



## ORIGINAL ARTICLE

# Morphometric Relationship between length- weight, length-length and condition factor in farmed rainbow trout (*Oncorhynchus mykiss*)

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### ABSTRACT

*This study describes the length-weight (LWR), length-length (LLR) relationship and condition factor in the farmed rainbow trout. The number of 150 three years old male and female broodstock were collected and anesthetized for measurement of 18 morphometric characters. The length and weight were measured using measuring board and digital balance. The coefficient of determination  $r^2$  as well as correlation ( $r$ ) coefficient of length-weight and length-length relationship was high between two parameters in male, female and combined sexes. The  $b$  value was below 3.0 in both female and male and showed an allometric growth pattern. The average of Fulton's condition factor in male and female was 1.3210 and 1.1926 respectively. The present investigation indicate that the growth rate is quite satisfactory provide the initial data on length- weight, length- length and condition factor of farmed rainbow trout broodstocks (*Oncorhynchus mykiss*).*

**Keyword:** condition factor, length- weight relationship, length- length, rainbow trout.

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### INTRODUCTION

The most important morphometric parameters are length-length (L-L) and length-weight (L-W) relationships and Fulton's K condition [1]. Length and weight and their relationship are known as important fishery management tool and basic component in the biology of species at the individual and population levels [2,3]. The relationship between Length and weight them (LWRs) is a practical index suitable for assessing the health, survival, growth, maturity and reproduction[4]. Ponderal index or Fulton's condition factor "K" or the fatness with a negative relationship with length has been used as a growth index and feeding intensity [5]. Its importance is to determine the possible differences between separate unit stocks of the same species[6] and comparison of the population of the same species from different environments[7].

salmonid culture is now a very substantial activity and has expanded geographically. Rainbow trout (*Oncorhynchus mykiss*), the dominant farmed species in Iran is a family member of Salmonidae. Typical growth patterns of any species are misleading, however, as there may be as much variation in growth within a species as among species because of environmental conditions [8]. Length-weight studies on *O. mykiss* has already been documented [9,10,11,12,13,14,15].

This study provides a comprehensive data on length-weight, length-length (LLRs) relationships, condition factor, as well as morphometric characteristic of farmed male and female in rainbow trout broodstocks.

### MATERIALS AND METHODS

From October 2012 to January 2013, numbers of 75 female and 75 male specimens of broodstock rainbow trout were collected from Research center of genetic and breeding of coldwater fishers, Iran. The fishes were anesthetized for measurement of 18 morphometric according Forese and Pauly[26]. morphometric characters included the length and depths of the head; the predorsal, preventral and

preanal length; the body and caudal peduncle depth; the dorsal, ventral, anal and pectoral fin length and depth; The total B length (TL), length fork (FL), standard length (SL) and The total weight of fish. All measurements were taken on the left side of the fish. In addition, the length of each specimen was measured on a measuring board to the nearest 1mm and whole body weight (W) was recorded by a digital balance to the nearest 0.01 g after removing the adhered water from the surface of body.

The relationship between the length (L) and weight (W) of fish was expressed by equation;

$$W = aL^b$$

Where the W is fish weight (g), L is Total Length (TL) (cm) a and b are estimated by  $[\ln(W) = \ln(a) + b \ln(L)]$  that 'a' is the regression intercept and 'b' is the regression slope. The correlation ( $r^2$ ), that is the degree of association between the length and weight was computed from the linear regression analysis:  $R = r^2$ .

Parameters of the length-length relationship (LLRs) were estimated using formula as follow:

$$SL = a + b TL$$

$$FL = a + b TL$$

$$SL = a + b FL$$

That TL, SL and FL are total length, standard length and fork length successively.

Fulton's condition factor, K, is calculated based on the relationship between the individual length and weight using following formula:

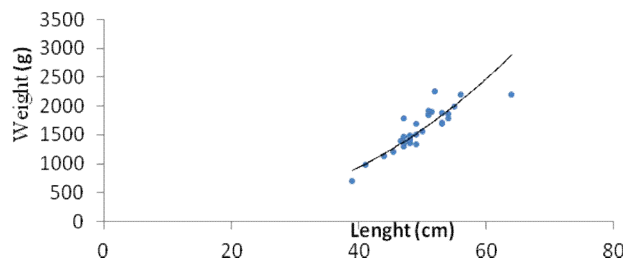
$$K = 100(W/L^3)$$

Where 'W' is the whole body weight (g), L is the length (cm). The factor '100' is used to bring 'K' close to a value of one. Statistical analysis including regression, calculation of correlation coefficients and comparison between the regression coefficients was carried out by using the spss 17.0. The length-weight relationship were estimated by the power regression ( $y = ax^b$ ) and the length-length relationships (LLRs) were established using linear regression analysis ( $y = bx + a$ ).

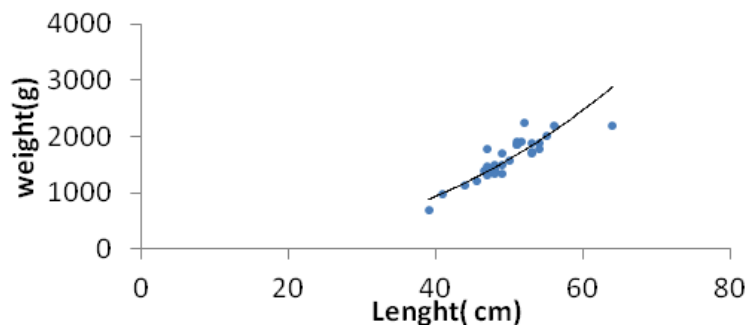
**RESULT**

Wet Body weights and length ranged from 700 to 3220 g and 39 to 66 cm among tested fishes. The minimum, maximum weight and length estimated in male and female respectively. Length- Weight relationship evaluated separately in male, female and sexes combined (Figs 1,2&3). This equations are as follows:

Male	$W = 0.1377 L^{2.392}$	$R^2 = 0.8003$
Female	$W = 0.0459 L^{2.6593}$	$R^2 = 0.8858$
Combined	$W = 0.1367 L^{2.3894}$	$R^2 = 0.8425$



**Fig 1:** length-weight relationship in males



**Fig 2:** length-weight relationship in females

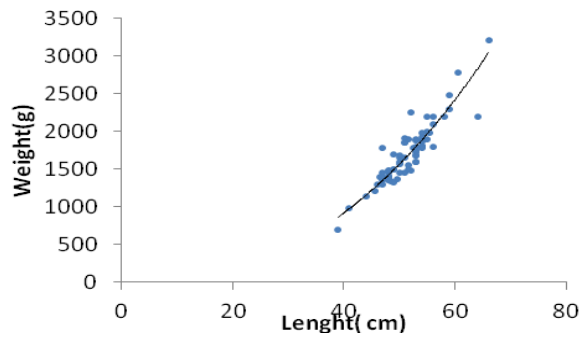


Fig 3: length-weight relationship in combined sexes

The condition factor in male were 0.8392 up to 1.600 with the average of 1.3210 . This factor in Female was 1.02496 up to 1.3523 with the average of 1.1926. Furthermore, it was 0.8392 up to 1.600 with average of 1.256 in combined sexes.

Moreover,  $r^2$  ,  $a$  and  $b$  in the length- length relationship are presented in Table1. All length-length relationship were highly significant (sig  $0 < .005$ ). Correlation between total and fork length (0.9072), fork and standard length (0.9493) in female and between standard length and total length in males (0.9096) were highly positive relationship.

Table 1. length- length relationship in *O.mykiss* male , female and combined sexes broodstocks

Sex	Equation	a	b	R <sup>2</sup>
Male		0.7276	1.0693	0.7685
Female	TL= a+b	2.0336	1.0354	0.9072
Combined	FL	2.1977	1.0345	0.8590
Male		5.9964	0.9085	0.8639
Female	FL= a+b	-	1.0503	0.9493
	SL	0.2527		
Combined		2.7021	0.9861	0.9240
Male		-	1.1372	0.9096
	SL=	0.0725		
Female	a+bTL	1.3695	1.0960	0.8747
Combined		1.7034	1.0925	0.9104

Table 2 shows the comparison of morphometric measurement of various parts of body with the total length in male, female and combined sexes. Among this characters ,the ventral fin length (  $b=3.5723$  ),anal fin length( $b= 3.2390$ ), caudal peduncle depth( $b=3.1292$ ), head depth( $b= 3.0973$ ), body depth( $b= 2.2660$ ) , predorsal length (  $b= 2.0334$ ), dorsal fin length( $b=1.9147$ ), standard length(  $b=1.0925$ ) and fork length ( $b=1.0345$ ) showed high growth rate in combine respectively. The preanal length ( $b= 0.0109$ ) and the preanal length(  $b=0.0219$ ) growth was very slow.

Table2: result of regression value of various morphometric characters as function of total length

Morphometric characters	male		female		Combine	
	b	r <sup>2</sup>	b	r <sup>2</sup>	b	r <sup>2</sup>
TL & FL	1.0693	0.7685	1.0354	0.9072	1.0345	0.8590
TL & SL	1.1372	0.9096	1.0960	0.8747	1.0925	0.9104
TL & HL	1.5041	0.2370	1.7802	0.2747	0.6253	0.0408
TL & Caudal peduncle depth	2.8812	0.1888	2.5804	0.1848	3.1295	0.2080
TL & Body depth	3.1530	0.5867	2.1807	0.4263	2.2660	0.3170
TL & Predorsal length	2.1226	0.6612	1.8315	0.7434	2.0334	0.6198
TL & Preventral length	0.0092	0.0018	1.5928	0.7474	0.0109	0.0094
TL & Preanal length	0.0183	0.0018	0.9485	0.7985	0.0219	0.0094
TL & Head depth	3.3106	0.3716	3.2198	0.3977	3.0973	0.2819
TL & Dorsal fin length	1.3636	0.0615	1.914	0.1973	1.9147	0.1302
TL & Anal fin length	3.2376	0.2026	2.5086	0.2706	3.2390	0.3244
TL & Ventral fin length	6.1625	0.4809	2.007	0.1882	3.5723	0.3360

Relationship between total length and head length ( $r^2 = 0.0408$ ), total length and preventral length ( $r^2 = 0.0094$ ), total length and preanal length ( $r^2 = 0.0094$ ), total length and dorsal fin length ( $r^2 = 0.1302$ ) exhibited low level and Relationship between total length and predorsal length ( $r^2 = 0.6198$ ) showed moderate level in sexes combined.

The minimum, maximum and the other statistical estimates of 18 morphometric characters are presented in Table 3.

**Table 3.** statistical estimates of various morphometric characteristics for male and female.

statistical estimates	male			female		
	Min.	Max.	Mean(cm)	Min.	Max.	Mean(cm)
Total length(TL)	39	64	49.44	46	66	53.24
Fork length(FL)	35	55	45.55	43	60	49.41
Standard length (SL)	36	54	43.54	42	56	47.33
Body depth	7.5	13	11.43	9.5	14	11.05
Caudal peduncle depth	4	8	5.18	4	8	5.40
Anal fin length	4	7	6.22	5.5	10	6.94
Anal fin depth	4.5	6	5.28	1.5	8	5.48
Dorsal fin length	1.5	2.58	2.13	3	7.5	6.07
Dorsal fin depth	1	6.5	2.5	1	7	2.77
Pectoral fin length	2	8	6.35	5	9	6.85
Pectoral fin depth	1.5	2.5	2.13	1.20	3	2.13
Ventral fin length	4	6	5.26	4.5	8	5.78
Ventral fin depth	1	2.5	1.59	1	2.5	1.52
Head length	7	12	10.55	5.5	11.5	9.14
Head depth	5	9	7.46	2	9	7.10
Predorsal length	16	25	22.42	20	29	22.70
Preventral length	18	29	24.50	22	31	25.00
Preanal length	26	39	33.7	25	47	35.55

## DISCUSSION

The coefficient of correlation ( $r$ ) of the length-weight relationship showed a high degree of positive correlation between the two parameters in the male, female and combined sexes. The slope value ( $b$ ) in male was 2.3920 and that of female was 2.6593 where the regression coefficient of female is higher than male. The  $b$  value in male and female was below 3.0 showing an allometric growth pattern. Allometric growth means that increasing in rate of body length is not in proportional to the rate of increase in body weight. Carlander [16] reported that the  $b$  value for weight-length relationship in most wild salmonide populations is between 2.5 -3.5, and usually within 2.8 to 3.2 while the  $b$  value of 2.683 in 340-1405g female *O. mykiss* was reported to be isometric based on this assumption that this amount does not differ significantly from 3.0 [14]. In the other works, the  $b$  value was reported to be 3.0, 2.81 and 3.0 [9,10,12]. The length-weight relationship in fishes can be affected by various factors such as: temperature, pH, dissolved oxygen, seasonal changes, habitat, gonadal maturity, sex, stomach fullness, health and preservation techniques [1,17,18].

The average Fulton's condition factor or  $K$  was 1.3 and 1.1 in male and female respectively. Proximity to unity (one), showed the perfect condition of both sexes. Our data is similar to other documented work. Tasaduq *et al.*, 2011 [14] reported the value of this factor to be between 0.95-1.44 in female *O. mykiss* and demonstrated that fish have excellent condition. Rabe 1967 [19] obtained condition factor for rainbow trout from Alpine lakes between 0.859 and 1.104. Cada *et al.*, 1987 [20] estimated this factor of rainbow trout southern Appalachian streams within 0.82 to 1.17. Murphy 1988 [21] reported the value of condition factor to be 1.13 in rainbow trout from Kings River. Zimmerman 1999 [22] obtained the average condition factor of rainbow trout were collected from Portal Lake as  $1.09 \pm 0.14$ .

All length-length relationships were significant ( $p < 0.05$ ) and  $r^2$  showed strongly positive correlation between these parameters in both male and female and indicated the growth of individual organs in relation to overall growth of the fish. Tasaduq *et al.*, 2011 [14] obtained the value of  $r^2$  in total length-fork length relationship for farmed rainbow trout to be 0.9979 that is very close to the female total length-fork length relationship (0.9072) in this study. The coefficient of correlation for total length-standard length relationship estimated as 0.9901 in research of Tasaduq *et al.*, 2011 [14] which is similar to our results for the sexes combined. This finding is likely attributed to the ecological conditions as well as variation of the animal physiology. Le Cren 1951 [4] expressed the reasons of variation of length-length

relationship in the similar species from different regions can be the ecological conditions of habits or variation in the physiology of animal or both.

Among all the morphometric characters indicated three levels including high ( $r^2 > 0.85$ ), moderate ( $r^2 < 0.60$ ) and low ( $r^2 = 0.60$ ) when compared to total length.  $r^2 < 0.60$  explained the disproportionate growth of these parameter in related to total length that obtained in head length, caudal peduncle depth, body depth, preventral length, preanal length, head depth, dorsal fin length, anal fin length and ventral fin length.

The minimum relationship between total length and different parameters might be due to the least growth changes in the parameters over the fish size [23]. The most important global differences in body shape are related to body elongation or shortening, thus leads to large difference in body height and caudal peduncle length among the species [24].

High growth rate was submitted according to the relationship between total length- standard length and total length-fork length. In this case the b values was  $b=1.09$  and  $1.03$  respectively.

The b value of female trout for TL-FL and TL-SL was reported to be  $1.03919$  and  $0.8663$  respectively [17]. Arsalan 2004 [25] reported the b values in total length-fork length relationship in *O. mykiss* inhabiting the Kan Stream in north- eastern Turkey as  $1.0202$  and in total length-standard length relationship as  $1.1178$ .

## CONCLUSION

The present investigation provide the initial data on length- weight, length- length and condition factor of farmed rainbow trout broodstocks (*Oncorhynchus mykiss*).

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