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Morphometric Analysis and Biochemical Estimation of Wild Shrimps (Family: Penaeidae) found in Coastal Waters of Pakistan

MORPHOMETRIC ANALYSIS AND BIOCHEMICAL ESTIMATION OF WILD SHRIMPS (FAMILY: PENAEIDAE) FOUND IN COASTAL WATERS OF PAKISTAN

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ABSTRACT

The world recognition of Seafood nutritional value for human consumption remain consistent throughout the time. Different informations and aspects have been studied and considered and generated various data sets but limited informations found about the biochemical concentration of various fishery species caught in the Pakistan. Therefore, the recent study design to evaluate the proximate levels of components in the edible component (flesh) of commercial shrimp species were studied. Four shrimp species; *Fenneropenaeus indicus, Metapenaeopsis stridulans, Metapenaeus stebbingi*, and *Parapenaeopsis stylifera* were selected for the assessment of proximate composition. The selected shrimp species were collected from the fishery catch of Korangi Fish Harbor, Sonmiani Fish harbor and Karachi Fish Harbor and Keti bander during Dec. 2015 – Nov. 2016. The estimated moisture contents were ranged (58.42–93). the lipids varied from (1.5–183.6 mg g-1), carbs ranged from (0.07–72.7 mg g-1). The statistically significant ($P < 0.05$) mean value of muscles constituents were observed with significant seasonal variations in the Wet weight and total length of Penaeid species and ranged in between (0.62 g to16.57 g) and (2.3 cm to16.6 cm), respectively. The results also revealed that the studied species are rich in protein as it ranged from (97.2 to 347.45 mg g-1), therefor it is also recommended as best for human health due to fewer lipids with high concentration of good saturated fats in according to compare with other edible group of organisms like beef and chicken etc. The present study revealed the shrimp as the best nutritional diet due to firm and balanced ratios of proximate constituents.

Keywords: Prawns, Pakistan, proximate analysis, quality control, seafood.

INTRODUCTION

In the human diet, most tasty and demanded products have always been the sea food products not only with the tastes; marine food items have long exasperated people's curiosity as important nutrient sources. Aside from being delicious, crustacean species including crab, shrimp, and lobster are high in amino acids, protein, and other valuable nutrients (Chaitiamvong and Supongpan, 1992). These nutritive factors which are mentioned ae extremely important to human health that's why highly prized (Oosterveer, 2006; Usydus et al., 2011). Crustaceans, mostly shrimps have a wide range of nutritional properties and can thus help people in under developed nations who are malnourished. It has a higher protein content than red and white meat (Hossain et al., ; Haruna et al., 2003; Islam et al., 2017). Among exporters in Pakistan, Shrimps are the backbone of the fishermen as they are highly prized, and they can help prevent many diseases not just cardiovascular disease but also cancer, that's why it is liked by many countries (MacLean et al., 2006). They also maintain the neurological system healthy owing to high amounts of HUFA n-3 fatty acids (Levitan et al., 2009). In subtropical and tropical fisheries and aquaculture, penaeid shrimps constitute a prominent element in

fishing zones (Ouraji et al., 2010). According to FAO data, worldwide shrimp output was expected to be around 6.5 million tonnes, with half of that coming through capture (FAO, 2010). The coasts of Pakistan have been rich in edible *Sicyonia, Gennadas, Penaeus, Fenneropenaeus, Marsupenaeus, Melicertus, Solenocera, Parapenaeus, Metapenaeus, Metapenaeus* and *Parapenaeopsis* with a considerable quantity of edible Shrimps (Kazmi, 2003). Twelve of the aforementioned genera' 30-recorded species are economically utilized. The commercial harvest of shrimps in local grades is classified into three primary categories depending on the shrimp's fresh colour and size. These are the "Jaira" (big), "Kalri/Patash" (middle) and "Kiddi" (small) categories (Kazmi and Sultana, 2005). The Jaira category consists mostly of *F. penicillatus, Fenneropenaeus indicus*, and, *F. merguensis* patash (Metapenaeus) and Kiddi (Parapenaeopsis) (Ayub and Ahmed, 2001). The most prized *Penaeus* (*Fenneropenaeus*), which extends south to India, Sri Lanka, Madagascar, East Africa, the Philippines, Northern Australia and South China in Pakistan, are the penaeus (Tirmizi and Bashir), which are known as the H. Milne Edwards (1837) shrimp species (Jayawardane et al., 2002). Their populations live at a depth less than 30 m in sand or mud, with shallow water at a depth of about 90 m from the coast (Fischer and Bianchi, 1984). Even though shrimps have had great economic value, the previous work on shrimps has remained mostly limited to taxonomic studies and biological studies in Pakistan, poor information was found on the biochemical and nutritional importance of Pakistani Penaeida shrimps (Amanat et. al, 2011) and work on many species but mostly limited to the taxonomy through morphological studies and biology of species. The biochemical studies are intermittent and data related to or refer only proximate composition of the tail muscle of *Penaeus spp*. The biochemical constituents includes, the water, protein, fat and inorganic matter present i.e. ash, with negligible quantities of carbohydrates can be detected. The biochemical composition and morphometry of the body vary and relate to food availability, inter and intra specific competition, development and feed use skills (Breck, 2014; Ruth et al., 2014). The seasonal variations are noticeable in the proximate compositions and usual in shrimp species (Karakoltsidis, 1995), the fatty acid profiles, the cholesterol content (Luzia et al., 2003) and the total carotenoid content (Yanar et al., 2004). In the proximate composition, seasonal changes and various coastal location and sites play a major part for change in temperature, salinity and chemical substances present in their natural habitat. This study was started in order to monitor their primary biochemical makeup by location and season. The objectives of this study are the evaluation of quality of shrimp's flesh based on macronutrients (total fat, carbohydrate and protein) and morphometric characteristics.

MATERIALS AND METHODS

Sampling Sites

Pakistan coastline has geographical and ecological varied areas (harbors, estuaries, bays and creeks) with the diversity of associated fauna exhibiting a wide range of distinctiveness. The 1,050 km, long Pakistan coast is consists of 350 km within the province of Sindh and around 700 km lies in the Baluchistan province, with about 240,000 square km of an Exclusive Economic Zone (EEZ) extends to aarea of 200 nautical miles out from coastal base (Saifullah et al., 2004). Main fishing harbors near the Sindh coast are Karachi fish harbor and Korangi fish harbor, while in Baluchistan Sonimiani, Damb is considered to be more active as fishing is done on the Balochistan coast far from Sonmiani point but these fishing areas not

considered as an active harbours. Shrimp species were collected from Karachi Fish Harbor (24.85° N, 66.97° E), Korangi Fish Harbor (24.85° N, 67.2° E), Sonmiani Fish harbor (25.43° N, 66.53° E) and KetiBunder (24.14° N, 67.45° E).

Sampling Methodology

The shrimp species were collected from various harbors during a period from December 2015 to November 2016 along the coastal areas of Pakistan. The samples were transported to the laboratory in icebox for further analysis.

Laboratory Analysis

The samples were washed and preliminary sorted according to color, white samples were named as genus *Fenneropenaeus*, Brown was named as *Metapenaeus*, Pink were called *Parapenaeus*, *Solenocera* and *Parapenaeopsis* and then identified up to species level according to Tirmizi and Bashir (1973) and kept in freezer until analysis. For the metric and regression analyses the total length (TL in cm) (distance from the tip of the rostrum to the tip of the telson) measured with the help of Vernier caliper upto 0.1 cm and total wet weight (TW in grams up to 0.01 digits) was determined from digital weight machine (Sania et al., 2017).

For biochemical analysis, the shrimps were thawed, peeled and deveined. The total edible portion of the wet tissue was dried in an oven at 70 °C until the wet tissue was dried completely.

Moisture Content Analysis

The moisture content was estimated by subtracting the dry weight of the sample from the total weight. The percentage of moisture was calculated (Soundarapandian, 2008). The dried tissues were used for analysis and remaining stored in a desiccator.

$$(A)\ Moisture\ content\ \ analysis = \frac{dry\ weight\ after\ 24\ hours}{Total\ wet\ weight}\ X\ 100$$

Value of 'A' will be subtracted from 100 as it is the percentage of dry weight.

Edible Meat Content Analysis

For the estimation of edible meat contents, complete exoskeleton along with the head and abdominal skeleton until the Telson was removed and only edible muscles of abdomen (1 to 6 segments) were weighed. Then this weight was divided by total body weight (wet) the percentage was calculated.

Muscle Protein Estimation

For protein estimation 100 mg of moisture free sample was homogenized with distilled water and centrifuged, 0.5 % beta mercaptoethanol was added to the pellet and shaken vigorously again centrifuged for 15 minutes; total 20 ml volume was saved for analysis. One ml aliquot was taken and 4.5 ml of alkaline copper reagent was added and allowed to stand for ten minutes at room temperature. To this 0.5 ml of Folin's phenol reagent was added. After 20 minutes, the absorbance was measured at 660 nm. The same was done on the standard using BSA. The concentration of protein was estimated by the standard curve from different BSA concentration (Lowry et al., 1951). The concentration of protein was estimated by the ratio of OD of sample to the OD of standard (Priyadarshini et al., 2015).

Lipid Analysis

The chloroform-methanol extraction procedure was used for extracting lipid from the various body parts. Lipid was estimated by homogenizing 1 g of moisture free sample

in 20 ml of chloroform-methanol mixture (2:1). The mixture was allowed to filter using Whatman No.1 filter paper and this extract was taken in a pre-weighed beaker. The sample was kept in air-drying oven at 70 °C for evaporation, Beaker was re-weighed with lipid, and the percentage of lipid was calculated (Folch et al., 1957). Weight of remaining dried sample (After oven dried)/weight of sample taken X100 (Priyadarshini et al., 2015).

Carbohydrate Assessment

For the estimation of carbohydrate, 1ml aliquot was taken from the prepared sample; 1ml of 5 % phenol was added followed by 5ml of 98 % conc. H_2SO_4. The mixture is allowed to react for 30 min and the absorbance was read at 490 nm. The concentration of carbohydrate was estimated by the standard curve, which was made from different concentration of D-glucose (Dubois et al., 1956). The concentration of carbohydrate was estimated by the ratio of OD of sample to the OD of standard (Priyadarshini et al., 2015).

Caloric Content Analysis

The estimation of calorific contents was determined by following Brett and Groves (1979). According to this, one gram of protein, lipid and carbohydrate were equivalent to 5.65 kcal, 4.45 kcal and 4.10 kcal in dry weight basis, respectively.

Statistical Analysis

All the extraction and composition analyses were conducted in triplicates for the study. Results are expressed as mean values ± standard deviation (SD). The differences between the mean values were calculated using one-way analysis of variance (ANOVA), and statistically significant differences were reported at $P < 0.05$. Data analyses were done with the use of SPSS 16.0.

RESULTS

Species Abundance and Seasonal Variation in the Catch

Total 359 shrimps of four species were examined in the present study as collected from four locations, were visited for sampling so it is assumed that these belong to four different populations (Figure 1). Abundance and population structure data were grouped according to following Seasons, Northeast monsoon (December to February = NEM), Pre-monsoon (March to May = PRM), Southwest monsoon (June to August = SWM) and Post-monsoon (September to November = POM) (Naz et al., 2012; 2015). The dominant species in the catch were *P. stylifera* (27 %) followed by *Metapenaeopsis stridulans* (22 %) in overall catch from Dec 2015 to November 2016. According to seasonal variation in Pre-monsoon, most shrimps were caught 38% while least was caught in Southwest monsoon (Figure 1). Approximately all types of shrimps were found throughout the year, but the abundance of shrimp species varies seasonally.

Biometric Data (Length - Weight Analysis)

The morphological variations (total length and total wet weight) were observed in the studied shrimp species as shown in Figure 2. The total length (cm) of the shrimp species varied from (6.6–16.6 cm, 4.7–13.5cm), (2.3–11.3 cm) and (4.2–14.2 cm) for *F. indicus, M. stebbingi, M. stridulans*, and*P. stylifera* respectively (Figure 2a). The total wet weight (g) of the shrimp species varied from (1.9–5.9, 0.8–12.5,) (1.5–10.05), and (0.62–16.57) for *F. indicus, M. stebbingi, M.stridulans,* and *P. stylifera*, respectively (Figure 2b). There was no significant ($P > 0.05$) intersexual and as well as interseasonal difference was observed in total length and wet weight for the studied species. The highest length and weight of shrimps was

evaluated from Sonmiani Bay indicated the favorable conditions for growth and development of shrimp fauna in the area. According to the size variability were observed among the shrimp species with respect to sites are shown in Table 1. All species were not present at three sites, while at the Karachi fish harbor (KFH) all species were available (Table 1).

All detailed regression parameters and statistical values of the relationships of length and weight (LWR) indicated in Table 2. The 'R^2' values for four shrimp species ranged from 0.74 to 0.88, minimum values observed in *F. indicus* and maximum values observed in *M. stebbingi*. Slope (b) value were observed highest for *P. stylifera* (7.47) and lowest for *M. stridulans* (4.32), indicating the positive allometric growth pattern as the parameter 'b' was found > 3.0 in all species. Analysis of condition factor (K) value ranged between (0.29–1.25) in *F. indicus* and *M. stridulans*, respectively. The result indicates that heavier shrimps of higher K-values are in better growth condition.

Biochemical Composition

The concentrations of total proteins, in the muscle showed significant differences among the species (Table 3). The percentages of proteins in the edible muscles in the individuals of *F. indicus* varied from (212.5–770 mg/g) in females and (117.5–362.9 mg/g) in males. *M. stebbingi* has higher ranges of protein contents in females (97.2–437.56 mg/g) than males (165.87–368.41 mg/g). Whereas, *M. stridulans* have similar protein contents in both genders (153–308.27) in females and (144.6–263.98 mg/g) in males. The protein concentrations in *P. stylifera* varied from (3.41 to 135.9 mg/g) in females and (9.73 to 135.9 mg/g) in males. Muscle protein, concentrations were lowest in *P. stylifera* in both genders (Table 3) and differed significantly ($P < 0.001$) in both the genders as it did not show any significant difference but seasonally. According to season significant differences can be observed (Figure 3) accordingly as environment matters in biochemical composition as well as presence and absence of the species. Therefore, all the species were not available in all the sites at the same time, variations in their composition and abundance (Figure 3).

The lipid serves as an energy bank for the body of an organism so it conserves energy and helps in cell functions. They contain omega fatty acids, which boosts antioxidant and anticancer activity and beneficial for cardiovascular blockages too (Swanson et al., 2012). The highest value of the estimated lipid amount was found in *F. indicus* (7.31 ± 3.88 mg/g) in penaeid shrimps. In northeast monsoon, *M. stebbingi* has shown the highest value (18.20 mg/g) of lipid while lowest *M. stebbingi and M. stridulans* showed ~2 mg/g lipid according to the size, but size did not show significant differences in lipid content.

As carbohydrates do not make a lot of percentage in edible muscles, but it plays vital role in chitin of exoskeleton, hence it was detected in minimum amount in all the species in edible part. The carbohydrate ranged from (1.65–72.77 mg/g) in female and (0.08–33.08 mg/g) in male for *F. indicus*. In *M. stebbingi*, carbohydrate varied from (0.24–40.82 mg/g) in female and (0.51–49.97 mg/g) in male, whereas, *M. stridulans* presented (0.26–21.22 mg/g) in female and (0.26–64.92 mg/g) in males. The concentration of carbohydrates varied in *P. stylifera* (69.84–87.22 mg/g) in female and (69.84–87.22 mg/g) in male.

The highest value of carbohydrate was detected in *P. stylifera* (87.22 mg/g) among all the species. The gender did not show significant variation, seasonal variations can be easily observed in carbohydrates.

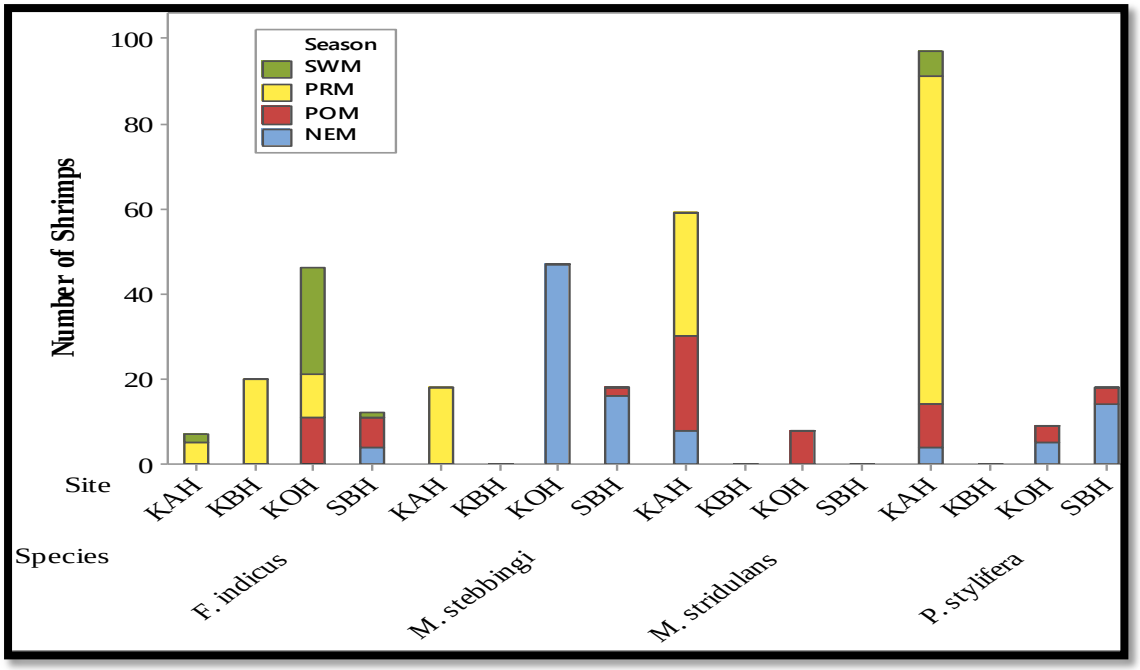

Figure 1: Seasonal distribution and abundance of shrimp species at different collection sites during the study (KAH: Karachi Fish Harbor; KBH: Keti Bander Fish Harbor; KOH: Korangi Fish Harbor and SBH: Sonmiani Fish Harbor).

In post monsoon, it is highly observed in *F. indicus as it* has shown highest values of carbohydrates according to the environment visited (7.277 mg/g) found in Sonmiani harbor. The Jaira shrimps i.e. *F. indicus* has shown significantly higher values at $p < 0.001$.

Seasonal Variations in Biochemical Composition

Fenneropenaeus indicus and P. stylifera contents were significantly highest ($p < 0.05$) while moisture was found higher in *P. stylifera* and edible meat was highest in *F. indicus*. According to reference daily intakes (RDI) Carbohydrate, Lipid and Protein amount vary according to human height and weight, by consuming shrimps at certain amount all the RDI demands can be fulfilled easily and are healthier compared to other food by consuming any size of the shrimp available. In Jaira prawns, maximum number of moisture percentage is observed (93.183 %), in Patash, dry matter was observed higher than others (41.57 %) and (89.20 %) of edible meat is observed in Kiddi shrimps.

Pearson Correlation Analysis

Relationship of nutritional components of shrimp with total length of the body did not show significant differences (Table, 4). Correlation of total weight has shown significant negative relations to all the aspects except the dry matter, while total length has shown the positive relationship except with the moisture variable. Regarding biochemical composition all the component variables (Protein, Carbohydrate and Lipid) have shown a significant positive correlation with all the factors except with the dry matter and moisture.

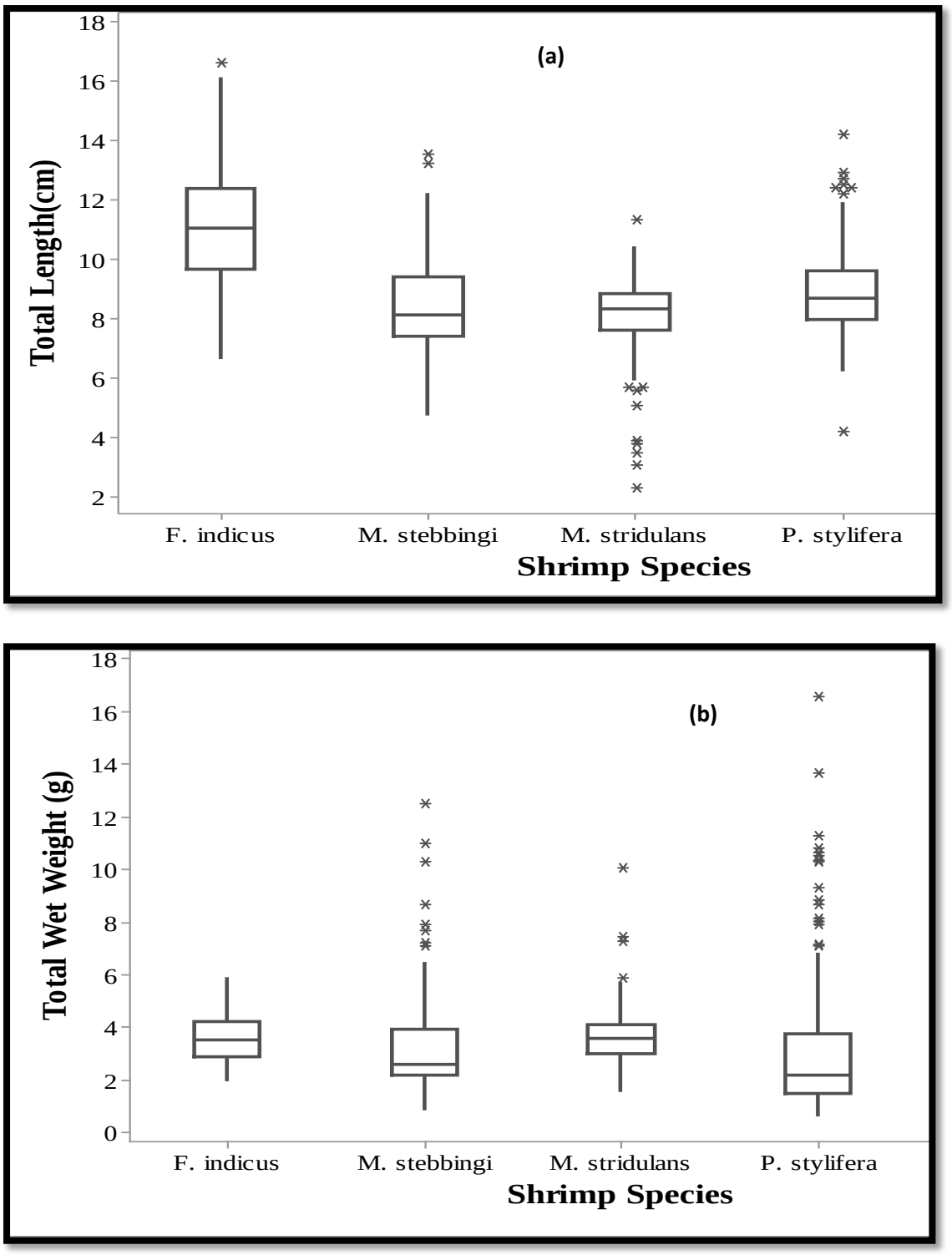

Figure 2: Total length (a) and wet weight (b) of shrimp species collected from the coastal areas of Pakistan.

Table 2. Descriptive statistics for total length and weight of shrimp speciescollected from different study sites

			KFH		KOH		SBH		KTH	
Species			**MALE**	**FEMALE**	**MALE**	**FEMALE**	**MALE**	**FEMALE**	**MALE**	**FEMALE**
F. indicus			**(n=5)**	**(n=2)**	**(n=25)**	**(n=21)**	**(n=6)**	**(n=6)**	**(n=7)**	**(n=13)**
	TL	Mean ± S.D	14.2 ± 1.1	13.6 ± 3.18	10.7 ±2.1	10.5 ± 1.86	12.8±2.2	12.3 ± 2.7	10.9±0.89	10.22 ± 0.93
	(cm)	Mn – Mx	13.5 – 16.1	11.40 – 15.9	6.6 – 14.7	8.1 – 13.5	9.9 – 5.5	9.8 – 16.6	9.7 – 12.1	8.70 – 11.8
	TW	Mean ± S.D	4.6 ± 0.8	4.15 ± 1.63	3.19 ± 1.03	3.30 ± 0.83	4.47 ± 0.75	4.37 ± 1.02	3.9 ± 0.48	3.45 ± 0.41
	(g)	Min – Max	3.2 – 5.30	3.00 – 5.30	1.9 – 5.7	1.9 – 4.7	3.6 – 5.4	3.10 – 5.9	3.2 – 4.7	2.9 – 4.2
P. stylifera			(n=49)	(n=48)	NA	(n=8)	(n=5)	(n=13)	NA	NA
	TL	Mean ± S.D	8.16± 1.43	8.9± 0.94	NA	9.53± 1.73	8.34±.65	11.51±1.12	NA	NA
	(cm)	Min – Max	4.2 – 14.2	7.3 –11.80	NA	6.9 – 12.7	7.3– 8.80	9.3– 12.9	NA	NA
	TW	Mean ± S.D	2.14 ± 2.4	2.5± 1.65	NA	6.98 ± 2.95	2.55±0.9	8.61± 2.22	NA	NA
	(g)	Min – Max	0.6– 16.57	0.7– 10.5	NA	4.66– 13.65	1.56– 3.7	4.4– 11.26	NA	NA
M. stebbingi			(n=28)	(n=30)	NA	(n=7)	(n=10)	(n=8)	NA	NA
	TL	Mean ± S.D	7.72± 0.95	9.06± 1.91	NA	10.47± 0.38	7.26±1.8	8.24± 0.87	NA	NA
	(cm)	Min – Max	5.4– 9.8	6.7– 13.5	NA	9.8– 10.9	4.7– 10.1	6.7– 9.8	NA	NA
	TW	Mean ± S.D	2.44± 0.63	4.48± 3.11	NA	5.71± 0.73	2.17±1.5	2.95± 0.92	NA	NA
	(g)	Mn – Mx	1.33– 3.92	1.33– 12.5	NA	4.27 – 6.44	0.8– 4.9	1.35– 4.45	NA	NA
M. stridulans			(n=31)	(n=28)	NA	(n=8)	NA	NA	NA	NA
	TL	Mean ± S.D	8.20± 0.50	8.23± 2.22	NA	5.41± 0.82	NA	NA	NA	NA
	(cm)	Min – Max	7.10– 9.20	2.3–11.3	NA	3.5– 5.9	NA	NA	NA	NA
	TW	Mean ± S.D	3.49± 0.61	4.4± 1.73	NA	2.34± 0.52	NA	NA	NA	NA
	(g)	Min – Max	2.4– 5.67	1.98– 10.05	NA	1.51– 3.05	NA	NA	NA	NA

TL= total length TW=total weight), KFH= KARACHI FISH HARBOR, KOH= KORANGI FISH HARBOR, SBH=SONMIANI BAY HARBOR, KTH= KETI BANDAR HARBOR

Table 2: Linear regression (R^2) analysis of shrimp species collected during the study period.

Family	Species	N	R^2	Parameter 'a'	Parameter 'b'	Growth pattern	Condition factor 'K'
Penaediae	*F. indicus*	85	0.74	1.532	5.617	Positive allometry	0.29
	M. stebbingi	83	0.88	0.690	6.039	Positive allometry	0.53
	M. stridulans	67	0.77	0.952	4.327	Positive allometry	0.73
	P. stylifera	124	0.78	0.436	7.479	Positive allometry	0.40

Table 3. The biochemical composition of four shrimp species collected from coastal areas of Pakistan during study.

Species	Biochemical Constituents	Female		Male	
		Mean ± SD	Min–Max	Mean ± SD	Min–Max
F. indicus (Female = 42; Male = 43)					
	Protein (mg/g)	347.45 ± 97.7	212.5 – 77	287.96 ± 64.17	117.5 – 362.9
	Carbs (mg/g)	13.38 ± 16.05	1.65 – 72.77	11.11 ± 7.34	0.08 – 33.08
	Lipid (mg/g)	78.5 ± 40.11	9 – 149.15	67.86 ± 37.2	11.3 – 175.76
	Moisture (%)	80.17 ± 7.47	69.04 – 93.18	75.95 ± 5.4	69.04 – 90.19
	Edible Part (%)	50.39 ± 7.04	36.02 – 59.22	49.43 ± 8.77	36.02 – 69.97
	Dry Matter (%)	19.83 ± 7.47	6.82 – 30.96	24.05 ± 5.4	9.81 – 30.96
M. stebbingi (Female = 45; Male = 38)					
	Protein (mg/g)	233.65 ±55.77	97.2 –437.56	244.44 ±35.39	165.87 –368.41
	Carbs (mg/g)	12.75 ±8.88	0.24 –40.82	11.86 ±8.68	0.51 –49.97
	Lipid (mg/g)	61.28 ±32.24	11.24 –182	58.32 ±27.14	1.5 –142.24
	Moisture (%)	73.7 ±4.48	58.42 –85.37	73.23 ±2.71	69.57 –80.18
	Edible Part (%)	42.84 ±9.33	25.93 –63.56	42.7 ±7.98	32.41 –61.67
	Dry Matter (%)	26.3 ±4.48	14.63 –41.58	26.77 ±2.71	19.82 –30.43
M. stridulans (Female = 36; Male = 31)					
	Protein (mg/g)	207.95 ± 37.18	153 – 308.27	195.63 ± 37.55	144.6 – 263.98
	Carbs (mg/g)	4.61 ± 5.38	0.26 – 21.22	6.59 ± 16.21	0.26 – 64.92
	Lipid (mg/g)	62.56 ± 38.93	19 – 171	58.17 ± 35.42	1.5 – 134.14
	Moisture (%)	77.54 ± 6.21	69.57 – 91.95	75.66 ± 6.88	69.57 – 91.74
	Edible Part (%)	41.09 ± 5.87	26.91 – 54.77	44.69 ± 14.1	26.91 – 89.2
	Dry Matter (%)	22.46 ± 6.21	8.05 – 30.43	24.34 ± 6.88	8.26 – 30.43
P. stylifera (Female = 69; Male = 55)					
	Protein (mg/g)	145.09± 26.2	3.41 – 135.9	148.56 ± 26	9.73 –135.9
	Carbs (mg/g)	78.3 ± 4.48	69.84 – 87.2	78.63 ± 5.01	69.84 – 87.2
	Lipid (mg/g)	49.73 ± 10.07	19.06 – 63.56	49.26 ± 9.52	19.06 – 61.48
	Moisture (%)	315.7 ± 121.73	117.5 – 576.48	272.88 ± 109.2	110 – 576.48
	Edible Part (%)	49.73 ± 10.07	19.06 – 63.56	49.26 ± 9.52	19.06 – 61.48
	Dry Matter (%)	21.7 ± 4.48	12.78 – 30.16	21.37 ± 5.01	12.78 – 30.16

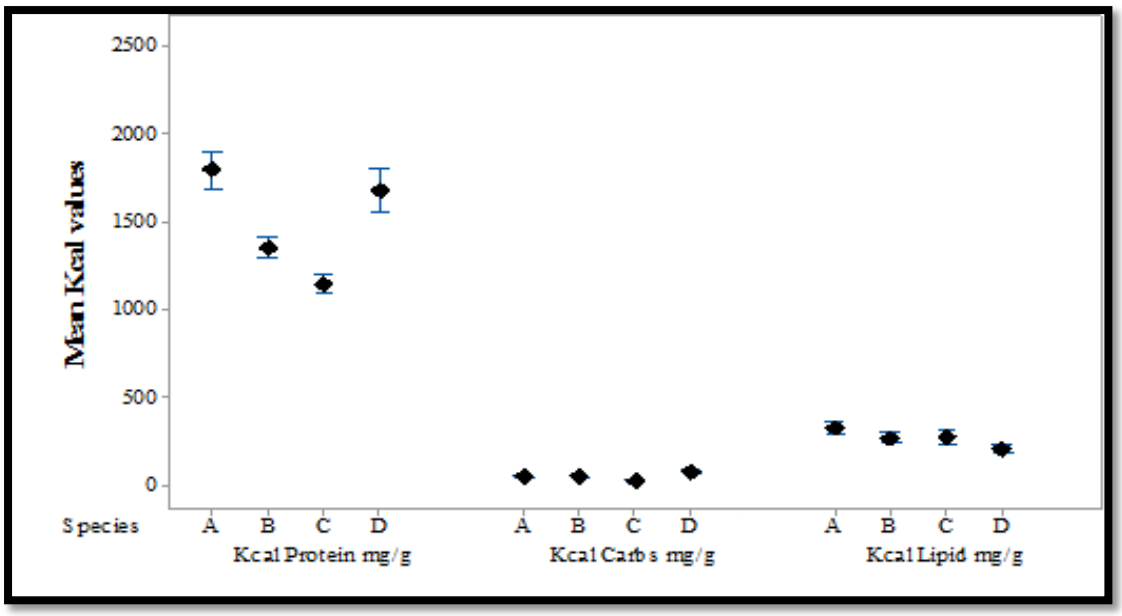

Figure 3: The estimated mean Kcal values of proteins, carbohydrate and lipid in four shrimp species collected from coastal areas of Pakistan.

Table 4: Pearson's Correlations Analysis among the proximate variables of shrimp species collected during study.

	TW	TL	%P	%C	%L	%M	%EM	%DM
Total Weight (TW)	1.000***							
Total Length (TL)	0.519***	1.000***						
Protein (% P)	-0.143**	0.082ns	1.000***					
Carbohydrate (% C)	-0.287***	0.060ns	0.507***	1.000***				
Lipid (% L)	-0.158**	0.083ns	0.336***	0.363***	1.000***			
Moisture (% M)	-0.122**	-0.083ns	0.175***	0.205***	0.083ns	1.000***		
Edible Meat (% EM)	-0.095*	-0.026ns	0.496***	0.367***	0.235***	0.401***	1.000***	
Dry Matter (% DM)	0.122**	0.083ns	-0.175***	-0.205***	-0.083ns	-1.000***	-0.401***	1.000***

Note: < 0.001 = ***; < 0.01 = **; < 0.05 = *; ns = not significant

DISCUSSION

Total 359 samples were analyzed; most samples were procured in Pre monsoon while the least in Southwest monsoon. The values obtained from the length and weight relationship (LWR) of shrimps showed that there was a high and significant correlation between the total length and weight of all four species of shrimp. This provides the information, that the length and weight of shrimps increase in the same proportion. In fisheries studies, the weight-length relationships assent to the inference of the average weight at a given length of any species in a specific area (Ferreira et al., 2008; Sousa et al., 2019). The comparison of the length and weight relationship provides the information about the difference of well being in between-population dynamics, ecological condition, stock evaluation, management and to approximation of the biomass of present population and production (Anderson and Gutreuter, 1983; Erzini, 1994; King, 1995; Santos et al, 2002). For shrimp catch, best season is pre monsoon

(March to May) and biochemical constituents does not vary significantly a lot, according to site, but seasons also affect the catch and calorie requirements in the body of shrimps as well. It showed that anthropogenic problems also affect the morphology of the shrimp as Sonmiani bay shown the highest growth of shrimp among all the visited areas as harbor does a lot of shrimping as compared to Korangi and Karachi fish harbor.

The present result revealed that heavier shrimps with higher K-values indicated the healthier growth conditions for the species. The condition factor is frequently used for the quantification of animal's physical wellness and prefered to be a valuable set off for the growth estimates in crustaceans (Bagenal and Tesch, 1978; Rochet, 2000 Sousa et al., 2019). Genus *Fenneropenaeus, Parapeneopsis, Metapenaeus, Metapenaeopsis, Litopenaeus, Marsupenaeus, Penaeus* (Family : Penaeidae) have been previously studied for their nutritional values with different aspect such as during their molting period, or during stages of immaturity to maturity , current studies have shown nutritional values seasonally and from different (locality) populations(Nisa and Sultana 2010; Banu et al., 2016; Islam et al., 2017; Gopan et al., 2020). Recently, a comparison indicated that the moisture content and protein contents in the muscle of shrimp collected from the coastal habitats is nearly same with little difference, observations of study indicated more protein content in *P. indicu*s (52.4 %), in *P. monodon (*48.6 %) and in *P. vannamei* (39.8 %) respectively. Protein has an importance as a building block of bones, muscles, cartilage, skin, blood, to make enzymes, hormones, and other body chemicals. In comparasion, the more fat content was observed in *P. vannamei (*16.1 %), as observed in *P. indicus (*11.3 %) and in P. *monodon (*10.9%) respectively. Fat performs many other important functions in the body of the organisms as available and used as a major source of fuel in the form of stored energy. The fat from the sea food source is beneficial for the health and a moderate amount is needed in the diet for good health (MacDonald et al., 1998). Carbohydrate content was also observed, with high concentration in *P. indicus (*13 %), in *P. monodon* (7.4 %) and least observed in *P. vannamei* (4.8 %). Carbohydrates not only provides fuel for the central nervous system as important for brain function and energy for working muscles, but also foil protein from being used as an energy source and facilitate the fat metabolism (Venkateswarlu, 2019).

In Pakistan, the size of Penaeids varied significantly from 2.3 cm to 16.6 cm, they are known as *kiddi* shrimps. Their significant variable size is used in many other useful products such as fish meal. The quality and the accuracy of environmental condition of any species is determined by their biochemical composition as it is of immense concern. The nutritional components are quite good enough in these shrimps especially proteins. Protein was found to be the key constituent in the edible muscle. As genus *Parapenaeopsis* data was found of the year 1957 and 1984 by Mahmud and Achukantakuttay (2015) from India, protein values are as 51.3 to 66.3 % and 84.13 %. The current finding in *Fenneropenaeus* (31.73 %), in *Metapenaeus* (23.85 %), in *Metapenaeopsis* (20.22 %), and in *Parapenaeopsis (*29.67 %) were close to the findings of Nisa et al., (2010) from Pakistan in genus *Fenneropenaeus* as 19.01 %. In Turkey (2014), *Metapenaeus* 19.1 % as it was found in Mexico in genus *Litopenaeus* as (20.04 %) (Kjeldhal method). In 2015, Banu et al., reported combined values of both the sexes of genus *Fenneropenaeus as* (35.13 ± 1.39 %). Priyadarshini (2015) reported genus *Solenocera* and *Metapenaeus*as (17 % and 39 %), while Salam (2013) and

Karuppasamy (2013) estimated the protein values in genus *Fenneropenaeus* 42.88 ± 1.11 % (male) and 40.68 ± 2.28 % (female) and 7.49 ± 0.072 mg/g. As protein is the major constituent of muscles and helps building the body physiological and metabolic functions, shrimps' utilization could be a better option for the consumption. As it contains less carbohydrates in the muscles in *Fenneropenaeus* (1.22 %), in *Metapenaeus* (1.23%), in *Metapenaeopsis* (0.55 %), and in *Parapenaeopsis (*1.89 %) they relatable with the research of Dincer (2014) as (0.96 %) in genus *Fenneropenaeus* from turkey whereas Banu (2015) research showed the lesser value of carbs from 2.82 to 3.34 % in Penaeid shrimps of India. Carbohydrates help giving the energy, but when it comes to taste, especially in Asian countries like Pakistan, people prefer spicy and less sweetness in the daily meal they consume in large amount, so by cooking it with home spices shrimp tastes better as it contains less amount of carbohydrates. Shrimps contain large amount of omega 3 fatty acids and have amount of cholesterol in it, the total lipid estimations lead to the conclusion that they contain high amount of total lipids. The lipids estimation showed the variability in concentration as in *Fenneropenaeus* (4.01 %), *Metapenaeus* (3.22 %), in *Metapenaeopsis* (3.89 %), and in *Parapenaeopsis (*2.63 %). Previously work done in (Family: Penaediae) and found 2.9 to 5.5 % of lipids which is relatable to the work done in this paper and other finding from India showed a bit higher amount of lipid from 15.12 to 17.45 % (Banu et al.. 2016). The Omega acids these lipids contain can help in the cure of cardiovascular diseases as they are good in cholesterol that is high density lipids. Moisture content is almost equal to the previous and current findings revealed moisture mean value as *Fenneropenaeus* (80.17 %), in *Metapenaeus* (73.7%), in *Metapenaeopsis* (77.54 %), and in *Parapenaeopsis (*78.3 %) while in previous report the Achukutakuttay (1984) from India *Fenneropenaeus* (76.31 %), in *Metapenaeus* (77.3 %) and in *Parapenaeopsis (76.6* %) and Banu (2015) reported the mean values of lipids in *Fenneropenaeus* (76.18 %), and in *Metapenaeus* (76.14 %). Dincer et al., (2014) from turkey reported in genus *Metapenaeus* (78.43 % in male and 77.47 % in female). Dry matter content was not found to be discussed in any of the such references but in our research it was found to be in *Fenneropenaeus* (30.96 %), in *Metapenaeus* (41.58 %), in *Metapenaeopsis* (30.43 %), and in *Parapenaeopsis (*30.16 %). This dry content becomes the part of certain edible foods as flavoring item while edible meat for consumption with moisture as it is consumed in daily meals was found to be in *Fenneropenaeus* (36.02 %), in *Metapenaeus* (25.93 %), in *Metapenaeopsis*(26.91 %), and in *Parapenaeopsis (*19.06 %). However, the Jaira shrimps (*F. indicus*) are considered large ones and are consumed by consumers worldwide apart from the value they produce as edible percent meat. Nutritional content suggests that kiddi shrimps (*M. stebbingi, M. stridulans and P. stylifera*) have the ability to contribute to the diet of deprived sections of the fish-eating population and also contributes critically to the current awareness of the nutritional importance of indigenous small shrimps that could be used to make usable food with a high percentage of ω -3 PUFA value added. The reports on the yield and the chemical composition of body components of some species of shrimps were also reported (Gopakumar, 1993) but the attributes of wild shrimp is substantially different and may have been affected by many aspects of their habitat such as weather changes, salinity differences, turbulence etc. Although our findings are novel, more study is needed to find out the variation of other nutritional compounds such as amino acid

profile, fatty acid profile, and wild shrimp and prawn valued minerals (Islam et al., 2017). However, our research indicates that shrimp are reasonable sources of proteins and can act as an additional source of high-quality protein for human consumption.

AUTHOR'S CONTRIBUTION

All authors have equal contribution in this article.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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