EUROPEAN ACADEMIC RESEARCH
Vol. II, Issue 10/ January 2015

Impact Factor: 3.1 (UIF)
DRJI Value: 5.9 (B+)

ISSN 2286-4822
www.euacademic.org

Biochemical composition of the deep water mud shrimp *Solenocera melantho* (De Man, 1907)

P. R. C. GANESH
Assistant Professor (C)
MYLA S. CHAKRAVARTY
Professor
Department of Marine Living Resources
Andhra University
Visakhapatnam, Andhra Pradesh, India

Abstract:

The biochemical composition- carbohydrates, proteins and lipids of muscles of the males and females of deep water mud shrimp S. melantho was studied quantitatively for a period of two years. Albumin proteins extracted with water and with increasing salt concentrations (0.1M, 0.2M, 0.3M, 0.4M & 0.5M) of potassium chloride and ammonium sulphate were also estimated. In males low carbohydrate content of 2.58mg in November and a high value of 3.34mg in July was found whereas in females it was low (3.18mg) in November and high (3.57mg) in August. Proteins of males ranged from 202.87mg in June to 362.12mg in December and in females they were 340.35mg in October to 442.09mg in November. Lipid content of males varied from 21.24mg in November to 25.94mg in August whereas in females it was from 18.94mg in April to 36.04mg in September. The albumin protein content varied as a function of sex, season with higher values in females than the males. The values of albumin fraction showed a downward trend with the increasing salt concentrations from 0.1M to 0.5M of KCl and $(NH_4)_2SO_4$.

Key words: *Solenocera melantho,* Muscle, Biochemical composition, Albumin proteins, Deep water mud shrimp

Introduction

Biomolecules particularly carbohydrates, proteins, lipids, vitamins etc play a pivotal role in cell organization and function of all the living organisms. Carbohydrates are the immediate source of energy, proteins are the building blocks of the cell and the lipids are mainly the stored forms of energy (Love, 1957). The change in the biochemical constituents varies with environment, season and also physiological state of the animal such as feeding, moult condition, reproduction, migration, maturation etc. (Love, 1957 & Viswanathan and Suseela Mathew, 2000).

Proteins constituent about 20% of the muscle in shrimps and is composed of albumins, myosin, actin, actomyosin, tropomyosin and are extractable with solvents of different ionic strengths of salt solutions, organic solvents and acids. Albumins are the proteins of sarcoplasmic and other interstitial fluids and the rest are the proteins of the myofibrils. Albumins are soluble in water, coagulated by heat and precipitated in salt solutions of low ionic strength. Albumins include water-soluble myoalbumins and water-insoluble myogens. The albumins contribute about 16-22% of the total muscle proteins and can be extracted with the salt solutions of low ionic strengths i.e., < 0.5M. The solubility of different albumin proteins is not uniform and are soluble in salt solutions of different ionic strengths below 0.5M. The albumin proteins impart specific taste and flavour to the muscle of a particular species and ultimately different species possess different types of albumin proteins. The accumulation of these proteins may vary with sex, size and season, since they are of primarily genetic origin and secondarily of the diet (Viswanathan and Suseela Mathew, 2000).

In penaeid shrimps, protein composition varies with species, sex, size and season (Shaikhmuhmad and Magar, 1957; Pillay and Nair, 1973; Ferguson and Raymont, 1974; Johnson

and Hopkins, 1978; Dupreez and Mc Lachlan, 1983; Chang and Tsai, 1997). Relatively little work has been done on the muscle albumins of the shrimps except those of Connell (1953), Chakravarty and Krishna Murthy (2006), Chakravarty *et al* (2013) and Karuppasamy *et al*., 2013. There are no biochemical studies carried out so far on the shrimps of the genus *Solenocera*. Therefore an attempt is made to study the biochemical composition particularly carbohydrates, proteins and lipids of muscles in the deep water mud shrimp *S. melantho* with reference to sex and in different months quantitatively for a period of two years. Studies have also been carried out on the quantitative distribution of albumin proteins with two salts - potassium chloride and ammonium sulphate.

Material and methods

Shrimps samples were collected fortnightly from the Visakhapatnam fishing harbour for a period of two years from November 2004 to October 2006 except the May month which was declared as fishing holiday. After bringing to the laboratory in an insulated box containing ice they were washed thoroughly with water blotted with filter paper and segregated as per the sex. The abdominal muscles of male and female were separated after removing the exoskeleton, gut etc. The wet muscle was blotted, weighed and dried in hot air oven at 50-60^{o}C for about 48hrs. The dried muscle was ground to powder and used for the estimation of carbohydrates by the anthrone method of Carroll *et al* (1956), Proteins by Lowry *et al* (1951) and lipids by Barnes and Blackstock (1973). Albumins were proteins extracted with water and with salt solutions of low ionic strength *i.e*., below 0.5M (0.1M, 0.2M, 0.3M, 0.4M and 0.5M) with two salts-potassium chloride and ammonium sulphate separately and the respective albumin proteins were estimated by Lowry *et al* (1951) method in both the sexes. A total of six albumin fractions with two salts individually were estimated (mg/g) every month

for two years *i.e.* from November 2004 to October 2006 and the data was merged of each month. Each estimation was repeated five times in every month and the error was estimated by standard deviation.

Results

Carbohydrates

Males showed high content of carbohydrate in July with 3.34 followed by June, August, October and September with the values of 3.20, 3.17, 3.15 and 3.02 respectively. The remaining months showed more than 2.50. Females showed a value of 3.57 in August followed by June with 3.56. In September it was 3.54 and 3.52 in December, February and July, 3.48 in March and in January and October it was about 3.47 and in April it was 3.46. A low value of 3.18 was found in November (Fig. 1). Seasonally carbohydrates showed higher values in females than the males and in both sexes low levels were found in northeast monsoon (Fig. 2).

Proteins

The protein content in males showed high in December (362.12) and low value in June (202.87). The protein composition was in the order of October (350.82), January (339.07), August (334.91), February (323.27), March (308.55), November (281.20), September (270.31), April (264.18) and July (232.78). In females, it was high in November (442.09) and low in October (340.35). It was 399.07 in December, 398.57 in March, 393.35 in September, 390.80 in July, and 387.30 in January followed by August (377.99), February (368.17), January (366.99) and April (345.54) (Fig. 3). Maximum protein was found in both sexes in north-east monsoon, though the females showed higher values (Fig. 4).

Lipids

The data of the lipids in males showed higher value in August (25.94) and low value in November (21.24). In July it was about 24.36. The remaining months showed the values of 23.79 in March, 23.76 in September, 23.59 in January, 23.49 in February, 23.41 in October, 23.26 in April and 23.22 in June, except in the month of December (21.57). In females, it was observed that the higher lipid value was noticed in September (36.04) and low value in April (18.94). The values were 35.74 and 31.67 in the months of October and August respectively. In July, January and June the values were 27.87, 27.57 and 27 respectively. The values were 24.19 in December, 23.94 in November, 23.76 in March and 22.56 in February (Fig. 5). Higher lipid values were found in females in southwest monsoon against males, whereas in males low levels were noticed in Northeast monsoon (Fig. 6).

Albumin Proteins

Water soluble albumins (Fig. 7)

Males exhibited higher water soluble albumins in September (141.67) and low in November (96.80) where as in females they varied from 142.28 in July to 152.10 in June, when the data of the two years were pooled. Females showed comparatively higher values to males in the months. There was not much variation observed from one month to the other in females whereas it was significant in males.

Albumins extracted with KCl (Fig. 8)

At 0.1M KCl

The albumins of males ranged from 179.49 in July to 219.59 in September. In females, they ranged from 198.44 in February to 311.22 in October. In all months, females showed higher values

to males except in February. In both sexes difference was observed from one month to the other month.

At 0.2M KCl

Males exhibited albumins ranging from 158.42 in July to 270.85 in April whereas in females they ranged from 210.76 in August to 252.24 in October. Except in November and April, the females showed higher values to males. Not much variation was observed in females in all months whereas males showed significant variation.

At 0.3M KCl

In males the average albumin fraction ranged from 142.60 in March to 210.16 in December. In females it was from 192.19 in July to 224.31 in September. Females showed higher values to males and in December males exhibited more albumin content. Difference was observed in males in all months whereas not much variation was observed in females.

At 0.4M KCl

The males showed the albumins ranging from 198.22 in February to 252.84 in November and in females they were from 178.81 in August to 212.28 in March. Males showed higher values to females in all months except in February. Difference was observed between males and females.

At 0.5M KCl

The albumins of males at this concentration ranged from 157.87 in July to 202.84 in August and in females it was from 147.51 in October to 179.53 in June. Except in June, males showed higher values to females.

Albumins extracted with $(NH_4)_2SO_4$ (Fig. 9)

At 0.1M $(NH_4)_2SO_4$

The albumins of males at this concentration ranged from 197.46 in January to 231.09 in July and in females they were from 197.89 in November to 242.11 in September. Females showed higher values in the months of January, February, March, April, June and in September whereas males dominated in the remaining months.

At 0.2M $(NH_4)_2SO_4$

The value showed that the males exhibited albumins ranging from 148.71 in November to 198.13 in August. In females they ranged from 161.81 in November to 189.39 in February. Females showed higher values to males in the months of November, February, March, April, June, September and in October. In the remaining months males showed higher values.

At 0.3M $(NH_4)_2SO_4$

Males showed the albumin fraction ranging from 121.12 in September to 173.68 in August and in females it varied from 128.87 in October to 160.57 in April. Females showed higher values to males in all months except in February, June, July, August and October.

At 0.4M $(NH_4)_2SO_4$

The data showed that in males these albumins ranged from 69.43 in September to 103.72 in March. In females they varied from 88.55 in November to 125.71 in August. In all months, females showed higher values to males and there was a marked difference in between males and females also.

At 0.5M $(NH_4)_2SO_4$

The albumins of males at this concentration ranged from 53.07 in November to 107.76 in August and in females they varied

from 76.33 in November to 124.30 in September. Except in the months of August and October, females showed higher values to males in all other months.

Discussion

The biochemical composition of body tissues vary widely and are dependent on several factors such as species, size, sex, the season and sexual maturity. (Viswanathan and Suseela Mathew, 2000). Variations also occur in the same species depending on several factors such as age, size, physiological condition and sexual maturity. The biochemical composition of the species indicates quality, nutritional and edible value of the meat in terms of energy compared to other species. In crustaceans, growth is an increase in the dry weight of the body which generally occurs in the intermoult, when the absorbed water is replaced by protein (Thomas, 1993). According to Huggins and Munday (1968), the rate of protein synthesis in crustacean tissues is higher than that of a mammal.

The biochemical composition of decapod crustaceans has been studied by several investigators. Shaikhmahamud and Magar (1957) have reported average protein content of *Penaeus penicillatus*, *Metapenaeus affinis*, *Parapenaeopsis stylifera*, *Hippolysmata ensirostris* and *Leander tenuipes* ranging 51.3% to 66.1%. The monthly protein content of female *Metapeneus affinis* vary from 43.04% to 66.84% (Pillay and Nair, 1973). Gopakumar and Nair (1975) have found the lipid content of wet muscle varying from 0.7% to 1.2% in five species of Indian penaeid shrimps. According to Nagabhushanam and Kulkarni (1980) the blood glucose of *Parapenaeopsis hardwickii* has shown a constant increase as ovary develops from stage I (2.8 ± 0.26mg/100ml) to stage IV (5.7±0.32mg/100ml) and there is a drastic fall after spawning. Clarke and Wilkins (1980) have reported that the lipid content of cultured *Fenneropenaeus merguiensis* is 1.99% of the fresh weight. Rajeswari (1982) has

reported the protein content ranging from 13.33% to 37.0% in females and 18.02% to 42.26% in males of fiddler crab, *Uca triangularis*.

Achuthankutty and Parulekar (1984) have found 80% protein, 6% lipid and negligible carbohydrate content in the muscles of four penaeid species – *Metapenaeus affinis*, *M. dobsonii*, *Fenneropenaeus merguensis* and *Parapenaeopsis stylifera*. According to them these muscle components do not vary significantly with size, sex or degree of maturity. Vijayaraghavan and Vijayakumaran (1990) have observed carbohydrate content ranging from 2.51% to 4.14% in males and 2.65% to 3.95% in females; lipid from 6.26% to 17.10% in males and 6.26% to 15.89% in females and proteins from 60% to 86% in males and 49% to 83% in females in the shrimp *Metapenaeus dobsoni*. Maheswarudu (1991) has observed the protein content ranging from 36.0% to 80.0% in *Metapenaeus monoceros*, 36.0% to 86.0% in *Penaeus monodon*, 36.0% to 78.0% in *Fenneropenaeus indicus* (marine) and 53.0% to 74.0% in *F. indicus* (brackish water). Muriana *et al* (1993) have found phospholipids in muscles of the shrimp *Metapenaeus japonicus*. Viswanathan and Suseela Mathew (2000) have reported the myofibrillar protein of about 64.5% in *F. indicus* and 60.93% in *M.dobson*i.

Chakravarty (2002) reports that the protein content in males and females of freshwater prawn, *M. rosenbergii* has ranged from 27.1% to 75.4% and 29.6% to 71.2% with respect to sex and size respectively and it is proportional to the size of the prawn. Chakravarty (2002a) has observed that the average glycogen content of the muscle and hepatopancreas is 0.9% and 1.13% respectively whereas the protein is 62.5% and 29.6% and the lipids are 16.5% in muscle and 62.2% in hepatopancreas of *M. rosenbergi*. Rosa and Nunes (2005) have found that the total amino acid content is 16.58% and 19.50% of the wet muscle in winter and spring respectively in *Parapenaeus longirostris.* Syama Dayal *et al* (2005) have reported 23.15% dry matter,

69.94% crude protein, 5.48% ether extract and 16.68% ash in the body and 56.48% dry matter, 23.11% crude protein, 1.09% ether extract and 6.3% dry matter in the shrimp *F. indicus*. Chakravarty and Krishnamurthy (2006) have observed the percentage of total proteins in males: females of three species of shrimps – *Trachypenaeus curvirostris*, *T. sedili* and *T. pescadorensis* as 43:51.5; 41.1:42.4 and 51:57 respectively. According to them the female shrimps have shown higher values than the males. Karuppasamy *et al* (2013) have observed that the shrimps *Penaeus monodon. Fenneropenaeus indicus* and *Aristeus virilis* showed a significant ($p<0.05$) result and varying concentration of protein, lipid, carbohydrate and moisture. Higher concentration of the protein has been found in *Aristeus virilis* (17.25) followed by *P. monodon* and *F. indicus*. The carbohydrate concentration is high in *A. virilis* (2.74) followed by *F. indicus* and *P. monodon* whereas the lipid is found to be high in *P. monodon* (80.89) followed by *F. indicus* and *A. virilis*.

In the present study, the carbohydrate content of muscles of males of *S. melantho* has shown a low value of 2.58 in November and a higher value of 3.34 in July whereas in females a low value of 3.18 in November and high value of 3.57 in August has been observed. The total muscle proteins of males has shown values ranging from 202.87 in June to 362.12 in December whereas females have shown a low value of 340.35 in October and a higher value of 442.09 in November. The lipid content of muscles of males varied from 21.24 in November to 25.94 in August whereas females exhibited a low value of 18.94 in April and higher value of 36.04 in September.

Connell (1953) has estimated the protein nitrogen content of 3.04mg/ml to 4.10mg/ml at 0.05I, 5.10mg/ml at 0.1I and 2.20mg/ml to 4.20mg/ml at 0.2I concentration in the muscles of the codling *Gadus callarias*. According to Chakravarty and Krishna Murthy (2006) the muscle albumin proteins of males and females of three species of trachypenaeid

shrimps- *T. curvirostris*, *T. sedili* and *T. pescadorensi* have shown higher values in females than the males. Chakravarty *et al* (2013) have observed a significant monthly variation of albumin proteins in water and at different salt concentrations of potassium chloride in males and females of *Pampus chinensis, P. argenteus* and *Apolectis niger*. In the present study the protein content varies as a function of sex, size, season etc. It has shown higher values in females than the males. The water soluble albumins showed a lower value of 96.80 in November and 142.28 in July in males and females respectively whereas higher values of 141.67 in September and 152.10 in June of males and females respectively. The values of albumin fractions showed almost a downward trend with the increasing salt concentration from 0.1M to the proteins at 0.5M $(NH_4)_2SO_4$ and KCl extracts because the solubility of different proteins varies at different salt concentrations.

Acknowledgements

The authors are grateful to the Head, Department of Marine Living Resources, Andhra University, Visakhapatnam for providing facilities to carry out research work.

REFERENCES

Achuthankutty, C. T. and A. H. Parulekar. (1984). Biochemical composition of muscle tissue of penaeid prawns. *Mahasagar*, 17(4): 239-242.

Barnes, H. and J. Blackstock. (1973). Estimation of lipids in marine animals and tissue. Detail investigation of the sulpho-phosphovanilin method for total lipids. *J. Exp. Mar. Ecol.,* 12: 103-118.

Caroll, W. V., R. W. Longley and J. H. Roe. (1956). The determination of glycogen in the liver and muscle by the use of anthrone reagent. *J. Biol. Chem.*, 220: 583-593.

Chakravarty, M. S. (2002). Effect of sex and size on the muscle glycogen, protein and lipid levels in the prawn, *Macrobrachium rosenbergii* De Man. *Jour. of Aqu. Biol.*, 17(1): 29-31.

Chakravarty, M. S. (2002a). Effect of starvation on glucose, proteins and lipids of the muscle and the hepatopancreas in *Macrobrachium rosenbergii* De Man. *Jour. of Aqu.Biol.*, 17(1): 33-36.

Chakravarty, M. S. and K. Krishna Murthy. (2006). Species-sex-related protein studies in the shrimps of the genus *Trachypenaeus* (Penaeidae: Crustacea: Decapoda) off Visakhapatnam Coast, Andhra Pradesh. *Jour. of Aqu. Biol.*, 21(1): 130-134.

Chakravarty, M. S., M. Navya and P. R. C. Ganesh. (2013). Species- and sex- related muscle

albumin proteins in three species of pomfrets – *Pampus argenteus* (Euphrasen, 1788), *P. chinensis* (Euphrasen, 1758) and *Apolectis niger* (Bloch, 1795) off Visakhapatnam coast, Andhra Pradesh. *Fishing Chimes* 33(3): 75-78.

Chang B. Keliang and T. Gengia. (1997). Response surface optimization and kinetics of isolating chitin from pink shrimp, *Solenocera melantho* shell waste. *Jour. of Agri. and Food Chemistry*, 45: 1900-1904.

Clarke, A. and J. F. Wilkins. (1980). Lipid content and composition of cultured *Penaeus merguiensis* fed with animal food. *Aquaculture*, 20: 17-27.

Connell, J. J. (1953). Studies on the proteins of fish skeletal muscle and electrophoretic analysis of low ionic strength extracts of several species of fish. *Biochemical Journal*, 54: 119-126.

Dupreez, H. H. and Mc Lachlan, A. (1983). Seasonal changes in biochemical composition and energy content of the three spot swimming crab, *Ovalepis punctatus* (De Haan)

(Crustacea, Brachyura). *Jour. of Exp. Mar. Biol. and Ecol.*, 72(2): 189-198.

Ferguson, C. F. and J. K. B. Raymont. (1974). Biochemical studies on marine zooplankton XII. Further investigations on *Euphasia superb*a Dana. *Jour. of Mar. Biol. Ass. of United Kingdom*, 54: 719-725.

Gopakumar, K and M. R. Nair. (1975). Lipid composition of five species of Indian prawns. *Jour. of the Sci.of Food and Agriculture*., 26: 319-325.

Huggins, A. K. and K. A. Munday. (1968). *In: Advances in Comparative Physiology and Biochemistry*, O. Lownstein (*Ed*.). *Academic press Inc*., New York: 271-378.

Jacquot, R. (1961). Organic constituents of fish and other aquatic animals: Fish as food. *Borgstorm Academic Press*, N.Y. and London: 145-209.

Johnson, J. J. and Hopkins, T. L. (1978). Biochemical components of the mysid shrimp *Taphrony simbowmani Bacesue*. *Journal of Experimental Marine Biology and Ecology*, 31: 1-9.

Karuppasamy, P. K. , R. Sri Sakthi Priyadarshini, N. Ramamoorthy, R. Sujatha, S. Ganga,

T. Jayalakshmi and P. Santhanam. (2013). Comparison of proximate, amino and fatty acid composition of *Penaeus monodon* (Fabricius, 1798), *Fenneropenaeus indicus* (H. Milne Edwards, 1837) and *Aristeus virilis* (Bate, 1881) of Nagapattinam landing centre, Tamil Nadu, *J. Mar. Biol. Ass. India*, 55 (2), pp.5-10.

Love, R. M. (1957). The biochemical composition of fish. In: *The Physiology of fishes*. (Ed. Brown, M.E.) Academic press, London and New York I: 401-418.

Lowry, O. H., Rosenberg, N. J., Para, A. and Randall, R. J. (1951). Protein measurement with the folin- phenol reagent. *Jour. Biol. Chem*., 193: 265-275.

Maheswarudu, G. (1991). Studies on the biochemical composition of haemolymph and muscle of penaeid

prawns, *Metapenaeus monoceros* (Fabricius), *Penaeus monodon* (Fabricius) and *Penaeus indicus* (H. Milne Edwards). *Thesis submitted to Andhra University for the award of Ph.D.*

Muriana Francisco, J. G., Valentina Ruiz-Gutierrez, M. Lourdes Gallardo-Guerrero and M. Isabel Minguez-Mosquera. (1993). A study of the lipids and carotenoproteins in the prawns *Penaeus japonicus*. *J. Biochem*, 114(2): 223-229.

Nagabhushanam and G. K. Kulkarni. (1980). Blood glucose in marine penaeid prawns. III. Variation in relation to ovarian growth in *Parapenaeopsis hardwickii* (Miers)(Crustacea, Decapoda, Penaeidae). *Hydrobiologia,* 70: 29-30.

Pillay, K. K. and N. B. Nair. (1973). Observation on the biochemical changes in gonads and other organs of *Uca annulipes, Portunus pelagicus* and *Metapenaeus affinis* (Decapoda:Crustacea) during the reproductive cycle. *Marine Biology*, 18: 167-198.

Rajeswari, G. (1982). Histochemical and Biochemical aspects of the fiddler crab *Uca triangularis* (Milne Edwards) (Crustacea; Decapoda) from Visakhapatnam harbour. *Thesis submitted to the Andhra University for the award of Ph.D.*

Rosa, R. and M. L. Nunes. (2005). Seasonal patterns of nucleic acid concentrations and amino acid profiles of *Parapenaeus longirostris* (Crustacea, Decapoda): relation to growth and nutritional condition. *Hydrobiologia*, 537: 207-216.

Shaikmahumud, F. S. and N. G. Magar. (1957). Studies on the nutritive value of Bombay prawns: Part I. Chemical composition of Prawns. *Jour. Sci. Indust. Res.* (India), 16A: 44-46.

Syama Dayal, J., S. Ahamad Ali and C. Sarada. (2005). Amino acid and biochemical composition of whole body and molt

of the Indian white shrimp. *Indian Jour. of Fisheries*, 52(3): 351-356.

Thomas, G. (1993). Relationship between growth rate and RNA/DNA protein ratio in *Penaeus indicus* (H.Milne Edwards). *CMFRI Special Publ.:* 58-60.

Vijayaraghavan, S and Vijakumaran. M. (1990). Caloric content of *Metapenaeus dobsoni*. *Indian Journal of Fisheries*. 40. pp. 120-126.

Viswanathan, P. G. and Suseela Mathew. (2000). Biochemical composition of Fish and Shell fish. *CIFT, Technology Advisory Series*, *Central Institute of Fisheries Technology, Cochin.*

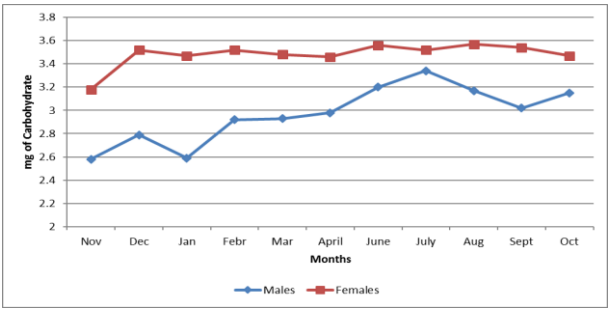

Fig. 1 Month-wise muscle carbohydrates in males and females of *S. melantho*.

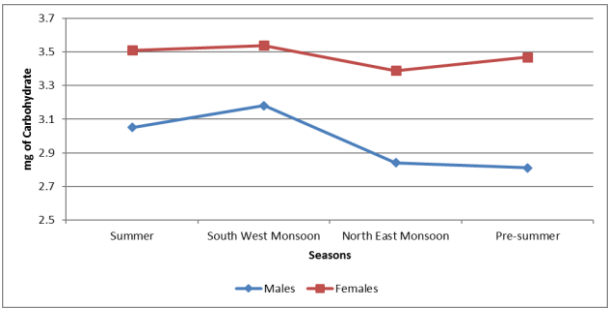

Fig. 2 Season-wise muscle carbohydrates in males and females of *S. melantho*.

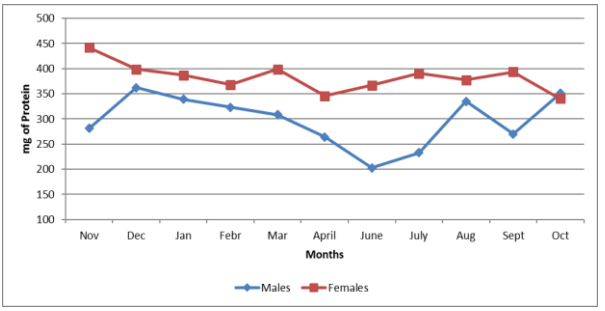

Fig. 3 Month-wise muscle proteins in males and females of *S. melantho*.

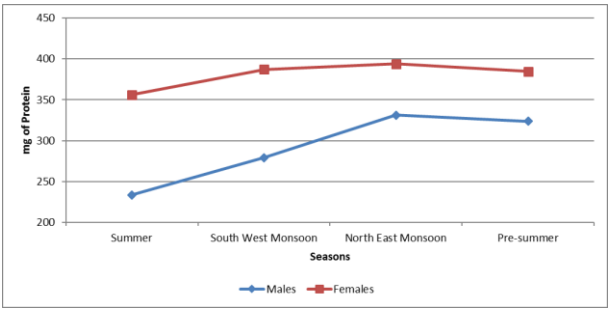

Fig. 4 Season-wise muscle proteins in males and females of *S. melantho*.

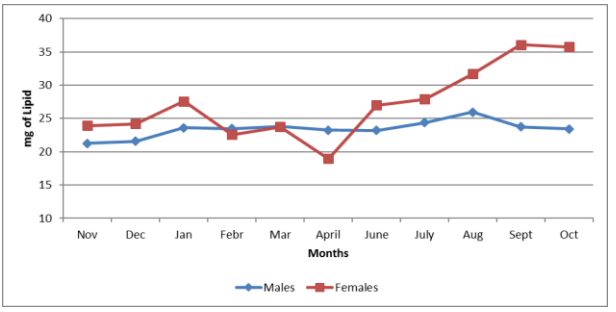

Fig. 5 Month-wise muscle lipids in males and females of *S. melantho*.

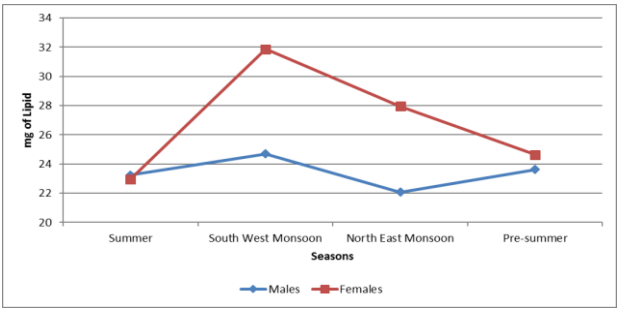

Fig. 6 Season-wise muscle lipids in males and females of *S. melantho*.

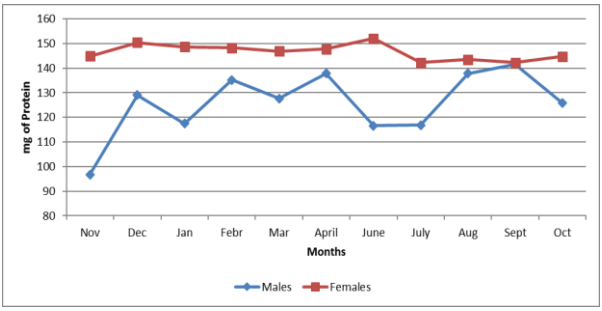

Fig. 7 Water soluble albumins of muscle in males and females of *S. melantho*.

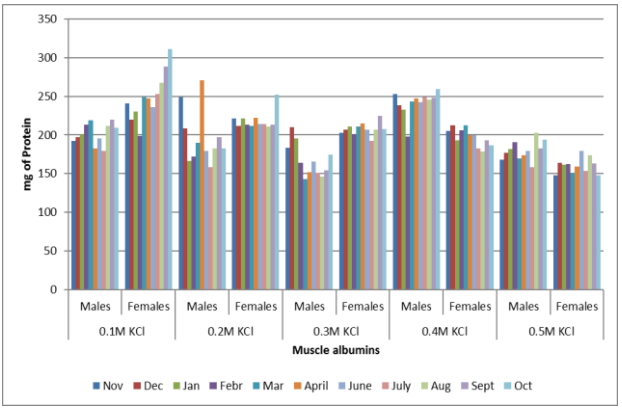

Fig. 8 Muscle albumin proteins of males and females of *S. melantho* at different KCl concentrations.

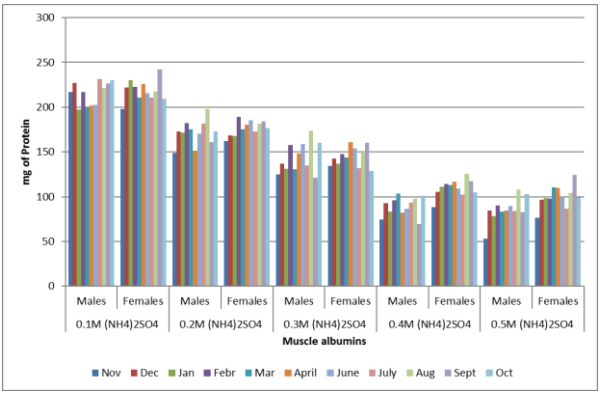

Fig. 9 Muscle albumin proteins of males and females of *S. melantho* at different $(NH_4)_2SO_4$ concentrations.