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Length-Weight Relationship, Condition and Relative Condition Factor of Four Mugilid Species (*Family mugildae*) from the Karachi Coast of Pakistan

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Abstract

Length-weight relationship, condition (K) and relative condition factor (Kn) of four mugilid species (*Liza melinoptera, Liza macrolepis, Valamugil speigleri and Mugil cephalus*) from the Karachi coast were determined. Log transformed regression was used to check whether the growth of these species was positive or negative allometric. It was observed that *Liza melinoptera* and *Valamugil speigleri* were showing negative allometric pattern of growth (b<3.0), while *Mugil cephalus* and *Liza macrolepis* indicated positive allometric pattern of growth with b-value greater than ideal value (b=3.0) Such deviation of b-value from the ideal value was found to be statistically highly significant (p<0.01), hence, it was concluded that their body shapes were changed as they grow or increase in size. Condition factor (K) showed an increasing trend with increase in size or weight of fish. Relative condition factor values (Kn>1.0) revealed that these fishes were in good condition on Karachi coast.

Keywords: Mullets; Length-weight relationship; Condition factor; Relative condition factor

Introduction

Fishes of the family Mugilidae are commonly known as "mullets" or "grey mullets". This family includes 18 genera and 81 species [1,2]. Commonly found in marine and brackish waters or estuaries at 20 m depth. Some species spend their whole lives in fresh water habitats, i.e., *Liza abu*. In Pakistan, Bianchi [3] described 3 genera and 12 species, while Fahmida [4] identified the eight mullet species on Karachi Coast, e.g., *Mugil cephalus, Valamugil seheli, Valamugil speigleri, Liza carinata, Liza parsia, Liza subviridis, Liza abu* and *Liza vaigiensis.*

Many researchers have published their reports on length-weight relationship (LWRs), condition factor (K) and relative condition factor (Kn) of the mugilid species such as, Length-weight relationship (LWRs) data of two mullet species, i.e., *Liza macrolepis* and *Mugil cephalus* from the different regions of world such as, near the coast of Mandapam (India), Negombo lagoon (Sri Lanka), Bonny estuary (Nigeria) and southwestern coast of Taiwan was given by Luther [5], Wijeyaratne and Costa [6] Aleleye-Wokoma et al. [7] and Chu et al. [8]. Karna et al. [9] described the LWRs of *V. speigleri* from Chilika lagoon of India. Though the information regarding to the LWRs of mullet species from Pakistan coast was still scarce, however, Abbas [10] studied the LWRs of Liza carinata from Bhanbhore tidal backwaters along the Sindh coast of Pakistan. Hence, the main purpose of this study was to calculate the length-weight relationship, condition and relative condition factors for the four selected mugilid species in order to observe their growth pattern and physical or heath conditions at Karachi coast.

Materials and Methods

Samples collection

A total of 246 specimens of the four species of family Mugilidae were collected monthly from the landings at Karachi fish harbour, during the period of April 2010 to December 2011. The total catch contained 69 individuals *of Liza melinoptera, 79 Valamugil speigleri, 62 Liza macrolepis* and *36 Mugil cephalus*, respectively. In Pakistan, these fishes are caught mainly with gillnets, castnets, liftnets and beach seines as reported by Bianchi [3]. Each specimen was identified to species level in the field as well as in laboratory by using the FAO field guide [3,11]. Total length (TL) of each specimen was measured in centimeters from the tip of snout to the end of caudal fin using measuring board. Weight (W) for each fish sample was noted on digital balance. Then fishes were immediately preserved in 10% formaldehyde solution for about one week, and after that stored in 70% ethanol for long time preservation.

Length-weight relationship (LWRs)

Length-weight relationship was calculated separately for male, female and combined sexes of each selected mullet species. The length-weight relationship was calculated by using cubic law suggested by Le Cren [12] as follows;

$$w=aL^b \quad \text{..... (1)}$$

Whereas, W is the wet weight in grams, L is the total body length in centimeters; a is the intercept and b is the exponent or regression slope. In order to confirmed that whether length and weight were linearly related with each other, the slope of the regression line (b) was subjected to t-test at 5% significant level ($p<0.05$) to test the null hypothesis Ho: b1=0 against the alternate hypothesis Ha: $B1 \neq 0$ by using following model 2 as follows;

$$t=\frac{b1}{se/\sqrt{SXX}} \quad \text{..... (2)}$$

Where b1 is the slope of regression line, S_{xx} is the notation used in

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regression; Se is the standard error of estimate, which can be calculated by following model 3 as follows;

$$se = \sqrt{\frac{SSE}{n-2}} \quad \ldots\ldots (3)$$

Where SSE is the sum of square error. The values of SSE can be calculated by model 4 as follows;

$$SSE = \sum (y - \hat{y})^2 \quad \ldots\ldots (4)$$

Where the values of Sxx was calculated by using model 5 as follows;

$$Sxx = \sum x^2 - (\sum (x)2 / n \quad \ldots\ldots (5)$$

Where x is the independent variable.

But the parameters a and b were estimated by the least square regression method for combined and separate sexes, so it is more better to use log transformation data than the regression equation obtained from the model 1 in order to make the relationship linear. So, the above model 1 was logarithmically transformed into model 6 as suggested by Anibeze [13] was as follows;

$$\text{Log } W = \text{Log } a + b \log L \quad \ldots\ldots (6)$$

Where b is an exponent or allometric growth coefficient usually has value between 2.5 to 4.0. Therefore, the values of an exponent b of the length-weight relationship was tested for departure from its ideal value, that is b=3, when growth is isometric. Hence, LWRs (logarithmic) was used to check whether the growth was positive or negative allometric.

In order to confirm that whether the b-values obtained in the linear regression analysis were significantly different from the ideal value (b=3.0), t-test was applied at a specified significant level ($p<0.05$) to test the null hypothesis Ho: b=3.0 against the alternate hypothesis Ha: b≠3. Therefore, data on LWRs for male, female and combined sexes of each mullet species were subjected to t-test by using modal 7 as suggested by Kumolu-Johnson and Ndimele [14] as follows;

$$t = (b-3)/S.E(b) \quad \ldots\ldots (7)$$

Where t=t-statistics and S.E (b) is the standard error of regression coefficient 'b'. The values of S.E (b) were obtained in the linear regression analysis by using Minitab demo 14.1 (Statistical software)

Coefficient of correlation (r):

The values of coefficient of correlation (r) were also calculated to measure the degree of linear relationship between all above mention parameters. The values of Pearson linear coefficient of correlation 'r' were also determined by using formula of Hossain [15] as follows;

$$r = \sum xy / \sqrt{\sum x^2 . \sum y^2} \quad \ldots\ldots (8)$$

Whereas x=X-X and y=Y-Y. X and Y are the mean values that used to predicted the values of X and Y variables. The values of X and Y were calculated by the following equations suggested by Niel [16] as follows;

$$X = \sum X / n \quad \ldots\ldots (9)$$

Whereas ΣX is the sum of X- values (independent variable) and 'n' is the sum of data.

$$Y = \sum Y / n \quad \ldots\ldots (10)$$

Whereas ΣY is the sum of Y-values (dependent variable)

Condition factor (K)

The condition factor (K) value was calculated with the help of following formula suggested by Offem et al. [17] as follows;

$$K = W \times 100 / L^3 \quad \ldots\ldots (11)$$

Where W is the total body weight and L is the total body length.

4.4 Relative condition factor (Kn)

The values of relative condition factor (Kn) were calculated from the following formula suggested by Le Cren [12] and Ranzani-Paiva et al. [18] as follows;

$$Kn = Wt/We \quad \ldots\ldots (12)$$

Where W_t is the observed body weight and We is the theoretically estimated weight. Both Wt and We were expressed in grams.

Results

Length-Weight relationship of mullets

The results of the length-weight relationships (LWRs) for the four mullet species were calculated separately for male, female and combined sexes, as given in the Table 1a. Analysis of t-test showed a highly significant relationships ($p<0.05$) between length and weight for male, female and combined sexes of four selected mullet species (except female of *Liza melinoptera*) Hence, if the total length increases than whole body weight of fish will also be increased accordingly. However, it was much better to use the logarithmic transformation equations than the Pearson linear regression equation, as the variability in weight for the different lengths of fish did not always remain constant.

The log transform data of length-weight relationship (LWRs) was analyzed by the cube law to check whether the growth was positive or negative allometric, as shown in Table 1b. In the present study, the exponent b-values were also found to be varied from an isometric value (b=3.0) In male, female and combined sexes of *L. melinoptera* and *V. speigleri*, the exponent b-values was less than 3.0, while in case of *M. cephalus* and *L. macrolepis,* the exponent b-values was greater than 3.0. In general, the b-values reported for the combined sexes of all four mullet species ranged from 2.65 for *V. speigleri* to 3.59 for *L. macrolepis*. However, all regression coefficients (b) calculated in the present study for the four mullet species were lies within the expected range (2.5-4.0), therefore, suggesting that the result of length-weight relationship of this study was valid. This departure of b-value from an ideal value (b=3.0) was subjected to the t-test analysis. The test results revealed that except the females of *L. melinoptera*, the b-values of male, female and sex combined of these four mullet species were significantly departed from an ideal value (b=3.0).

Highly significant correlation coefficients values ($r>0.90$; $p<0.05$) were obtained for the male, female and combined sexes for the three mullet species such as *M. cephalus, V. speigleri* and *L. macrolepis,* indicating that both length and weight of each mullet species were highly correlated with each other. The r-values for male and sex combined of *L. melinoptera* were moderately strong ($r>0.70$; $p<0.05$), while weak or insignificant ($r=0.32$; $p>0.05$) for female, hence, indicating that both length and weight were weakly correlated with each other. The scattered plot diagrams were also drawn to show the parabolic relationship between length and weight indicating the applicability of general cube law to all these four mullet species, respectively.

Condition factor (K)

The condition factor was determined only for observed body weights (Table 1c). In general, the mean condition factor (K) ranging from 0.99 (females of *L. melinoptera*) and 1.23 (males of *L. macrolepis*), as shown in the Table 1c. Thus, in general, the values of condition

Species	Sex	N	Length range (cm.)		Mean± S.D	Weight range (g)		Mean ± S.D				*t*-test	p-value
			Max.	Min.		Max.	Min.		a	b	r		
Liza melinoptera	Combined sexes	69	18	14.5	16.48 ± 0.95	72	24	47.68a ± 12.22	69.3	7.09	0.551**	5.4	0.0a
	Female	33	18	14.5	16.84 ± 0.76	72	24	53.93 ± 11.35	6.6	2.81	0.188*	1.07	0.30NS
	Male	36	18	14.5	16.15 ± 0.99	72	30	41.94 ± 10.07	69.9	6.92	0.68**	5.41	0.0a
Liza macrolepis	Combined sexes	62	29	12.5	17.49 ± 3.23	500	25	78.6 ± 83.8	308	22.1	0.854***	12.69	0.0a
	Female	41	25.5	12.5	17.74 ± 3.32	400	25	83.0 ± 75.8	251	18.8	0.827***	9.17	0.0a
	Male	21	29	13	17.0 ± 3.07	500	28	70.2 ± 99.1	440	30	0.929***	10.93	0.0a
Valamugil speigleri	Combined sexes	79	19.4	13.1	15.83 ± 2.01	68	20	42.35 ± 14.60	69.4	7.06	0.973***	36.82	0.0a
	Female	32	19.4	13.1	16.07 ± 2.17	68	20	45.12 ± 15.76	68.6	7.07	0.978***	25.5	0.0a
	Male	47	19	13.5	15.65 ± 1.89	68	26	40.46 ± 13.61	68.7	6.97	0.97***	26.87	0.0a
Mugil cephalus	Combined sexes	36	37.8	20	26.38 ± 4.73	685	80	232.5 ± 185.3	727	36.4	0.928***	14.54	0.0a
	Female	16	36.6	20	26.11 ± 5.22	645	80	221.12±183.5	646	33.2	0.944***	10.68	0.0a
	Male	20	37.8	21.7	26.61 ± 4.43	685	104	241.5 ± 191.03	817	39.8	0.923***	10.18	0.0a

Length (L) in cm; Weight (W) in g; N=sample size; S.D=Standard deviation. *** shows the strong correlation (r>0.70); ** shows moderate correlation (r>0.60); * represent weak correlation (r>0.50) NS=not significant (when p>0.05) a: significant at 5% level (p<0.05)

Table 1a: Regression parameters of the length-weight relationship (W=a. Lb) of the four species of family Mugilidae.

Species	Sex	N	Log a	Log b	S.E (b)	r	*t*-test when b=3	p-value	G.T
Liza melinoptera	Combined sexes	69	-1.64	2.72	0.43	0.615**	-0.65	0.0a	-
	Female	33	-0.21	1.58	0.85	0.316*	-1.67	0.07NS	-
	Male	36	-1.46	2.54	0.44	0.703***	-1.05	0.0a	-
Liza macrolepis	Combined sexes	62	-2.66	3.59	0.12	0.97***	5.09	0.0a	s
	Female	41	-2.65	3.59	0.13	0.977***	4.69	0.0a	s
	Male	21	-2.62	3.54	0.27	0.95***	2.03	0.0a	s
Valamugil speigleri	Combined sexes	79	-1.56	2.65	0.08	0.968***	-4.38	0.0a	-
	Female	32	-1.59	2.68	0.13	0.968***	-2.54	0.0a	-
	Male	47	-1.51	2.6	0.1	0.964***	-4.05	0.0a	-
Mugil cephalus	Combined sexes	36	-2.74	3.54	0.23	0.937***	2.38	0.0a	s
	Female	16	-2.56	3.41	0.21	0.975***	1.95	0.0a	s
	Male	20	-2.94	3.68	0.41	0.903***	1.66	0.0a	s

*** shows the strong correlation (r>0.70); ** shows moderate correlation (r>0.60); * represent weak correlation (r>0.50) NS=not significant (when p>0.05); a: significant at 5% level (p<0.05); s represent positive allometric pattern of growth; - shows negative allometric pattern of growth; GT=growth type

Table 1b: Regression parameters of the length-weight relationship (log W=log a+log b L) of the four species of family Mugilidae. Length (L) in cm; Weight (W) in g; N=sample size; S.D=Standard deviation.

Species	Sex	N	Length range (L) in cm.		Weight (Wt) range in grams.		Condition factor (K) range		Mean K value	Relative condition factor (Kn) Range		Mean Kn value
			Max.	Min.	Max.	Min.	Max.	Min.		Max.	Min.	
Liza melinoptera	Combined sexes	69	18	14.5	72	24	1.6	0.67	1.06	1.51	0.66	1
	Female	33	18	14.5	72	24	1.6	0.67	0.99	1.62	0.7	1
	Male	36	18	14.5	72	30	1.6	0.79	1.13	1.36	0.51	1
Liza macrolepis	Combined sexes	62	29	12.5	500	25	2.53	0.92	1.2	21.77	-2.89	1.18
	Female	41	25.5	12.5	400	25	2.05	0.92	1.14	30.9	-0.56	2.85*
	Male	21	29	13	500	28	2.53	0.98	1.23*	9.35	-1.58	1.81
Valamugil speigleri	Combined sexes	79	19.4	13.1	68	20	1.24	0.85	1.04	1.15	0.82	1
	Female	32	19.4	13.1	68	20	1.2	0.89	1.03	1.17	0.86	1
	Male	47	19	13.5	68	26	1.24	0.85	1.05	1.12	0.79	1
Mugil cephalus	Combined sexes	36	37.8	20	685	80	1.73	0.48	1.08	2.24	0.36	1.09
	Female	16	36.6	20	645	80	1.73	0.48	1.11	2.24	0.35	1.08
	Male	20	37.8	21.7	685	104	1.4	0.83	1.05	4.38	0.64	1.4

*shows the highest value

Table 1c: Condition factor (K) and Relative condition factor (Kn) values of the four species of family Mugilidae. Length (L) in centimeters; Weight (Wt) in grams; N=sample size.

factor (K) obtained in the present study revealed that four selected mullet species of this study were in good condition.

Relative condition factor (Kn)

For each mullet species, Kn values were calculated separately for male, female and combined sexes (Table 1c) The main difference between condition (K) and relative condition factor (Kn) was that condition factor (K) was used to measure the deviation of an individual from a hypothetical fish, while the relative condition factor (Kn) was used to measure the deviation of an individual from an theoretically expected weight at a specific length, as described by Omogoriola et al. [19].

The result of the present study revealed that the mean Kn values

obtained for four mullet species of this study were ranged from 1.00 (*V. speigleri* and *L. melinoptera*) to 2.85 (females of *L. macrolepis*), respectively. The mean Kn values obtained for four mullet species of this study were either equal to or greater than expected value (Kn=1.0), therefore, they were in good condition. Furthermore, as the mean Kn values calculated for the L. macrolepis and M. cephalus was found to be higher than *V. speigleri* and *L. melinoptera*, therefore, the former species were found in more better physical conditions than later ones.

Discussion

Lagler [20] and Wootton [21] suggested that if fish grow isometrically than it retains its body shape and its specific gravity will also remain unchanged during the life time, therefore, in such cases, its b-value must be equal to 3.0. Hence, this growth pattern in fish will follow the cube law. But under natural condition, most fish do not show the cube law, because they change their body shape as they grow or increase in size and become heavier in one season and lighter in the other season. Hence, Le Cren [12] reported that the actual relationship between length and weight of fish may departure from the ideal value (3.0), which may be due to certain environmental conditions or condition of fish. Hence, the b-value for each fish species could be significantly greater or less than ideal value (3.0), indicating that growth pattern is allometric [22]. Thus, if b-value is equal to 3.0, than growth is isometric. But if b-value is less than 3.0, than fish becomes more slender as it increase in length, therefore, its growth will be negative allometric that might be because habitat conditions are not suitable for its growth. On the other hand, if b-value is greater than 3.0, than fish becomes heavier and showed positive allometric pattern of growth for their specific lengths, which may be due to optimum condition [23,24]. Hence, the high b-values (2.5-4.0) obtained in this study for the four mullet species revealed that the present condition of these mullet species exists in the study area was more suitable for feeding and optimum growth of fish (Table 1b).

The overall result of this study revealed that both *L. melinoptera* and *V. speigleri* showed negative allometric pattern of growth with the b-values less than ideal value (3.0) On the other hand, the b-values of *M. cephalus* and *L. macrolepis* were greater than the ideal value (3.0), therefore, indicating the positive allometric growth. While the results length-weight relationship of *L. melinoptera* showed differences in the b-values between male, female and combined sexes. The deviation of b-value from the ideal value (3.0) was found to be statistically highly significant ($p<0.01$) in all four mullet species (except the female of *L. melinoptera* that showed insignificant ($p>0.05$) departure from ideal value, that is 3.0) of this study. Hence, the b-values could be varied among the different populations of same species. These variations in the b-values for the same species might be due to the differences in sampling time, sample size, differences in ages and growth rates, maturity stages and food availability [25]. Hossain [15] also reported that the LWRs in fishes can also be affected by certain factors such as habitat, spawning season, condition environment (including temperature, salinity and seasonality), food availability, sex, maturity stages, appetite and gonadal content that can effect on the b-values, even within the same species. Therefore, in the present study, the variations observed in b-values among the four mullet species as well as within the same species might be because of the above mention reasons.

The results of LWRs of these four mullet species were compared with the available literature. The length-weight relationship for the *M. cephalus* of the present study revealed that the exponent b-value for combined sexes was significantly departed from the ideal value (b=3.0) This b-value was higher than those observed by Luther [5], Wijeyaratne and Costa [6] and Aleleye-Wokoma et al. [7] from the sea near Mandapam (India), Negombo lagoon (Sri Lanka) and Bonny estuary (Nigeria) The b exponent of *L. macrolepis* was greater than 3.0 in this study, which was higher than those observed by Luther [5] Wijeyaratne and Costa [6] and Chu et al. [26]. Hence, LWRs of *L. macrolepis* in the present study revealed the positive allometric pattern of growth, while Luther [5], Wijeyaratne and Costa [6] and Chu et al. [26] studies revealed isometric growth pattern. The calculated b-value of *V. speigleri i*n the present study was significantly less than 3.0, which was in agreement with Karna et al. [9] who also reported similar value from Chilika lagoon of India.

The change in body weight in relation to the total length was not always based on specific gravity but due to change in the form of volume. According to the Le Cren [21] all these changes can be analyzed by the condition factor (K) or "Pondered index". The condition of any fish species can be determined on the basis of its length-weight relationship (LWRs) data [17]. Therefore, Wotton [19] reported that if b value is equal to 3.0, than K value remain constant. However, if weight of fish will increases more rapidly than the cube of its length ($b>3.0$), than its K value will be increases with increasing the length of fish. While on the other hand, if weight of fish increases less than the cube of its length ($b<3.0$), its K value will tend to be decreased. With increase in the length of fish [27]. Hence, the value of condition factor (K) appears to be different with increase in the size or weight of fish.

Among the other mullet species, the highest K values recorded for the *L. macrolepis* was indicating that it can survive well even when environmental condition (both abiotic and biotic) were less favourable as reported by Akombo et al. [28] for other fish species. Except *M. cephalus*, males of *L. melinoptera* (1.13), *V. speigleri* (1.05) and *L. macrolepis* (1.23) showed the highest mean value of condition factor (K) than females, indicating that males of these mullet species at a given length were heavier than females of similar length. This might be due to the presence of testes that were heavier than ovaries in females. Therefore, the maximum K values may coincides with the beginning of spawning season [26], however, when fish reached at spent stage, than K values will decline or minimum due to the considerable reduction in gonadal weight of fish [6]. Offem et al. [26] observed that as the condition factor was seems to be totally depends on the length and weight of fish, therefore, all those factors that can effect on the length-weight relationship of fish, could also produce variations in condition factor (K) In the present study, both length and weight of four mullet species of this study were highly correlated with each other. Therefore, K values of this family would tend to be increased with increase in length of fish, which was in agreement with Ali et al. [29]. However, decreasing trend in K values with increase in length of fish was observed in females of *L. melinoptera* of this study. According to the Lawson et al. [30], the low K value was considered as a period, when fat stored in fish body was utilized for spawning, while its high value was indicating a period of maximum feeding, followed by gradual accumulation of fat for the preparation of a new reproductive period. Hence, the variations in K values of four mullet species obtained in this study might be due to the differences in the maturation of gonads, increases or decrease in feeding behavior, amounts of fats or population changes that may occurs due to the changes in food items, as reported by Akombo et al. [25] for other fish species.

According to the Le Cren [12], the relative condition factor (Kn) was defined as ratio between observed and theoretically expected weight for a given length. Thus, the relative condition factor (Kn) allows the

statistical comparison of estimated Kn value to the standard value or expected value, Kn=1.0 [31,32]. According to the Ranzani-Paiva et al. [33], if observed weight (Wt) of an individual is equal to theoretically expected weight (We) for a specific length, than its Kn value is equal to standard or central value (Kn=1.0) However, if observed or total weight of individual is less than the expected weight, the mean Kn value is less than one (Kn<1.0), indicating that such individual will be in poorer condition. While if observed weight of an individual is greater than the expected weight, than the mean Kn value of fish is greater than one (Kn>1.0), which revealed that such individual will be in good condition. Hence, Kn values obtained for any particular fish species can be used to compare with its with standard value (Kn=1.0), in order to determine the condition of fish species as observed by Le Cren [12], Lagler [34], Swingle [35] and Zubia and Rehana [36] for various fish species.

The overall results of this study revealed that the mean values of relative condition factor (Kn>1.0) for *M. cephalus* and *L. macrolepis* revealed that the total weight (Wt) in these two mullet species was found to be greater than the theoretically expected weight (We) While mean values of relative condition factor (Kn=1.0) of the remaining other two species such as, *V. speigleri* and *L. melinoptera* showed that they have a total weight (W_t) was very close to the theoretically expected weight (We), as shown in the Table 1c. Therefore, in the present study, both *M. cephalus and L. macrolepis* with highest Kn values were in more better condition than the other two mullet species i.e., *V. speigleri* and L. melinoptera, respectively. These fluctuations in Kn values might be due to the several reasons such as condition of environment, seasonality, abundance of food resources, maturity stages, size range, ages, sex, increases or decrease in feeding activities, amounts of accumulated fats and effect of parasites [13,37,38]. Information regarding to the relative condition factor (Kn) of these four mullet species on the Pakistan coast was still limited. However, Luther [5] had reported the Kn values for combined sexes of *L. macrolepis* ranged from 0.81 to 1.13, while in *M. cephalus*, Kn values ranged from 0.88 to 1.10, therefore, both were in good condition.

Conclusions

The study length-weight relationship (LWRs) data of four mullet species of this study of length could be consider as very useful tools in the fisheries research, because it permits the conversion of growth-in-length equation to growth-in-weight that can be used in fisheries management, fish biology, physiology, ecology, heath, condition and growth pattern of fish [17,24,39]. The value of condition factor (K) of these mullet species revealed that the condition of Karachi coast was found to be more suitable for their growth. Anene [40] observed that as the condition factor was greatly influence by certain abiotic and biotic factors of the environments, hence, can be used to assess the state of an aquatic ecosystem of fish in which they lived. As the mean Kn values for all four mullet species were equal to or greater than the expected or standard value (K_n=1), therefore, these species were found to be in good condition during the period of study. Hence, the analysis of relative condition factor (Kn) could also be used to assess the condition of a fish [34].

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