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FILLET YIELD, DRESS-OUT PERCENTAGE AND PHENOTYPIC RELATIONSHIP BETWEEN DIFFERENT TRAITS OF GREY MULLET (*Liza parsia*, Hamilton 1822)

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ABSTRACT

Phenotypic relationships between different traits of Grey mullet (Liza parsia) were estimated from a sample of 100 individuals having size range 10-15 cm in length and 17-62 g in weight. Fillet percentage and dress-out percentage were also calculated. Data were recorded and analyzed for total weight (TW), trunk weight (TrW) standard length (L), body depth (BD), dress-out weight (DW) and fillet weight (FW). The mean condition factor (K) of the samples was computed as 1.1±0.13 suggesting that the specimens were in good condition having normal shape. The average fillet yield and dress-out yield were calculated as 60.73(±4.67) % and 64.70(±4.64)% respectively. There was no significant variation (p>0.05) in condition factor, fillet % and dress-out % between male and female. All the true traits were strongly and positively correlated (r>0.8) with one another. The correlations of fillet % and dress-out % with other traits were moderately low (r<0.5), because these two were calculated traits which are quite independent of the size and weight of the fish. Both bi-variate and multi-variate regression analysis were done to estimate the regression coefficient between the traits and to find out the best fitted model. The value of regression coefficient of logTW as a function of logL was calculated as 2.74.. Bivariate linear regression (arithmetic) analysis showed that the regression coefficient of total weight on L, BD, TrW and DW were estimated as 7.6, 30.16, 1.19 and 1.35 respectively. The arithmetic regression coefficient of fillet weight on L, TW, BD, TrW and DW were 4.93, 0.66, 20.04, 0.79 and 0.94 respectively. In case of multiple regression analysis of TW, FW and DW, the best fitted model gave the equations as TW= - 64.4 + 3.76 L+ 18.1 BD, FW = - 43.9 + 2.14 L + 13.2 BD and DW=-47.3+2.30L+14.1 BD respectively.

Key words: Grey mullet, *Liza parsia*, dress out %, fillet weight

1. Introduction

Liza parsia is a brackish water mullets and locally known as Parse, Phaissa, Phasa etc. It is found in coastal region of the Bay of Bengal in Bangladesh, especially in the Sibsa River, Kapotakkha River, estuaries and polder areas. This fish is also distributed in many countries, like Southeast Asia, India, Taiwan, the Mediterranean and Eastern European countries and in many parts of central and South America and it products also contribute to valuable fishery economics in Japan and Australia (Nash and Shehadesh, 1980).

It is one of the most favorite, testy and commercially important fish in Bangladesh. Culture of L. parsia has not yet been developed in Bangladesh, though it has a great potential as a cultivable species. It can be a good source of protein and currency through artificial breeding and culture of the species. In artificial breeding and selection program, choosing the best quality

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and healthy parents is a major concern. For selection of the parents for next generation, some traits are economically important such as higher weight, length, fillet percentage and dress-out percentage. Though fillet percentage and dress-out percentage are the most important and targeted traits, it can not be measured without slaughtering the fish. Thus it is a problem to directly estimate fillet percentage and dress-out percentage. The alternative way is to use the correlation between other traits that can be measured easily such as length, weight, body depth etc. For this reason, it is very important to know the relationships between different traits.

Many works have been conducted on the relationships between different traits, especially length-weight, in many fishes (Gonçalves et al., 1996; Haddon et al., 1995; O'Reilly et al., 2004; Schweigert et al., 1990; Shao et al., 2007; Soranganba et al., 2007)) . However, this type of work is rare in *L. parsia*. That is why the present investigation was carried out on phenotypic relationship between some economically important traits of *Liza parsia* and to find out the best-fitted model that express the relationships between the traits with high accuracy.

2. MATERIALS AND METHODS

2.1. Sample collection:

The study was conducted in April of 2011. A total of 100 fishes were collected as sample. Samples of *L. parsia* were collected directly from the different local market of Khulna region. After collection, samples were brought immediately to the Fish Biology laboratory of Fisheries and Marine Resource Technology Discipline, Khulna University. The samples were kept as fresh condition without icing or freezing.

2.2. Sex identification:

Fish were identified by using the identification key of Soljan (1975). Sexes of all fishes of the sample were determined by striping the bally of fish or observing the internal sex organ. In case of external sex determination for the reason of striping egg for female and milt for male were come out while in internal sex determination by observing testis and ovary it was determined whether the fish was male or female. Out of total size 100, 50 were identified as male and 50 as female.

2.3. Data collection and measurement:

Data were recorded on the traits Total weight (TW), Standard length (SL), Body depth (BD), Head length (HL), Head weight (HW), Dress-out weight (DW) and Fillet weight (FW). Dress-out percentage, fillet percentage and coefficient of condition (K) were also calculated.

Standard length (SL) was measured as the length from the tip of the snout to the posterior end of the last vertebra or to the posterior end of the midlateral portion of the hypural plate. Simply, this measurement excludes the length of the caudal fin.

Dress-out percentage was calculated as:(the weight of the fish without head, viscera, and skin/divided by total weight) x100 %

Fillet percentage was calculated as:{the weight of muscle (removed with an sharp knife from the vertebra of the dressed fish)/divided by total weight} x100 %

The coefficient of condition or condition factor of the fish was measured by the formula,
$K=W/L^3\times100$

Where: W = the weight of the fish in grams; L = the standard length of the fish in centimeters.

In the laboratory important phenotypic data were collected using different tools such as cm scale, slide calipers, electric weight machine (Model: AND GF-300), scissors, knife, forceps etc.

Length measurements were taken using a slide calipers and a ruler for all individuals. Weight was measured with 2 decimals precision by electric weight machine of Fish Nutrition Laboratory of Fisheries and Marine Resource Technology Discipline. Then it was dissected by sharp knife and scissor and weighted. Fish were gutted in order to remove and measure the dressing weight. The body depth was collected by using slide calipers. Then the weight of the fish was measured by electric weight machine of Fish Nutrition Laboratory of Fisheries and Marine Resource Technology Discipline. Then it was

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dissected by sharp knife and scissor and weighted.

2.4. Data analysis and model setting:

All the data were analyzed by using statistical software Minitab-15. Other softwares SAS 9.1 and SPSS 12.0 were used to check the consistency of the results.

The relationship between length (L) and weight (W) was calculated by the equation: $W=aL^b$

Where: W = the weight of the fish in grams; L = the length of the fish in centimeters.

Values of W were calculated from the logarithmic (base 10) equivalent: $\log W = \log a + b \log L$

For model setting bivariate regression model and multiple regression models were used to estimate the relationships between different traits: The model was assumed as:

$$Y=a+b_1X_1+b_2X_2+b_3X_3+\ldots\ldots\ldots\ldots\ldots\ldots\ldots+b_nX_n$$

Where: a = constant or intercept; b = regression coefficient or the slope of the regression curve;Y= Response variable; X = predictable variables as X_1, X_2, X_3……..X_n.

3. RESULTS AND DISCUSSION

3.1. Descriptive Statistics:

The descriptive statistics of all traits are shown in the table 1. In the present study, the mean standard length and body depth of the samples were found as 12.3 ± 1.36 cm (range 9.2-15.3 cm) & 3.06 ± 0.34 cm (range 2.4-3.7 cm).

The average total weight was 37.15 ± 10.91 g where minimum was 17.08g and maximum was 62.11g. In case of body weight the mean was 29.59 ± 9.16 where minimum body weight was 12.56 g and maximum 47.36g. Mean fillet weight was 22.77 ± 7.38 with a range of 10.00g to 38.24g. The average fillet % and dress-out % were 60.73±4.67 and 60.73±4.67 respectively. Mean condition factor of the samples was 1.10±0.13 (range 0.77-1.40), which shows that all the fish had normal shape.

There was no significant difference ($p>0.05$) in fillet %, dress-out % and condition factor between male and female (result not shown).

Table 1: Sample size, mean (±standard deviation) and range of the traits.

Traits	N	Mean (±std)	Minimum	Maximum
Length (cm)	100	12.33±1.36	10.20	15.30
Total Weight (g)	100	37.15±10.91	17.08	62.11
Body Depth (cm)	100	3.06±0.34	2.40	3.70
Trunk weight (g)	100	29.59±9.16	12.56	47.36
Dress-out Weight (g)	100	24.27±7.89	10.66	40.62
Fillet Weight (g)	100	22.77±7.38	10.00	38.24
Dress-out Percentage	100	64.70±4.64	54.82	73.17
Fillet Percentage	100	60.73±4.67	51.059	70.007
Condition factor	100	1.10±0.13	0.77	1.40

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3.2. Correlation between traits:

Phenotypic correlations among all the selected traits are shown in the table 2. . It is evident from the table that all the true traits were strongly and positively correlated (r>0.8) with one another. The correlations of fillet % and dress-out % with other traits were low, because these two were calculated traits which are independent of the size and weight of the fish.

Table 2: Correlation matrix between different traits.

Traits	Length	Total Weight	Body depth	Body Weight	Dress-out Weight	Fillet Weight	Dress-out %	Fillet %
Length	1	0.92*	0.83*	0.90*	0.89*	0.89*	0.37*	0.33*
Total Weight	0.92*	1	0.94*	0.99*	0.98*	0.97*	0.46*	0.41*
Body depth	0.83*	0.94*	1	0.95*	0.93*	0.92*	0.49*	0.44*
Trunk Weight	0.90*	0.99*	0.95*	1	0.98*	0.98*	0.51*	0.45*
Dress-out Weight	0.89*	0.98*	0.93*	0.98*	1	0.99*	0.63*	0.58*
Fillet Weight	0.89*	0.97*	0.92*	0.98*	0.99*	1	0.64*	0.60*
Dress-out %	0.37*	0.46*	0.49*	0.51*	0.63*	0.64*	1	0.98*
Fillet %	0.33*	0.41*	0.44*	0.45*	0.58*	0.60*	0.98*	1

* Significant at 0.01 level (2-tailed).

3.3. Bivariate Relationship of total weight, fillet weight and dress-out weight with other traits:

Bivariate relationship of total weight, fillet weight and dress-out weight with other traits are shown in Table 3. The fitted regression line of total weight and fillet weight as functions of other traits are presented in Fig. 1-14. The logarithmic regression coefficient "b" has a value almost equal to b =3.0. The regression equation of Total weight (W) on Length (L) is log$W$=-1.4+2.74 log$L$ $(r=0.83)$. According to many authors (for example: Gonçalves et al., 1996; Soranganba et al. 2007), b values may range from 2.5 to 3.5 suggesting that result of this study is valid. Model 1 shows that the arithmetic regression coefficient (b) of total weight as a function of length is about 8, which means that each 1 cm increase in length will lead to 8 g increase in weight. Model 2 shows that the arithmetic regression coefficient (b) of total weight as a function of body depth is about 30, which means that each 1 cm increase in body depth will lead to 30 g increase in weight. In the same way, model 3 shows that 1 g increase of trunk weight lead to 1 g increase in total weight (Model 3); model 4 shows that 1 g increase of dress-out weight lead to 1 g increase in total weight (Model 4). Model 5 shows that the arithmetic regression coefficient (b) of fillet weight as a function of length is about 5, which means that each 1 cm increase in length will lead to 5 g increase in fillet weight, as well as 1 cm increase in body depth will lead to 20 g increase in fillet weight (Model 7) and 1 g increase in Dress-out Weight will lead to 1 g increase in fillet weight (Model 9).For the models of dress-out weight (Model 10) shows that the arithmetic regression coefficient (b) of dress-out weight as a function of length is about 5.3, which means that each 1 cm increase in length will lead to 5.3 g increase in dress-out weight. As well as 1 g increase in trunk weight will lead to 1 g increase in fillet weight (Model 13).

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Table 3: Bivariate Relationship of total weight, fillet weight and dress-out weight with other traits:

Model #	**Response variable**	**Predictable variable**	r^2	**a**	**b** (±se)	**Regression equation**
Model 1	Total Weight(g)	Length (cm)	85%	- 56.45	7.60* (±4.25)*	TW = - 56.45 + 7.60 L
Model 2	Total Weight(g)	Body Depth(cm)	88.5%	- 55.10	30.16* (±3.73)*	TW = - 55.10 + 30.16 BD
Model 3	Total Weight(g)	Trunk Weight(g)	99.0%	2.07	1.19* (±1.1)*	TW = 2.07 + 1.19 TrW
Model 4	Total Weight(g)	Dress-out Weight(g)	95.6%	4.30	1.35*(±1.3)*	TW = 4.30 + 1.35 DW
Model 5	Fillet Wight(g)	Length (cm)	78.3%	- 38.02	4.93*(±3.45)*	FW = - 38.02 + 4.93 L
Model 6	Fillet Wight(g)	Total Weight(g)	94.6%	- 1.68	0.66*(±0.03)*	FW = - 1.68 + 0.66 TW
Model 7	Fillet Wight(g)	Body Depth(cm)	85.3%	- 38.54	20.04*(±0.05)*	FW = - 38.54 + 20.04 BD
Model 8	Fillet Wight(g)	Trunk Weight(g)	95.9%	- 0.59	0.79*(±0.03)*	FW = - 0.59 + 0.79 TrW
Model 9	Fillet Wight(g)	Dress-out Weight(g)	99.7%	0.06	0.94*(±0.04)*	FW = 0.06 + 0.94 DW
Model 10	Dress-out weight(g)	Length (cm)	79.2%	- 41.00	5.29*(±3.61)*	DW= - 41.00 + 5.29 L
Model 11	Dress-out weight(g)	Total Weight(g)	95.6%	- 1.97	0.71*(±0.03)*	DW = - 1.97 + 0.71 TW
Model 12	Dress-out weight(g)	Body Depth(cm)	86.3%	- 41.55	21.52*(±2.93)*	DW = - 41.55 + 21.52 BD
Model 13	Dress-out weight(g)	Trunk Weight(g)	96.8%	- 0.79	0.85*(±0.02)*	DW = - 0.79 + 0.85TW
Model 14	Dress-out weight(g)	Fillet Weight(g)	99.7%	- 0.01	1.07*(±0.4)*	DW = - 0.01 + 1.07 FW

Asterisk on the coefficients indicate significant differences from zero. *p<0.01

Here, TW= Total weight, L= Length, BD= Body depth, TrW= Trunk weight and DW= Dress-out weight & FW= Fillet weight

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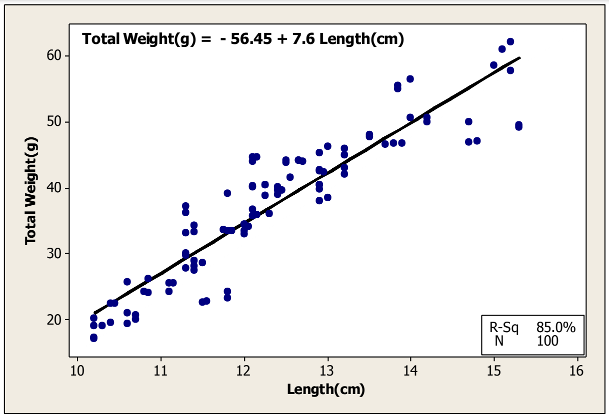

Fig 1. Linear regression of Total wt vs. Length

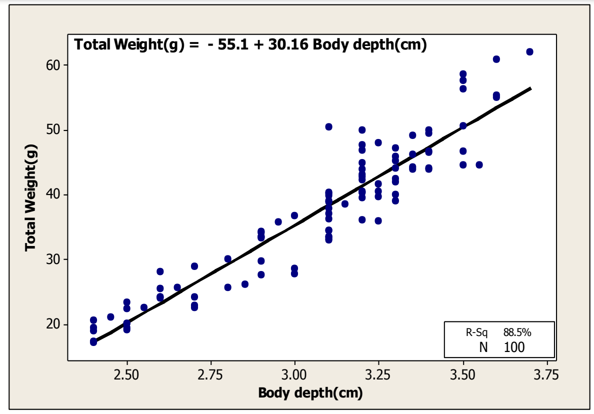

Fig 2. Linear regression of Total wt vs. Body Depth

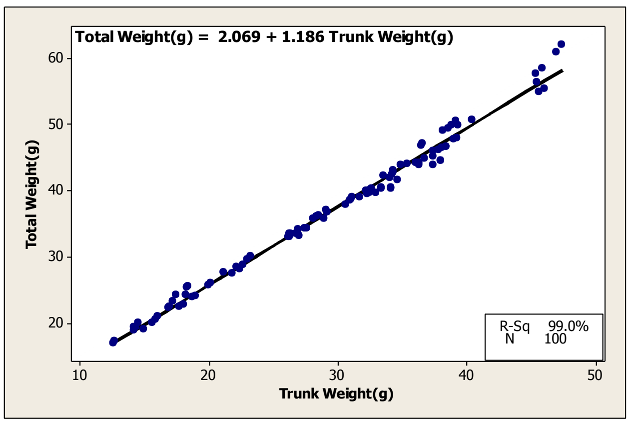

Fig 3: Linear regression of Total wt vs. Trunk wt

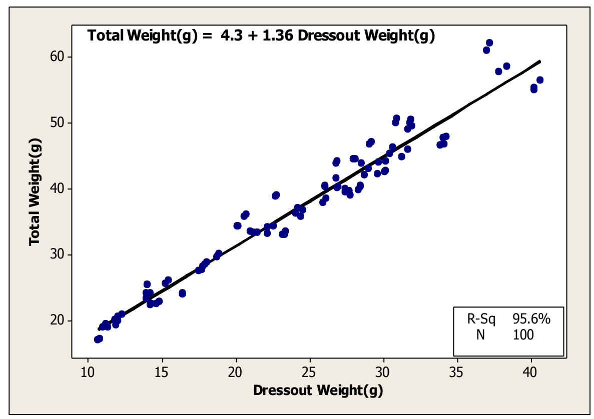

Fig 4: Linear regression of Total wt vs. Dress-out wt

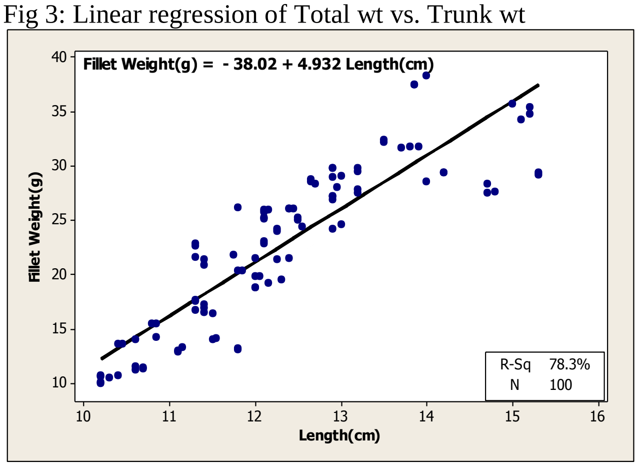

Fig 5: Linear regression of Fillet wt vs. Length

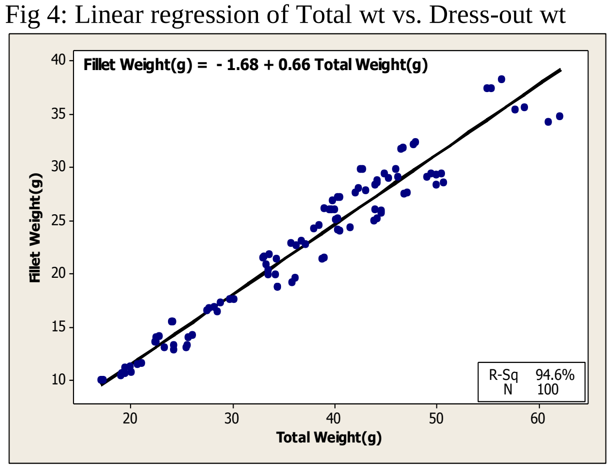

Fig 6: Linear regression of Fillet wt vs. Total wt

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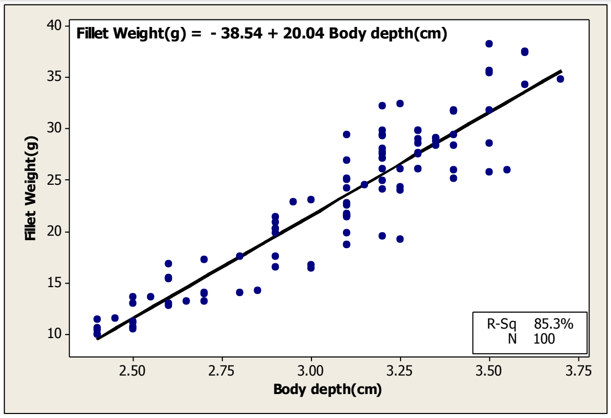

Fig 7: Linear regression of Fillet wt vs. Body Dpt.

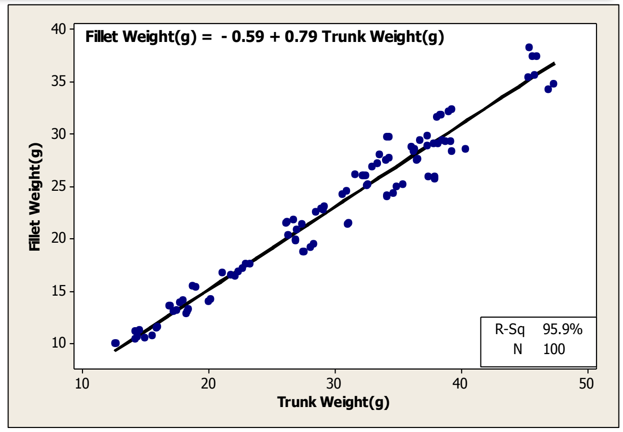

Fig 8: Linear regression of Fillet wt vs. Trunk wt

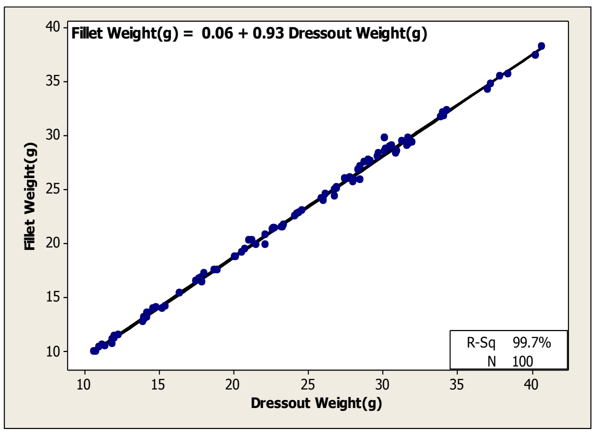

Fig 9: Linear regression of Fillet wt vs. Dress-out wt

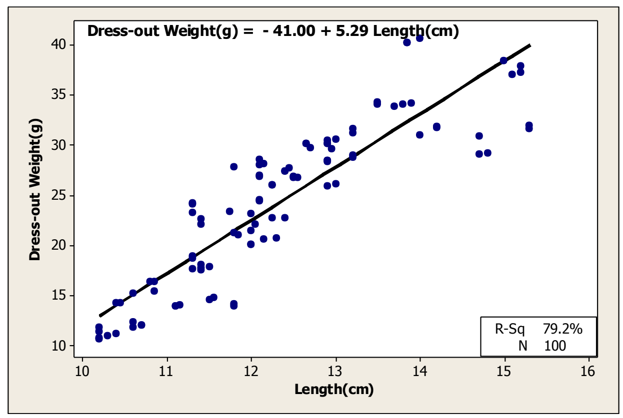

Fig 10: Linear regression of Dress-out wt vs. Length

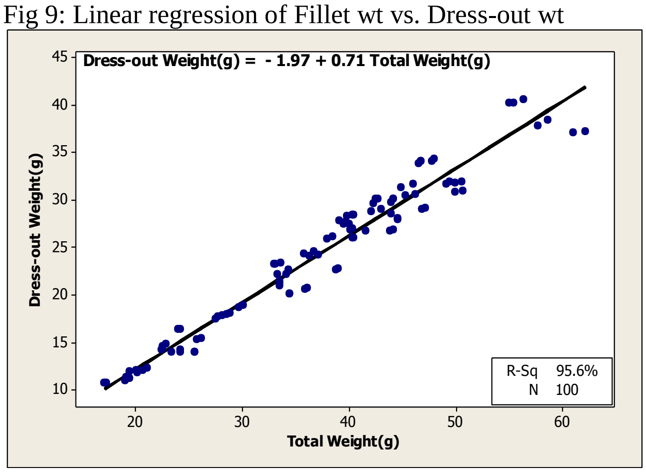

Fig 11: Linear regression of D. wt vs. T. Weight

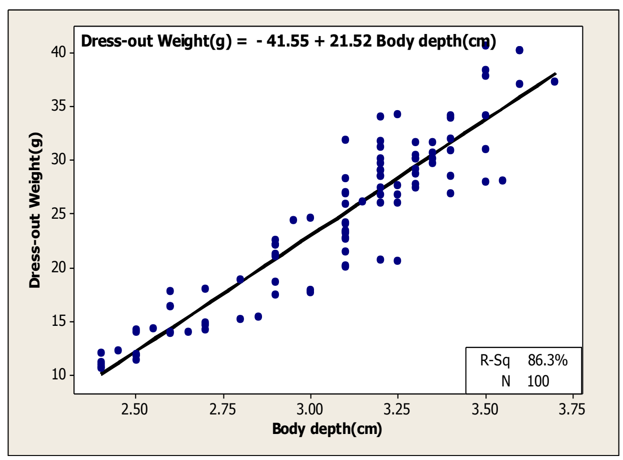

Fig 12: Linear regression of D. wt vs. Body Dpt.

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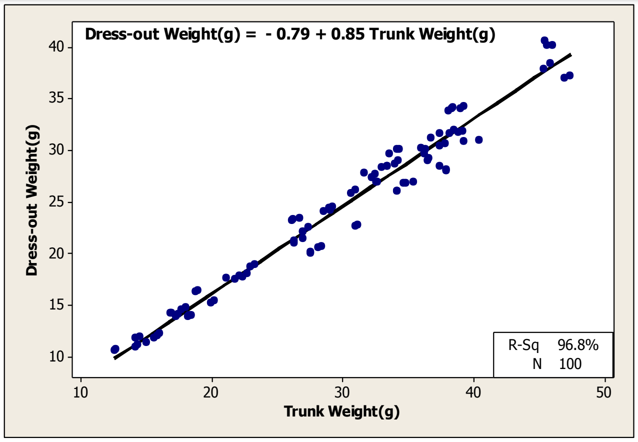

Fig 13: Linear regression of D. wt vs. Trunk wt

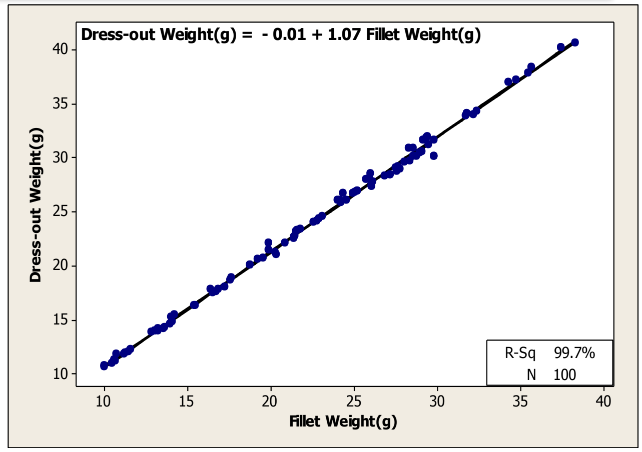

Fig 14: Linear regression of D. wt vs. Fillet wt

3.4. Multivariate Relationship of total weight and fillet weight with other traits:

Sometimes bivariate relationship could not show the accurate result. Multivariate relationship can provide more accurate result then the bivariate relationship. Multivariate relationship of total weight and fillet weight with other traits are shown in Table 4.

Table 4: Multivariate Relationship of total weight and fillet weight with other traits

Model #	Response Variable	Predictable Variable	r^2	a	b	Fitted regression equation
Model 15	Fillet Weight	Length	90.0%	- 43.9	2.14*	**FW** = - 43.9 + 2.14 L + 13.2 BD
		Body Depth			13.2*	
Model 16	Total Weight	Length	95.1%	- 64.4	3.76*	**TW**= - 64.4 + 3.76 L+ 18.1 BD
		Body Depth			18.1*	
Model 17	Dress-out Weight	Total Weight	95.7%	- 1.76	0.71	**DW** = - 1.76 + 0.71 TW - 0.36 L + 1.38 BD
		Length			- 0.36	
		Body Depth			1.38	

Asterisk on the coefficients indicate significant differences from zero.*p<0.01

From above table it is seems that the best fitted model for the relationship measure is relation with fillet weight with combined to length and body depth, total weight with combined to length and body depth and dress-out weight with combined to total weight, length and body depth.

So the best fitted models are:

Fillet weight= -43.9+2.14 Length+ 13.2 Body Depth

Total Weight= - 64.4 + 3.76 Length+ 18.1 Body Depth

Dress-out Weight= -17.6+ 0.71 Total Weight – 0.36 Length + 1.38 Body Depth

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Condition factor "k" when plotted ($k=W/L^3 \times 100$) against length and body weight, it was found to remain constant with increasing length or weight. The regression parameters of condition factor (k) on wet body weight (w) and total length (TL) are presented below

Condition Factor (K) = 1.048 + 0.004456 Length (r^2=0.2)

Condition Factor (K) = 0.9635 + 0.003754 Total Weight (r^2= 0.10)

Condition factor (K) appears to increase with increasing length and weight in the present study. The condition factor may vary with increasing length when average weight of fish does not increase in direct proportion to the cube of its length. Therefore when b =3.0, K remains constant, if however the weight increase more rapidly than cube of length, the K would increase with increase in length. When weight increases less than the cube of length, K would tend to decrease with the growth of the fish.

3.5. Practical Conversion Table for Important traits:

Here are two conversions shown in table 5 which were made by using the best fitted bivariate relationship of length and body depth with total weight and fillet weight. From the table it seems that the data is valid within the range of the sample used for current study. As an example the tabular value of total weight for a 15 cm length fish is 57.6 g where the observed weight of a 15 cm length fish was 58.5 g. above or below this point it may lead to error. For accurate results, samples should include small to bigger sized fish

Table 5. Conversion from length and body depth to total weight and fillet weight

From Length to wt.		*From body depth to wt.*		*From Length to Fillet wt.*		*From BD to Fillet wt.*	
Length (cm)	Weight (g)	Body depth (cm)	Weight (g)	Length (cm)	Fillet Weight (g)	Body Depth (cm)	Fillet Weight (g)
10	19.6	2	5.2	10	11.3	2	1.5
10.5	23.4	2.1	8.2	10.5	13.8	2.1	3.5
11	27.2	2.2	11.3	11	16.2	2.2	5.5
11.5	31.0	2.3	14.3	11.5	18.7	2.3	7.5
12	34.8	2.4	17.3	12	21.2	2.4	9.5
12.5	38.6	2.5	20.3	12.5	23.6	2.5	11.5
13	42.4	2.6	23.3	13	26.1	2.6	13.5
13.5	46.2	2.7	26.3	13.5	28.6	2.7	15.5
14	50.0	2.8	29.3	14	31.0	2.8	17.5
14.5	53.8	2.9	32.4	14.5	33.5	2.9	19.5
15	57.6	3	35.4	15	36.0	3	21.5
15.5	61.4	3.1	38.4	15.5	38.4	3.1	23.5
16	65.2	3.2	41.4	16	40.9	3.2	25.5
16.5	69.0	3.3	44.4	16.5	43.3	3.3	27.5
17	72.8	3.4	47.4	17	45.8	3.4	29.5
17.5	76.6	3.5	50.5	17.5	48.3	3.5	31.5
18	80.4	3.6	53.5	18	50.7	3.6	33.5
18.5	84.2	3.7	56.5	18.5	53.2	3.7	35.5
19	88.0	3.8	59.5	19	55.7	3.8	37.5
19.5	91.8	3.9	62.5	19.5	58.1	3.9	39.5
20	95.6	4	65.5	20	60.6	4	41.5
20.5	99.4	4.1	68.6	20.5	63.1	4.1	43.5
21	103.2	4.2	71.6	21	65.5	4.2	45.5
21.5	107.0	4.3	74.6	21.5	68.0	4.3	47.5

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22	110.8	4.4	77.6	22	70.5	4.4	49.5
22.5	114.6	4.5	80.6	22.5	72.9	4.5	51.5
23	118.4	4.6	83.6	23	75.4	4.6	53.5
23.5	122.2	4.7	86.7	23.5	77.9	4.7	55.5
24	126.0	4.8	89.7	24	80.3	4.8	57.5
24.5	129.8	4.9	92.7	24.5	82.8	4.9	59.5
25	133.6	5	95.7	25	85.3	5	61.5
25.5	137.4			25.5	87.7		
26	141.2			26	90.2		
26.5	145.0			26.5	92.6		
27	148.8			27	95.1		
27.5	152.6			27.5	97.6		
28	156.4			28	100.0		
28.5	160.2			28.5	102.5		
29	164.0			29	105.0		
29.5	167.8			29.5	107.4		
30	171.6			30	109.9		

N.B: The shaded values indicate the range that is covered by our data set

4. CONCLUSION

For more accuracy, it leaves scope of research with large sample size with respect to sex, size and seasons. However, the present work was the first ever of its kind on *Liza parsia*. So, we are confident that the information of this work will definitely contribute to further research on this fish in general, and particularly to artificial breeding, selective breeding and making breeding values for index selection of this species.

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