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Nutritional Status of Fresh Water Crab Maydelliathelphusa Masoniana (Henderson) From Gho-Manhasan Stream, Jammu (J&K), North India

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Abstract: **The present study aims to analyse the nutritional status of edible meat in adult male and female of the fresh water crab, *M.masoniana* with respect to the proximate composition (protein, lipid, moisture, ash) during two year study period. Protein & lipid exhibit minimum values during spawning period and maximum during non-spawning period. Moisture exhibited inverse relationship with proteins & lipids. Ash content showed irregular trend with no definite relationship with spawning activity. The aim of the present study was to evaluate the nutritive value of *M. masoniana* with respect to seasonal variations viz spawning, post spawning and post monsoon periods, with an aim to assess its potential as an edible and culture candidate species.**

Keywords: **Proximate composition, protein, lipid, moisture, ash.**

1. INTRODUCTION

Crabs are the basic components of the ecosystem and they are consumed as food in many countries. Edible crustaceans such as crabs, prawns, shrimps, crayfishes and lobsters comprise major sources of nutritious food for humans. The nutritive value of crustaceans depend on their biological constituents such as proteins, carbohydrates, lipids, vitamins & minerals. Crabs have exceptional and scrumptious taste as compared to fish & molluscs and rank third after shrimps and lobsters for their revered delicacy and value of fishery they support (Savad & Raghavan, 2001). Crab meat contains many nutrients and is an excellent source of high quality proteins, vitamins and minerals. It has been reported that a large number of potamids and parathelphusids are consumed in Thailand. Yeoetal (2008) reported that potamids are consumed by natives of South America to improve health and cure physical injuries. Many curative properties are attributed to crab meat in view of the fact that it is used to treat asthma and chronic fever (Raja, 1981). Crab fishery in India is fast developing and there is immense scope for crab meat due to its delicacy and nutritional richness. Because of their delicacy and large size, crabs are in great demand in both National & International markets.

In India, a total of 12 marine/brackish water species belonging to six genera, viz *Scylla, Portunus, Charybdis, Matuta, Varuna* and *podophthalmus* are of commercial value. Proximate composition, amino acids and cholesterol contents have been extensively studied in marine crabs from India (Srinivasagam, 1979; Sudhakar *et al*, 2009, 2011). Limited research, however has been focused on freshwater crabs (Sayyad *et al*, 2008; Sengul and Zeliha, 2011). The fresh water crab, *M. masoniana* (Henderson) abundant in Gho-manhasan stream of Jammu region (J&K) India, offers a cheap source of animal protein to the local dwellers. In spite of its abundance and commercial value, very less data is on record (Manhas 2012). The knowledge of the biochemical composition of any edible organism is extremely important since the nutritive value is reflected in biochemical contents as stated by Nagabhushanam and Mane (1978).

Presently, an attempt has been made to evaluate the nutritive value of the edible meat of adult male and female *M. masoniana* and to establish its relationship with spawning activity. Such observations, in long run shall be of definite help in chalking out their culture strategies in general and harvesting strategies in particular.

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2. MATERIAL AND METHODS

Crabs were collected from their natural habitat, at Gho-Manhasan stream, at a distance of about 12 Kms from University of Jammu, Jammu ($32^0$67' Lat N; $74^0$79' E). During the present course of study, only adult male and female crabs, of carapace width 5-6 cm were selected and the juveniles were again released into their natural habitat. The analaysis was performed for a period of two years (Jan, 2012 to Dec, 2013). Soon after catching, crabs were brought to the laboratory and male and female crabs were segregated. The crabs were then dissected for body meat.

The organic constituents of each component were determined by standard methods such as total proteins (Lowry *et al*, 1951); Lipid (Folch *et al*, 1956), Moisture and Ash (Standard method of AOAC, 1999). The results were expressed on dry weight basis.

3. RESULTS

The seasonal variations in the protein, lipid, ash and moisture content in female crabs have been shown in Table- 1

Table 1: Seasonal Variations in the proximate composition of Body meat of female crab during two years of study period (Jan 2012-Dec 2013), The results are expressed on dry weight basis.

Periods	Months	Proteins (Mean±SD)			Lipids (Mean±SD)			Ash (Mean±SD)			Moisture (Mean±SD)		
		I Yr	II Yr	Mean	I Yr	II Yr	Mean	I Yr	II Yr	Mean	I Yr	II Yr	Mean
Spawning Period	June	50.77± 0.41	52.66± 0.40	51.71± 0.40	4.44± 0.51	4.24± 0.41	4.34±0. 46	6.54± 0.35	6.84± 0.35	6.69±0. 35	80.98± 1.57	81.64± 1.62	81.31 ±1.59
	July	48.51± 0.12	49.51± 0.15	49.01± 0.27	3.99± 0.32	3.90± 0.22	3.94±0. 27	6.98± 0.41	6.90± 0.40	6.94±0. 40	84.23± 1.60	84.26± 1.80	84.24 ±1.70
	Dec	46.05± 0.82	48.05± 0.85	47.05± 0.83	4.08± 0.40	4.06± 0.20	4.07±0. 30	7.75± 0.34	7.85± 0.43	7.80±0. 38	82.56± 1.40	82.24± 1.20	82.40 ±1.30
	Jan	54.75± 0.47	52.25± 0.45	53.50± 0.46	4.22± 0.54	4.32± 0.64	4.27±0. 59	8.54± 0.33	8.64± 0.44	8.59±0. 38	82.20± 1.65	82.10± 1.63	82.15 ±1.64
Post Spawning Period	Feb	56.03± 0.24	55.03± 0.22	55.53± 0.23	4.76± 0.87	4.67± 0.81	4.71±0. 84	9.67± 0.33	9.65± 0.45	9.66±0. 39	79.61± 1.55	80.16± 2.53	79.88 ±2.04
	March	62.16± 0.30	63.15± 0.40	62.65± 0.35	5.49± 0.38	5.35± 0.35	5.42±0. 36	12.35 ±0.72	12.24 ±0.62	12.29± 0.67	78.13± 1.45	79.14± 1.54	78.63 ±1.49
	April	60.50± 0.50	61.50± 0.50	61.00± 0.50	5.03± 0.28	5.05± 0.30	5.04±0. 29	8.85± 0.23	8.65± 0.22	8.75±0. 22	78.53± 1.40	78.23± 1.42	78.38 ±1.41
	May	57.54± 0.42	56.54± 0.44	57.04± 0.43	4.84± 0.63	4.62± 0.52	4.73±0. 57	7.17± 0.30	7.27± 0.32	7.22±0. 31	79.28± 1.61	79.61± 1.55	79.44 ±1.58
Post Monsoon Period	Aug	50.98± 0.71	50.52± 0.16	50.75± 0.43	5.45± 0.43	5.35± 0.34	5.40±0. 38	6.78± 0.52	6.75± 0.48	6.76±0. 50	81.30± 1.53	82.32± 1.63	81.81 ±1.58
	Sept	54.29± 0.32	54.30± 0.32	54.29± 0.32	5.85± 0.46	5.65± 0.44	5.75±0. 45	9.89± 0.73	9.90± 0.83	9.89±0. 78	81.90± 1.61	81.50± 1.52	81.70 ±1.56
	Oct	55.85± 0.48	56.85± 0.48	56.35± 0.48	5.33± 0.19	5.13± 0.15	5.23±0. 17	7.60± 0.24	7.80± 0.34	7.70±0. 29	81.29± 1.57	81.45± 1.52	81.37 ±1.54
	Nov	53.98± 0.47	55.77± 0.41	54.87± 0.44	4.41± 0.53	4.14± 0.24	4.27±0. 38	8.32± 0.63	8.54± 0.73	8.43±0. 68	81.76± 1.48	81.26± 1.48	81.51 ±1.48
Annual Average		54.28± 0.43	54.67± 0.39	54.47± 0.42	4.82± 0.46	4.70± 0.38	4.76±0. 42	8.37± 0.42	8.41± 0.46	8.39±0. 44	80.98± 1.53	81.15± 1.62	81.06 ±1.57

Date presented above is the mean of three readings i.e. Mean ± SD

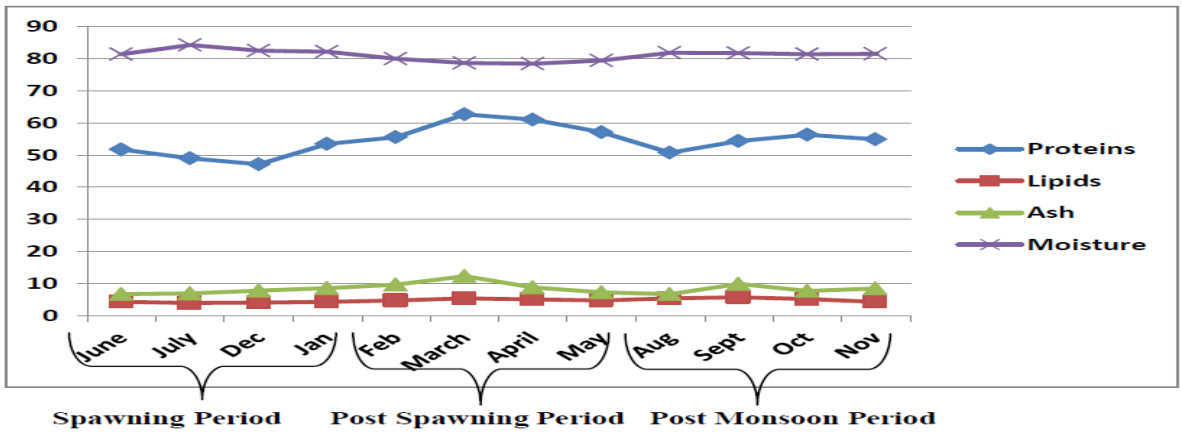

Fig: 1. Seasonal variations in the proximate composition of body meat of female *M. masoniana* during study period (Jan 2012-Dec 2013)

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Protein:

The mean average protein content recorded during the study period (Jan 2012-Dec 2013) in the body meat of female *M. Masoniana* was 54.47± 0.42 with minima of 47.05± 0.83% in Dec i.e. during spawning period and maxima of 62.65± 0.35% in March i.e. during post spawning period. (Table: 1)

Protein showed a highly significant and negative correlation with moisture, the values being r=-0.84311 and r=-0.86942 for Ist and IInd year respectively. Values however, exhibit highly significant and positive correlation with ash (r=0.659093 and r=0.649427) for Ist and IInd year respectively. Proteins showed insignificant positive correlation with lipid (r=0.549235 and r=-0.52197) for Ist and IInd year respectively.

Lipids:

The mean average lipid content recorded in the body meat of female crab was 4.76± 0.42 with minima of 3.94± 0.27% in July i.e. during spawning period and maxima of 5.75±0.45% in September i.e. post monsoon period. (Table-I)

Lipid showed an insignificant positive correlation with ash (r=0.452726 and r=0.469045) in Ist and IInd year respectively. Lipid content, however, showed insignificant negative correlation with moisture (r=-0.49769 and r=-0.45325) in 1st and 2nd year respectively.

Ash Content:

The mean average ash content was 8.39±0.44 with minima of 69±0.35 % in June i.e. during spawning period and maxima of 12.29± 0.67% in March i.e. during post spawning period. (Table :1)

Again a rising trend was observed during post monsoon period. There is no direct relationship between ash cycle & spawning activity.

Moisture:

The mean average moisture content of female crab was 81.06±1.57 with minima of 78.38±1.41% in April i.e. during post spawning period and maxima of 84.24±1.70% in July i.e. during spawning period (Table:1)

Minimum values were evident during post spawning period (March & April) whereas increasing trend was again witnessed during post monsoon period.

Thus moisture exhibit an inverse trend (relationship) with lipids & protein contents, while on insignificant and negative correlation with ash (r=-0.99367 and r=-0.53252) in both years respectively could be recorded.

Table 2: Seasonal Variations in the Proximate composition of Body meat *(M. masoniana)* of male crab during two years of study period Jan 2012-Dec 2013.The results are expressed on dry weight basis (values represent± standard deviation)

Periods	Months	Proteins (Mean±SD)			Lipids (Mean±SD)			Ash (Mean±SD)			Moisture (Mean±SD)		
		I Yr	II Yr	Mean	I Yr	II Yr	Mean	I Yr	II Yr	Mean	I Yr	II Yr	Mean
Spawning Period	June	59.90± 0.62	59.90 ±0.52	59.90 ±0.57	4.98± 0.73	4.89±0 .64	4.93± 0.68	11.38 ±0.37	11.58 ±0.53	11.48 ±0.45	78.26 ±1.77	78.36± 1.83	78.31 ±1.80
	July	59.98± 0.90	59.81 ±0.80	59.89 ±0.85	5.40± 0.54	5.50±0 .55	5.45± 0.54	8.47± 0.34	8.67± 0.38	8.57± **0.36**	79.08 ±1.98	79.28± 1.88	79.18 ±1.93
	Dec	62.00± 0.24	61.20 ±0.12	61.60 ±0.18	4.08± 0.31	4.10±0 .36	4.09± 0.33	8.65± 0.51	8.85± 0.61	8.75± **0.56**	80.67 ±1.76	80.98± 1.89	80.82 ±1.82
	Jan	58.50± 0.25	58.40 ±0.22	58.45 ±0.23	4.41± 0.29	4.62±0 .32	4.51± 0.30	11.26 ±0.21	10.90 ±0.21	11.08 **±0.21**	79.67 ±1.69	80.79± 1.79	80.23 ±1.74
Post Spawning Pd	Feb	58.00± 0.32	58.10 ±0.36	58.05 ±0.34	4.98± 0.82	4.80±0 .80	4.89± 0.81	9.84± 0.26	9.64± 0.23	9.74± **0.24**	78.49 ±1.77	79.63± 1.63	79.06 ±1.70
	March	59.00± 0.67	59.20 ±0.72	59.10 ±0.69	5.18± 0.52	5.20±0 .55	5.19± 0.53	8.97± 0.28	8.70± 0.25	8.83± **0.26**	77.41 ±1.43	78.59± 1.87	78.00 ±1.65
	April	64.50± 0.11	64.40 ±0.22	64.45 ±0.16	5.69± 0.51	5.80±0 .50	5.74± 0.50	7.11± 0.33	7.41± 0.44	7.26± **0.38**	75.01 ±1.58	77.31± 1.45	76.16 ±1.51
	May	60.89± 0.80	60.69 ±0.70	60.79 ±0.75	5.03± 0.36	5.10±0 .30	5.06± 0.33	8.68± 0.32	8.82± 0.42	8.75± **0.37**	76.96 ±1.63	76.86± 1.53	76.91 ±1.58
Post Monsoon Pd	Aug	58.75± 0.35	58.25 ±0.33	58.50 ±0.34	6.52± 0.41	6.60±0 .44	6.56± 0.42	6.78± 0.47	6.98± 0.67	6.88± **0.57**	78.65 ±1.69	78.75± 1.69	78.70 ±1.69
	Sept	57.56± 0.50	57.26 ±0.45	57.41 ±0.47	5.68± 0.46	5.78±0 .45	5.73± 0.45	6.60± 0.44	6.78± 0.54	6.69± **0.49**	79.12 ±1.78	79.15± 1.79	79.13 ±1.78
	Oct	55.12± 0.30	55.10 ±0.25	55.11 ±0.27	5.48± 0.44	5.38±0 .42	5.43± 0.43	7.27± 0.33	7.25± 0.35	7.26± **0.34**	78.51 ±1.80	78.25± 1.70	78.38 ±1.75
	Nov	59.92± 0.39	59.70 ±0.32	59.81 ±0.35	4.42± 0.41	4.52±0 .34	4.47± 0.37	7.65± 0.17	7.85± 0.27	7.75± **0.22**	77.41 ±1.59	78.31± 1.49	77.86 ±1.54
Annual Average		59.51± 0.45	59.33 ±0.41	59.42 ±0.43	5.15± 0.48	5.19±0 .47	5.17± 0.47	8.55± 0.33	8.61± 0.40	8.58± **0.37**	78.27 ±1.70	78.85± 1.71	78.56 ±1.70

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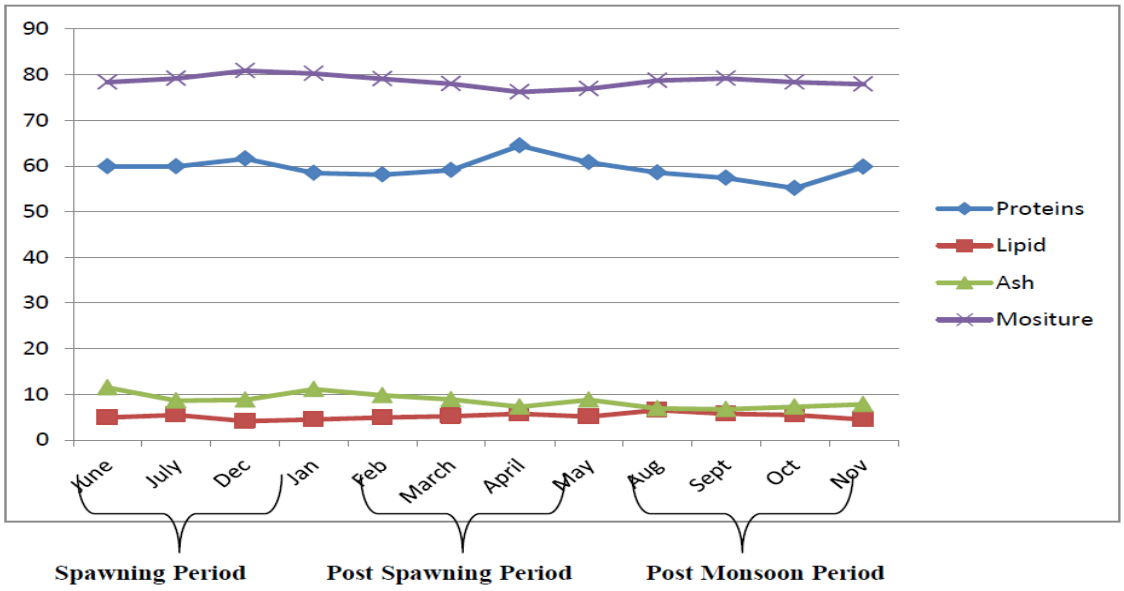

Fig: 2. Seasonal variations (mean) in the proximate composition of body meat of male *M. masoniana* during study period (Jan 2012-Dec 2013).

Protein:

In males proteins show higher percentage than females throughout the study period .Males did not show any well marked seasonal fluctuation with respect to proteins as they do not invest much energy for reproduction but use for somatic growth. As evident from Table 2 the mean average protein content recorded during the study period in the body meat of male *M.masoniana* was 59.42±0.43 with minima of 55.11±0.27% in October i.e. post monsoon period and maxima of 64.45±0.16% in April i.e. post spawning period.

Protein recorded an insignificant and negative correlation with moisture during both the years, the values being (r=-043661 and r=-0.24393). Highly significant and positive correlation of ash with protein was another characteristic observation during the present period of study with values being r=0.045 and r=0.1048 for two years respectively.

Lipids:

A look at table 2 indicated the mean average lipid content in the range of 5.17±0.47 with minima of 4.09±0.33% in December i.e. spawning period and maxima of 6.56±0.42% in August i.e. post monsoon period. A study of table I & II further reveal that *M.masoniana*, males have higher lipid content than the females & the seasonal variations in the lipid content were much more pronounced in females as compared to males.

Lipid showed an insignificant and negative correlation with moisture, the value being r=-0.31735 and r=-0.43068 in 1st and 2nd year respectively.

Ash:

The mean average ash content recorded in the body meat of male crab was 8.58± 0.37 with minima of 6.69±0.49% in September i.e. post monsoon period and maxima of 11.48± 0.45% in June i.e. spawning period.

Moisture:

The moisture content in the male crab exhibited mean average value of 78.56±1.70 with minima of 76.16±1.51% in April i.e. post spawning period and maxima of 80.82±1.82% in December i.e. spawning period.

As evident from I & II male record less moisture content than females and show an inverse trend with proteins & lipids. Moisture content was observed to be higher during spawning period (Dec-July).

Moisture content showed in significant and negative correlation with ash (r=-0.004 and r=-0.003) in 1st and 2nd year respectively.

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4. DISCUSSION

The seasonal variations in biochemical composition of body meat of male and female crabs are presented in Table I & II. Results are expressed on dry tissue weight basis. Two year study revealed distinct variations in relation to varied reproductive phases i.e., spawning period, post spawning period and monsoon period.

Proteins:

Protein content in body meat of female crabs (Table -1) remained low during winters with lowest average being 46.05% in the month of December and 48.51% in the month of July during the two year study period. This lower percentage of protein during Dec- July coincides with their spawning period when the gonads are in advance stage of maturity. On the other hand, average protein values viz 62.16±0.30% and 63.15% were recorded to be maximum during the month of March in two years of study period. This higher percentage of protein content in female body meat during March coincides with their non spawning period and a similar rise is also witnessed during post monsoon period (Table-1). As evident from table I, protein content in female crab showed marked seasonal fluctuations in the body meat. The pronounced fall in the protein content in female tissues during spawning period (December & July) suggested mobilization of protein from muscle to the gonads for their development. A similar trend has been observed by Bakhtiyar (2008) in *M. dayanum* who recorded a fall in the muscle protein which coincides with their spawning season when gonads were in advanced stage of maturity. On similar lines Lambert & Dehriel (1974) reported that in crustaceans, a great amount of energy gets channeled to the gonads during reproduction, which is reflected in the deposition or depletion of nutrients with the advent or departure of reproductive period.

Our observations get authenticated by the work of Hislop (2001) who recorded that during both wintering and spawning periods, food intake is significantly reduced and fish depends entirely on stored energy resources for its survival. A similar trend was observed by Sriraman (1978) in shrimp, *Penaeus merguiensis* and in fresh water prawn *M. idea.*

High mean levels of proteins during post monsoon (October: 55.85%) & non spawning phases (March: 63.15%) can definitely be attributed to planktonic blooms during this period. Moreover, high levels of proteins during this period indicates the diversion and deposition of proteins in the muscles, primarily aiming to meet the protein requirement for the next breeding seasons. Our observations get strengthened by previous recording made in the same stream where benthic species like *chironomous* larvae (*Tubifex* sps) were abundant during summer and monsoon as indicated by work of Sawhney (2004), Parvez (2005) and Nelofer (2005). Since the variations in protein is influenced by feeding & breeding capabilities therefore, the protein cycle appears to have a strong correlation with feeding & spawning phases which are further species specific. Protein maxima & minima corresponding to the development/spawning & biological regression/resting phases respectively, gets authenticated by work of Lee (1986) on green mussel.

In males (Table 2), the protein content did not show any well marked seasonal fluctuation throughout the study period. It exhibited lowest value 55.10% in Oct (Post monsoon) & highest value of 64.50% in April viz Post spawning period and a stable range during spawning period. From the study it has been hypothesized that males do not invest much energy for reproduction, but use most of it for somatic growth i.e. males have lower energy requirement than females to form a fully developed gonad (Kyomo, 1988; Jackel, *et.al.* 1989). When compared with males, females had lower mean average protein content viz 59.42± 0.43 & 54.47± 0.42 respectively (Table I & II)

Mean protein levels, therefore, were greater in male crab meat than females. Along the same lines our findings further get authenticated by observations of Adeyeye (2002) in freshwater crab like *Sudanonautes africans* and Sengul & Zeliha, (2011) in *Potamon potamios*, who reported low protein values for female crab meat in comparison to male. Our observations are in tune with the findings of Ozogul *et.al* (2010) who have also reported variations in the protein contents of both male and female crab meat in *Callinectes sapidus*. Present findings however, contradict to those reported by Khan (1992) and Zafar *et.al* (2004) who found greater concentration of protein in female crab meat than their male counter parts.

Crustacean muscles contain high concentrations of free amino acids such as arginine, glycine, proline, glutamine and alanine (Cobb et.al., 1975). Konsosu and Yamaguchi (1982) have pointed out that the Free Amino Acids (FAA) content in crustaceans is higher than those in fish and mollusc. Shell fish meat provides high quality protein with all the dietary essential amino acids for the growth and maintenance of the body (FNB, 2007). The nutritive value of any animal is

decided by the presence of essential amino acids. Total essential amino acid contributions are much higher in hard shell crabs than the soft shell crabs. Free amino acids such as alanine, glutamine & glycine are responsible for the unique flavor and taste of crab meat.

Lipids:

Lipids are highly efficient source of energy and offer more than double the energy released by carbohydrates and protein (Okuzumi & Fuji 2000). Generally muscles of Crabs & prawns contain lesser quantity of lipid (Bhavan 2009) and fresh water crab meat is generally low in fat as compared to marine crabs (Adeyeye 2002).

As evident from table 1, the lipid content in female crabs remain low during monsoon (July) & winters (Dec-Jan) which coincides with their spawning season when the gonads are in an advanced stage of maturity. The decline in the lipid content during spawning period is possibly due to mobilization of lipid as energy source to meet the high energy demands, during act of ovulation and spawning. Similar reports on energy mobilization in fishes during spawning seasons have been made by Jafri & Khawaja (1964), Love (1970) Diana (1983), John & Hameed (1995), Kitne & Willet (2002), Jonson & Jonson (2005) Nargis (2006) & Zaboukas *et.al.* (2006).

Wide fluctuations in muscle lipids have been reported to occur both in hepatopancreas and gonads of prawns during gonadal development (Pillai & Nair, 1973). Similar trend was observed in *M.dayanum* by Samyal (2007) & Bakhtiyar (2008) who recorded a fall in lipid content of muscles during spawning season when gonads are in advanced stage of maturity.

It has been observed that in body meat the lipid content vary from 3.90 to 5.85% in females and 4.08 to 6.60 in male crabs respectively. Our observations are in accordance with the findings of Radhakrishnan & Natrajan (1979) who assessed the lipid values in *P. vigil* from 5.13 to 9.73% those recorded by Radhakrishan (1979) in *P. pelagicus* where the mean lipid value was 3.3 to 5.6%. On similar lines, Balasubramanian & Suseelan (2001) too, reported the lipid values from 6.2 to 7.6% in *C. smithi.* A low level of lipid content have been observed in the body meat in mud crab (0.9-1.6%) by Thirunavukatasu (2005).

Presently, male crabs have been observed to have higher lipid content than female crabs and such observations that male crabs necessarily have high lipid content is not a universal phenomenon as contradictory results have been reported by Clarke (1980). According to Clarke (1980) in many marine invertebrates, lipids are the most variable fraction and low levels of lipids characterized males rather than females.

Lipid content in the present species is comparatively low as against higher values recorded in fin fishes. Higher values of lipid content have been reported in *I. crenata* (5.4-15.6%) by Thomas (1985) and *P. vigil* (16.8-31.9%) by Radhakrishnan (1979). Thus, the candidate species has been placed in a better quality food list for human beings.

Freshwater crab meat is generally low in fat, which is good for health (Adeyeye, 2002). Generally, the muscles of crabs and prawns contained lesser quantity of lipid (Bhavan, 2009). Therefore, crabs and prawns are preferred by the consumer. Freshwater crab meat is low in cholesterol when compared to marine and brackish water species (Sinha & Ahmed 2011).

Ash:-

Ash content determines the total amount of micronutrient present in the tissue of an animal. Micronutrients include mineral content present in the tissue. In the present study , it has been observed that there is an increase in the level of ash content in the body meat of *M. masoniana* (female) but male crabs, show no well marked seasonal fluctuations in the ash content.

As is evident from table –I, figure I and II peaks; one in the month of March (12.35±0.72%) and second in the month of September (9.90 ± 0.83%) can clearly be recorded. This increase in ash content corresponds to the post spawning period of female crab, and matches well with the recordings made by Love (1970) who also have witnessed a similar rise in ash level during post spawning period.

Samyal (2007) and Bakhtiyar (2008) while investigating *M. dayanum* also recorded two peaks in ash content in the months of February & August and have attributed such variability in ash content to the utilization of mineral matter for the growth and maturation of ovaries & spawning purposes. The mean average value of ash in present study ranged from 8.39±0.44 to 8.58±0.37 in female and male crabs respectively. (Table: 1 & 2).

Our findings are in accordance with the findings of Adeyeye (2010) in *Sudananautes africans africans* where ash concentration ranged between 4.60 to 14.92% in whole body meat. On similar lines Gokoglu & Yerlikaya (2003) reported ash content of blue crab *Callinectus sapidus* and *swim crab Portums pelagicus* in the range of 1.39±0.019 and 0.89±0.08% respectively for claw and body meat. As observed presently, ash content in *M.masoniana* was higher (8.58±0.37%) than those reported in other fin fishes and crustaceans viz *M. rosenbergii* (0.37%) by Gopakumar (1993); *Catla Catla* (1.268%) and *Labeo-rohita* (1.021%) as reported by Jafri & Khawaja (1964).

In comparison to other fin fishes (1.09%-1.431%) & other crustaceans (0.37%-22%) *M. masoniana* could be a good source of micronutrients, with respect to high values of ash content.

The Ash is left out after complete combustion of fish meat and gives a measure of the total mineral content. The mineral serve as component of bones, soft tissues. The calcium and phosphorus together account for 70 to 80% of the mineral in skeleton of fish (Nair and Mathew, 2000). The hard shell crabs contributed maximum (3.985 mg) of minerals (calcium>sodium>magnesium>potassium>zinc) and minimum was in soft shell crabs (3.018mg) of mineral (calcium>magnesium>sodium>potassium>zinc). In both cases calcium showed maximum concentration.

Moisture:-

Water as a component , contributed maximum to the chemical composition in the muscle tissue of all organisms including fin fishes & shell fishes investigated so far. The mean average value of moisture in present study ranged between 78.56±1.70 to 81.06±1.57 in male and female crabs respectively. (Table: I & II). That the females have higher moisture content than males in the body tissue (body meat) is in accordance to the findings of Kuley *et.al.* 2008 who reported that male blue crab meat had lower moisture content than female crab meat. Our result, however, are in contradiction with the findings of Srinivasagam (1979) in *S.serrata* meat where moisture content was found to be slightly higher in males than females. Similar observations were made in the muscles of male prawns (Bhavan *et.al* 2010) were also higher levels of water content have been recorded in males as compare to females.

In the present investigation, there is significant variation in the moisture content of *M. masoniana* throughout the period of investigation. Comparatively high values of moisture content were recorded during July & December viz 84.26±1.80% in females and 80.98±1.89% in males. These two months viz July and December, happen to be the breeding period of *M. masoniana* when they develop gonads and therefore a positive correlation exists between moisture content and gonadal activity in the species under observation.

Our findings are in accordance to the finding of Pillay & Nair (1970) & Farragut (1965) who also reported high moisture content during breeding season in C*ancer magister*.

Similar fluctuation of moisture content in response to reproductive cycle has been observed by Tagore (1990) during monsoon months as well as by Samyal (2007) in *M.dayanum.* Samyal (2007) observed high moisture content during the months of May-June & Sept-October which happen to be the breeding seasons of the species as *M. Dayanum* is a by annual breeder. Bakhtiyar (2008) also observed similar trend in *M. Dayanum* & *L. rohita* where the variation in the moisture content were related with the spawning, related activities.

The values for moisture content so obtained in *M masoniana* are well within the range reported for other species of fin fishes & shell fishes by Jafri & Khawaja (1964) viz. *Tor putitora* -77.98%; *Labeo-rohita*-78.37% and *Channa punctatus* 76-43%. The moisture content ranged from 73.5 to 81.8% in body meat of *S. tranguebarica* (Thirunavukkarasy 2005); 77.7% in the body meat of blue swimming crab (Prasad & Neelkandan, 1989); 80.19% in *S.Serrata* (George & Gopakumar, 1987).

Appoint worth mentioning here is that increase in the moisture content accompanied by a decrease in protein & lipid content in body tissue therefore moisture exhibit an inverse relationship with lipid & protein contents.

The higher percentage of moisture noticed in body meat on one hand and the negative correlation observed between water content and protein concentration of *M.masoniana* on the other hand are in agreement with the observations made by Zafar *et.al*. (2004) in *S. serrate* Observed inverse relation might be due to low temperature, low feeding rate and high energy demand to maintain body temperature and to cope up with food scarcity during winter. Similar results highlighting the relationship between moisture and muscle protein have been advocated by Nargis (2006).

These variations in the moisture content therefore might be due to spawning effect & breakdown of lipid as a consequence of vigorous metabolism as supported by the work of Idler & Bitners (1958) and Danbergs (1964).

The average moisture content recorded in the present study was higher than that reported for marine and intertidal crabs (George and Gopakumar, 1987). According to Bassey et.al. (2011), knowledge of the moisture content of food stuff serves as a useful index of their keeping qualities and susceptibility to fungal infection.

5. SUMMARY

From the present investigation on the seasonal variation in the bio-chemical composition of the body meat of *M. masoniana*, it appears that there are two distinct period of variation i.e.

- Spawning period ranging from June–July and December-January when the gonads are in advance stage of maturity and there is mobilization of nutrients from muscle to the gonads for their development.
- Non-spawning period ranging from February to May (Post-spawning period) and August to November (Post-monsoon period). During this period *M.masoniana* is nutritionally more rich in protein, lipid, moisture and ash content which are high in the muscles.

Further, it was observed that protein, lipids, ash and moisture content in *M.masoniana* are comparable with other edible species of fin and shellfishes and therefore qualify the criteria of edible food organism. The values however, are considerably high during non spawning period that is an indication of relation which these macro nutrients bear with reproductive cycle and in no way should be taken as the period of its harvesting and consumption. This small piece of information can well be utilized to qualify *M.masoniana* as an ideal item in dietary as it possesses high protein and low lipid content thus prove to be a good candidate for health conscious or those prescribe to have rich protein and low lipid diet in preparation.

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