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RESEARCH ARTICLE

BIOCHEMICAL COMPOSITION OF FOUR OCTOPUSES REPRESENTED IN TRAWL NET BY-CATCHES OFF VISAKHHAPATNAM, EAST COAST OF INDIA

***Mohana Rao, M., Yedukondala Rao, P. and Ramesh Babu, K.**

Department of Marine Living Resources, College of Science and Technology, Andhra University, Visakhapatnam - 530003, A.P., India

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ABSTRACT

The biochemical parameters such as protein, lipid, carbohydrate and ash besides water content in the muscle of *Octopus aegina, O. membranaceus*, *O. dollfusi* and *Cystopus indicus* have been conducted during October2009 to September, 2011 at Visakhapatnam. The percentage composition of protein, lipid, carbohydrate and ash ranges from 9.95 to 17.56, 3.98 to 9.01, 0.23 to 0.62 and 3.73 to 7.79 respectively in juveniles and adults of four species. There was no remarkable variation in the biochemical composition of four species. Seasonally highest protein and lipid contents were noticed in summer in four species. Variations in biochemical composition in present study may be governed by spawning cycle and feeding activity. The present study indicated that all the four species of *Octopuses* studied were nutritionally equal to any food fish and they could be used for food and for preparation of various fish by-products.

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INTRODUCTION

Octopuses are diverse group of aquatic organisms and are non-target species incidentally or accidentally caught by trawling in Visakhapatnam coast. At present there is no demand for octopuses within the country except in bait fishery. Due to the growing demand for octopuses in the international market, octopus fishery is gaining importance in Nicobar Island, Lakshadweep and Northwest region of India especially along Maharashtra Coast (Silas, 1985; Sujith and Sarang, 2004). Organic constituents like protein, glycogen and lipid act as key substances for energy metabolism were used by an organism to produce energy (Suja and Muthiah, 2010; Shaik, 2011). Studies on biochemical composition are very essential to assess the nutritional value of octopuses because Indian seas abound with thirty eight species of octopuses belonging to the family Octopodidae, Tremactopodidae, Argonautidae (Silas, 1985). There are four species belonging to two genera namely, Octopus (*O. aegina*, *O. membranaceus*, *O. dollfusi*) and Cistopus (*C. indicus*) of family Octopodidae found in the trawl catches at Visakhapatnam fishing harbor. Among the four species, *O.aegina* and *O.membranaceus* were dominant.

****Corresponding author: Mohana Rao, M.***
Department of Marine Living Resources, College of Science and Technology, Andhra University, Visakhapatnam - 530003, A.P., India.

Considering the paucity of information on biochemical composition of four octopus species i.e. *O. aegina*, *O. membanaceus*, *O. dollfusi* and *C. indicus* particularly from Visakhapatnam, east coast of India. The present study aims to investigate the biochemical composition of four octopus species represented in trawl net by-catches at Visakhapatnam fishing harbor.

MATERIALS AND METHODS

The present study was based on 268 specimens of *O. aegina*, ranging from 109mm to 435mm total length and 10 to 269g weight; 246 specimens of *O. membranaceus,* ranging from 146 to 477mm total length and 18 to 258g weight; 213 specimens of *O. dollfusi* ranging from 137 to 752mm total length and 10 to 545g weight and 197 specimens of *C. indicus* ranging from 192 to 547mm total length and 12 to 156g weight were collected from commercial trawl catches at Visakhapatnam fishing harbor (Lat.17° 41¹ N, Lon.83° 17¹ E) at regular intervals (once in a month) from October, 2009 to September, 2011. The samples were not available during May due to fishing holidays which was implemented as a part of conservation of resources.

The collected samples were stored in crushed ice and immediately brought to the laboratory for further analysis. The octopuses were identified based on standard taxonomic keys (Roper *et al* 1984; Silas, 1985). The males and females were identified by the right third arm in male hectocotylized with well developed ligula. After measuring total length from tip of the longest arm to posterior most end of mantle. The octopuses were classified into juveniles (<200mm) and adults (>200mm) based on length and gonad maturity. The animals were then dissected and muscle tissue was taken out from both mantle and arms. The muscle tissue was weighed immediately and kept in hot air oven at 60-70^{o}C for about 48 hours till the moisture was completely evaporated. The dried tissue was then ground in mortar for further analysis. The powder samples were used for determination of protein, carbohydrate, lipid and ash by using standard methods (Lowry *et al* 1951; Carroll *et al* 1956; Bligh and Dyer, 1959 and Hort and Fisher, 1971 respectively). The values were presented in percentages.

Water Content: Water content was calculated as the difference between the wet weight and dry weight of the tissue. The water content was expressed in percentage.

ANOVA (Microsoft excel) was carried out for water content, protein, carbohydrate, lipid and ash of four octopus species for their significance.

RESULTS AND DISCUSSION

Water

The water content ranged from 67.62% to 78.31% in juveniles and 68.10% to 79.09% in adults (Figure 1-4). The water content on an average more than 70% was noticed in *O. aegina*, *O. membranaceus, O. dollfusi* and *C. indicus* in both juveniles and adults in the present study. The mean values of water content for four species represented in figure 9. There exists an inverse relationship between water and fat content. Low water content was usually associated with relatively high fat content and vice-versa (Das, 1978; Nair & Mathew, 2000; Anthony *et al* 2000; Zaboukas, 2006; Shamson, 2008 and Manal, 2009). The water content was inversely related to the lipid contents in all four octopuses analysed in the present study. The low value of water content, observed during summer in both juveniles and adults during the study period (Figure 5-8) indicated that the water content decreased as octopuses advance towards maturity. The mean values of water content in the muscle of juveniles and adults indicated that four octopuses were almost similar in their water content.

Protein

The protein content ranged from 10.11% to 17.56% in juveniles and 9.95% to 17.29% in adults (Figure 1-4). The protein content in the muscle of four species in both juveniles and adults were almost similar in the present study. The mean values of protein content for four species represented in figure 9. Seasonal variations indicated that highest protein content was noticed in summer in both juveniles and adults (Figure 5-8). The protein was dominant constituent among biochemical components except water in four octopuses in the present study. It was also observed that protein content was inversely related to water content in the present study.

Balasubrahmanyan and Natarajan (1988) showed that protein in mantle tissue was higher percentage than gonad during summer. Giese *et al* (1967) stated that protein level had no relation to the reproductive season, but rather were related to nutrients conditions and other variable in the environment. Pierce *et al* (1999) stated that there was a negative correlation between protein concentration and gonado – somatic index in some Cephalopods. O'Dor and Wells (1979) demonstrated that the activation of the glands inhibits protein synthesis and increases amino acid levels in the blood, which are fundamental to the formation of yolk proteins. In fact, the yolk of the oocytes of *Octopus vulgaris* were rich in neutral glycoproteins, sulphidric and thiolic proteins and proteins rich in tyrosine and tryptophan residues (Bolognari *et al*., 1976). The protein depletion due to the maturation of gonads and/or long periods of feed deprivation which results in tissue depletion in muscle was also verified in other marine animals, such as *Pacific salmon* (Bilinski *et al*, 1984) *Atlantic cod* (Love, 1988), *Dover sole* (Hendrickson *et al*, 1986), *American plaice* (Haard 1987) etc.

The organism would be expected to make compensatory adjustments to both the components of energy gain and energy loss in the fate of changes in the environmental conditions (Vedpathak, 1989). The protein content can be correlated with the phases of maturity and spawning (Parulekar and Bal, 1969). Van Bohemen and Lambert (1980) stated that the highest protein content in pre-spawning stage might be due to its ready supply by the liver. The protein cycles and lipid cycles of muscle of *O. aegina*, *O. membranaceus, O. dollfusi* and *C. indicus* were more or less inversely related. It seems that there was an alternate use of the energy sources (lipids and proteins) in all four octopuses studied. Shamson (2008) also noticed such relationship in *Sillago sihama*.

Lipid

The lipid content ranged from 4.07% to 8.85% in juveniles and 3.08% to 9.01% in adults (Figure 1-4). The lipid content in both juveniles and adults of four species were almost similar in the present study. The mean values of lipid content for four species represented in figure 9. Seasonally highest lipid content (8.54%) was noticed in adult of *O. dollfusi* during summer than other three species studied (Figure 5-8). The lowest value of lipid content was noticed in cephalopods and other bivalves (Rosa *et al*., 2002; Hagashi and Bower (2004); Ozyurt *et al*., (2006); Sieiro *et al*., (2006); Zlatanos *et al*., (2006); Ozogul *et al*., (2008); Yesim *et al*., 2008; Lakshmilatha, 2009; Beyza, 2010; Ramasamy *et al*., 2012; Nurjanah *et al*., 2012). The present study indicated that the lipid content was fairly high in four species studied which was compensate with the work of Forough *et al*., 2011; Shaik *et al*., 2011; Jadhav *et al*., 2012; Paradeshi and Vedpathak, 2013; Srilatha *et al*., 2013.

There was no clear cut determination between intensive feeding and lipid content in the present study, because octopuses used for this study spawns throughout the year.

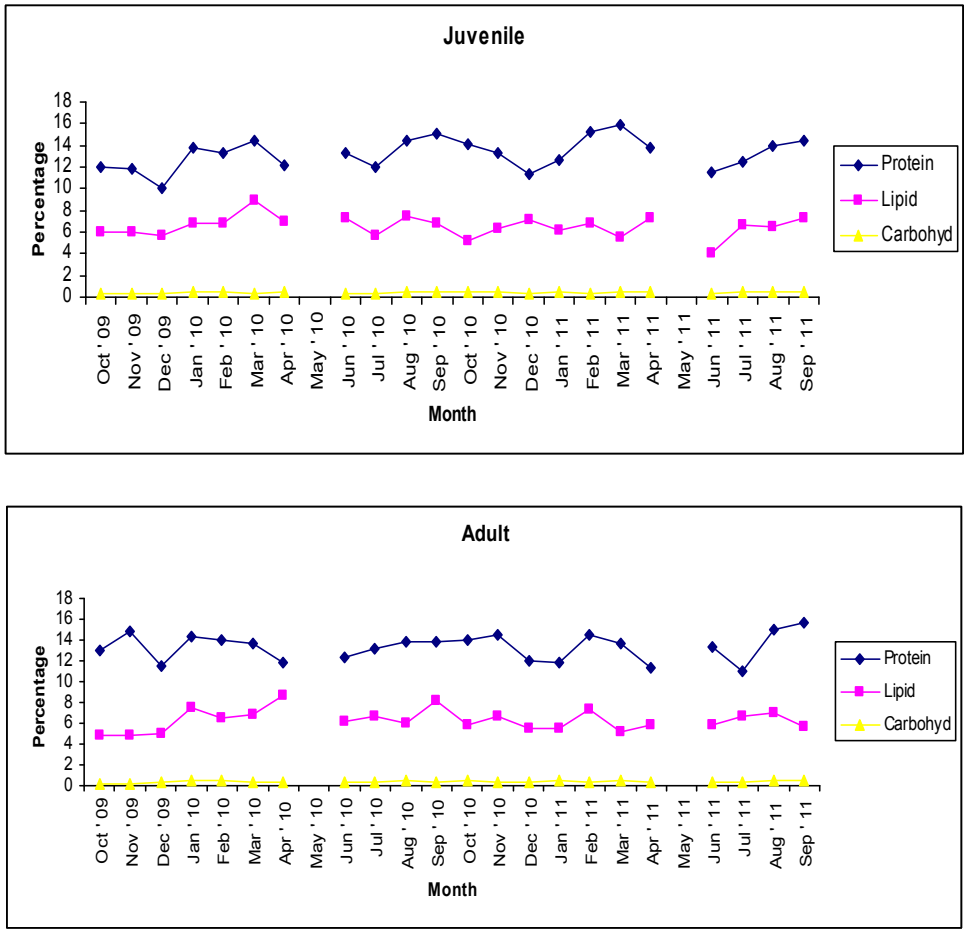


Fig.1. Percentage composition of Protein, Lipid, and Carbohydrate in the muscle of *Octopus aegina* during October 2009 to September 2011

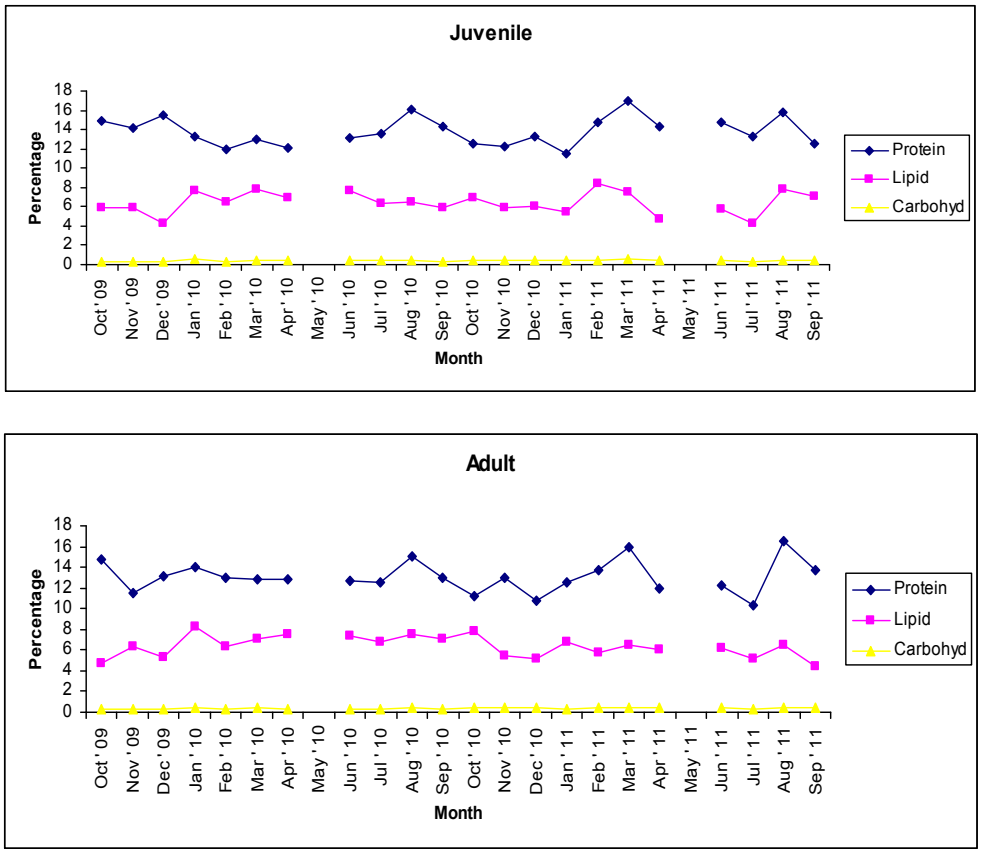


Fig.2. Percentage composition of Protein, Lipid, and Carbohydrate in the muscle of *Octopus membranaceus* during October 2009 to September 2011

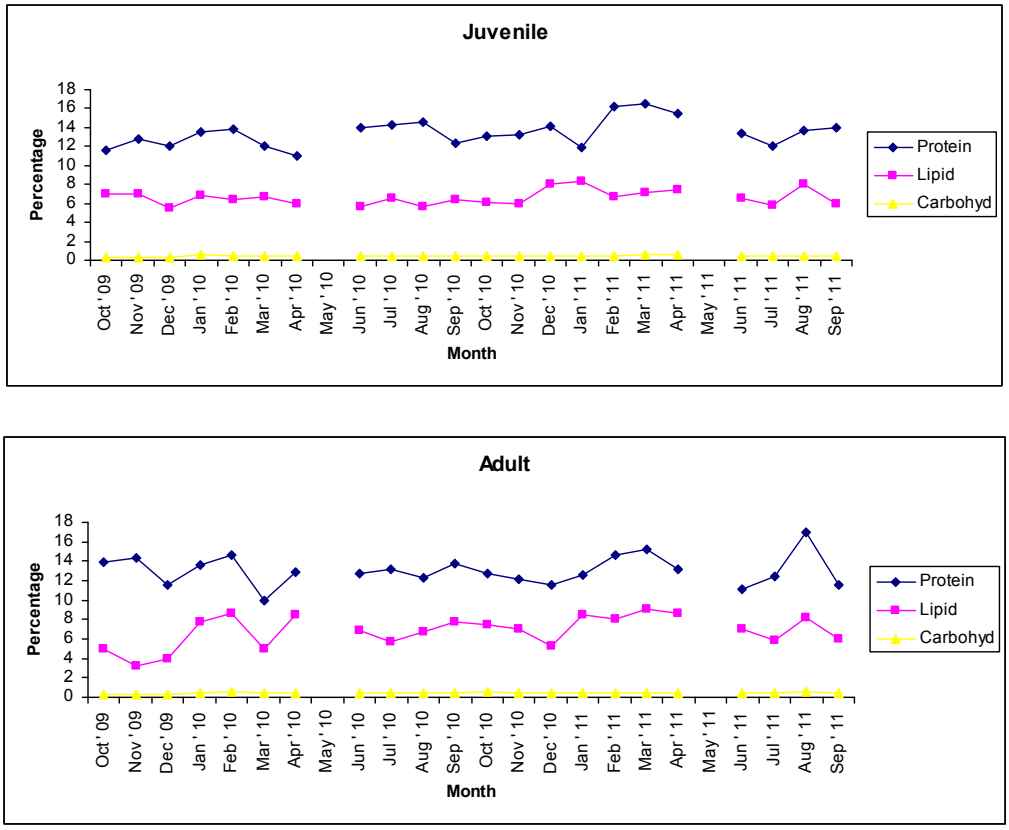


Fig.3. Percentage composition of Protein, Lipid and Carbohydrate in the muscle of *Octopus dollfusi* during October 2009 to September 2011

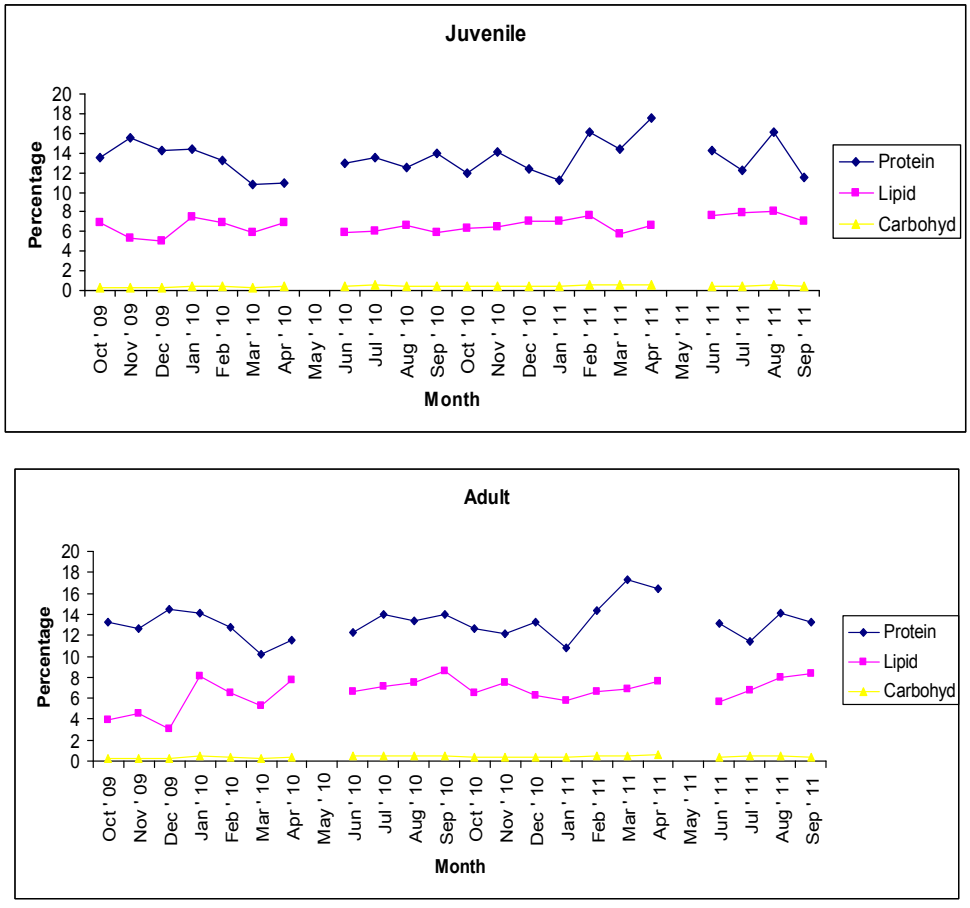
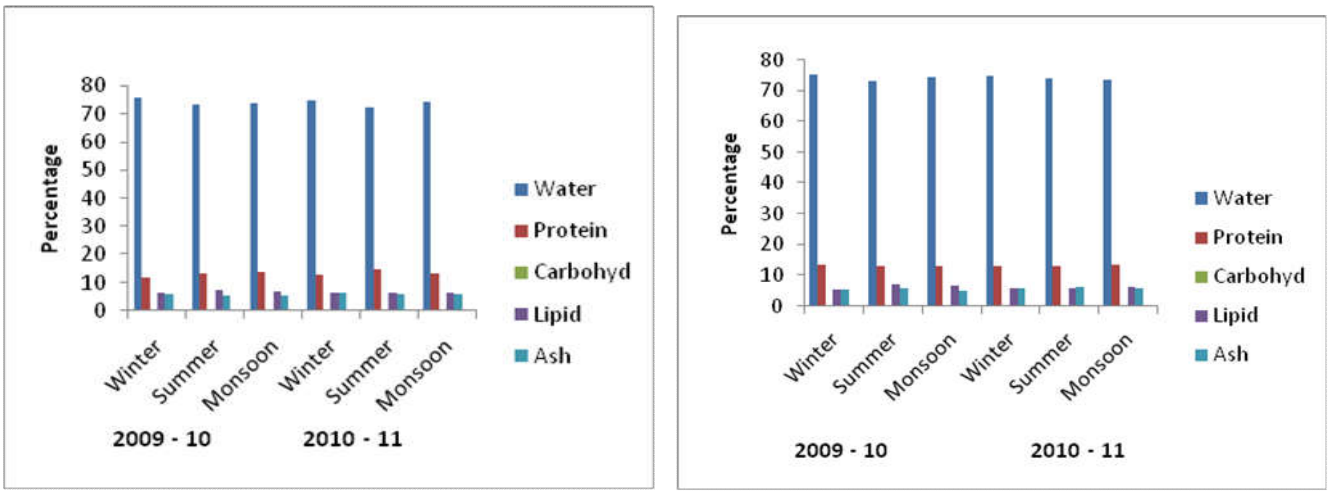
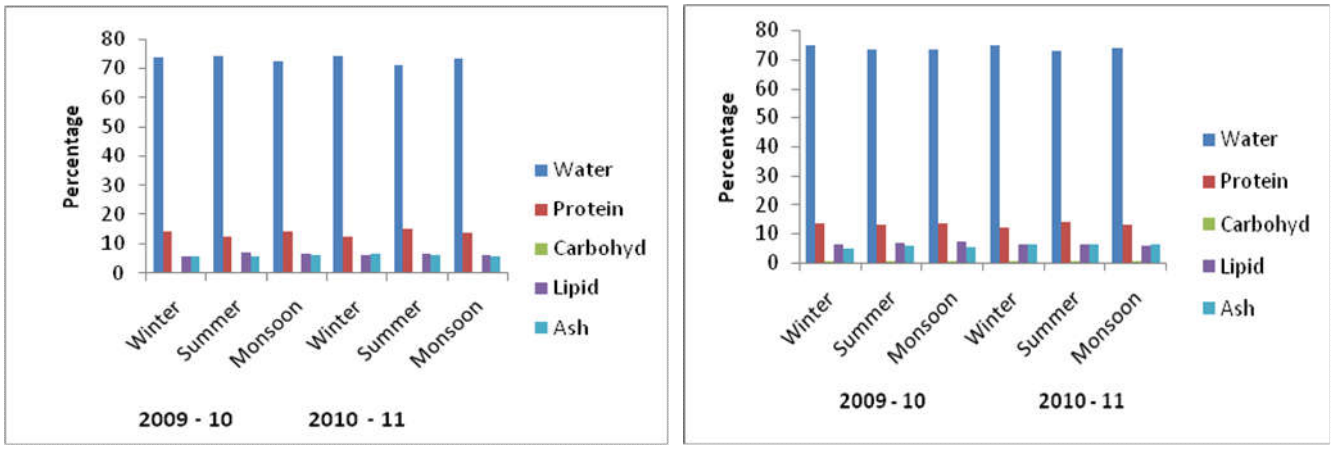


Fig.4. Percentage composition of Protein, Lipid and Carbohydrate in the muscle of *Cistopus indicus* during October 2009 to September 2011



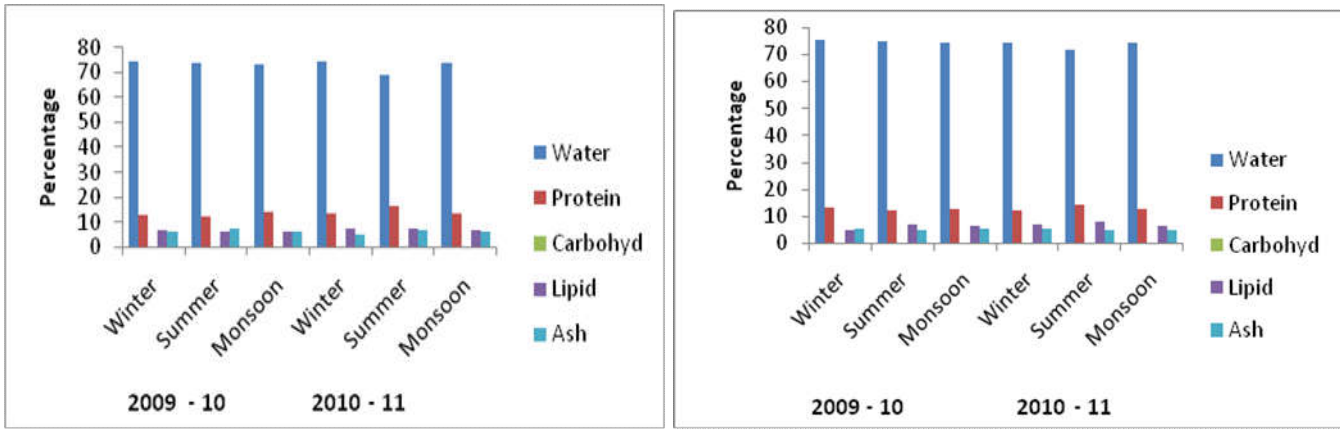
Juvenile **Adult**

Fig.5. Seasonal variations of water, protein, carbohydrate, lipid and ash content (Percentage mean values) in muscle of *Octopus aegina* during October 2009 to September 2011



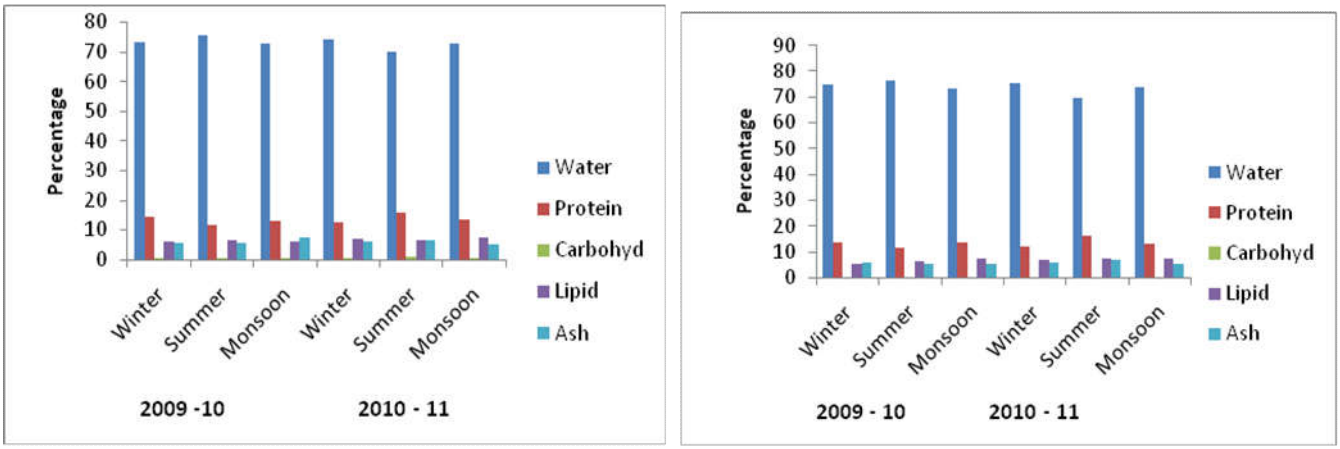
Juvenile **Adult**

Fig.6. Seasonal variations of water, protein, carbohydrate, lipid and ash content (percentage mean values) in muscle of *Octopus membranaceus* during October 2009 to September 2011



Juvenile **Adult**

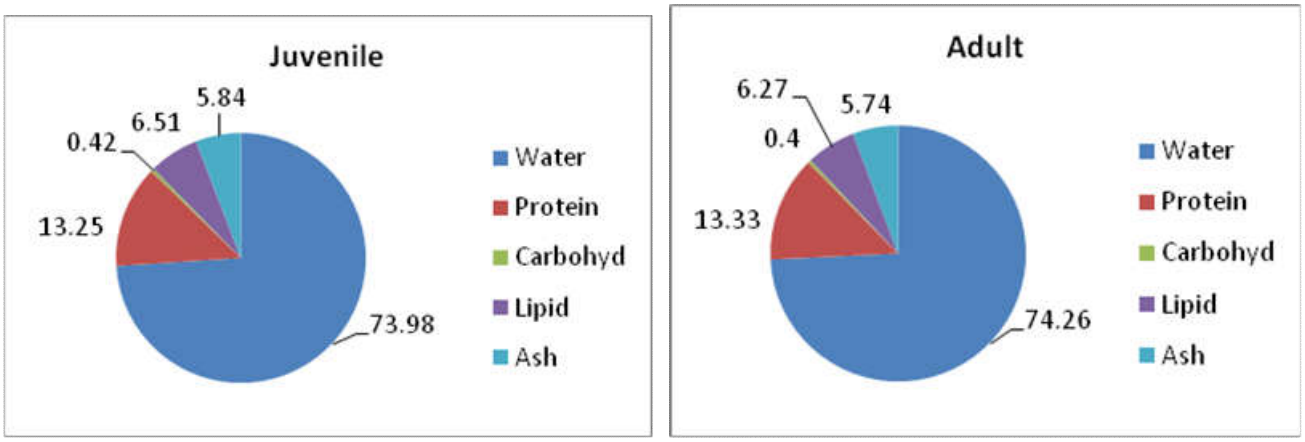
Fig.7. Seasonal variations of water, protein, carbohydrate, lipid and ash content (Percentage mean values) in muscle of *Octopus dollfusi* during October 2009 to September 2011



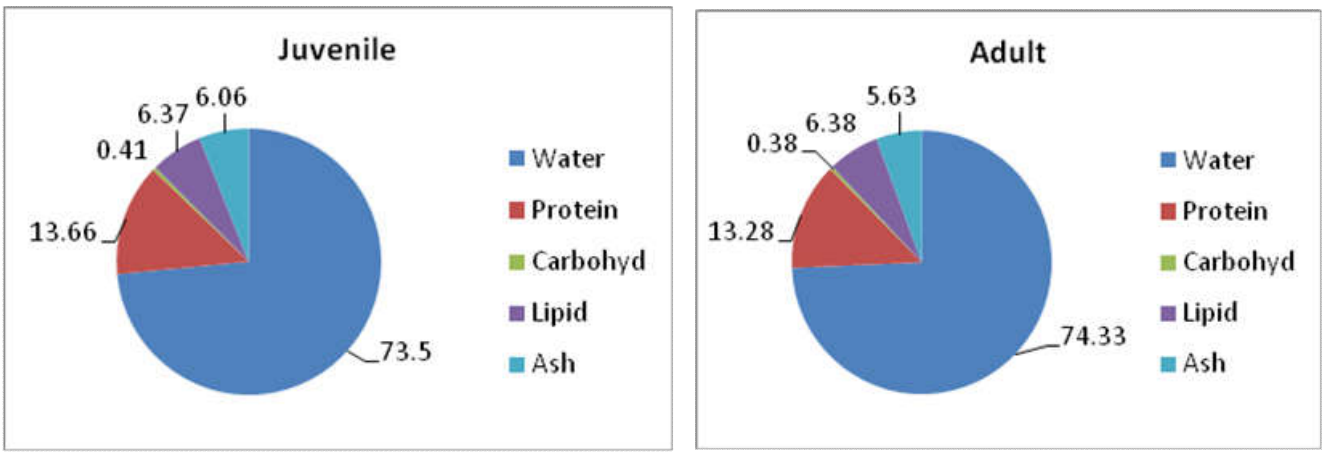
Juvenile **Adult**

Fig.8. Seasonal variations of water, protein, carbohydrate, lipid and ash content (percentage mean values) in muscle of *Cistopus indicus* during October 2009 to September 2011

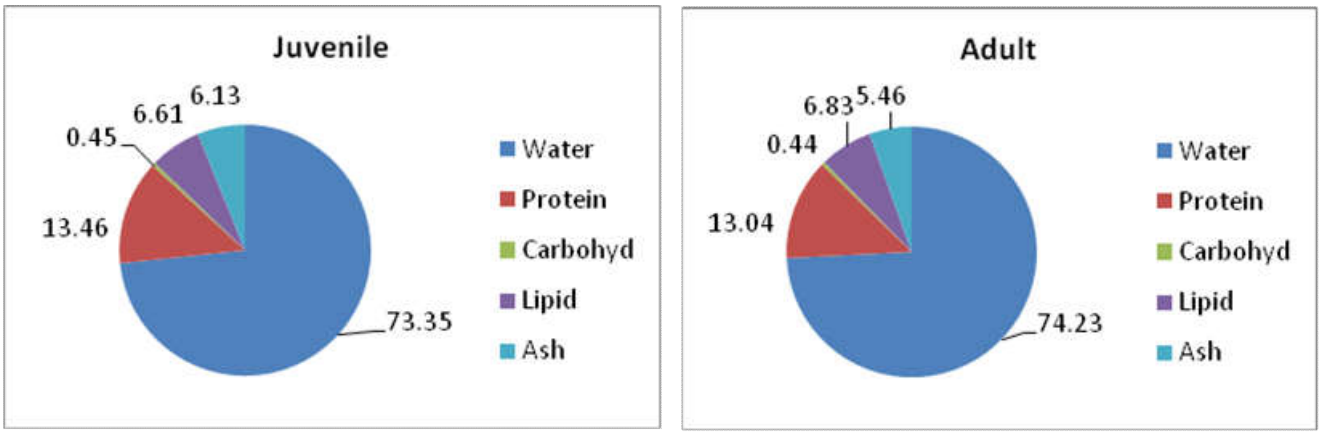
***Octopus aegina*:**



Octopus membranaceus:



***Octopus dollfusi*:**



***Cistopus indicus*:**

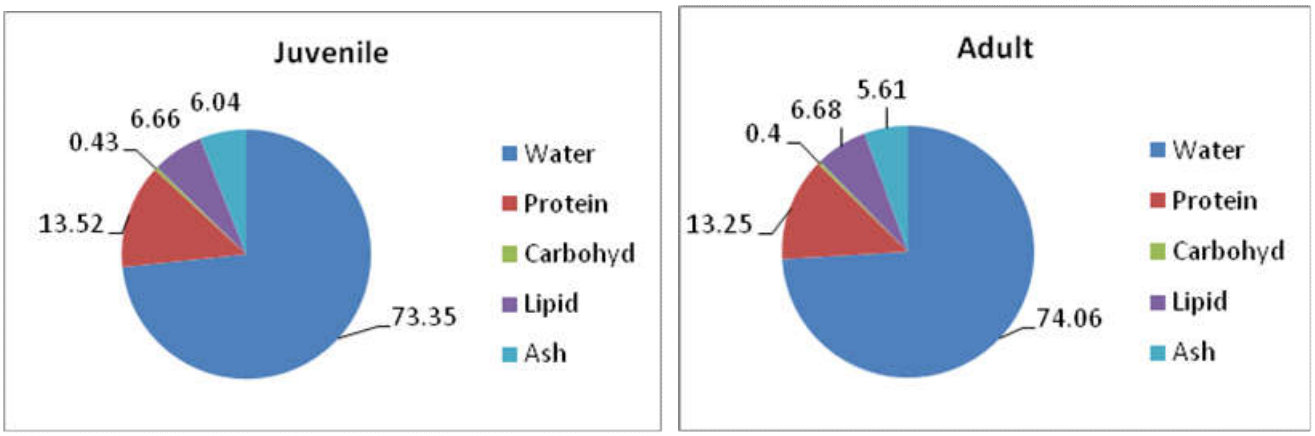


Fig.9. Percentage composition of water, protein, carbohydrate, lipid and ash content (mean values) in muscle of four octopuses during October 2009 to September 2011

Seasonal variations in the lipid content in the present study may be due to spawning periodicity. Fat was the second major constituent, quality wise, in octopus muscle. Lipids play an important role in the physiology of marine animals particularly during the reproductive activity (Park *et al*., 2001; Ojea *et al*., 2004). During Oogenesis and spermatogenesis there was a rapid increase in lipid and protein contents in the gonad as reported for Scallop (Barber & Blake, 1991).

Carbohydrate

The carbohydrate content ranged from 0.24% to 0.62% in juveniles and 0.23% to 0.61% in adults (Figure 1-4). Carbohydrates formed a minor percentage of the total composition of the muscle. The carbohydrate content in both juveniles and adults of four species were almost similar. The mean values of carbohydrate content in all four species of octopuses represented in figure 9. Seasonally highest content of carbohydrate (0.56%) noticed in *C. indicus* during summer (Figure 5-8). Vijayakumaran (1979) stated that carbohydrate plays a minor part of energy reserves of *Ambassis guywlephale* and depletion due to spawning was negligible. The lowest content of carbohydrate was noticed in *Sepia recurvirostra* (Nurjanah *et al*., 2012). Highest content of carbohydrate was noticed in other bivalve molluscans (Shaik, 2011; Meryem *et al*., 2013; Srilatha *et al*., 2013). The low values of carbohydrates recorded in the present study could be because glycogen in many marine animals does not contribute much to the reserves in the body.

Ash

The ash content ranged from 3.90% to 7.79% in juveniles and 3.73% to 7.71% in adults (Figure 1-4). The ash content was almost similar in both juveniles and adults of four species in the present study. The ash content was relatively low in molluscans (Rosa *et al*., 2002; Yesim *et al*., 2008; Laxmilatha, 2009; Beyza and Hulya, 2010; Forough *et al*., 2011; Nurjanah *et al*., 2012). The highest content of ash (17.44-35.98%) was noticed in common cockle-*Cerastoderma edule* (Meryem *et al*., 2013). The mean values of ash content ranged between 3.73 and 7.79% in muscle of four species of octopuses analysed in the present study (Figure 9). Seasonally highest ash content (7.22%) was noticed in juveniles of *C. indicus* during Monsoon (Figure 5-8). Similar values were also noticed in Cuttlefish-*Sepia kobiensis* (Ramasamy *et al*., 2012) and *Meretrix casta* (Srilatha *et al*., 2013).

However detailed comparisons and broad generalizations are difficult in such biochemical studies. This was mainly due to variations in the habitat, season, and breeding periodicity of the species concerned. Moreover, aspects like age, sex, social interaction and physiological state of such experimental animals are also found to have significant influence (Okuzumi and Fujii, 2000; Forsythe *et al*., 2002; Celik *et al*., 2012). Relatively moderate changes were observed in the biochemical composition of the muscle of *O. aegina, O. membranaceus, O. dollfusi* and *C. indicus* in both juveniles and adults during different seasons of the year, which may be the result of the processes mentioned above.

Analysis of variance (Two-way) showed statistically no significant difference (P> 0.05) between the species of four octopuses for their biochemical constituents, but significantly differ (P< 0.05) within the species.

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