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Proximate composition of commercially important marine fishes and shrimps from the Chennai coast, India

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Abstract
Proximate composition of dorsal and ventral portions of fishes (*Synagris japonicus*, *Lutianus quinquelinearis*, *Lutianus lineolatus* and *Mugil cephalus*) and shrimps whole body, edible portion (flesh) and non-edible portion (exoskeleton) of Tiger shrimp (*Penaeus monodon*), Indian white shrimp (*Fenneropenaeus indicus*), Pacific white leg shrimp (*Litopenaeus vannamei*), collected from fish landing center of Kasimedu Chennai, India were determined. The length of the fishes varied from (22.1 to 42.1cm) and weight (183.4 to 905.1 g) similarly shrimps varied from the length (11.86 to16.9 cm) and weight (30.6 to 12.15) respectively. The proximate composition of dorsal and ventral portions of fishes showed significant differences (P < 0.05) in moisture, crude protein, crude lipid, total ash and carbohydrates. Crude protein was higher in dorsal and ventral portions. Similarly whole body, edible and non-edible portions of shrimps showed significant (P < 0.05) differences in all the parameters. Similarly, crude protein (23.60 ±1.63, 22.87 ± 1.63, 19.80 ± 0.04) was higher in edible portions of shrimps. However total ash (7.94 ± 0.17, 9.03 ± 0.17, 6.75 ± 0.47) and crude fiber (1.54 ± 0.13, 1.56 ± 0.08, 3.31 ± 0.06) showed highest values in the non-edible portions in the shrimps. The results showed that fishes and shrimps can serve as an alternative source of high- quality protein, energy and mineral supply for human consumption and feed formulation in animals.
Keywords: body parts, lipid, protein, proximate composition, shrimp
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1. Introduction
The world's demand for an aquatic source of foods is on the rise not only because of its growing population, but also because of a preference for healthier foods for human beings [1]. Seafood is easily digestible because it has a very little connective tissue. For that reason, fish and shrimps is recommended in many special diets. The chemical composition of any edible organisms is extremely important since the nutritive value is reflected in its biochemical contents [2]. The nutritional value of fish meat comprises the contents of moisture, dry matter, protein, lipids, vitamins, minerals plus the caloric value of the fish. It is excellent for growth and development of human body and prevents several nutritional deficiency diseases [3]. As compared to red meat, fish protein is considered slightly superior to any other land animal proteins and is nutritionally equivalent [4].

Shrimp is one of the world's most popular shellfish. It provides high-quality rich protein, calcium and various extractable compounds and minerals for the human body, while low in calorie and fat [5]. They have a high quality of body composition including proteins, fats and amino acids etc that are the indicators of the existence of good physiological and biochemical condition. Since the aquatic animal fats are good sources of essential fatty acids that cannot be synthesized in the human body and they are required for the maintenance of growth, reproduction and synthesis of vitamins. Fats and essential polyunsaturated fatty acids (PUFA) contribute to shrimp dietary quality and are to their nutritional and sensory values [6]. The consumption of w-3 polyunsaturated fatty acids (PUFA), especially eicosapentaenoic acid (EPA, C20: w-3) and docosahexaenoic acid (DHA, C22:6 w-3) has both anti-atherogenic and antithrombotic effects as well as an important role in the control of hypertension, preventing cardiac arrhythmias, reducing the risk of coronary heart diseases, diabetes and cancer [7].

Shrimps are known to be a source of protein rich in essential amino acids like lysine, methionine, cysteine, threonine and tryptophan [6]. Essential amino acids play an important role in human nutrition and health promotion. The present study is intended to provide information on the chemical composition of body parts of some marine fishes and shrimps from the Chennai coast.

2. Materials and methods

2.1 Source of fishes and shrimps

Fishes (*S. japonicus*, *L. quinquelinearis*, *L. lineolatus* and *M. cephalus*) and shrimps Tiger shrimp (*P. monodon*), Indian white shrimp (*F. indicus*) and Pacific white leg shrimp (*L. vannamei*) were purchased from fish landing center Kasimedu Chennai coast in the early morning. The fishes and shrimps were brought to Central Institute of Brackishwater Aquaculture (CIBA) Nutrition Laboratory, Chennai in preserved condition in the ice box. The fishes were first properly cleaned in the laboratory and the total length and weight of each fish were determined. The fish samples were dissected and separated into dorsal and ventral portions similarly, the total length and weight of each shrimp was determined. The shrimp samples were separated into three body parts: whole shrimp, edible portion (flesh) and non-edible (exoskeleton) were ground in an electrical grinder and dried at 105°C 24 h. The oven-dried samples were packed in air tight containers and stored in a refrigerator until use for subsequent chemical analysis. The following parameters were determined which include moisture crude protein, crude lipid, total ash and carbohydrates by using the standard methods [8].

2.2 Chemical analysis

Moisture content was estimated by gravimetric analysis after oven drying at 105° C for 12 h. Crude protein (CP) was determined by Kjeldahl method (N 9 6.25) after acid hydrolysis (Kjeltec 2100, FOSS, Tecator, Sweden). Crude lipid (CL) was calculated gravimetrically after extraction with petroleum ether in a soxhlet system SOCS, Pelican, India. Total ash was determined gravimetrically by ignition at 600°C for 6 h in a muffle furnace. Crude fiber was estimated gravimetrically after acid and alkali digestion and loss in mass by combustion at 600° C for 3 h. Nitrogen-free extract (NFE) was calculated from 100 - (crude protein + crude lipid + crude fiber + total ash). All the chemical analyses were carried out in triplicate, and the results were expressed in dry matter basis.

2.3 Morphometric characters

The morphometric characters like total length, standard length and body indices were measured and determined following the standardized protocols [9].

2.4 Total length

It is the maximum elongation of the body from end to end. Thus, from the anterior projecting part of the head to the posterior most tip of the caudal fin is included in total length.

2.5 Standard length

It is the distance from the anterior most part of the head to the end of the vertebral column (i.e. caudal peduncle)

2.6 Condition factor (CF)

Condition factor is used to compare the 'condition', 'fatness' or 'well-being' of fish and are based on the hypothesis that heavier fish of a given length are in better condition.

Condition factor (CF, g $(cm^3)^{-1}$) = [(live weight, g) / (length, cm) ^{3}] x 100

2.7 Hepatosomatic index (HSI)

It is defined as the ratio of liver weight to the body weight. It is expressed as:

$$(HSI) = \frac{\text{Liver weight (g)}}{\text{Body weight (g)}} \times 100$$

2.8 Viscerosomatic index (VSI)

It is defined as the weight of gut as a percentage of the total body weight of fish. It is expressed as:

$$(VSI) = \frac{\text{Visceral weight (g)}}{\text{Body weight (g)}} \times 100$$

2.9 Gonado somatic index (GSI)

It is defined as the weight of gonad as a percentage of the total body weight of fish. It is expressed as:

$$(GSI) = \frac{\text{Gonad weight (g)}}{\text{Body weight (g)}} \times 100$$

2.10 Muscle ratio

It is defined as the weight of the muscle as a percentage of the total body weight of fish. It is expressed as:

$$(MR) = \frac{\text{Muscle weight (g)}}{\text{Body weight (g)}} \times 100$$

2.11 Statistical analysis

Data were analyzed using one-way analysis of variance (ANOVA) to compare significant differences between treatments, whereas Duncan's multiple range tests were used to compare the means of the treatment. The data were analyzed using SPSS version 16.0 software

3. Results and Discussion

3.1 Morphometric characters

The various morphometric characters of the four commercially important marine fishes are outlined in (Table 1).

Table 1: Morphometric characters of fishes

S. No	Particulars	*Synagris japonicus*	*Lutianus quinquelinearis*	*Lutianus lineolatus*	*Mugil cephalus*
1	Total length (cm)	22.1	25.3	29.2	42.1
2	Standard length (cm)	18.2	20.3	21.7	37.2
3	Weight (g)	183.4	233.9	221.6	905.1
4	Liver wt (g)	1.22	2.15	3.13	22.3
5	Gut weight (g)	2.11	5.24	6.17	63.5
6	Gonad weight (g)	1.26	5.27	1.31	139
7	Mouth	Upward	Upward	Upward	Triangular

8	Teeth	Present	Present	Present	Present
9	Gill rackers	Filamentous	Filamentous	Filamentous	Filamentous
10	Sex	Female	Female	Male	Female
11	Maturity	Immature	Immature	Immature	Matured

3.2 Body indices of fishes

The body indices of fishes showed significant differences in condition factor, hepatosomatic index, viscera somatic index and gonado somatic index. The condition factor was highest in *S. japonicas* compared to other fishes. However HSI, VSI and GSI showed the highest values in *M. cepahlus* (Table 2).

Table 2: Body indices of Fishes

Parameters	*Synagris japonicus*	*Lithuania lineolatus*	*Nemipterus japonicas Mugil cephalus*	
CF (k)	1.71	1.49	0.91	1.59
HIS (%)	0.54	0.85	1.35	2.46
VSI (%)	1.09	2.14	2.71	7
GSI (%)	0.54	2.14	0.45	15

3.3 Proximate composition of fishes

3.3.1 *Synagris japonicus*

Results of the present study clearly indicate the wide variations in the major biochemical constituents among different fish species. The proximate composition of dorsal and ventral regions of *S. japonicus* is shown in the (Fig. 9). The moisture content was slightly lower in ventral region (43.9 %) as compared to dorsal aspects were numerically higher moisture content (47.1 %). The crude protein content of was higher in dorsal region (86.4 %) lower protein content (81.9 %) was recorded on the ventral region. Similarly, the crude lipid content was also varied among both regions, representing the higher value of lipid content on the ventral region (3.43 %) compared to the dorsal region (2.7 %). The total ash content was higher (10.9 %) in ventral region whereas low ash content (6.8 %) was recorded in the dorsal region. The overall whole body carbohydrates of *S. japonicus* did not show much variation with both aspects however the protein and ash contents showed wide variation among dorsal and ventral regions of the fish.

3.3.2 *Lutianus quinquelinearis*

The proximate composition of dorsal and ventral regions of *L. quinquelinearis* is shown in the (Fig. 10). The moisture content was slightly lower in ventral region (47.7%) as compared to dorsal aspects were numerically higher moisture content (48.9%). Similarly, the crude protein and total ash content were higher in ventral region (84.8%), (9.7%) low protein and total ash content was recorded on the dorsal region (81.9 %), (8.8 %). However crude lipid and carbohydrates were higher in dorsal region (3.32 %), (5.87%) compared to the ventral region (2.95 %), (2.44%).

3.3.3 *Lutianus lineolatus*

The proximate composition of dorsal and ventral regions of *L. lineolatus* is shown in the (Fig. 11). The moisture content was slightly lower in dorsal region (47.1 %) as compared to ventral aspects were numerically higher moisture content (49.1%). Similarly the crude protein and total ash content was higher in ventral region (88.5 %) (9.1%) low protein and total ash content was recorded on dorsal region (87.8 %), (7.43 %). However crude lipid and carbohydrates were higher in the dorsal region (3.47 %), (1.22) compared to the ventral region (2.28 %), (0.12).

3.3.4 *Mugil cephalus*

The proximate composition of dorsal and ventral regions of *M. cephalus* is shown in the (Fig. 12). The moisture content was slightly lower in ventral region (63.8 %) as compared to dorsal aspects were numerically higher moisture content (66.9 %). The crude protein was higher in dorsal region (60.8 %) low protein content (52.8 %) was recorded on the ventral region. Similarly, the crude lipid content was also varied among both regions, representing the higher value of crude lipid content on the ventral region (41.7 %) compared to the dorsal region (30.5 %). However carbohydrates were higher in dorsal region (2 %) compared to ventral region (0.7%).

The biochemical composition of the fish muscle generally indicates the fish quality. Therefore, proximate composition of a species helps to assess its nutritional and edible values. An increasing amount of evidence suggests that due to the high content of polyunsaturated fatty acid, fish flesh and fish oil are beneficial in reducing the serum cholesterol level [10]. In addition to that, the special type of fatty acid, the omega-3 PUFA, recognized as an important nutritive supplement to prevent a number of coronary heart diseases is also present in fishes [11]. The chemical composition of fish muscles varies from one species to other species [12]. It has been well established that in many fishes, both from fresh water and marine environment shows variations in the biochemical composition of whole body and different tissues are related to many factors including season, feeding, growth, maturation and spawning etc. Quantitative analysis of primary body constituents of fish has been reported for numerous marine fish and freshwater species [13]. Generally, live weight, whole body composition of fish contained 70-80% water, 20-30% protein and 2-12% fat [14]. Several studies have shown significant changes in the composition of the specific organs or muscle tissues due to age, diet, feeding, frequency, migration, ration, seasons, sex, starvation and temperature.

3.4 Body indices of shrimps

The various body indices of the three commercially important marine shrimps are presented in (Table 3).

Table 3: Body indices of Shrimps

Shrimp species	Length (cm)	Weight (g)	Edible (g)	Non-edible (g)	HIS (%)	VSI (%)	Muscleratio (%)
P. monodon	16.9	30.6	20.4	10.2	3.28	5.84 66.6	
F. indicus	16.7	23.3	12.1	11.1	2.68	4.70	51.9
L.vannamei	15.2	21.2	10.7	9.7	3.32	4.72	50.8
P.merguiensis	12.9	18.8	10.2	8.6	3.17	4.64	54.2

P. japonicus	11.8	12.1	6.9	5.2	2.14	3.12	57.0

3.5 Proximate composition of shrimps

The proximate composition of the whole body, edible and non-edible portions of *P. monodon*, *F. indicus*, and *L. vannamei* is presented in (Tables 4-6). All the results were expressed in wet weight basis. The results showed that there was a significant difference in the moisture ($P < 0.05$) content between whole body, edible and non-edible portions of the shrimps. However non-significant differences were observed in the moisture content of *P. monodon*. The percentage of moisture in the composition of shrimp is a good indicator of the relative energy, protein and fat contents [15]. The proportion of moisture in shrimp varies widely between 65-90 % although it is normally in the range of 70- 75%. The existence of an inverse relationship between moisture and fat contents has been reported by several workers. It has been reported that low moisture content is usually associated with the relatively high-fat content and vice-versa [16]. High level of protein was obtained in all the body parts of shrimps with the highest level were found in the (23.60 ±1.63, 22.87 ±1.63, 19.80 ± 0.04, 21.72 ± 0.08, 16.96 ± 0.57) in edible portion. Similar to our results has been reported the protein level in edible and non-edible portions from *P. indicus.* [17]. Shrimp is considered as a high-range protein containing nutrient like fish. It has been reported that protein content of shrimp varies depending on shrimp species [18]. The protein level in *P. indicus* was varied from 44 to 80%. The high protein content in the lowest size groups may be attributed to increased protein synthesis during the active growth phase as it has been observed elsewhere in shrimps and mantis shrimps [19]. Protein was found as the major constituent in the muscle of shrimps. The same difference in the proximate composition in the edible muscle part was reported in *F. pennicillatus, F. merguiensis, Parapnaeus longirostris* black tiger shrimp and white shrimp [18]. Thus, this high protein content may be valuable for food formulation as a protein replacement for other expensive animal protein source in feed production. The total ash content showed the highest values in the non-edible portions in the shrimps. The ash content was high in the samples containing the exoskeleton with values ranging from (6.66 –9.03% wet basis). The ash content of any sample is a measure of the likely mineral content of such a sample. High ash content in shrimps is due to the high level of chitin strengthened by a high level of calcium metal in the exoskeleton. Chitin is a linear polymer of acetyl D-glucosamine that has properties similar to cellulose in many respects [20]. Crude lipid content showed significant differences in the whole body, edible and non-edible portions of the shrimps. However, lowest lipid content was observed in edible portions. The crude lipid content for *M. vollenhovenii* was 11. ± 0, 15.67 ± 2.89 and 4.67 ± 2.08 whole prawn, edible portion and exoskeleton respectively and that of *M. macrobrachion* with 10.33 ± 1.53, 10.67 ± 2.30 and 6.67 ± 1.15 for the whole prawn edible portion and the exoskeleton respectively in dry matter basis [21]. These findings were quite high compared with findings of other scientists carried out on prawns and shrimp. The little variation between this report and the work of these authors may be due to season and prawn sizes. Crude fiber content observed in this study was quite low in the whole prawn and the flesh of all species but higher in their exoskeleton. This is contrary to the findings who recorded a higher level of crude fiber content (8.2%) in edible and (8.7%) non-edible portions of *Penaeus indicus* [17]. The NFE was higher in the non-edible portions of *P. monodon*, *P.merguiensis* and *P. japonicas.* However, *F. indicus* showed the highest NFE (9.74 ± 0.02) in the edible portions compared to other shrimps.

Table 4: Proximate composition (% of wet basis) of whole body, edible and non-edible portions of *P. monodon*

Parameters	Whole body	Edible	Non-edible
Moisture	72.24^{a}±0.40	72.56^{a}±1.09	72.10^{a}±0.47
Crude protein	19.12^{b}±1.31	23.60^{c}±1.63	14.41^{a}±0.56
Crude lipid	0.76^{a}±0.41	0.91^{b}±0.13	0.67^{a}±0.06
Total ash	5.23^{b}±0.41	2.34^{a}±0.07	7.94^{c}±0.17
Crude fiber	0.71^{a}±0.1	0.19^{a} ±0.11	1.54^{c}±0.13
NFE	1.94^{b}±0.03	0.40^{a} ±0.02	3.34^{c}±0.04

Table 5: Proximate composition (% of wet basis) of whole body, edible and non-edible portions of *F. indicus*

Parameters	Whole body	Edible	Non-edible
Moisture	70.74^{b}±2.39	64.16^{a}±1.09	72.65^{b}±0.47
Crude protein	18.33^{b}±1.31	22.87^{c}±1.63	13.50^{a}±0.56
Crude lipid	1.01^{c}±0.41	0.71^{a}±0.13	0.92^{b}±0.06
Total ash	5.68^{b}±0.41	2.35^{a}±0.07	9.03^{c}±0.17
Crude fiber	0.79^{a}±0.11	0.17^{c}±0.11	1.56^{b}±0.08
NFE	3.45^{b}±0.03	9.74^{c} ±0.02	2.34^{a}±0.04

Table 6: Proximate composition (% of wet basis) of whole body, edible and non-edible portions of *L. vannamei*

Parameters	Whole body	Edible	Non-edible
Moisture	75.52^{b} ± 0.40	75.43^{b} ± 0.40	71.33^{a} ± 0.35
Crude protein	17.9^{b} ± 0.05	19.80^{c} ± 0.04	17.10^{a} ± 0.25
Crude lipid	0.94^{b} ± 0.04	0.76^{a} ± 0.03	1.29^{c} ± 0.04
Total ash	3.05^{b} ± 0.42	2.99^{a} ± 0.36	6.75^{c} ± 0.47
Crude fiber	1.33^{b} ± 0.03	0.06^{a} ± 0.01	3.31^{c} ± 0.06
NFE	1.26^{c} ± 0.02	0.96^{a} ±0.03	0.22^{a}±0.02

4. Conclusion

The results revealed that fishes and shrimps are good sources of proteins, energy and average mineral supply based on the ash content and shell of these shrimps can serve as an alternative source of high-quality protein for human consumption and for the formulation of animal feed, shrimp feed, shrimp industry, nutritionists, pharmaceuticals, chemists etc.

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Fig 1: Fish landing center

Fig 2: Synagris japonicas

Fig 3: *Lutianus* quinquelinearis

Fig 4: *Lithuania lineolatus*

Fig 5: *Mugil cephalus*

Fig 6: *Penaeus monodon*

Fig 7: *Fenneropenaeus indicus*

Fig 8: *Litopenaeus vannamei*

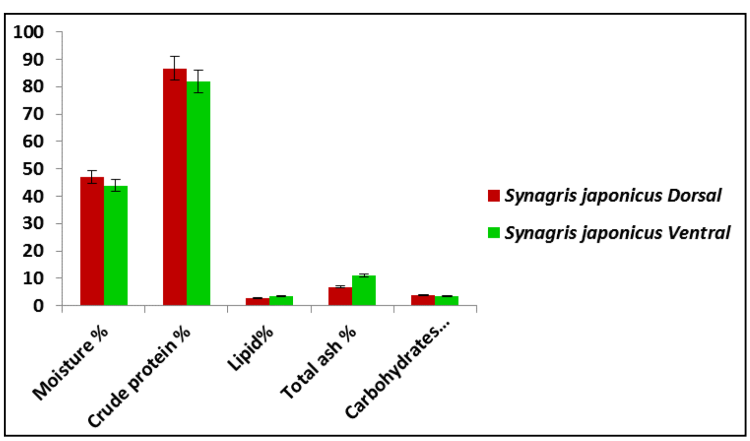

Fig 9: Proximate composition of dorsal and ventral portion of *Synagris japonicas.* (All values are mean ± SE).

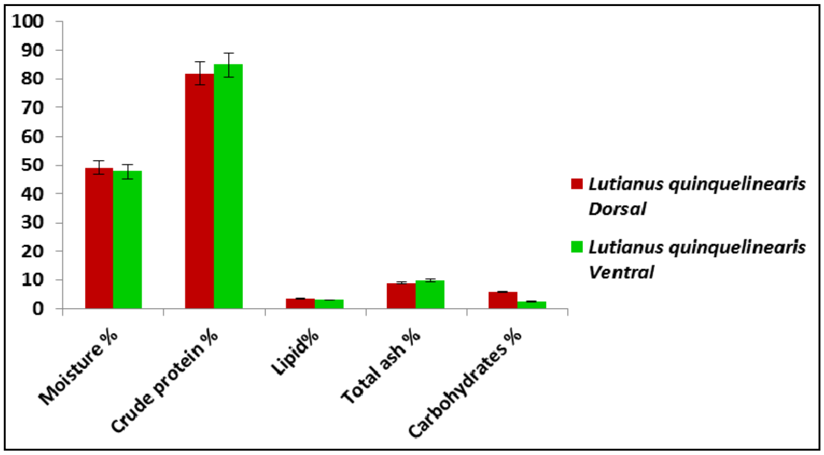

Fig 10: Proximate composition of dorsal and ventral portion of *Lutianus quinquelinearis*. (All values are mean ± SE).

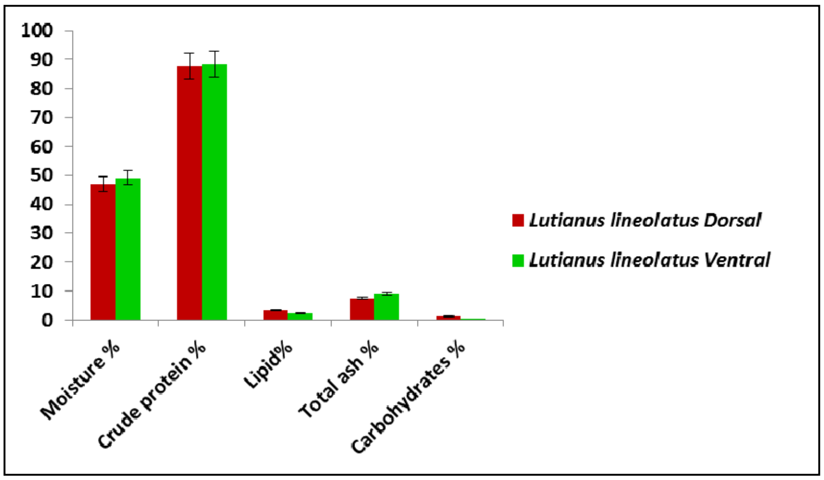

Fig 11: Proximate composition of dorsal and ventral portion of *Lutianus lineolatus*. (All values are mean ± SE).

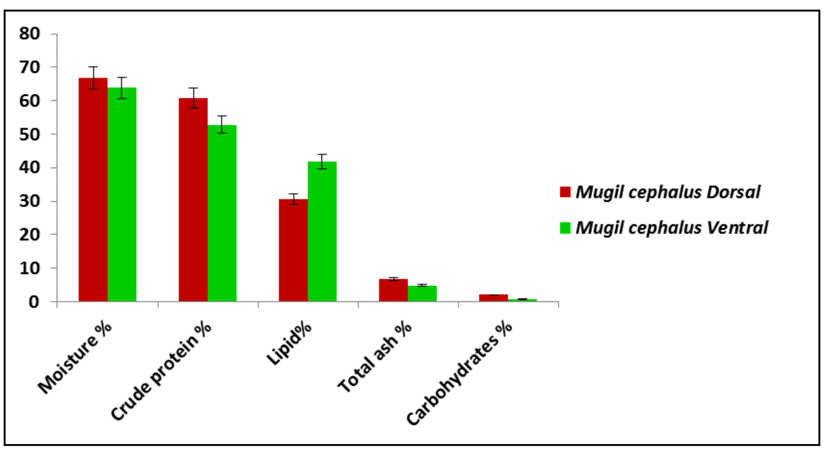

Fig 12: Proximate composition of dorsal and ventral portion of *Mugil cephalus*. (All values are mean ± SE).

6. References

1. Abimorad EG, Carneiro DJ. Digestibility and performance of pacu, *Piaractus mesopotamicus* juveniles fed diet containing different protein, lipid and carbohydrate levels. Aquaculture Nutrition. 2007; 13:1-9.
2. Soundarapandian P, Ravichandran S, Varadharajan D. Biochemical Composition of Edible Crab, *Podophthalmus Vigil* (Fabricius). Journal of Marine Science Research and Development. 2013; doi:10.4172/2155-9910.1000119
3. Agusa T, Kunito T, Sudaryanto A, Monirith I, Kan-Atireklap S, Iwata H, Ismail A, Sanguansin J, Muchtar M, Tana TS, Tanabe S. *et al*. Exposure assessment for trace elements from consumption of marine fish in Southeast Asia. Environmental Pollution. 2007; 145:766-777.
4. Andrew AE. Fish Processing Technology. University of IIorin press, Nigeria. 2001, 7-8.
5. Gunalan B, Nina Tabitha S, Soundarapandian P, Anand T. Nutritive value of cultured white leg shrimp *Litopenaeus vannamei*. International journal of fisheries and Aquaculture. 2013; 5(7):116-171.

6. Karuppasamy PK, Sri Sakthi Priyadarshini R, Ramamoorthy N, Sujatha R, Ganga S, Jayalakshmi T, *et al*. 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. 2015; doi: 10.6024/jmbai.2013.55.2.01783-0x.
7. Murphy RA, Mourtzakis M, Mazurak VC. *n* – 3 Polyunsaturated fatty acids: the potential role for supplementation in cancer. Curr. Opin. Clin. Nutr. Metab. Care. 2012; 15:246-251.
8. AOAC. Official methods of analysis, 19th edn. Association of Official Analytical Chemists, Arlington, 2012.
9. Syed Raffic Ali S, Ambasankar K, Praveena PE, Nandakumar S, Syamadayal J. Effect of dietary fructooligosaccharide supplementation on growth, body composition, hematological and immunological parameters of Asian seabass (*Lates calcarifer*) Aquacult International. 2017; 25:837-848
10. Stansby ME. Fish or fish oil in the diet and heart attack. Marine Fisheries Review. 1985; 46:60-63.
11. Edirisinghe EMRKB, Perera WMK, Tayasooriya SP, Bamunuarachchi A. Health related fatty acids in some pelagic fishes in Sri Lanka. Sri Lankan Journal of Aquatic Science. 1998; 3:97-107.
12. Food and Agricultural Organization Chemical composition, quality and quality changes in fresh fish. 2002; htt://w.w.w.fao.org/ docrep/v7180e/v7180E05. htm.
13. Jacquot R. Organic constituents of fish and other aquatic animals: Fish as Food. Borgstorm Academic Press, N.Y. and London. 1961, 145-209.
14. Weatherly AH, Gill HS. The Biology of Fish Growth. Academic Press, London. 1987.
15. Barua P, Pervez MA, Sarkar D, Sarker S. Proximate biochemical composition of some commercial marine fishes from Bay of Bengal, Bangladesh. Mesopot. Journal of Marine Science. 2012; **27**:59-66.
16. Yanar Y, Celik M. Seasonal amino acid profiles and mineral content of green tiger shrimp (*Penaus semisulcatus*, De Haan, 1844) and speckled shrimp (*Metapenaus monoceros,* Fabricus 1789) from the Eastern Mediterranean sea. Food Chemistry. 2006; 94:33-36.
17. Ravichandra S, RameshKumar G, Rosario Prince A. Biochemical composition of shell and flesh of the Indian white shrimp *Penaeus indicus* (H. milne Edwards 1837). American – Eurasian Journal of Scientific Research. 2009; 4(3):191-194.
18. Sriket S, Benjakul P, Visessanguan W, Kijroongrojana K. Comparative studies on chemical composition and thermal properties of black tiger shrimp (*Penaeus monodon*) and white shrimp (*Penaeus vannamei*) meats. Food Chemistry. 2007; 103:1199-1207.
19. Pedrazzoli A, Molina C, Montoya N, Townsend S, Leon-Hing A, Parades Y, Calderon J. *et al*. Recent Advances on Nutrition Research of *Penaeus vannamei* in Ecuador. Rev. Fish Science. 1998; 6:1-2.
20. MacDonald P, Greenhalgh JFD, Morgan CA. Animal Nutrition, 5th edition: Longman Publication. 1998, 607
21. Ehigiator FAR, Nwangwu IM. Comparative Studies of the Proximate Composition of Three Body Parts of Two Freshwater Prawns' Species from Ovia River, Edo State, Nigeria. Australian Journal of Basic and Applied Sciences. 2011; 5(12):2899-2903.