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Comparison of Meat Yield and Proximate Composition of Rainbow Trout (*Oncorhynchus mykiss*) Grown in Concrete Ponds and Cages of Two Farms in Two Different Provinces of Turkey

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Abstract

In this study, it was aimed to compare meat yields and nutrient contents of male and female rainbow trout individuals obtained from pond and cage units of two fish farms located in two provinces, Kayseri and Kahramanmaraş, Turkey. The results showed that the highest meat yield was in female individuals reared in the pond unit of the farm in Kahramanmaraş with 55.70% and the lowest meat yield was in male individuals reared in the pond unit of the farm in Kayseri with 47.17%. When all males and females were compared, it was determined that female individuals had higher meat yield and no significant differences were found between pond and cage groups. The highest condition factor (1.55) was found in the Kahramanmaraş cage male group, while there was no significant difference in other groups. HSI values were higher in male individuals and VSI values were higher in the cage groups. Protein values were found to be higher in females. The highest protein contents were determined in the Kahramanmaraş cage female (20.16%), Kahramanmaraş pond female (20.11%), and Kayseri cage female (19.89%) groups. Moreover, the highest lipid values were found in the Kahramanmaraş cage male (7.36%) and Kahramanmaraş pond male (7.16%) groups. The highest moisture was observed in the Kayseri pond male group with 75.84%. The ash content did not differ between groups.

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INTRODUCTION

Fish meat contains favorable amino acids for nutritional physiology, has a low carbohydrate and fat ratio, and has a high polyunsaturated fatty acid ratio. The combination of these factors along with its easy digestibility and richness in vitamins and minerals make fish meat a high-valued food product (Varlık et al., 2007). Fish meat is among recommended and easy-to-digest food sources since it does not contain cellulose and fibers like plants and cartilage and nerves like other meats (Gorga, 1998).

Salmonids are one of the most produced and economically important fishes in the World after carp and tilapia. According to the statistics of 2020 in Turkey, rainbow trout accounts for approximately one-third of the total amount of annual aquaculture with 144.182 tons of production (TUİK, 2021).

Rainbow trout culture in Turkey is mainly carried out in concrete ponds, cage systems installed in dam lakes, and cage enterprises located in the Black Sea. In addition to spring waters; streams and well waters are also used as a water source for fish farming in ponds.

The importance of trout, which is currently a significant agricultural product preferred in the global market as fresh, frozen, or processed, increases day by day. Meat quality in trout production is particularly an uncompromisable matter. Demonstrating the extent to which rearing conditions can affect meat and nutritional quality is of great importance in terms of the standardization of products and the need for studies on this topic is gradually increasing. Therefore, the present study aimed to demonstrate the effects of two different rearing environments and sex differences on rainbow trout's meat yield, nutrient content, and parameters such as VSI (viscerosomatic index), HSI (hepatosomatic index), and K (condition factor).

MATERIALS AND METHODS

Sample Preparation

The rainbow trout (*Oncorhynchus mykiss*) individuals used in the study were obtained from concrete ponds and net cages in Kahramanmaraş and Kayseri provinces of Turkey, where trout farming is a common practice. A total number of 80 fish, which were of similar length and weight and fed with similar diets, were used as the study materials. The proximate analyse results of feed sample are given in Table 1. Forty fish from each province were obtained (for each province: 10 individuals of both sexes from cages and 10 individuals of both sexes from ponds; i.e., a total of 20 males and 20 females) in April. These rainbow trout individuals obtained from different regions for the study were brought to the laboratory at Çukurova University, Fisheries Faculty, Aquaculture Department in cold chain and analyzed. Sex determination was carried out by macroscopic examination of the dissected fish's gonads (Lagler, 1956).

Table 1. Proximate analysis of the diets (%)

Ingredient	Result (%)
Protein	44.16±0.13
Lipid	19.10±0.32
Crude ash	9.50±0.06
Dry matter	91.65±0.06

Meat Yield

The net weight of fish [of which head, internal organs, and spine (including intermuscular bones) were removed] was calculated using the formula below:

Skinned and Skinless (net) weight (yield) = Weight of edible parts/Total body weight x100

Proximate Analysis

The fish fillets were obtained after removing viscera, bones, skin, and head. The fillets were then thoroughly cleaned by washing and homogenized. The AOAC (1990) procedures were employed to determine the moisture and ash contents of the fish. The nitrogen content, which was determined as per Kjeldahl's method (AOAC, 1990), was converted to estimate the crude protein content. Bligh & Dyer (1959)'s method was used to analyze the lipid content. All analyzes were carried out in triplicate.

Estimation of Performance Parameters

The following equations described by Korkut et al. (2007) were used in the calculations for condition factor (K), hepatosomatic index (HIS), and viscerosomatic index (VSI):

$K = W \text{ (body weight)} / L^3 \text{ (fish length)} \times 100$

HSI = Liver weight / fish weight x 100

VSI = Weight of all internal organs / fish weight x 100

Statistical Analysis

Data were compared with one-way variance analysis (ANOVA). Duncan's multiple range test was employed to determine significant differences at the confidence level of 5%. Statistical analyses were performed using the SPSS software (SPSS Inc., Chicago, IL, USA).

RESULTS AND DISCUSSION

Meat Yield

The weight values of rainbow trout individuals, obtained from the concrete pond and lake cage units of two commercial fish farms in Kahramanmaraş and Kayseri, are given in Table 2. The mean weights of female and male individuals obtained from the pond units of the farm in Kahramanmaraş were determined to be 261.07 and 236.47, respectively, while the mean weights of female and male individuals obtained from the same farm's cage units were 252.63 and 283.93, respectively.

On the other hand, the mean weights of female and male individuals obtained from the pond unit of the farm in Kayseri were measured to be 285.23 and 223.80, respectively. The mean weights of female and male individuals of the same farm's cage units were 272.90 and 275.10, respectively.

Statistical differences were observed when the weights of fillets as well as inedible parts were examined ($p<0.05$).

Table 2. Mean whole body, fillet, inedible part weights, and meat yield of rainbow trout individuals.

Farm and unit where fish samples were obtained from	Whole body weight (g)	Fillet weight (g)	Inedible part weight (g)	Meat yield (%)
(G1) Kahramanmaraş Pond Female	261.07±13.42^{ab}	145.40±8.22^{a}	105.17±7.60^{c}	55.70±2.42^{a}
(G2) Kahramanmaraş Pond Male	236.47±12.32^{bc}	119.17±8.11^{bc}	107.07±5.92^{c}	50.35±2.55^{c}
(G3) Kahramanmaraş Cage Female	252.63±17.04^{abc}	127.20±6.75^{abc}	112.25±8.26^{bc}	50.44±1.20^{c}
(G4) Kahramanmaraş Cage Male	283.93±9.53^{a}	141.73±8.95^{ab}	142.70±9.87^{a}	49.81±2.61^{cd}
(G5) Kayseri Pond Female	285.23±5.51^{a}	137.13±2.88^{ab}	138.47±1.55^{a}	48.07±2.60^{cd}
(G6) Kayseri Pond Male	223.80±11.28^{c}	105.40±9.74^{c}	113.43±11.64^{bc}	47.17±2.60^{d}
(G7) Kayseri Cage Female	272.90±2.72^{a}	145.20±6.86^{a}	120.03±11,.64^{abc}	53.18±3.67^{b}
(G8) Kayseri Cage Male	275.10±6.47^{a}	134.90±4.12^{ab}	134.90±3.78^{ab}	49.04±1.61^{cd}

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$). Sample groups of each environment are numbered from one (G1) to eight (G8) and are displayed in the table.

The lowest fillet weight was observed in the G6 group, which also displayed the lowest whole-body weight. However, the meat yield was relatively low in the G4, G5, and G8, the groups which had the highest whole body weight. Moreover, although the G1, G2, G3, and G7 showed lower whole-body weights than these groups, they displayed higher meat yield values.

The highest whole-body weights and fillet weights of rainbow trout were found in the G1, G4, G5, and G7 groups. Regarding the inedible part weights, it was observed that the values in the G4 and G5 were higher than in the G1 and G7 groups. The main reason for this difference in the G1 and G7 could be attributed to that inedible parts consist of different components (head, internal organs, bones) and the weight and size of these components depend on various factors. Therefore, the weights of visceral fats and liver were also determined in the study.

Various evaluations have been made regarding meat yield in studies on rainbow trout. Bugeon et al. (2010) found the meat yield of all female individuals having a mean weight of 3.6 kg as 61%. In another study, de Souza et al. (2015) determined the mean meat yield of rainbow trout, which they divided into two different weight groups (i.e., 330-370 g and 371-440 g) as 45.29% and 47.61%, respectively. In the former study, the meat yield is higher than that of this study, while the values obtained in the latter are lower. Similar results to the present study were reported by Duman et al. (2011). In their study on *Salmo trutta macrostigma*, they used 4 different sizes of fish and reported meat yield values between 58.04% and 61.07%.

In the present study, statistical analyzes were carried out also to reveal whether the sex and environment in which the rearing was performed (pond or cage unit) have effects or whether these factors influence meat yield (Table 3).

Table 3. Weight changes and meat yields (%) of samples, regardless of unit or farm

Sex	Whole body weight (g)	Fillet weight (g)	Inedible part weight (g)	Meat yield (%)
Female	267.96±14.25^{a}	138.73±12.24^{a}	118.98±16.03^{b}	51.85±3.97^{a}
Male	254.83±22.32^{b}	125.30±16.32^{b}	124.53±18.92^{a}	49.09±3.71^{b}

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$).

As a result of the statistical analysis, without considering any other factor than sex, it was observed that the fillet weight and meat yield of female individuals, which also had higher whole body weight, were higher than that of male individuals. This could be attributed to the fact that female individuals grow faster and more than male individuals. Okumuş (2000) stated that

since cultured individuals grow faster than wild ones, the inedible parts grow more and cause a decrease in meat yield. However, in another study conducted on *Salmo gairdneri*, it was reported that the edible part ratio increases with the increase in fish weight (Kim, 1998). The high mean weight of females, of which mean meat yield was high, supports this study.

These results are in line with the study of Çelik and Kızak (2018) on the meat yield of rainbow trout reared in ponds and cages. They determined the groups' mean meat yields as 61.37% and 62.81% and found no statistical difference.

Furthermore, in several other studies, it has been reported that the meat yield may be the data related to the nutrition of trout (Arıman and Aras, 2003), and feed quality and type may be influential on meat yield (Alexis et al., 1986; Beyter, 2008). It has also been stated that the rearing environment (Kiriş and Dikel, 2002) and genotypic characteristics can affect meat yield (Bosworth et al., 2004; Şahin et al., 2011).

Performance Parameters

Condition factor, hepatosomatic index, and viscerosomatic index data of rainbow trout obtained from different environments were also computed and the results are presented in Table 4.

Table 4. Condition factor (K), hepatosomatic index (HSI), and viscerosomatic index (VSI) values of different rainbow trout individuals

Farm and unit where fish samples were obtained from	K	HSI	VSI
(G1) Kahramanmaraş Pond Female	1.31 ± 0.01^{bc}	1.13 ± 0.07^{b}	$5.14\pm.22^{d}$
(G2) Kahramanmaraş Pond Male	1.39 ± 0.01^{abc}	1.89 ± 0.12^{a}	8.55 ± 0.93^{abcd}
(G3) Kahramanmaraş Cage Female	1.52 ± 0.09^{ab}	1.30 ± 0.09^{b}	11.08 ± 0.72^{ab}
(G4) Kahramanmaraş Cage Male	1.55 ± 0.08^{a}	1.51 ± 0.06^{ab}	9.05 ± 1.29^{abc}
(G5) Kayseri Pond Female	1.45 ± 0.09^{abc}	1.44 ± 0.22^{b}	11.94 ± 0.82^{a}
(G6) Kayseri Pond Male	1.26 ± 0.10^{c}	1.14 ± 0.04^{b}	7.58 ± 2.04^{bcd}
(G7) Kayseri Cage Female	1.36 ± 0.09^{abc}	1.17 ± 0.21^{b}	7.45 ± 0.85^{de}
(G8) Kayseri Cage Male	1.50 ± 0.09^{ab}	1.49 ± 0.12^{ab}	8.92 ± 0.67^{abc}

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$). Sample groups of each environment are numbered from one (G1) to eight (G8) and are displayed in the table.

Various statistical differences were observed in all three parameters. The condition factor was the highest (1.55) in male individuals obtained from the cage unit of Kahramanmaraş farm, whereas the lowest value was determined to be 1.26 in male individuals obtained from the pond unit of Kayseri farm.

The condition factor is one of the important parameters that can give an idea regarding the nutrition and development of fish and accordingly their morphology (Korkut et al., 2007). The K value has been determined in wild and farmed fish of many fish species. Yiğit and Aral (1999) stated that this value should be between 1.14 and 1.53 (optimum 1.37) for trout. When these values and the data obtained from this study are compared, it can be stated that the samples of all groups in the present study displayed very high condition factor values.

Çelik and Kızak (2018) compared market-size trout samples cultured in cages and ponds and found the condition factors as 1.03 and 1.05. Yıldırım et al. (2002), on the other hand, found the K values as 1.5 and 1.6 in the study they performed on albino and normal-pigmented rainbow trout (315 g and 366 g). Consequently, it was determined the values obtained from this study are acceptable and similar to the optimum values stated by Yiğit and Aral (1999). Thus, it was determined that there were no significant drawbacks in the nutrition, caring, and rearing conditions as well as the general health status of the fish.

The highest HSI value was determined to be in the male individuals obtained from the pond unit of Kahramanmaraş farm (G2) and there was homogeneity in the majority of the samples, except for a few values. The difference between the HSI values of the G1, G3, G5, G6, and G7 was insignificant. Moreover, the G4 and G8 displayed higher HSI values than the G2 but lower values than the other groups.

Fishes store the excess energy in the liver except during the breeding season. Typically, a high HSI value indicates liver enlargement due to the fat accumulation caused by low quality or high quantity of dietary fat (Korkut et al., 2007). In addition, HSI is also considered an index of growth (Halver and Hardy, 2002).

It has also been employed to understand energy and fat metabolism in trout in many studies, especially where different nutrients and feed additives are tested. The HSI values were reported between 0.98 and 1.24 after zeolite application (Danabaş, 2009), between 0.97 and 1.15 after prebiotic supplementation (Azari et al., 2014), between 1.10 and 1.48 after fig and rosemary extract utilization (Yılmaz and Er, 2019), and between 1.3 and 1.9 after Vitamin E supplementation at different rates (Yıldız, 2005). As a result, it was inferred that the differences detected in the current study were not caused by the diet because both fish

farms use the same feed. Since the data regarding the genetic source of fish, water temperature, nurturing performance of employees, or stocking density of fish were not recorded in the study, it does not seem possible to build an explanation on solid ground for the differences observed in the HSI values. However, the lower HSI observed in females could be attributed to females' faster growth and higher energy expenditure in comparison with males. It can also be stated that the efficiency of cage and pond environments is not at the level to reveal the differentiation of both environments in terms of the HSI values.

Considering the VSI values, it was observed that there were great variations between groups. As a result of the analysis, it was determined that the females obtained from the cage unit of the farm in Kahramanmaraş (G3) and the pond unit of the farm in Kayseri (G5) displayed significantly higher values, while the lowest VSI was in the females obtained from pond unit of the farm in Kahramanmaraş (G1) (Table 5).

Table 5. Condition factor (K), hepatosomatic index (HSI), and viscerosomatic index (VSI) values computed for sexes, regardless of unit or farm

Sex	**K**	**HSI**	**VSI**
Female	1.41±0.32	1.26±0.27^{b}	8.90±3.01
Male	1.42±0.1	1.51±0.31^{a}	8.53±2.07

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$).

VSI is a method typically used to estimate the effect of nutrition on the visceral part of the fish by revealing the level of fat in this part (Korkut et al., 2007). Based on this data, an interpretation can be made regarding the extent to which the fish can metabolize the fat in the diet. For this reason, it is a frequently applied tool in aquaculture studies, especially in feeding trials. It has also been reported from feeding studies in trout. Yıldız (2005) found the VSI values of rainbow trout between 16.2% and 17.19% after Vitamin E supplementation at various levels. Similarly, Dernekbaşı and Hamzaoğlu (2018) reported that the VSI values of rainbow trout were between 11.64% and 16.10%. These values are considerably higher than those obtained in this study. Moreover, Dernekbaşı (2012) reported a VSI value range between 10.03% and 11.99% in rainbow trout after canola oil application. These values, on the other hand, are more close values to the results obtained in the present study. As can be understood from these values, the diet did not pose a significant problem in terms of quality and quantity, and the fat in the diet was adequately metabolized by the samples used in the research.

The K, HSI, and VSI values were calculated for total male and total female individuals, regardless of unit or farm. Consequently, it was determined that the condition factor and viscerosomatic index values did not differ between the sexes, while the hepatosomatic index values were higher in male individuals (Table 6).

Table 6. Condition factor (K), hepatosomatic index (HSI), and viscerosomatic index (VSI) values computed for units, regardless of farm or sex.

Unit	**K**	**HSI**	**VSI**
Pond	1.35±0.11	1.40±0.09	8.30±3.01^{b}
Cage	1.37±0.24	1.37±0.12	9.12±1.23^{a}

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$).

In the evaluation made based on the units, where the samples were obtained from, there was no difference for condition factor and hepatosomatic index values, while the VSI value was found to be higher in individuals reared in cages.

Nutritional Composition

The nutritional compositions of rainbow trout obtained from different environments are given in Table 7.

Table 7. Nutritional composition of rainbow trout obtained from different environments (%)

Farm and unit where fish samples were obtained from	Protein	Lipid	Moisture	Ash
(G1) Kahramanmaraş Pond Female	20.11±0.06^{a}	5.74±0.07^{c}	73.79±0.08^{c}	1.49±0.03
(G2) Kahramanmaraş Pond Male	18.08±0.07^{d}	7.16±0.10^{a}	73.23±0.12^{cd}	1.37±0.08
(G3) Kahramanmaraş Cage Female	20.16±0.15^{a}	5.15±0.08^{d}	73.35±0.21^{c}	1.40±0.01
(G4) Kahramanmaraş Cage Male	18.65±0.17^{c}	7.36±0.09^{a}	71.99±0.12^{e}	1.40±0.10
(G5) Kayseri Pond Female	19.12±0.06^{b}	4.69±0.17^{e}	74.55±0.34^{b}	1.38±0.03
(G6) Kayseri Pond Male	18.72±0.13^{c}	3.37±0.01^{f}	75.84±0.54^{a}	1.46±0.03
(G7) Kayseri Cage Female	19.89±0.22^{a}	5.16±0.02^{d}	73.94±0.13^{bc}	1.42±0.03
(G8) Kayseri Cage Male	17.48±0.11^{e}	6.73±0.13^{b}	72.57±0.06^{de}	1.37±0.01

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$). Sample groups of each environment are numbered from one (G1) to eight (G8) and are displayed in the table.

According to the analysis results for protein, lipid, moisture, and ash; no statistically significant difference was found between the ash values of the samples. However, the differences for the other three parameters were significant. The highest protein value was observed as 20.16% in female individuals obtained from the cage unit of the farm in Kahramanmaraş and the lowest value was determined to be 17.48% in male individuals obtained from the cage unit of the farm in Kayseri. Statistical differences were also observed in terms of lipid values.

The highest lipid value was observed in the Kahramanmaraş cage male group (G4) and Kahramanmaraş pond male group (G2), while the lowest was determined in the Kayseri pond male group (G6). In terms of the moisture detected in the fish meat, the highest moisture was found in the Kayseri pond male group (G6), whereas the lowest was observed in the Kahramanmaraş cage male group (G4).

Sexes and units were compared in terms of nutritional composition (Table 8), as in other parameters.

Table 8. Nutritional composition of the samples according to sex, regardless of farm or unit (%)

Sex	Protein	Lipid	Moisture	Ash
Female	19.82±0.48^{a}	5.19±0.42^{b}	73.90±0.51	1.42±0.51
Male	18.23±0.55^{b}	6.15±0.98^{a}	73.41±0.92	1.40±0.09

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$).

While high protein and low lipid values were observed in females, on the contrary, males displayed lower protein and higher lipid values. There was no difference in moisture and ash contents in the analyzes performed by comparing only sexes. The lower lipid ratio of females could be explained by the higher energy expenditure of females, which have a higher growth performance.

Table 9. Nutritional composition of the samples according to the unit, regardless of farm or sex (%)

Unit	Protein	Lipid	Moisture	Ash
Pond	19.01±0.78	5.25±0.86^{b}	74.35±0.98^{a}	1.42±0.07
Cage	19.04±0.97	6.10±0.91^{a}	72.96±0.81^{b}	1.40±0.08

± Indicates standard deviation. The letters on the values in the same column indicate statistical differences ($p<0.05$).

As can be seen in Table 9, there were no significant differences in terms of protein and ash in the pond and cage samples compared without taking the sexes into account, but there were significant differences in terms of lipid and moisture. While cage individuals were found to contain significantly more fat, the moisture was found significantly higher in pond individuals.

When the nutritional composition values determined in various similar studies conducted on rainbow trout were compared with the findings of the present study, it was observed that the differences were in the lipid content rather than protein, ash, and moisture. Çelik and Kızak (2018) reported that there was no statistical difference in terms of the nutritional composition between the rearing environments of market-size rainbow trout individuals sampled from cages and concrete ponds. According to the results, they found the highest crude protein ratio 20.63, the highest lipid ratio 2.25, the highest ash ratio 1.39, and the highest dry matter ratio 24.44. Of these values, the crude lipid ratio is considerably lower than the one obtained in the present study. This suggests that such a significant difference in the lipid ratio may have resulted from the difference in feed ingredients. However, to come to an unambiguous conclusion, it is essential to obtain information regarding environmental factors.

Similar to the present study; moisture, protein, lipid, and ash contents of rainbow trout captured from Atatürk Dam Lake were determined as 71.65, 19.60, 4.43, and 1.36, respectively (Çelik et al., 2008). What is remarkable here is that the lipid contents of wild individuals are lower, as also reported in previous research. It has been stated that this difference is related to food type, high-fat diet content, and farmed fish's limited activity (Periago et al., 2005; Baki et al., 2015; Tarricone et al., 2022). Souza et al. (2015), in the study where they investigated the nutrient contents in rainbow trout of different sizes (330 g – 370 g and 371 g – 440 g), found no differences in protein (18.43) and ash (1.70) values. However, they reported that larger individuals had higher lipid rates (7.96 and 9.04) and lower moisture rates (71.15 and 74.30). In another research conducted on fish samples of the same species obtained from three different fish farms, Dernekbaşı and Hamzaoğlu (2018) found protein ratios between 17.36 and 19.90, lipid ratios between 4.24 and 7.24, moisture ratios between 76.16 and 77, and crude ash ratios between 1.55 and 1.62.

It should be noted that the differences in the chemical composition of fishes vary depending on various biotic and abiotic factors such as species, rearing conditions, season, sex, age, gonad development, and nutrition (Brukert et al., 2008).

CONCLUSION

As a result, it was observed that the female individuals generally had higher meat yield rates compared to the male individuals. When the individuals reared in pond and cage environments were compared, no difference was found in terms of the meat yield. Therefore, it can be concluded that culturing predominantly female individuals may have positive effects on the total meat yield. Regarding the condition factor, no aggregation was observed. Although the highest value was determined to be in the Kahramanmaraş cage male group, all individuals of both sexes sampled from cage and pond units displayed high condition factor values. The HSI value was found to be the highest in Kahramanmaraş pond male individuals and the lowest in Kahramanmaraş pond female individuals, however, similar or close values were not determined in the majority of other samples. The lowest HSI observed in females could be explained by the fact that females are more active physiologically and develop faster than males. A highly heterogeneous distribution was observed in the VSI values. It was found as the highest in Kayseri pond female individuals and the lowest in Kahramanmaraş pond female samples. The VSI value was found to be higher in both females and cage individuals. Interestingly, these values showed a similar trend to the HSI values. When the samples were compared in terms of nutritional composition, it was determined that females had higher protein values, while males had higher lipid values. There was no difference between the sexes in terms of moisture and ash. When the pond and cage environments were compared, statistical differences were only observed in lipid and moisture ratios. It was determined that the lipid amount was higher and the moisture ratio was lower in the individuals reared in cages. It is thought that more interesting results can be obtained in such studies if individuals are obtained from the same genetic source, rearing starts simultaneously, feeding and nurturing are applied with the same method, and other drivers are as homogeneous as possible.

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