was suddenly increased during January – February (73.42 ± 1.06 % - 73.18 ± 0.34). The average protein content was 19.04 ± 0.36% for *S. commerson* and the results are presented in Figure 2. The maximum protein content was observed in June (20.52 ± 1.27%) and minimum in December (16.81 ± 0.43%). Low protein content in this month may suggest that protein may be utilized for metabolic energy.

Seasonal variation of lipid content ranges between 3.07 ± 0.21 % in January and 12.35 ± 0.28 % in December as presented in Figure 2. The average value was about 5.52 % ± 0.96 indicating that this species is a fatty fish. In one district of Tamil Nadu, it is locally known as "Ney meen" which means Ghee fish and the present study also

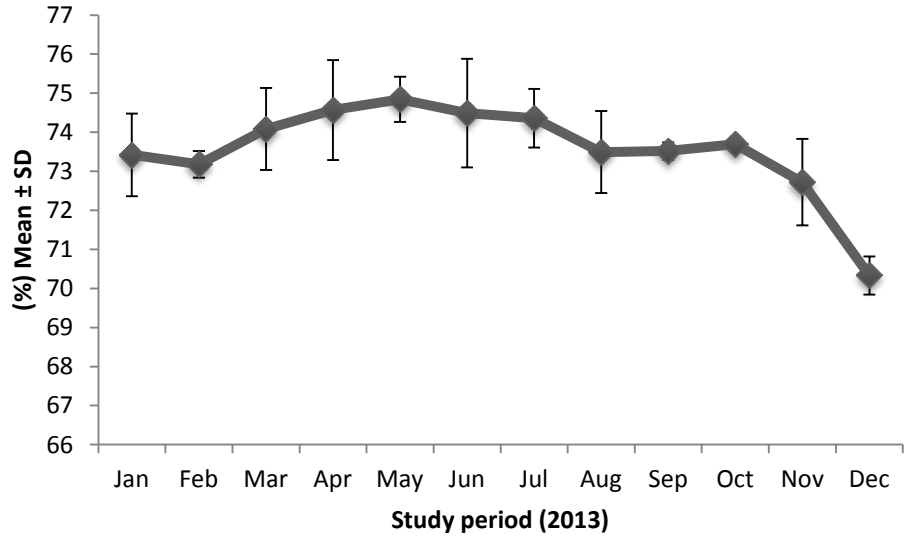

Figure 1. Seasonal variation on moisture content of *S. commerson.*

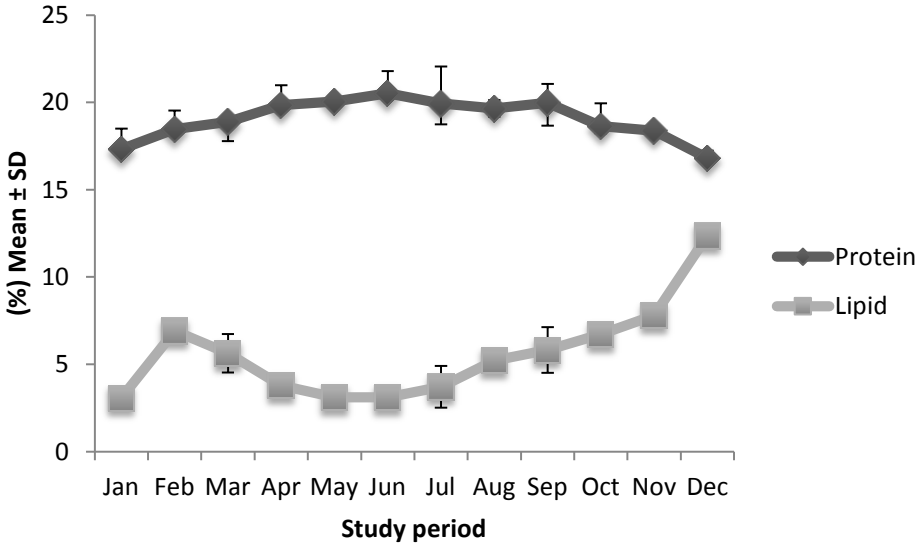

Figure 2. Seasonal variation on protein and lipid content of *S. commerson.*

observed the same indication. The percentage of lipid content showed low values during April - July, followed by a sharp increase in August - December just prior to sexual maturity. Thereafter, gradual decline was observed to reach its lowest value in January, after which the value increased in February (6.92 ± 0.08) and decreased in March (5.63 ± 1.1). Glycogen occurs in a very low quantity in the fish muscle and the results are represented in Figure 3. In the present study, it varies between 0.52 ± 0.35 % (May) and 1.26 ± 0.09 % (June) with an average value of 0.8 ± 0.27%. Monthly variation shows that carbohydrate level were significantly increased between January to April (0.78 ± 033% and 0.85 ± 0.23 %) followed by a sudden fall of 0.52 ± 0.35 % in May. Abrupt increase was observed in June (1.26 ± 0.09 %) to September (0.78 ± 0.31 %) with slight decrease in July (0.69 ± 0.22%). Thereafter, there was a decline in Glycogen value until December (0.64 ± 0.21%).

Ash content was found to vary from 0.941±0.06% (December) to 1.42 ± 0.37 % (March) with an average of 1.25 ± 0.14% (Figure 3). The percentages of calcium in the fishes were shown in Figure 4. They varied from 344.31 ± 3.25 mg/100g (June) to 114.31 ± 2.16 mg/100g (July) with the annual average value of 213.82 ± 1.93 mg/100g. Maximum level obtained in June coincides with the advancement of maturity in fish, indicating the high

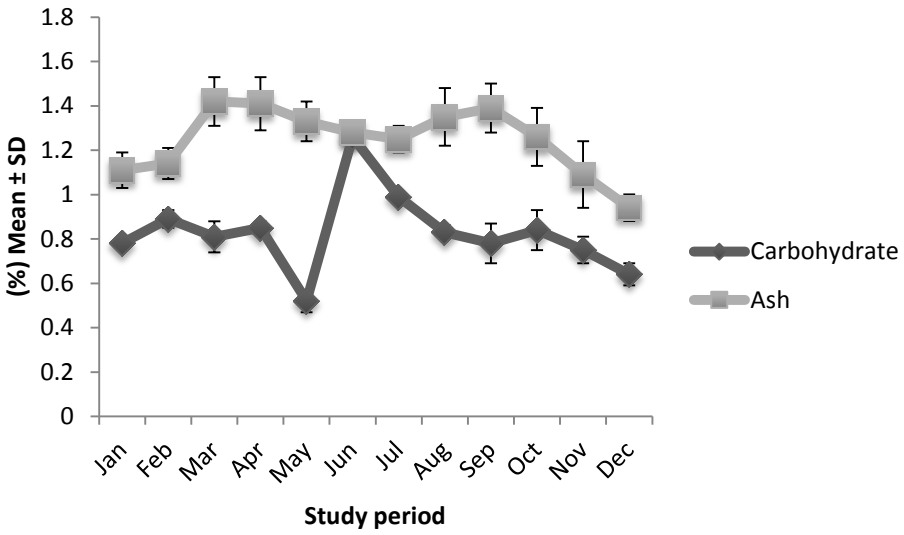

Figure 3. Seasonal variation on carbohydrate and ash content of *S. commerson.*

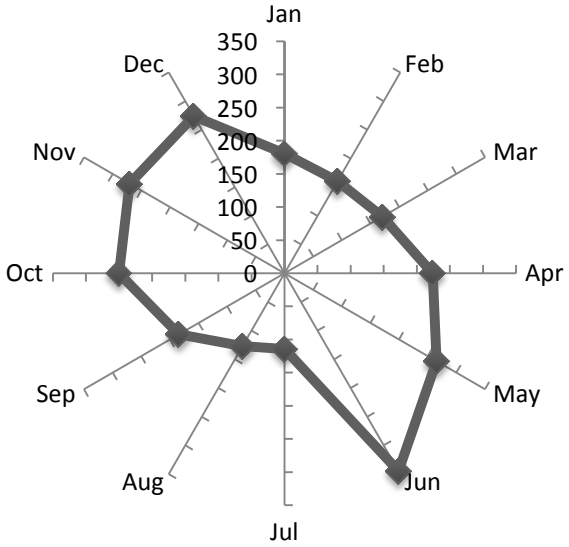

Figure 4. Seasonal variation on calcium content of *S. commerson.*

accumulation of calcium during this period. The seasonal changes in the phosphorus content in the muscle tissue are shown in Figure 5. The maximum level of phosphorus was found to be 1878.58 ± 0.12 mg/100g in April and minimum level was found in August (746.96 ± 0.07 mg/100g). However, the fluctuations in the phosphorus percentage could not be correlated with sexual maturity. The iron content in muscles ranged from 13.36 mg (in January) to 5.2 mg (in April) (Figure 6). Like phosphorus, fluctuations in iron content cannot be correlated with the female sexual maturity of the fish.

Two ways ANOVA results shows a significant ($P < 0.05$) difference between the months, however, there was no significant variation between the proximate compositions and mineral content. The correlation Co - efficient proved to be positive and highly significant, viz., protein and glycogen, lipid and glycogen, moisture and ash. Moisture positively correlated to protein, carbohydrate and ash and negatively correlated to lipid, calcium, phosphorus and iron followed by protein positively correlated to carbohydrate, ash and phosphorus and negatively correlated to lipid, calcium and iron. Lipid positively correlated to calcium and phosphorus and negatively correlated to carbohydrate, ash and iron. Carbohydrate positively correlated to ash, calcium and phosphorus and ash is negatively correlated

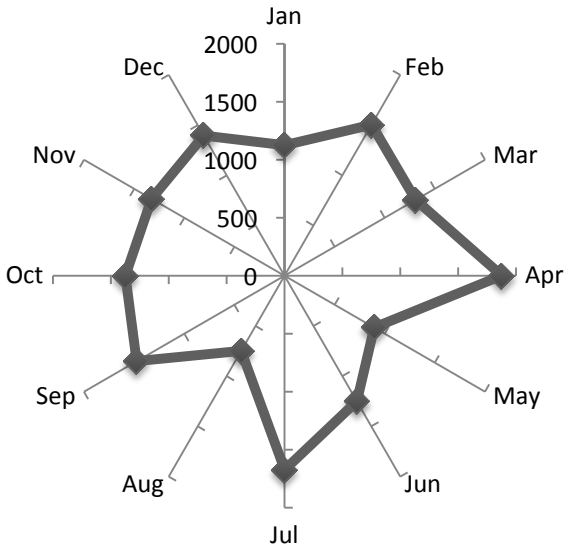

Figure 5. Seasonal variation on phosphorus content of *S. commerson.*

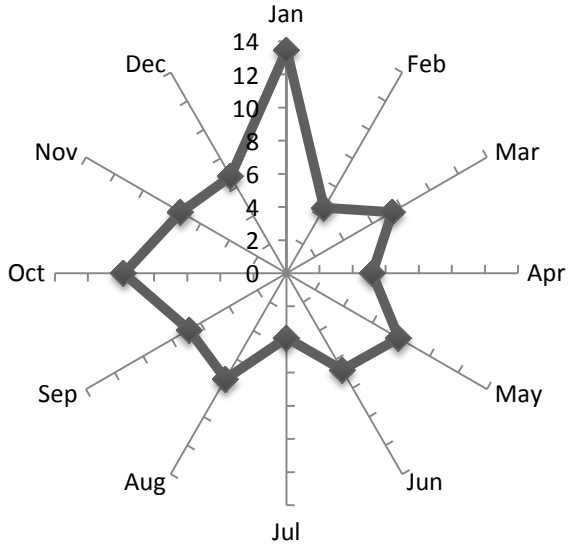

Figure 6. Seasonal variation on iron content of *S. commerson.*

to calcium, phosphorus and iron. Calcium positively correlated to iron.

DISCUSSION

Proximate composition of fish varied not only in relation to species, but in relation to individuals of a same species (Mackie et al*.,* 1971). The proximate composition of Spanish mackerel was determined for a period of one year. The chemical composition of marine organisms comes quite close to that of land animals. The principal constituents of fishes are water (66 – 84 %), proteins (15 – 24 %), lipids (0.1 – 22 %), minerals (0.8 – 2 %) and sugar in very minute quantity (0.3%) (Jacquot, 1961). The highest values of moisture was obtained in May i.e. at sexual maturity time because during these period, muscles contain more moisture than any other time of the year. The findings are more or less similar to other related fishes as well as in other vertebrates due to maturation of gonads (Dembergs., 1964; Suppes et al*.,* 1969; Marais and Erasmus, 1977). The low values of moisture during certain seasons have been observed in several other fishes which attributed to maturation of gonads (Nabi and Hossain, 1989). The moisture content was lower in monsoon and higher in summer. The same

result was also found on Gobi fish (Ahmed et al*.,* 1977) and *Rastrelliger kanagurta* (Nisa and Asadullah, 2011). The moisture was inversely related to lipid content in the present study. The inverse relationship has also been reported in marine fishes such as *Mugil cephalus* (Das, 1978); *Sarda sarda* (Zaboukas, 2006) and in freshwater fishes like *Mystus seenghala* (Jafri, 1968) and *Ophicephalus punctatus* (Jafri and Khawaja, 1968). Ramaiyan et al*.* (1978) observed in *Septipinnataty,* when oil content is high in fish, the moisture content was observed low. The results of the present study revealed that, changes in moisture content in the muscle of *S. commerson* could be attributed to changes in lipid level directly and to sexual maturity and feeding intensity indirectly.

A steady increase in percentage of protein from January to June and thereafter a decline till December was observed. Similar results were recorded in *Rastrelliger kanagurta* by Nisa and Asadullah (2011). The recorded values for crude protein were not only in agreement with the values of Bandarra et al*.* (2001) but also to some extent with the findings of Mehmet (2008) in mackerel species. Like fat, protein values are also inversely proportional to water, suggesting therefore, that the depletion in water content is made up by fat and protein. However, in herring Milroy (1908), it was noted as lowest percentage of protein when fat content is at its highest, whereas Bruce (1924) found decrease' in muscle protein with advancing age and progressive maturation of gonads when the fat content was found to rise. Our present study of protein and lipid results also strongly correlated to the earlier results. Jafri and Khawaja (1968) noted high values of muscle protein in *Ophicephalus punctatus* with ripe gonads.

Lipids are highly efficient as sources of energy and they contain more than twice the energy of glycogen and proteins (Okuzumi and Fujii, 2000). Lipids are also good sources of essential fatty acids necessary for normal growth (Ponnusami, 1997). Lowest lipid value coincided with peak sexual maturity season. In general, the high values for fat were observed during the pre-maturity and sexual maturity months and low during the post-maturity months. The fat reserves are more in a fully ripe fish which has to perform breeding migration (Jones, 1941) and undergo the spawning exertion. It can be noted that the low values of fat coincided with the high values of water and vice versa. The same results were observed in *Rastrelliger kanagurta* reported by Nisa and Asadullah (2011). Seasonal data showed that even though fat content is somewhat high in the present study, the variation trend was to some extent in agreement with the values of Bandarra et al*.* (2001) for the Indian horse mackerel. According to Borges and Gordo (1991), the sexual maturity season of these species takes place during the first semester of the year, which would be the probable reason of low fat content in this time of year. The seasonal variation in the lipid composition of marine organisms is generally influenced by many factors that may differ from year to year or season to season and may also depend on the feeding or preying of the organisms (Patton, 1975; Osako et al*.,* 2003). A rise in the fat content of mackerel muscles before sexual maturity followed by a fall after sexual maturity was observed by Chidambaram et al. (1952). Reduction in the lipid content during the sexual maturity season has been recorded in *Bregmaceros mclellandi* (Parulekar and Bal, 1969), *Mugil cephalus* (Das, 1978) and *Ambassis commersoni* (Bumb, 1992).

The lowest and highest glycogen values were recorded in May and June. It appears that the muscle glycogen may be associated with feeding in addition to the sexual maturity. The moderate values of glycogen during the post-maturity period may be due to the high feeding activity during these months (Somvanshi, 1976). The low values of glycogen recorded in the present study could be that many marine animals do not contribute much to the reserves in the body (Jayasree et al., 1994). The accumulation of glycogen starts from May and attains its peak in June which is associated with the attainment of maturity. The diminution in glycogen in females in November shows utilization of glycogen as an energy source in addition to fat for the ripening of the gonads.

High and low level of ash content was observed in December and low in March. These findings were in agreement with Mehmet (2008) and Nisa and Asadullah (2011), as ash content of the studied species was high in March. The fluctuation of ash content made it difficult to show any relationship with the sexual maturity season. In general, body composition of fishes seems to depend on age, sex, season and diet (Phillips et al*.,* 1966).

Conclusion

S. commerson is more nutritious during pre-sexual and sexual maturity periods. The results suggest that the proximate composition of fish species greatly varies during the catching season. 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. This study provides valuable information on variations in proximate composition of fish species studied in order to take necessary precautions in processing from a manufacturer’s point of view and to distinguish their nutritional value and make a choice based on the information from a consumer point of view.

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