Study of Some Morphological Characters of Three Trout Breed Farmed in Salmonid Exploitations from Moldova

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Abstract

Study of morphological characters at fish by means of biometry is a frequently utilized method and consists in determining the variability of characters in groups of individuals, by direct measurement, weighting and statistical processing of obtained data.

Effectuation of body measurements and weighting is used to determine the increase in length of fish and to evaluate the general physiological condition. Brook trout, rainbow trout, and brown trout were the object of the current study by analyzing of 50 individuals, 10 individuals in each batch (F_1, F_2, C_1 C_2 and I_1), from two trout farms from Moldova. After processing the obtained data were calculated the most representative indexes and maintenance coefficients. The obtained values were between 3.49 at batch F_1 and 3.94 at batch I_1 for profile index; 1.5 at batch I_1 and 1.75 at batch F_1 for Fulton coefficient; 1.47 at batch F_2 and 1.6 at batch I_1 for Kiselev index; 41.36 for batch F_1 and 47.94 at batch C2 for thickness index; 19.94 C_1 batch and 22.08 at F_1 batch for fleshy index I, and 19.05 C_2 batch and 21.2 at I_1 batch for fleshy index II. Having in view the obtained results we can conclude that the analyzed fishes had a good state of maintenance.

Keywords: body indices, maintenance coefficients, morphological characters, trout

1. Introduction

Analysis of some morphological characters of fish by means of biometry is a frequently used method and consists in determining the variability of characters in isolated individuals or groups of individuals, by direct measurement, weighting and statistical processing of obtained data [1-3]. Effectuation of body measurements and weighting is used to determine the increase in length of fish and to evaluate the general physiological condition. Based on the somatic measurements could be calculated a series of corporal indexes which offers information regarding fishes maintenance state and corporal shape of body [1, 2, 6].

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2. Materials and methods

Corporal indexes represent the ratio of two dimensions, morphological or physiological related, or which indicate certain general characteristics, specific productive skills [6-8].

Characters determinate through biometric studies were metric characters: length, width, height, perimeters and gravimetric character: weight.

Biometric data are used to determine growth in length of fish and to determine the general physiological condition and is obtained by measurements taken with special instruments (ihtiometers) or other measuring instruments (ruler, callipers) [7, 8].

Body mass (g) was established through weighting; total length of body (L) was measured from the top of the snout till the top of the lobs of caudal fin; standard length of body (l), was measured from the top of snout till the base of caudal fin;

maximum height of body (H) was measured in the highest area of body, from ventral line to the dorsal line; maximum circumference of body (C) was measured at the level of maximum thickness and maximum height, respectively before dorsal fin, length of the head (lc) represents the distance from top of snout to the posterior edge of operculum bone; length of caudal peduncle (lp) was measured from the posterior extremity of anal fin to the base of caudal fin.

Based on the somatic measurements could be calculated a series of corporal indexes which offers information regarding fishes maintenance state and corporal shape of body [6, 9, 10].

Profile index (IP) express the morphological appearance and is calculated as*:*

$$IP=l/H$$

where:

l–standard length of body;

H-maximum height of body

Thickness index (IG) (dorsum width) expresses the width of musculature from dorsum area in connection with the maximum height of body. Thickness index could be calculated with the formula:

$$IG=G/H \times 100$$

where:

G=maximum thickness of body (cm);

H=maximum height of body (cm).

Body circumference index (Kiselev) (IC) reflects the individual's weight, length, thickness, fattening degree and maturation of the gonads degree.

It is a stable index, accurate with a small variation scale and is given by:

$$IC = l/C$$

where:

1 - standard length of body;

C – body circumference.

Fattening coefficient, Fulton (K) expresses the state of maintenance of fish and is calculated as:

$$K=g \times 100/1^3$$

where:

g–body weight;

1-standard length of body.

Fish length is taken at cube, since weight gain is directly proportional to the growth of the body.

Fleshy index (Ic) expresses the proportion of head or caudal peduncle from the standard length of the body. For its calculation, was used the following formula:

$$Ic=lc \times 100/ls, \text{ or,}$$

$$Ic=lp \times 100/ls$$

where:

lc=length of the head, in cm;

ls=standard length of body, in cm;

lp=length of caudal peduncle, in cm.

Biological material was represented by 50 individuals of brook, rainbow and brown trout of both sexes, reared in two trout farms from Neamț and Suceava County. To achieve the proposed goals, from the biological material which was studied during 2012-2013, were made up five experimental batches, each of 10 individuals per batch, for the three studied breeds.

3. Results and discussion

Research has debuted with biometric determinations: body weight, total body length (L), body length (standard length) (ls), maximum height (H), maximum body circumference (C), length of the head (lc), caudal peduncle length (lp).

Following measurements were calculated the statistical indexes for each experimental batch (Table 1 and Table2).

Data from the literature [9, 11-15] indicates values close to those obtained. So, for brook trout specimens from batch F_1, at a average corporal mass of 270.21 g, standard length-(ls), had 24.91 cm, maximum height-(H), 7.08 cm, head length–(lc), 5.5 cm, maximum circumference-(C), 16.9 cm, length of caudal peduncle-(lp), 5 cm and maximum thickness of body (G) 2.95 cm.

As concerning brook trout specimens from batch F_2, at a average corporal mass of 259.39 g, standard length-(ls), had 24.83 cm, maximum height-(H), 7.03 cm, head length–(lc), 5.32 cm, maximum circumference-(C), 16.95 cm, length of caudal peduncle-(lp), 5.16 cm and maximum thickness of body (G), 2.99 cm.

The consulted literature [9-17] indicates values close to those obtained. So, for rainbow trout specimens from batch C_1 at a medium mass of 285.19 g, standard length-(ls), had 26.59 cm; maximum height-(H), 6.86 cm, head length–(lc), 5.29 cm, maximum circumference-(C), 17.16 cm, length of caudal peduncle-(lp), 5.09 cm and maximum thickness of body (G), 3.14 cm.

As concerning rainbow trout specimens from batch C_2, at a average corporal mass 285.19 g, standard length-(ls), had 25.6 cm; maximum height-(H), of 6.63 cm, head length–(lc) of 5.53

cm, maximum circumference-(C) of 16.95 cm, length of caudal peduncle-(lp) of 4.89 cm and maximum thickness of body (G) of 3.17 cm.

Table 1. Biometric measurements at brook, rainbow and brown trout

Specification	Brook trout F_1		Brook trout F_2		Rainbow trout C_1		Rainbow trout C_2		Brown trout I_1	
	$\bar{X} \pm s_{\bar{x}}$	V%	$\bar{X} \pm s_{\bar{x}}$	V%	$\bar{X} \pm s_{\bar{x}}$	V%	$\bar{X} \pm s_{\bar{x}}$	V%	$\bar{X} \pm s_{\bar{x}}$	V%
Body weight, (g)	270.21±12.03	14.08	259.39±8.58	10.46	285.19±6.93	7.69	285.19±9.97	11.06	318.45±12.39	12.30
Fisher Test	4.7759 (F) > F (0.010) (4 ; 45) 3.83 ** d.s									
Standard length, (cm)	24.91±0.37	4.78	24.83±0.41	5.32	26.59±0.28	3.40	25.6±0.46	5.74	27.68±0.46	15.34
Fisher Test	8.7939 (F) > F (0.001) (4 ; 45) 5.70 *** f.s									
Maximum height, (cm)	7.08±0.12	5.57	7.03±0.10	4.64	6.86±0.11	5.46	6.63±0.12	9.95	7.04±0.14	6.66
Fisher Test	8.1853 (F) > F (0.001) (4 ; 45) 5.70 *** highly significant									
Head length, (cm)	5.50±0.17	9.99	5.32±0.12	7.18	5.29±0.09	5.80	5.53±0.06	3.52	5.86±0.15	8.59
Fisher Test	3.0992 (F) > F (0.050) (4 ; 45) 2.61 * significant									
Maximum circumference, (cm)	16.9±0.32	6.03	16.95±0.13	2.50	17.16±0.34	6.33	16.95±0.13	2.50	17.36±0.32	5.19
Fisher Test	0.5145 (F) > F (0.050) (4 ; 45) insignificantly									
Length of caudal peduncle, (cm)	5.00±0.12	8.05	5.16±0.10	6.27	5.09±0.10	6.51	4.89±0.21	13.68	5.84±0.33	18.05
Fisher Test	3.6109 (F) > F (0.050) (4 ; 45) 2.61 * significant									
Maximum thickness of body, (cm)	2.95±0.09	10.02	2.99±0.09	10.15	3.14±0.05	5.45	3.17±0.02	2.59	3.22±0.08	8.38
Fisher Test	2.3835 (F) > F (0.050) (4 ; 45) insignificantly									

Table 2. Tukey test for biometric measurements at brook, rainbow and brown trout with statistical differences between batches

Specification	Brook trout F_1		Brook trout F_2	Rainbow trout C_1	Rainbow trout C_2	Brown trout I_1
	Indicators		Means' difference	Semnificance		Significance level
Body weight	MF_1	MI_1	59.07	distinctly significant		p<0.01
	MF_2	MI_1	48.24	significant		p<0.05
	Indicators		Means' difference	Significance		Significance level
Standard length	LsF_1	LsI_1	2.77	distinctly significant		p<0.01
	LsF_2	LsI_1	2.85	distinctly significant		p<0.01
	LsC_2	LsI_1	2.09	distinctly significant		p<0.01
	LsC_1	LsF_1	1.68	significant		p<0.05
	LsC_1	LsF_2	1.76	significant		p<0.05
	Indicators		Means' difference	Significance		Significance level
Maximum height	HC_2	HF_1	0.49	distinctly significant		p<0.01
	HC_1	HF_1	0.37	distinctly significant		p<0.01
	HF_2	HF_1	0.28	significant		p<0.05
	HF_1	HI_1	0.34	distinctly significant		p<0.01
	Indicators		Means' difference	Significance		Significance level
Head length	LcC_1	LcI_1	0.57	significant		p<0.05
	LcF_2	LcI_1	0.54	significant		p<0.05
	Indicators		Means' difference	Significance		Significance level
Length of caudal peduncle	PcC_2	PcI_1	0.95	significant		p<0.05
	PcF_2	PcI_1	0.84	significant		p<0.05

* rest of the difference were insignificantly (p>0.05)

Data from the consulted literature are less conclusive regarding biometry of brown trout, and the existing data are controversial, so our research aims to bring new information to enrich it. So, trout specimens from batch I_1 had at a corporal mass of 318.45 g, standard length-(ls), was 27.68 cm, maximum height-(H), 7.04 cm; head length–(lc), 5.86 cm, maximum circumference-(C), 17.36 cm, length of caudal peduncle-(lp), 5.84cm and maximum thickness of body (G) of 3.22 cm.

Based on data obtained by measurement and weighing, it can be calculate various indicators and tangible factors that make it possible for the farmer to evaluate the fish population [18, 19].

After processing the data obtained from measurements and weighing were then calculated the values of the most representative maintenance and coefficients indexes to highlight the state of maintenance of studied fish.

Profile index (Table 3) highlights the corporal shape of the fish, and allows the placement of the individuals from a population in a certain profile type. The profile index registered a mean value of 3.49±0.06 at batch F_1 and 3.94±0.08 at specimens from batch I_1 which indicated a good body shape at all experimental batches.

Table 3. Profile index at brook, rainbow and brown trout

Specification	Batch	n	$\bar{X} \pm s_{\bar{X}}$	V%	Min.	Max.
Brook trout	F_1	10	3.49±0.06	5.39	3.14	3.79
Brook trout	F_2	10	3.54±0.08	6.93	3.26	4.08
Rainbow trout	C_1	10	3.89±0.09	7.41	3.34	4.33
Rainbow trout	C_2	10	3.88±0.12	9.68	3.39	4.42
Brown trout	I_1	10	3.94±0.08	6.15	3.66	4.41

Thickness index presented a mean value of 41.36±1.35 for specimens from batch F_1 and 47.94±0.84 for those in batch C_2 (Table 4).

Table 4. Thickness index at brook, rainbow brown trout

Specification	Batch	n	$\bar{X} \pm s_{\bar{X}}$	V%	Min.	Max.
Brook trout	F_1	10	41.36±1.35	10.33	35.26	49.84
Brook trout	F_2	10	41.74±1.63	12.33	31.51	47.95
Rainbow trout	C_1	10	45.84±0.87	5.98	42.25	49.25
Rainbow trout	C_2	10	47.94±0.84	5.51	43.24	47.94
Brown trout	I_1	10	45.77±0.97	6.68	41.94	51.56

Specimens that have the lowest values for Kiselev index are recommended because they have greater circumference in relation to standard length, which indicates a healthy muscular mass. Trout's specimens from F_2 batch presents the lower values for quality index, of only1.47±0.03, in comparison with specimens from batch I_1, which had a greater value for this index of 1.60±0.03 (Table 5).

Table 5. Quality index at brook, rainbow and brown trout

Specification	Batch	n	$\bar{X} \pm s_{\bar{X}}$	V%	Min.	Max.
Brook trout	F_1	10	1.48±0.02	4.84	1.37	1.63
Brook trout	F_2	10	1.47±0.03	5.77	1.37	1.59
Rainbow trout	C_1	10	1.56±0.04	7.65	1.34	1.70
Rainbow trout	C_2	10	1.51±0.03	5.23	1.42	1.63
Brown trout	I_1	10	1.60±0.03	6.78	1.47	1.80

Fulton coefficient provides information on food factor, reflecting the maintenance condition of trout. The higher the Fulton index values are higher, the fish is more developed. Fulton coefficient calculated for trout specimens ranged between 1.50±0.03, value recorded at batch I_1 and, respectiely, 1.75±0.05, for batch F_1 (Table 6).

Table 6. Fulton coefficient at brook, rainbow and brown trout

Specification	Batch	n	$\bar{X} \pm s_{\bar{X}}$	V%	Min.	Max.
Brook trout	F_1	10	1.75±0.05	9.50	1.54	1.97
Brook trout	F_2	10	1.70±0.06	10.96	1.49	2.02
Rainbow trout	C_1	10	1.52±0.06	12.19	1.30	1.88
Rainbow trout	C_2	10	1.71±0.05	10.03	1.48	1.98
Brown trout	I_1	10	1.50±0.03	10.47	1.22	1.66

Fleshy index I (Table 7), express the head proportion from the standard length of the body and fleshy index II, express the proportion of the caudal peduncle from the standard length of the body. Fleshy index I presented values ranking between 19.94±0.52 for batch C_1 and 22.08±0.56 at batch F_1. Values for fleshy index II, ranged between 19.05±0.57 for batch C_2 and 21.20±1.33 at batch I_1. The fact that the values of fleshy indexes oscillates around the value of 20% certify that the studied trout have a high percentage of meat.

Table 7. Fleshy index at brook, rainbow and brown trout

Specification	Batch	n	Ic	$\bar{X} \pm s_{\bar{X}}$	V%	Min.	Max.
Brook trout	F_1	10	I	22.08±0.56	8.06	19.67	24.81
			II	20.07±0.38	6.02	18.33	21.76
Brook trout	F_2	10	I	21.46±0.54	7.98	19.70	24.90
			II	20.79±0.29	4.35	19.09	22.13
Rainbow trout	C_1	10	I	19.94±0.52	8.29	17.75	22.96
			II	19.13±0.25	4.18	17.12	20.22
Rainbow trout	C_2	10	I	21.65±0.37	5.38	19.71	23.30
			II	19.05±0.57	9.42	16.73	21.87
Brown trout	I_1	10	I	21.24±0.74	11.08	18.48	26.05
			II	21.20±1.33	19.88	17.25	28.42

After processing the major statistical indicators for the body measurements of trout breeds, performed on total studied individuals (Table 8a and Table 8b), were revealed strong positive correlations between corporal mass and total length of the fish, standard length and maximum thickness of body.

Table 8a. Correlations coefficients between biometric measurements

	Correlations	g	L	Ls	Lc	Pc	H	C	G
g	Pearson Correlation	1	.775**	.785**	.271	.411**	.385**	.442**	.676**
	Sig. (2-tailed)		.000	.000	.057	.003	.006	.001	.000
	N	50	50	50	50	50	50	50	50
L	Pearson Correlation	.775**	1	.969**	.231	.514**	.072	.250	.443**
	Sig. (2-tailed)	.000		.000	.107	.000	.620	.080	.001
	N	50	50	50	50	50	50	50	50
Ls	Pearson Correlation	.785**	.969**	1	.291*	.483**	.115	.303*	.517**
	Sig. (2-tailed)	.000	.000		.040	.000	.428	.033	.000
	N	50	50	50	50	50	50	50	50
Lc	Pearson Correlation	.271	.231	.291*	1	.263	.206	.151	.194
	Sig. (2-tailed)	.057	.107	.040		.065	.150	.294	.177
	N	50	50	50	50	50	50	50	50

Table 8b. Correlations coefficients between biometric measurements

	Correlations	g	L	Ls	Lc	Pc	H	C	G
Pc	Pearson Correlation	.411**	.514**	.483**	.263	1	-.060	.040	.176
	Sig. (2-tailed)	.003	.000	.000	.065		.680	.781	.220
	N	50	50	50	50	50	50	50	50
H	Pearson Correlation	.385**	.072	.115	.206	-.060	1	.529**	.239
	Sig. (2-tailed)	.006	.620	.428	.150	.680		.000	.095
	N	50	50	50	50	50	50	50	50
C	Pearson Correlation	.442**	.250	.303*	.151	.040	.529**	1	.322*
	Sig. (2-tailed)	.001	.080	.033	.294	.781	.000		.023
	N	50	50	50	50	50	50	50	50
G	Pearson Correlation	.676**	.443**	.517**	.194	.176	.239	.322*	1
	Sig. (2-tailed)	.000	.001	.000	.177	.220	.095	.023	
	N	50	50	50	50	50	50	50	50

4. Conclusions

Values obtained by calculating indexes and growth coefficients are comparable with those from the literature, resulting that the specimens analyzed had a good maintenance condition.

The values of the calculated main indexes reflect a corresponding increase, a better use of nutrition, correlated with good maintenance and health.

Growth and development of brook, rainbow and brown trout specimens' from the two salmonid exploitations taken in study, fits within the breeds characteristics which show a good adaptation to the specific area.

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