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Seasonal variation in the proximate body composition of *Macrobrachium dayanum* (Henderson, 1893) (Decapoda, Caridea) from Gho-Manhasa stream, Jammu, North India

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Abstract: The present study describes the seasonal fluctuation in the proximate body composition of different size groups of *Macrobrachium dayanum* and among the sexes MdbI (Size 6.0-20.0 mm), MdbII (Size 21.0-40.0 mm), MdbIII, (Size 41.0-60.0 mm Male) and MdbIV (Size 41.0-60.0 mm Female). The results revealed that average moisture and protein content in muscles of *M. dayanum* was found to be maximum (79.42±0.59% and 16.98±0.51%) in lower size group MdbI (6.0-20.0 mm) and lowest (78.09±0.82% and 16.36±0.72%) in the adult female group. The average lipid and ash content was found to be highest in adult males MdbIII (1.97±0.72% and 2.63±0.53%). The highest muscle protein and lipid content were recorded in all the groups of *M. dayanum* during spring and early winters. In the mature stages, fall in the muscle protein and lipid coincided with their spawning season when gonads were in advanced stage of maturity. Ash content did not provide any significant difference among different groups with respect to the season during the present study.

Keywords: *Macrobrachium dayanum*, Seasonal variation, Size groups, Body composition, Jammu.

Introduction

The edible crustaceans are considered as delicious food throughout the world and thus command a market in both domestic and international markets. In India, there are 18 species of prawns and three species of crabs, which are commercially important (Jana and Jana, 2003). In recent years, freshwater prawn viz. *Macrobrachium* has emerged as an accepted candidate for aquaculture. Out of 125 *Macrobrachium* species, only a small number (*M. rosenbergii*, *M. malcolmsonii*, *M. birmanicum*, *M. choprai* etc.) have been exploited from the culture point of view. In addition to the above-mentioned species, *M. dayanum* has been rendered as a notable species withstanding good economic potential (Jhingran, 1982). The species is recorded to attain a maximum size ranging from 84 mm (female) to 92 mm (male) (New et al., 2000) and in Jammu (India) a maximum size up to 65 mm and 60 mm has been reported by Kailoo (1984) and Bakhtiyar (2008). The palatable size of the prawn though small when compared to other cultivable species of prawn, the absolute uniqueness of *M. dayanum* lies in the fact that it completes whole of its life cycle in freshwater as compared to its counterparts who have to spend a part of their life cycle in brackish or sea water thus, making the culture of *M. dayanum* practically convenient and economically notable.

As the prawns have become the major sources of animal protein to low income earners due to its low priced availability (Adeyeye and Adubiaro, 2004), it has therefore become necessary that studies of the nutritive value of prawns or shrimps be carried out. Besides biotic and abiotic factors, extensive studies have also been carried out on growth performance during the larval development of many decapods mainly in terms of weight, size, moult frequency and development rate time (Lovett and Felder, 1988; Nurnadia et al., 2011).

Table 1. Seasonal variations in the moisture content of the freshwater prawn *Macrobrachium dayanum*.

Months	MdbI	MdbII	MdbIII	MdbIV
January	80.43±0.43^{a}	79.46±0.12^{a}	78.60±0.96^{abcd}	78.53±0.95^{bc}
February	79.87±0.07^{abc}	79.25±0.25^{ab}	78.40±0.56^{bcd}	77.81±0.25^{cd}
March	79.63±0.63^{bc}	79.14±0.22^{ab}	79.17±0.41^{ab}	78.26±0.07^{c}
April	78.48±0.32^{e}	78.23±0.16^{d}	79.32±0.26^{a}	77.54±0.20^{d}
May	78.74±0.26^{de}	78.56±0.13^{cd}	77.85±0.33^{d}	78.46±0.42^{c}
June	79.80±0.30^{abc}	79.48±0.21^{a}	78.23±0.26^{cd}	78.21±0.30^{cd}
July	79.39±0.21^{bcd}	78.91±0.44^{bc}	79.30±0.17^{a}	77.91±0.43^{cd}
August	79.13±0.20^{cde}	79.14±0.14^{ab}	79.14±0.58^{ab}	79.14±0.35^{ab}
September	79.51±0.24^{bc}	79.18±0.09^{ab}	79.33±0.33^{a}	79.42±0.08^{a}
October	79.68±0.63^{bc}	78.89±0.14^{bc}	78.79±0.14^{abc}	78.19±0.20^{cd}
November	79.97±0.36^{ab}	77.84±0.21^{e}	76.43±0.16^{e}	76.79±0.25^{e}
December	79.59±0.59^{bc}	78.43±0.22^{d}	76.47±0.25^{e}	76.89±0.11^{e}
Mean	79.42±0.59	78.87±0.52	78.42±1.06	78.09±0.82

Values having the same super script in a column do not differ significantly (P>0.05)

However, still biochemical composition has been suggested to be a more relevant indicator of growth during the larval development when the nutritional values of different natural or experimental diets are assessed (Ceccaldi, 1982).

In the case of the present study, nutritional status of the *M. dayanum* from Jammu region is lacking though it is eaten by the local populace. Thus the objective of this study is to interpret nutritional status and the variation in the body composition of different sizes of locally available freshwater prawn *M. dayanum* from different seasons of the year from Gho-Manhasa stream of Jammu, Northern India, which is considered to be one of the good habitats of local freshwater prawn.

Materials and Methods

Collection and transportation: For biochemical analysis live specimens of *M. dayanum* were collected from Gho-Manhasa stream (32.56°N and 74.95°E) because of easy access and availability in abundance throughout the year. Since the stream is located at a short distance (14 to 15 Km), live specimens could be brought safely with less stress to the laboratory where they were analyzed for their proximate body composition. This analysis was performed over a period of one year (January 2004-December 2004). For the analysis of main body constituents the *M. dayanum* were divided into four groups on the basis of their size as:

1. MdbI(Size 6.0-20.0 mm)
2. MdbII (Size 21.0-40.0 mm)
3. MdbIII (Size 41.0-60.0 mm Male)
4. MdbIV (Size 41.0-60.0 mm Female)

Proximate body composition: The sample of muscles was accurately weighed (1 gm) and was dried in hot air oven at 105±1°C to constant weight. The difference between the initial weight and the final weight was used to determine the moisture constant (AOAC, 1999). The protein content of the muscles was estimated following Lowry et al. (1951). The total lipid content was determined by the method of Folch et al. (1957). Ash content was estimated by heating the samples in a muffle furnace at 550°C for about 3 hours (AOAC, 1999).

Statistical Analysis: The data was analyzed to test the level of significance using Microsoft Excel 2003 and SPSS (12.0 Version, Chicago, USA). The level of significance was tested by one way ANOVA, Duncan Post Multiple comparisons (Duncan, 1955).

Results

Proximate analysis of four major components viz., moisture, protein, lipid and ash of the muscles of *M. dayanum* during the present study exhibited a well-marked seasonal variation and the same seems to be correlated with age and size (Tables 1-4 and Fig. 1).

Moisture: Seasonal variation in the moisture contents of the MdbI, MdbII, MdbIII and MdbIV during the present study are depicted in Table 1. MdbI recorded minimum value (78.48±0.32%) of moisture in the month of April

Table 2. Seasonal variations in the protein content of the freshwater prawn *Macrobrachium dayanum*.

Months	MdbI	MdbII	MdbIII	MdbIV
January	16.82±0.12^{def}	16.20±0.08^{cd}	16.70±0.34^{c}	15.91±0.27^{c}
February	16.53±0.24^{fg}	16.85±0.18^{b}	16.17±0.07^{d}	15.69±0.06^{c}
March	16.67±0.22^{efg}	16.28±0.22^{c}	15.97±0.13^{de}	15.45±0.27^{c}
April	17.89±0.29^{a}	17.42±0.07^{a}	15.65±0.27^{f}	16.72±0.27^{b}
May	17.63±0.24^{ab}	17.56±0.13^{a}	17.01±0.07^{b}	17.21±0.20^{ab}
June	16.56±0.34^{fg}	16.13±0.07^{cde}	16.77±0.13^{bc}	16.86±0.14^{b}
July	16.72±0.13^{efg}	15.92±0.27^{de}	16.59±0.06^{c}	15.61±0.89^{c}
August	16.28±0.06^{g}	15.87±0.17^{e}	15.92±0.25^{def}	15.82±0.20^{c}
September	17.22±0.38^{bcd}	16.06±0.06^{cde}	15.71±0.07^{ef}	16.02±0.06^{c}
October	17.48±0.08^{abc}	16.77±0.23^{b}	16.89±0.15^{bc}	16.84±0.15^{b}
November	17.05±0.14^{cde}	17.61±0.07^{a}	17.78±0.06^{a}	17.51±0.34^{a}
December	16.95±0.41^{def}	17.00±0.22^{b}	17.54±0.08^{a}	16.67±0.11^{b}
Mean	16.98±0.51	16.64±0.64	16.56±0.68	16.36±0.72

Values having the same super script in a column do not differ significantly (P>0.05)

Table 3. Seasonal variations in the lipid content of the freshwater prawn *Macrobrachium dayanum*.

Months	MdbI	MdbII	MdbIII	MdbIV
January	0.52±0.09^{g}	1.28±0.13^{f}	1.89±0.15^{cd}	1.64±0.07^{d}
February	0.68±0.06^{ef}	1.63±0.11^{de}	1.23±0.19^{fg}	1.51±0.29^{d}
March	0.81±0.14^{de}	1.97±0.08^{bc}	1.11±0.12^{g}	1.62±0.20^{d}
April	1.44±0.21^{ab}	1.90±0.15^{bcd}	1.53±0.20^{def}	2.02±0.21^{c}
May	1.49±0.14^{a}	1.84±0.40^{bcd}	1.66±0.44^{de}	1.09±0.09^{e}
June	1.42±0.06^{ab}	1.80±0.22^{cd}	2.04±0.06^{c}	2.13±0.11^{c}
July	1.11±0.04^{c}	2.16±0.14^{b}	1.86±0.11^{cd}	2.18±0.22^{c}
August	1.02±0.08^{cd}	1.37±0.16^{ef}	1.72±0.04^{cde}	0.92±0.06^{ef}
September	0.85±0.03^{de}	1.72±0.07^{cd}	1.39±0.23^{efg}	0.76±0.10^{f}
October	1.23±0.34^{bc}	2.15±0.10^{b}	2.86±0.09^{b}	2.04±0.06^{c}
November	1.52±0.05^{a}	2.68±0.18^{a}	3.09±0.10^{ab}	3.26±0.25^{b}
December	1.15±0.08^{c}	2.15±0.09^{b}	3.29±0.25^{a}	3.72±0.05^{a}
Mean	1.10±0.34	1.89±0.39	1.97±0.72	1.91±0.86

Values having the same super script in a column do not differ significantly (P>0.05)

and the maximum value (80.43±0.43%) in January. The data reveals significant variation in the moisture content of the muscles of wild caught *M. dayanum* throughout the period of investigation. Although, moisture content was not observed to follow a sharp regular trend but a decline in moisture content of MdbI was prominent in April, June and August, respectively.

The moisture content in the size group MdbII ranged from 77.84±0.21% to 79.48±0.21% in November and June, respectively. Moisture content of MdbII decreased from January to March and from September to November. While in summers and extreme winters, it showed an increasing trend. Above and beyond a significant difference (P<0.05) in moisture content was recorded between different months throughout the year.

The moisture content in adult males (MdbIII) was observed to range between 76.43±0.16% to 79.33±0.33% in the months of November and September, respectively. The minimum value of moisture content observed in the month of November did not differ significantly (P>0.05) with the values observed in the month of December (76.47±0.25%). Mean values of moisture content

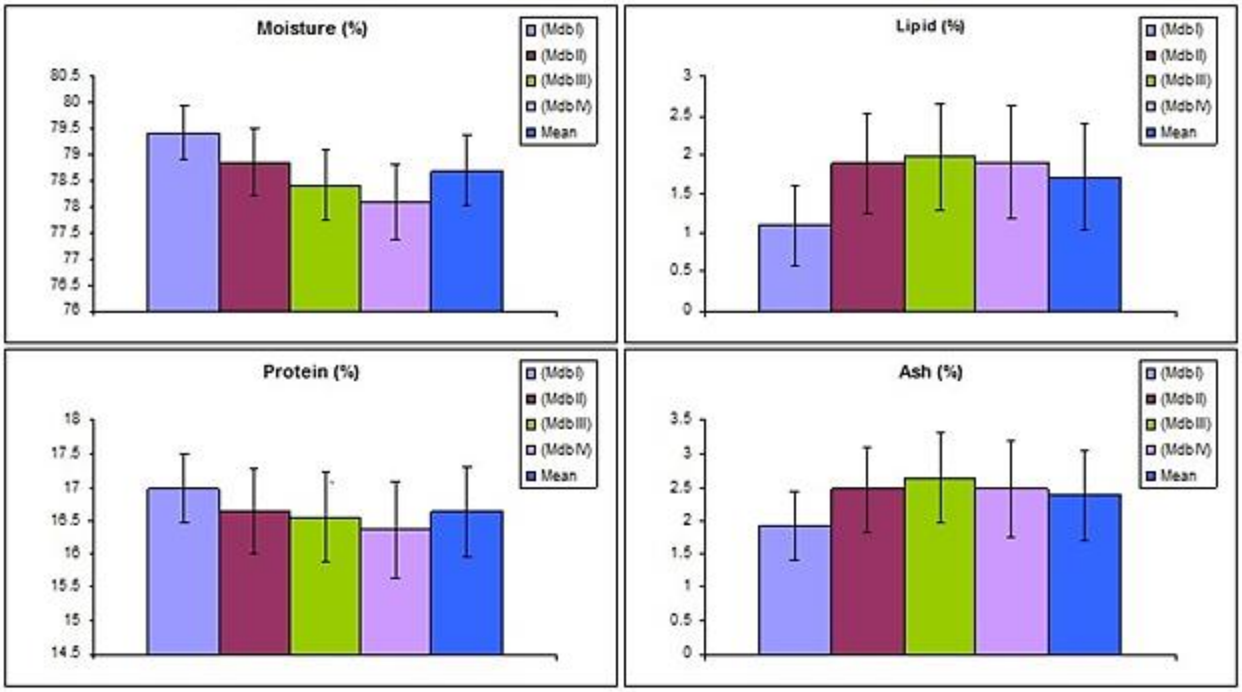

Figure 1. Graphical representation of mean values of the body components in four size groups of *Macrobrachium dayanum*.

computed for MdbIV (adult females) varied from 76.79±0.25% to 79.42±0.09% during the months of November and September, respectively. In the present study, it was observed that moisture content in muscle was found to decrease with age, however variation in the moisture content among adult males and females showed no significant ($P>0.05$) difference. When moisture content data was clubbed with each other it was observed that all groups conferred a mean of 78.70±0.94% moisture content (Fig. 1).

Protein: Seasonal variation in the muscle protein contents of the MdbI, MdbII, MdbIII and MdbIV during the present study are depicted in Table 2. The muscle protein of MdbI which ranged from 16.28±0.06% (August) to 17.89± 0.29% (April) recorded an increase during spring and post monsoon (October) followed by a progressive decline in winter season (January and February) and monsoon (July and August). The mean protein content of the year was recorded to be 16.98 ±0.51%.

Mean value of muscle protein in MdbII ranged from 15.87±0.17% (August) to 17.61±0.07% (November). The protein content exhibited a gradual increase from winter (January) towards spring and summer (April and May) and subsequent decrease towards monsoon (August, September) and winter (January), respectively. Mean protein content of this size group throughout the year was recorded to be 16.64±0.64%.

Muscle protein of adult males (MdbIII) ranged from 15.65±0.27% during spawning season (April) and 17.78±0.06% in post spawning and post monsoon (November). Protein content recorded an increase in May and from September to November and a decrease from June to September. However, the annual mean protein content of this group was recorded to be 16.56±0.68%.

Muscle protein of adult females (MdbIV) of M. dayanum varied from 15.45±0.27% in March (spawning period) and 17.51 ± 0.34% in November (Resting phase). The increase in protein content occurred in spring and early summer (March to May) and decreased in monsoon. The annual mean protein content of this group was recorded to be 16.36±0.72%.

Mean muscle protein content computed in *M. dayanum* (Fig. 1) revealed that muscle protein content ranged from 16.28±0.06% to 17.89±0.29% with a mean of 16.98±0.51% for MdbI, from 15.87±0.17% to 17.61± 0.07% with a mean of 16.64±0.64 in case of MdbII, from 15.65±0.27% to 17.78±0.6% with a mean of 16.56±0.68% in case of MdbIII and from 15.45±0.27% to 17.51±0.34% with a mean of 16.36±0.72% in case of MdbIV. The total mean protein content as determined on wet weight basis in all the groups was recorded 16.63±0.67% with significantly ($P<0.05$) higher protein values in small sizes which were found to decrease with increase in size (Fig. 1).

Table 4. Seasonal variations in the ash content of the freshwater prawn *Macrobrachium dayanum*.

Months	MdbI	MdbII	MdbIII	MdbIV
January	1.83±0.11[bc]	2.91±0.18[a]	2.88±0.27[abc]	2.01±0.10[de]
February	2.52±0.21[a]	2.21±0.18[cde]	2.42±0.39[bcde]	3.16±0.15[a]
March	2.41±0.06[a]	2.76±0.23[ab]	3.30±0.21[a]	3.23±0.22[a]
April	2.02±0.16[b]	2.32±0.17[cd]	2.79±0.49[abcd]	2.25±0.06[cd]
May	1.82±0.05[bc]	2.51±0.11[abc]	2.87±0.49[abc]	2.77±0.25[b]
June	1.79±0.11[c]	2.59±0.15[abc]	2.14±0.12[de]	2.19±0.14[d]
July	1.63±0.07[c]	2.52±0.10[abc]	2.14±0.70[de]	2.53±0.10[bc]
August	2.58±0.17[a]	2.93±0.45[a]	3.04±0.17[ab]	3.15±0.15[a]
September	2.45±0.09[a]	2.76±0.36[ab]	2.73±0.22[abcd]	3.17±0.28[a]
October	1.15±0.05[d]	1.93±0.12[de]	3.19±0.19[a]	1.29±0.14[f]
November	1.10±0.06[d]	1.87±0.13[e]	1.91±0.20[e]	1.83±0.06[e]
December	1.79±0.17[c]	2.39±0.17[bc]	2.24±0.41[cde]	2.09±0.15[de]
Mean	1.92±0.49	2.47±0.38	2.63±0.53	2.47±0.62

Values having the same super script in a column do not differ significantly ($P>0.05$)

Lipid: Seasonal variation in the lipid contents of the MdbI, MdbII, MdbIII and MdbIV during the present study are presented in Table 3. During the present study lipid content in the muscles of MdbI was observed to vary from minimum 0.52±0.09% (January) to a maximum 1.52± 0.09% (November) which apparently did not vary significantly ($P>0.05$) from the values observed in April (1.44±0.21%), May (1.49±0.14%) and June (1.42±0.06%) respectively.

Lipid content of MdbII recorded minima of 1.28±0.13% (January) and maxima of 2.68±0.18% (November). The lipid content showed a declining trend towards winter (January) and monsoon (August), whereas, it marked an increase during spring (March and April) and post monsoon (March-July and September-November). The minimum value of lipid recorded in the month of January (1.28±0.13%) did not differ significantly ($P>0.05$) from the value observed in the month of August (1.37±0.16%).

The lipid content in adult males recorded minimum (1.11±0.12%) during the March and a maximum of 3.29±0.25% in December. The lipid content of muscles in adult males was observed to remain low during spawning season (February-April) whereas higher values were observed during resting and recoupment phase (October-December).

Lipid content of muscles of adult females (MdbIV) recorded 0.76±0.10% (September) which did not differ significantly ($P>0.05$) with the value recorded in August (0.92±0.06) and a crest at 3.72±0.05% in December. Furthermore, the muscles lipid content recorded an all-time low value during post monsoon months (August-September) and maximum during post spawning season (November-December).

Mean muscle lipid content values (Fig. 1) varied from 0.52±0.09% to 1.52±0.05% with a mean of 1.10±0.34% in MdbI, from1.28±0.13% to 2.68±0.18% with a mean 1.89±0.39% in MdbII, from 1.11±0.12% to 3.29±0.25% with a mean of 1.97±0.72% in MdbIII and from 0.76±0.10% to 3.72±0.05% with a mean of 1.91±0.86% in MdbIV, respectively. The lipid content was found to be significantly low ($P<0.05$) in MdbI and thereafter muscle lipid content increased in MdbII, MdbIII and MdbIV with no significant difference. Finally from the recorded mean of all the groups it was concluded that *M. dayanum* contain overall lipid content of 1.72±0.71% (Fig. 1) throughout the year.

Ash: Seasonal variation in the ash contents of the MdbI, MdbII, MdbIII and MdbIV during the present study are depicted in Table 4.The ash content of MdbI ranged between 1.10±0.06% (minima) in November to 2.58± 0.17% (maxima) in August. The minimum value recorded during the month of November did not differ significantly ($P>0.05$) from the value recorded during the month of October (1.15±0.05%).

In MdbII, the minimum value (1.87±0.13%) was recorded in the month of November and the maximum value (2.93±0.43%) was found during the month of

August. Ash content in adult males MdbIII ranged between 1.91±0.20% (minimum) to 3.30±0.21% (maximum) in the months of November and March respectively.

Ash content of MdbIV also varied between 1.29±0.14% (October) and 3.23±0.22% (March). Mean values of ash content furnished a range varying from 1.10±0.06% to 2.58±0.17% and a mean of 1.92±0.49% in MdbI, from 1.87±0.13% to 2.93±0.45% giving a mean of 2.47±0.38, from 1.91±0.20 to 3.30±0.21 with a mean of 2.63±0.53 in MdbIII and from 1.29±0.14 to 3.23±0.22 with a mean of 2.47±0.62 in MdbIV, respectively. The ash content was also found to be significantly low in MdbI and increased in higher groups with no significant difference among them. The mean of all recorded data of ash in all groups revealed that *M. dayanum* contains 2.37±0.58% of ash content (Fig. 1).

Discussion

From the present study, it emerges that during the winter season moisture content marks an increase while lipid content showed a declining trend. This inverse relationship might be due to low temperature, low feeding rate, and high energy demand to maintain body temperature and to cope up with food scarcity in winter. Similar results have been obtained by Dinakaran et al. (2009) while working on the proximate composition of edible palaemonid prawn *Macrobrachium idae*. Thus an inquisitive study of Tables 1 and 3 pointed out an increase in the moisture content accompanied by a decrease in lipid content in all the groups under investigation (MdbI, MdbII, MdbIII and MdbIV).

Overall mean range of moisture of different groups showed a decrease in the content of moisture with the growth of organism. Similarly Munz and Morris (1965) suggested that growth induces a decrease in water content of *Eptatretus stoutii*. Their results further indicated that annual variations in the moisture content were more pronounced in mature specimens than immature.

Watanabe et al. (1992) while working on white abalone observed high moisture content in its muscles during the spawning period which thereafter was observed to decrease to lowest. A similar trend has been recorded by Zaboukas et al. (2006) wherein water content of somatic tissues of Atlantic bonito increased with gonadal maturation and decreased after spawning and was lowest in immature bonitos.

Fish (Fin fish and shell fish) protein occupies an important place in human nutrition as it provides for an alternate source of animal protein. It has high digestibility, high unsaturated fats, besides biological and growth promoting value (Nargis, 2006). Seasonal variation in the protein content of MdbI, MdbII, MdbIII and MdbIV as evident in table 2 precisely deliberate on the very low protein content of MdbI and MdbII during the month of August (monsoon) and the maximum value of protein during April (MdbI) and November (MdbII). Such remarkably low protein content in monsoon may be attributed to inadequate food availability due to heavy rains, the rise in the level of water, low density of plankton and organic food. The low protein content in August did not differ significantly with the values recorded in June and July.

However, the higher value recorded in the month of April in the case of MdbI was not observed to differ significantly from the values observed in October. The high values of protein content recorded in MdbII in the month of November did not differ significantly from the values recorded in the month of May and November. The variation in protein content in case of immature specimens may be attributed to two factors viz. food availability and temperature. Maximum diversity of plankton during the month of spring and a minimum during monsoon has been reported by (Collins, 1999; Langer et al., 2007; Langer et al., 2011). Besides dipteran population also recorded a declining trend during monsoon (Sawhney, 2004) although they contribute to the diet of prawns. Therefore, in the present study higher muscle protein content during spring season (April-May) to a considerable extent can be ascribed to food availability in the natural habitat.

However, the protein content of MdbIII and MdbIV reveals that muscle protein experiences a fall in the months of February-April and August-September in the case of MdbIII and a fall in the month of February upto March and from July to August in case of MdbIV. The fall in the protein content coincides with their spawning season when the gonads are in an advanced stage of maturity. In MdIV, the protein content was observed to show a remarkable increase during late spring (April), early summer (May) and from September to November when gonads were in the initial stages of maturity. These observations are in conformity with the findings of many workers (Langer et al., 2008; Samyal et al., 2011; Langer et al., 2013). The variation in protein content of mature specimens (MdbIII and MdbIV) may thus be attributed to gonads maturation and spawning season besides the food availability and environmental factors, which in one or the other way affect almost all the physiological features of any organism.

The quintessence of high muscle protein content observed in all the studied groups of *M. dayanum* during spring and early winters happens to be due to active feeding, optimum temperature regime and maximum availability of food as algal blooms and plankton during this period when they acquire maxima. This adequate influx of energy is not only used for maintenance of ovarian development but also for other metabolic activities as well. Rosa and Nunes (2003) have also reported significant increase in the protein content in muscle of deep sea decapods, *Aristeus antennatus* during winter and early spring. Love (1970) documented that the building up of gonads during gonadal growth is always accomplished at the expense of body proteins thus supporting the present observations. The seasonal (intra-annual) variations in muscle protein content may be coupled with the changes in the feeding activity as starvation leads to loss of muscle protein in deep sea decapod species (Dall, 1981). However, mean annual protein content in all size groups exhibit a declining trend when the animal increases in size and a difference between male and female specimens was visible. The higher protein content in lower size groups may be due to increased protein synthesis during active growth phase and has also been observed by many workers (Sriram and Reddy, 1977; Achuthankutty and Parulekar, 1984; Tanuja, 1996; Dinakaran and Sundarapandian, 2009; Dinakaran et al., 2010; Devi et al., 2015). In case of *M. idae* and *M. Scabriculum* also the greater variation in protein content with respect to the size group was noticed and the protein content was found to be higher in younger groups and in males than females (Sriram, 1978; Dinakaran et al., 2010). This may be attributed that some amount of Protein is being spared for the development of gonadal activity i.e., developing of eggs in berried females.

In the case of lipid content, MdbI revealed an evident peak during spring, summer and early winter (April, May and November) and a decline in monsoon (September) and winters (January). In MdbII, the lipid content showed a declining trend towards January and August to September and an increase during March to July and September-November. In this context, it seems that variation in lipid content is totally environment dependent although food availability does cast its effect on the said feature. Likewise in mature specimens (MdbIII and MdbIV), low lipid content was observed during February-March (Spring) in MdbIII and from January to May in MdbIV while lipid content recorded higher values during October to December in MdbIII and MdbIV. Similar results have been earlier documented by Jonsson and Jonsson (2005) and Nargis (2006). In mature specimens low lipid content was recorded during the period when most of the adults of *M. dayanum* undergo breeding and show reduced feeding intensity and enhanced metabolic rate. Reduction in the amount of lipid content in the muscles for the development and maturation of gonads has also been well reported by many workers (Dinakaran and Sundarapandian, 2009; Dinakaran et al., 2010; Langer et al., 2013; Devi et al., 2015)

The reproduction cycle of *M. dayanum* has been well discussed by Kailoo (1984) wherein the authors put forth the biannual spawning behaviour of *M. dayanum*. The first breeding period is a prolonged one extending from February-May while other one i.e. second breeding period is short (August-September). Young specimens have low lipid content than their adult counterparts and the similar results on variation in lipid content among mature and immature specimens have also been reported in past by Shaikhmahmud and Magar (1957) also obtained higher lipid content in mature females of *Parapanaeopsis stylifera* when compared to immature ones. Similar results were also reported in *M. scabriculum* by Tiwary (2009) and in *M. idae* by Chandra (2009).

The results of all the groups, when put together, indicated an increase in ash content with an increase in the size of prawn. The results reveal that protein and ash contents behave antagonistically while ash and lipids behave synergistically. Contrary to this Lupatsch et al. (1998) reported no change in protein and ash content with an increase in fish size. The results of present study further reveal that in immature groups, ash content tends to increase while as in mature groups, ash content tends to decrease. While as in immature groups, minima of ash was recorded in the month of November and maxima in August, mature specimens recorded a minima in the month of November and October and maxima in the month of March. Such variability in ash values could be attributed due to the differential requirement of minerals with respect to different seasons.

The values recorded for moisture content (78.70± 0.94%) in *M. dayanum* during the present study were almost similar to values reported in *M. rosenbergii* (78.29%) and *Scylla serrata* (79.23%) (Gopakumar, 1993).

Chiou et al. (2001) reported average moisture content i.e. 77.7±1.0% in the muscles of small abalone which corresponds to the values observed in the muscles of *M. dayanum* in the present work. Moreover, Olsson et al. (2003) found average water content in the muscles of both wild and farmed halibut which ranged between 70.6%± 1.0% to 79.2±0.9%, respectively.

Mean of the protein content (16.63±0.67%) as tabulated on wet weight basis in Figure 1 is very similar to the earlier reports on the same species reported by Langer et al. (2008) who found a protein level of 83.89% (on dry weight basis) and 17.5% (wet weight basis) in the muscles of *M. dayanum*. Gopakumar (1993) reported high protein content in the muscle of adult giant fresh-water prawn, *M. rosenbergii* (22%). Similarly, Perrone et al. (2003) also reported high protein content in the tissues of amphipod, *Eurythenes gryllus* (39-53% dry weight). Similarly Jafri et al. (1964) reported 17.18 % protein content in the muscles tissues of freshwater fish *Labeo rohita*, 14.37% in *Puntius sarana*, 15.7% in *Mystus aor*. Chiou et al. (2001) reported high crude proteins (18.0±0.7%) in the muscles of small abalone, *Haliotis diversicolor*. From the above findings it can be asserted that protein content of *M. dayanum* (16.63±0.67%) recorded in the present study is in close conformity with the protein content recorded by many workers in crustaceans and fishes.

The mean lipid content (1.72±0.71%) in the muscles of *M. dayanum* in the present study matches well with other crustaceans. A large number of workers estimated lipid content of muscles in decapod crustaceans (Barclay et al., 1983; Sureshkumar and Kurup, 1998; Cavalli et al., 2001; Wouters et al., 2001; Rosa and Nunes, 2003; Langer et al., 2008). The mean value of ash content (2.37±0.58%) found in the muscles of *M. dayanum* is higher than the ash values reported for *M. rosenbergii* (0.37%), *Scylla serrata* (1.39%) (Gopakumar, 1993) and *M. rosenbergii* (1.62-1.84%) (Reddy et al., 2013).

The differential variation in the biochemical composition of the muscles might be attributed to many factors viz. the differences in the sex of prawn, environmental factors, maturity of gonads/spawning time, food availability and genetic factors. Similar factors have also been put forth by other authors especially in fishes and crustaceans (Love, 1957; Roustainian and Kamarudin, 2001; Lemos and Phan, 2001; Rosa and Nunes, 2003; Dinakaran et al., 2009; Langer et al., 2013; Devi et al., 2015).

From the above findings, it can be aptly concluded that *M. dayanum* is a good source of protein, minerals and lipid and is highly recommended as an ideal food item of diet in general besides being a good candidate for aquaculture.

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