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A Research on Growth and Meat Quality Parameters and Economic Conversion Rates of Different Feeding Regimes Applied to Cultured Large Rainbow Trout (*Oncorhynchus mykiss*) in Net Cages in the Black Sea

Dilara KAYA ÖZTÜRK[1] ✍, Recep ÖZTÜRK[2]
[1]Sinop University, Faculty of Fisheries and Aquatic Science, Department of Aquaculture, Sinop, Turkey, [2]Sinop University, Vocational School Department of Motor Vehicles and Transportation Technologies, Sinop, Turkey
[1] https://orcid.org/0000-0003-2505-231X , [2] https://orcid.org/0000-0002-8842-0493
✉: dilara.kaya55@gmail.com

ABSTRACT
This study aimed to determine the effects of different feeding regimes applied to large commercial rainbow trout (*Oncorhynchus mykiss*) with an initial weight of 1045.12±43.51 g in the Black Sea on growth, meat quality performances, and economic conversion rates. The study was conducted in a commercial fish farm in the Sinop district of the Southern Black Sea (Turkey). Fish were grouped according to three different feeding regimes (R group fed according to feeding table (1% fish weight); D group fed 1 day/fasted 1 day; E group fed 6 days/fasted 1 day) and fed twice a day for five months. At the end of the 150-day study, it was found that the R and E groups had the best growth parameters (weight gain, specific growth rate, and thermal growth rate) and these results were statistically different from the D group ($p<0.05$). The best feed conversion rates (FCR) were determined to be in the E (1.57±0.04) and R (1.59±0.01) groups. Depending on the FCR of the groups, the economic conversion rate (ECR) of the E group was better than the other groups. In terms of meat quality, the biochemical, fatty acid, and amino acid compositions of the large rainbow trout fillets commercially grown in the Black Sea were found to be of good quality, nutritious, and safe for human consumption.

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Karadeniz'de Ağ Kafeslerde Yetiştirilen Büyük Gökkuşağı Alabalıklarına (*Oncorhynchus mykiss*) Uygulanan Farklı Besleme Rejimlerinin Büyüme ve Et Kalite Parametreleri ile Ekonomik Dönüşüm Oranları Üzerine Bir Araştırma

ÖZET
Bu çalışmada, Karadeniz'de ticari olarak üretilen ve başlangıç ağırlıkları 1045.12±43.51 g olan gökkuşağı alabalıklarına (*Oncorhynchus mykiss*) uygulanan farklı besleme rejimlerinin büyüme, et kalitesi performansları ve ekonomik dönüşüm oranları üzerindeki etkilerinin belirlenmesi amaçlamıştır. Çalışma, Güney Karadeniz'in (Türkiye) Sinop ilçesindeki ticari bir balık çiftliğinde yürütülmüştür. Balıklar üç farklı besleme rejimine göre gruplandırılmış (besleme tablosuna göre beslenen R grubu (% 1 balık ağırlığı); 1 gün beslenen/1 gün aç bırakılan D grubu; 6 gün beslenen/1 gün aç bırakılan E grubu) ve beş ay boyunca günde iki kez beslenmiştir. 150 günlük çalışma sonunda, R ve E grupları en iyi büyüme parametrelerine (ağırlık artışı, spesifik büyüme oranı ve termal büyüme oranı) sahip olduğu ve bu sonuçların istatistiksel olarak D grubundan farklı olduğu bulunmuştur ($p<,05$). En iyi yem dönüşüm oranlarının (YDO) E (1,57±0,04) ve R (1,59±0,01) gruplarının olduğu belirlenmiştir. Grupların YDO'larına bağlı olarak da E grubunun ekonomik dönüşüm oranının (EDO) diğer gruplardan daha iyi bulunmuştur. Et kalitesi bakımından ise, Karadeniz'de ticari olarak yetiştirilen büyük gökkuşağı alabalığı filetolarının biyokimyasal, yağ asidi ve aminoasit kompozisyonları iyi kalitede, besleyici ve insan tüketimi için güvenli bulunmuştur.

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INTRODUCTION

Nutrition is the most crucial concern in aquaculture, similar to other culture systems. Because nutrition, which determines all vital activities of every living thing, is effective in the production period and costs as well as the biological activity of the living thing. Therefore, feeding activities are important for the blue economic sustainability of cultural systems. Fish nutrition aims to develop production and feeding procedures that are both blue economically viable and environmentally friendly, with minimal feed and total consumption costs. They are still researching fish nutrition studies nowadays to ensure blue economic sustainability by determining suitable feeding models for fish development performance (Martínez-Llorens et al. 2007; Silva et al. 2007; Eroldoğan et al. 2008; Ofor & Ukpabi 2013; Adaklı & Taşbozan 2015; Nagar & Patidar 2015; Hvas et al. 2022).

In natural habitats, fish can starve for short or long periods under unsuitable environmental conditions (Dempster et al. 2016; Stehfest et al. 2017; Wade et al. 2019). In culture conditions, this situation occurs when feeding cannot be done under adverse environmental conditions, before harvest, or during the transfer processes of fish (Remen et al. 2014; Hvas et al. 2017; Hvas et al. 2021). Fish have been observed to exhibit compensatory growth after being subjected to complete or restricted starvation (Ali et al. 2003). Even though changes in body biochemistry during starvation (Adaklı & Taşbozan 2015; Dong et al. 2017; Ashouri et al. 2020; Altaf et al. 2021), fish have been shown to have high growth efficiency (Ali et al. 2003). Many starvation treatments were administered to fish in various investigations, and their growth performance, infection risks, flesh quality characteristics, stock density in the transporting and stress enzymes were assessed (Känkänen et al. 2009; Peres et al. 2011; Stefansson et al. 2009; Pérez-Jiménez et al. 2012; Dong et al. 2017; Ashouri et al. 2020; Torfi Mozanzadeh et al. 2021; Sakyi et al. 2020; Tamadoni et al. 2020; Yanar et al. 2020; Cai et al. 2021; Altaf et al. 2021; Hasanpour et al. 2021; Hvas et al. 2021; Hvas et al. 2022; Messina et al. 2023; Xavier et al. 2023). Rainbow trout (*Oncorhynchus mykiss*) is an inland water fish that is farmed all over the world and is produced (191130 t, Anonymous 2023). Even though it has been produced for a long time in Türkiye, it is now sold on the worldwide market as "Turkish salmon" and competes with Atlantic salmon (*Salmo salar*) in terms of both meat quality and price. So much so that, for 10 years, producers produced solely large rainbow trout / Turkish salmon in net cages in the Black Sea, with (45454 tons of production in 2022), 86.7 % of this production exported (Anonymous 2023).

As long as aquaculture development continues, companies use feed most efficiently reduce to feed and overall consumption expenditures in their operations, as mentioned above. Considering sustainable blue economics and fish growth performance, studies on starvation, feed restriction, compensation feeding, and different feeding regimes are still gaining importance. For the first time, three different feeding regimes were administered to large rainbow trout in this study, which was conducted in collaboration with large rainbow trout producers in the Black Sea. The study's objective is to determine how three different feeding regimens for large rainbow trout affect the fish's growth performance, biochemical, fatty acid, and amino acid compositions, and rates of economic conversion.

MATERIAL and METOD

The large rainbow trout (*Oncorhynchus mykiss*, 1045.12±43.51 g body mass) was obtained from the Altınkaya Dam Lake in Samsun-Bafra. Fish (SAGUN Aqua) were produced in Sinop, Turkey's southern Black Sea (Demirciköy site; 35°10′55,92″E–41°54′44,15″N; 35°11′03,42″E–41°54′33,92″N; 35°10′60,00″E–41°54′32,52″N; 35°10′52,50″E–41°54′) in nine open sea cages (⌀=30 m) under natural photoperiod. The study was carried out between 15 December 2018 and 15 May in a sea cage in 2019.

Water temperature, salinity, and oxygen were measured using the HANNA (HI9829) multiparameter device and during the study, water temperature, salinity, and O2 value were 11.02±0.94 °C, 16.86±0.74 ppt, and 11.76±0.40 mg L-1. Each cage contained approximately 16000 fish that were fed commercial diets (4.5–6 mm pellets, BioMar-SAGUN, Aydın-Turkey). The diet manufacturer uses a closed diet formula for large rainbow trout. (In pursuant to the manufacturer's diet label, the biochemical composition of the diet is shown in Table 1). The feeds used in the study were in two different sizes, and the fish were given 4.5 mm feed in the dam lakes and 6 mm in the sea. The biochemical, amino, and fatty acid compositions of the diets are given in Table 2.

The feeding regimes of the fish were determined by the operating protocols. Three different feeding regimes were tested on the fish. According to this, three treatment groups were fed two times a day: according to the feeding table, everyday feeding (1 % of fish weight) (R), 1 day feeding/1 day fasted (D), 6 days feeding/1 day fasted (E).

Table 1. Biochemical compositions of the diets used in the study
Çizelge 1. Çalışmada kullanılan yemlerin biyokimyasal kompozisyonları

Biochemical composition	*Initial diet (4.5 mm*)*	*Final diet (6.0 mm**)*
Crude Protein, %	42.60	41.80
Crude Fat, %	26.80	28.50
Crude Ash %	7.10	5.90
Crude cellulose, %	2.30	5.90
Phosphorus, %	1.07	0.90
Calcium, %	1.18	0.90
Sodium, %	0.28	0.22
Astaxanthin, mg/kg	50.00	50.00
Copper (II) sulfate pentahydrate, mg/kg	1.10	1.00
Manganese (II) sulfate monohydrate, mg/kg	9.00	8.00
Zinc (II) sulfate monohydrate, mg/kg	57.00	50.00
Calcium iodate, mg/kg	1.40	1.20
*Antioxidant (BHA)****	88.00	84.00

Raw materials:
*Fish Meal, fish oil, chicken meal, sunflower meal, guar protein, wheat, wheat flour, blood meal, hydrolyzed feather meal, soy concentrate, soy meal (made from genetically modified soy), astaxanthin, mineral substance
**Fish meal, fish oil, pea proteins, sunflower meal, blood meal, wheat, wheat flour, guar protein, chicken meal, wheat gluten, soy flour (genetically modified soy), astaxanthin, mineral substance
*** BHA Butylated hydroxyanisole

Growth Performance, Chemical Analysis, Amino and Fatty Acids Analysis

Farming personnel killed fish with a high dose of anesthetic (MS-222, 25–50 mg L^{-1}, Ortuno et al. 2002) and randomly sampled 30 fish at the start and end of the study. Therefore, no ethical approval is required for this manuscript. Fish and feed samples taken from the farm were transported to the Faculty of Fisheries and Aquaculture's Scientific and Technological Research Center under cold chain conditions (University of Sinop). For the length measurement of fish, a 1 mm precision height measurement ruler, fish, internal organs, etc. weight Kern brand balance with 0.1g precision was use According to Jobling (2003), Abdel-Tawwab et al. (2015), and Lu et al. (2020), growth and feed efficiency parameters, and biometric data were calculated:

SGR: specific growth rate (%) = $((\ln BW_f - \ln BW_i) / t) \times 100$, where t is experimental period = 150 days;
WG: weight gain (%) = $((BW_f - BW_i)/BW_i) \times 100$;
SR: survival (%) = number of fish in each group remaining on day 150/initial number of fish) × 100;
TGR: Thermal growth rate=$((BW_f)^{1/3}-(BW_i)^{1/3})/((\text{Temperature} \times \text{experimental days}))$
FCR: feed conversion ratio = (feed intake (g) / weight gain (g));
HSI: hepatosomatic index (%) = (liver weight (g) / BW_f (g)) × 100;
VSI: viscerosomatic index (%) = (visceral weight (g) / BW_f (g)) × 100;
K: Fulton's condition factor = (BW_f (g)/ standard length $(cm)^3$) × 100;

in which BW_i and BW_f are initial body weight and final body weight, respectively.

Economic indices were calculated using formulas reported by Martínez-Llorens et al. (2007):

Economic conversion ratio (€ kg^{-1}) (ECR)=feed offered (kg) × feed cost (€ kg^{-1})/Weight gain (kg)

Economic profit index (€ $fish^{-1}$) (EPI)=final weight (kg $fish^{-1}$) × fish sale price (€ kg^{-1})−ECR (€ kg $fish^{-1}$) × weight increase (kg).

The economic conversion rate and economic profit ındex calculated used a price of 2 euros per kilogram of feed and an 8 euros per kilogram pricing for fish sales.

Fish were filleted into boneless fillets in the laboratory after their internal organs and skins were separated, and they were maintained in a deep freezer (WiseCryo/WUFD500 80 °C) until analysis. Association of Official Agricultural Chemists (AOAC 1995) approved techniques were used for the biochemical analyses of the diet and fillet samples. All biochemical analyses in fillets were done in triplicate and on a wet basis. Amino acid and fatty acid analyses of diets and fillets were made by the Sinop University Scientific Research and Application Center (SUBITAM).

Table 2. The biochemical (%), amino acid (g 100g^{-1} protein) and fatty acid compositions of the diets
Çizelge 2. Yemlerin biyokimyasal (%), amino asit (g 100g^{-1} protein) ve yağ asidi (%) kompozisyonları

	Initial diet	***Final diet***		***Initial diet***	***Final diet***
Crude Protein	46.28±0.22^{b}	41.71±0.56^{a}	*C12:0*	0.11±0.01^{a}	0.08±0.01^{a}
Crude Fat	19.47±0.05^{a}	23.96±0.68^{b}	*C13:0*	0.02±0.01^{a}	0.02±0.01^{a}
Crude Ash	8.33±0.17^{a}	9.57±0.33^{b}	*C14:0*	3.56±0.02^{a}	3.78±0.01^{b}
Dry Matter	91.36±0.05^{a}	92.64±0.24^{b}	*C15:0*	0.34±0.01^{a}	0.38±0.01^{a}
Alanine	2.43±0.01^{b}	1.97±0.01^{a}	*C16:0*	11.16±0.08^{b}	10.61±0.09^{a}
Aspartic acid	4.95±0.01^{b}	4.04±0.01^{a}	*C17:0*	0.34±0.01^{a}	0.34±0.01^{a}
Methionine	0.91±0.01^{a}	1.03±0.01^{b}	*C18:0*	4.65±0.07^{b}	3.96±0.01^{a}
Glutamic acid	5.89±0.01^{b}	5.10±0.01^{a}	*C20:0*	0.88±0.01^{a}	1.05±0.01^{b}
Phenilalanine	1.85±0.01^{b}	1.65±0.01^{a}	*C21:0*	0.04±0.01^{a}	0.02±0.01^{a}
Lysine	3.79±0.01^{b}	2.67±0.01^{a}	*C22:0*	0.42±0.01^{a}	1.12±0.01^{b}
Histidine	0.96±0.01^{b}	0.91±0.01^{a}	*C23:0*	0.07±0.01^{a}	0.07±0.01^{a}
Tyrosine	1.07±0.04^{b}	0.91±0.01^{a}	*C24:0*	0.40±0.01^{a}	0.48±0.01^{b}
Glysine	2.34±0.01^{b}	1.98±0.01^{a}	*C14:1*	0.18±0.01^{a}	0.19±0.01^{a}
Valine	1.95±0.01^{b}	1.58±0.01^{a}	*C15:1*	0.05±0.01^{a}	0.06±0.01^{a}
Leucine	2.97±0.01^{b}	2.69±0.02^{a}	*C16:1*	0.29±0.01^{a}	0.33±0.01^{a}
Isoleucine	1.26±0.01^{b}	1.03±0.01^{a}	*C17:1*	0.27±0.01^{a}	0.32±0.01^{a}
Threonine	1.79±0.01^{b}	1.52±0.01^{a}	*C18:1n-9c*	25.16±0.12^{b}	23.91±0.11^{a}
Serine	2.40±0.02^{b}	1.95±0.01^{a}	*C18:1n-9t*	4.15±0.02^{b}	2.83±0.57^{a}
Proline	2.32±0.01^{b}	2.00±0.01^{a}	*C20:1n-9c*	5.85±0.01^{a}	6.26±0.05^{b}
Ornitine	0.02±0.01^{a}	0.02±0.01a	*C22:1n-9*	4.93±0.01^{a}	5.32±0.04^{b}
Cystine	0.19±0.01^{a}	0.17±0.01^{a}	*C24:1*	1.01±0.03^{a}	1.18±0.02^{a}
Arginine	2.69±0.01^{b}	2.24±0.01a	*C18:2n-6t*	0.29±0.01^{a}	0.35±0.01^{b}
ΣEAA	18.15±0.03^{b}	15.30±0.02^{a}	*C18:2n-6c*	13.84±0.06^{b}	13.45±0.09^{a}
ΣSEAA	3.65±0.01^{b}	3.15±0.01^{a}	*C18:3n-3*	7.59±0.01^{a}	8.71±0.09^{b}
ΣNEAA	21.60±0.02^{b}	18.12±0.02^{a}	*C18:3n-6*	0.25±0.01^{a}	0.28±0.01^{b}
			C20:2	1.99±0.01^{a}	2.25±0.02^{b}
			C20:3n-3	0.01±0.01^{a}	0.02±0.01^{a}
			C20:3n-6	0.44±0.01^{a}	0.51±0.01^{b}
			C20:4n-6	0.53±0.01^{a}	0.62±0.03^{b}
			C20:5n-3	4.85±0.02^{a}	5.05±0.01^{b}
			C22:2	0.21±0.01^{a}	0.25±0.01^{a}
			C22:6n-3	6.09±0.01^{a}	6.17±0.06^{b}
			ΣSFA	21.97±0.18^{a}	21.91±0.12^{a}
			ΣMUFA	41.88±0.13^{b}	40.40±0.47^{a}
			ΣPUFA	36.10±0.08^{a}	37.65±0.38^{b}

∑SFA=C12:0+C13:0+C14:0+C15:0+C16:0+C17:0+C18:0+C20:0+C21:0+C22:0+C23:0+C24:0
∑MUFA=C14:1+C15:1+C16:1+C17:1+C18:1n-9c+C18:1n-9t+C20:1n-9c+C22:1n-9+C24:1
∑PUFA=C18:2n-6t+C18:2n-6c+C18:3n-3+C18:3n-6+C20:2+C22:2+C20:3n-6+C20:5n-3+C20:4n-6+C22:6n-3
Essential Amino Acids (EAA)= Histidine + Lysine+ Phenylalanine+ Methitonine+ Threonine+ Leucine+ Isoleucine+Valine+ Arginine
Semi-Essential Amino Acids (SEAA)= Histidine + Arginine
Non-Essential Amino Acids (NEAA)= Alanine+ Aspartic acit+ Glutamic acit+ Tyrosine+ Glicine+ Serine+ Proline

Each value means mean±standard error. Values in rows marked with different letters are significantly different (p <0.05).

The fillet and diet samples were converted to methyl esters by derivatization of fat samples in a gas chromatography device (Thermo Scientific Trace 1310) for fatty acid analyses. For this purpose, 0.25 g of the extracted oil was removed, and 4 ml of heptane and 0.4 ml of 2 N KOH were added. The mixture was stirred in a vortex for 2 min and then centrifuged at 5000 rpm for 5 min. After centrifugation, 1.5–2 ml of the heptane phase was collected and transferred to glass tubes for GC/MS analysis. The injection of samples into the device was carried out with an automatic sampler (Autosampler AI 1310). Samples were analyzed by Thermo Scientific ISQ LT model GC/MS. For this analysis, Trace Gold TG-WaxMS capillary column (Thermo Scientific code: 26088-1540) with a film thickness of 0.25 µm and 60 m length was used. The injection block temperature was set to 240 °C, and the column temperature was increased from 100 °C to 240 °C in the temperature program. Helium gas (1ml/min) was used as a carrier gas at constant flow, and a 1:20 split ratio was applied. The MS unit (ISQ LT) was used in electron ionization mode. Fatty acids were defined by comparing the standard FAME mixture of 37 components based on the arrival times. Once fatty acid compositions were determined, total fatty acids and fatty acid quality assessments were calculated according to Ulbricht and Southgate, (1991) and Santos-Silva et al. (2002).

Atherogenicity Index (AI)= [(C12:0+(4 x C14:0)+C16:0)] / (MUFA+Omega-3+Omega-6);
Thrombogenicity Index (TI)=(C14:0+C16:0+C18:0)/[(0.5 x MUFA)+(0.5xOmega-6) +(3xOmega-3)+(Omega-3/Omega-6)];
Hypocholesterolemic/Hypercholesterolemic ratio ratio (HH)= (C18:1n-9+C18:2n-6+C18:3n-3+C20:4n-6+C20:5n-3+C22:6n-3) /(C14:0+C16:0)

Amino acid analyses of diet and fish fillets were performed using the Jasem LC-MS/MS amino acid assay kit. The concentration of the target amino acids was measured using the electrospray ionization (ESI)-based multiple reaction monitoring (MRM) mode. 0.5 g sample was taken into a glass vial with a screw cap and 4 ml of reagent-2 was added, and then, a hydrolysis reaction was performed at 110 °C for 24 hr. The hydrolysate was centrifuged for 5 min at 4000 rpm when it reached room temperature. Then, 100 µl of the supernatant was transferred to a vial and completed to 1 ml with distilled water. This dilution procedure was repeated to yield 800-fold diluted hydrolysate of the sample. 50 µl of the diluted hydrolysate was transferred to a sample vial and 50 µl of internal standard mixture with isotope-labeled and 700 µl of reagent-1 was added, respectively, and then, the mixture was vortexed for 5 s. All samples were prepared according to the above procedures and injected into the LC-MS/MS system, where the amounts of amino acids were read. According to the obtained amino acid data, total amino acids and the quality of amino acids were calculated according to Li et al. (2009).

Color Analysis of Fish Skin and Meat

white plate as a reference before each measurement (standard values for white plate L*=91.97; a*=−1.4; b*=2.0, Standard C2-22326). L*, a*, and b* values represent lightness, redness, and yellowness, respectively. Color measurement of fillets of fish groups was done from three locations: 1st location: between the behind of the operculum; 2nd location: under the dorsal fin; and 3rd location: front of the caudal fin. The hue is a descriptor of what is generally understood to be the true color, and the chroma (C*) is the intensity or degree of saturation of the color. The angle of Hue and C* was calculated using a* and b* values (Hernández et al. 2009):

$$C^*=\sqrt{(a^{*2}+b^{*2})} \quad \text{and} \quad Hue=\arctan(b^*/a^*).$$

Statistical Analysis

The data were reported as average values with standard error (average±SE). The IBM SPSS 21 statistics package application was used for statistical analysis. The significance of the differences in the data was determined using one-way ANOVA, followed by Tukey's procedure for multiple comparisons.

RESULTS

Growth Performance, Economic Parameters, Biochemical Composition and Biometric Index of Large Rainbow Trout

The growth parameters, biometric indices, and biochemical composition of fish in the study are provided in Table 3; Table 4 lists the fish's feed conversion and economic conversion rates. After the study, the R and E groups had the best growth outcomes [weight gain (p= .043), specific growth rate (p= .048), and thermal growth rates (p= .438), which were statistically distinct from the D group. Fish carcass yield (CY) was in the following order: R> D> E and the CY of group E was statistically different (p= .037).

In comparison to the initial study, the crude protein (CP) values of the R and E group fillets increased, whereas those of the D group fillets fell. Additionally, group D fillet had the lowest level of crude protein at the end of the study (p= .026). After 150 days, all group fillet's crude lipid (CL) ratios of fillets, with the R and E group fillets having the highest CL values and the CL values of E group fillets were significantly different (p= .046)

At the end of the 150-day study, there was no statistical difference between the feed conversion rates of the R and E groups, while the D group was statistically different (p= .043). In the study, the best feed conversion rates were in the groups fed every day according to the feeding table (R) and fed for 6 days starved for 1 day (E). The E group had the highest economic conversion rate, whereas the D group had the highest economic profit index.

Amino and Fatty Acid Composition and Color Analysis of Large Rainbow Trout Fillets

Table 5 lists the amino acid compositions of large rainbow trout fillets with different feeding regimens. The total amino acid values of all group fillets increased from the start of the study to the completion of the 150-day research. In particular, the total amino acid (TAA), essential amino acid (EAA), total branched-chain amino acid (BcAA), total sulfur-containing amino acid (SAA), total aromatic amino acid (ArAA), total basic amino acid (BAA) and total acidic amino acid (AAA) values of the R group fillets were higher than the other two group fillets (D and E groups). The D group fillets that had been fed one day and then fasted had high levels of total non-essential amino acids, and there was a statistically significant difference between the groups for all groups (p= .033). The order of the EAA/NEAA ratio and essential amino acid index (EAAI) values was R>E>D. Group D's fillets' EAA/NEAA and EAAI values were statistically different from those of the other two groups (respectively p= .048 and p= .046).

Table 3. Growth performance (weight gains, specific growth rate, thermal growth rate), biometric indices (condition factor, viscerosomatic index, hepatosomatic index, and carcass yield), and biochemical composition (crude protein, crude fat, crude ash, and dry matter) of the groups during the study.

Çizelge 3. Çalışma süresince grupların büyüme performansı (ağırlık kazançları, spesifik büyüme oranı, termal büyüme oranı) biyometrik indeksleri (kondisyon faktörü, viserosomatik indeks, hepatosomatik indeks ve karkas randımanı) ve biyokimyasal kompozisyonu(ham protein, ham yağ, ham kül ve kuru madde)

Parameters	***Initial***	***Final***			***p value***
		R	*D*	*E*	
Weight (g)	1045.12±43.51	3769.80±226.89^b	3445.03±102.12^a	3770.60±127.51^b	.049
CF[1]	1.55±0.04	1.46±0.07^a	1.54±0.03^b	1.51±0.03^b	.030
VSI (%)[2]	16.21±0.81	13.42±0.51^a	14.67±1.06^a	14.25±0.70^a	.875
HSI (%)[3]	1.50±0.07	0.88±0.05^a	0.91±0.10^a	1.09±0.05^b	.049
CY (%)[5]	49.31±0.05	55.61±0.78^b	54.58±0.50^b	51.39±0.68^a	.037
SR (%)[6]		87.93±0.04^a	86.00±0.01^a	98.20±0.06^b	.047
Weight gain (g)		2721.89±226.89^b	2397.12±102.12^a	2722.69±127.51^b	.043
Weight gain (%)		259.74±21.65^b	228.75±9.75^a	259.82±12.17^b	.025
SGR (%)[7]		0.85±0.03^b	0.79±0.02^a	0.84±0.04^b	.048
TGR (%)[8]		0.33±0.02^a	0.30±0.01^a	0.32±0.01^a	.438
CP[9]	19.97±0.34	20.56±0.22^b	15.92±0.15^a	20.00±0.61^b	.026
CL[10]	10.52±1.36	27.67±0.30^b	27.92±1.20^b	17.79±1.75^a	.046
CA[11]	2.98±0.25	2.96±0.11^a	2.85±0.17^a	3.21±0.20^b	.041
DM[12]	31.04±0.69	49.12±0.20^b	50.21±1.02^b	41.99±1.60^a	.023

Each value means mean±standard error. Values in rows marked with different letters are significantly different (p <0.05).
[1]CF= condition factor, [2]VSI= vicerosomatic index, [3]HSI = hepatosomatic index, [4]GSI= gonadosomatic index, [5]CY= carcass yield, [6]SR= survival rate, [7]SGR = specific growth rate, [8]TGR= thermal growth rate, [9]CP= crude protein, [10]CF= crude lipid, [11] CA= crude ash, [12]DM= dry matter

Table 4. The feed and economic conversion ratio and economic profitability indices of large rainbow trout fed with different feeding regimes at the end of the study

Çizelge 4. Farklı besleme rejimleri ile beslenen büyük gökkuşağı alabalıklarının deneme sonundaki yem ve ekonomik dönüşüm oranı ile ekonomik karlılık indeksleri

Parameters	***R***	***D***	***E***	***p value***
FCR[1]	1.59±0.01^a	1.66±0.02^b	1.57±0.04^a	.043
ECR[2] (€ kg^{-1})	3.18	3.32	2.54	-
EPI[3] (€ fish^{-1})	21.50	19.60	23.25	-

Each value means mean±standard error. Values in rows marked with different letters are significantly different (p <0.05).
[1]FCR = feed conversion ratio; [2]ECR=Economic conversion ratio; [3]EPI= Economic profit index

The fatty acid compositions of large rainbow trout fillets with different feeding regimens are shown in Table 6. The C16:0 was the most prevalent saturated fatty acid found in all group fillets.

At the start of the study, the C16:0 value was 11.60±0.36 %; however, at the end of the study, it had dropped in all groups, and the R group fillets were found to have the highest C16:0 value. The C16:0 value of Group E fillets was statistically different from the C16:0 values of other groups' fillets (p= .046). The fillets' total saturated fatty acid (ΣSFA) levels were in the following order: E>R>D, and there was a statistically significant difference between the groups (p= .019). The most prominent representative of all total monounsaturated fatty acids (ΣMUFA), C18:1n-9c, rose in the R and E group fillets as compared to the initial fillets while declining in the D group fillets. All groups' C18:1n-9c levels showed a statistically significant difference (p= .023). Total monounsaturated fatty acids of fillets showed parallelism with C18:1n-9c. The C12:2n-6c, C22:6n-3 (DHA), C18:3n-3, C20:5n-3 (EPA), and C20:2 were the polyunsaturated fatty acids (PUFA) most commonly found in fillets in this study. Among these fatty acids, C20:2 was found at the highest values in the R group, C18:2n-6c, C18:3n-3, and C22:6n-3 in the E group, and C20:5n-3 in the D group. While the statistical difference between the C20:5n-3 (EPA) values of large rainbow trout fillets was significant in all groups (p= .010), the difference between the fillets' C22:6n-3 (DHA) values was significant only in group E (p= .040).

In group E fillets, total polyunsaturated fatty acids were prominent. Total omega-3 and omega-6 values of fillets were high in group E, which was fed for 6 days/fasted for 1 day, and the statistical difference between these values was significant (respectively, p=.048 and p= .040). Group D fillets had a high total omega-3/omega-6 value and omega-6/omega-3 value. In fatty acid quality values, the atherogenicity index (AI)value was high in group D fillets, the thrombogenicity index (TI) value was high in R and D groups, and the hypocholesterolemic/hypercholesterolemic ratio (HH) value was high in E and R groups. The results of the study showed that there was no statistically significant difference between the fatty acid quality values (AI, TI, and HH) found in the fillets of the experimental groups.

Table 5. Amino acid compositions of large rainbow trout fillets at the initial and end of the study (g 100g^{-1} protein)
Çizelge 5. Deneme başı ve deneme sonunda büyük gökkuşağı alabalığı filetolarının amino asit kompozisyonları (g 100g^{-1} protein)

Amino Acids	*Initial*	*Final*			*p value*
		R	D	E	
Alanine	1.08±0.05	1.09±0.01^a	1.24±0.01^b	1.11±0.05^a	.040
Aspartic Acid	1.93±0.20	1.88±0.01^b	2.12±0.01^c	1.64±0.01^a	.023
Methinonine	0.53±0.01	0.52±0.01^b	0.48±0.01^a	0.52±0.01^b	.039
Glutamic Acid	2.48±0.04	2.60±0.01^c	2.31±0.01^a	2.52±0.12^b	.037
Phenylalanine	0.73±0.01	0.75±0.01^b	0.68±0.01^a	0.73±0.04^b	.046
Lysine	1.84±0.03	2.23±0.01^b	1.96±0.01^a	2.00±0.15^b	.040
Histidine	0.49±0.02	0.47±0.01^a	0.58±0.01^b	0.49±0.02^a	.036
Tyrosine	0.56±0.01	0.65±0.01^b	0.49±0.01^a	0.62±0.04^b	.038
Glysine	0.70±0.13	0.19±0.01^a	0.75±0.01^c	0.60±0.08^b	.045
Valine	0.68±0.02	0.90±0.01^c	0.60±0.01^a	0.80±0.06^b	.044
Leucine	1.28±0.02	1.43±0.01^c	1.23±0.01^a	1.35±0.07^b	.035
Isoleucine	0.40±0.01	0.56±0.01^c	0.34±0.01^a	0.50±0.05^b	.045
Threonine	0.77±0.01	0.89±0.01^b	0.69±0.01^a	0.86±0.08^b	.043
Serine	0.85±0.02	0.92±0.01^b	0.82±0.01^a	0.92±0.03^b	.048
Proline	0.70±0.01	0.78±0.01^b	0.68±0.01^a	0.75±0.04^b	.046
Ornithine	0.19±0.02	0.29±0.01^b	0.19±0.01^a	0.24±0.03^b	.039
Cystine	0.14±0.01	0.17±0.01^a	0.14±0.01^a	0.15±0.01^a	.865
Arginine	0.98±0.01	1.13±0.01^b	0.99±0.01^a	1.12±0.07^b	.047
TAA	15.99±0.28	17.43±0.01^b	16.27±0.01^a	16.71±0.02^a	.045
ΣEAA	7.71±0.01	8.87±0.01^c	7.54±0.01^a	8.36±0.52^b	.040
ΣSEAA	1.47±0.02	1.60±0.01^a	1.57±0.01^a	1.60±0.01^a	.678
ΣNEAA	8.28±0.29	8.57±0.01^b	8.74±0.01^c	8.35±0.01^a	.033
EAA/NEAA	0.93±0.03	1.04±0.01^b	0.86±0.01^a	1.00±0.04^b	.048
ΣBcAA	2.39±0.02	2.89±0.01^b	2.17±0.01^a	2.65±0.01^b	.048
ΣSAA	0.67±0.01	0.69±0.01^b	0.62±0.01^a	0.67±0.02^b	.043
ΣArAA	1.29±0.01	1.40±0.01^b	1.17±0.01^a	1.35±0.01^b	.040
ΣBAA	3.33±0.02	3.83±0.01^b	3.53±0.01^a	3.60±0.01^a	.048
ΣAAA	4.16±0.25	4.48±0.01^b	4.43±0.01^b	4.15±0.07^a	.047
EAAI	0.89±0.01	0.95±0.01^b	0.88±0.01^a	0.92±0.03^b	.046

The each value means mean±standard error. Values expressed with different exponential letters on the same line are statistically different from each other ($p<0.05$).
Branched-chain amino acid (BcAA)= Leucine+ Isoleucine+ Valine; Sulfur-containing amino acids (SAA)= Cystine+ Methinonine; Aromatic amino acids (ArAA)= Phenylalanine+ Tyrosine; Basic (alcaline) amino acids (BAA)= Lysine+ Arginine+ Histidine; Acidic amino acids (AAA)= Aspartic acid+ Glutamic acid

The table 7 lists the L*, a*, b*, C*, and Hue values found in the skins and fillets of large rainbow trout fed on three different feeding regimes. At the conclusion of the study, all groups' fillets' lightness (L*) values decreased, and the L* values of the R group's fillets fed consistently in accordance with the feeding table were statistically different (p= .040). The fillets' redness (a*) value was approximately twice the initial, with the highest value occurring in the E group, which was fed 1 day/fasted for 6 days (p= .035). The yellowness (b*) and C* values of group E fillets were statistically different and, higher than the b* and C* values of the other two groups (respectively, p= .017 and p= .0.41). Despite the high Hue values of the fillets in the R and D groups, there was no statistically significant difference between the groups (p= .538).

Table 6. Fatty acid compositions of large rainbow trout fillets at the initial and end of the study (% of fatty acids)
Çizelge 6. Deneme başı ve deneme sonunda büyük gökkuşağı alabalığı filetolarının yağ asitleri kompozisyonları (% yağ asitleri)

Fatty acid	*Initial*	*Final*			p value
		R	*D*	*E*	
C12:0	0.06±0.01	0.08±0.01^{a}	0.07±0.01^{a}	0.09±0.01^{a}	.636
C13:0	0.02±0.01	0.02±0.01^{a}	0.02±0.01^{a}	0.02±0.01^{a}	.405
C14:0	2.88±0.14	2.99±0.02^{a}	3.26±0.04^{b}	3.03±0.08^{a}	.019
C15:0	0.41±0.01	0.39±0.01^{a}	0.39±0.01^{a}	0.44±0.02^{b}	.035
C16:0	11.60±0.36	11.48±0.06^{b}	11.36±0.15^{b}	11.04±0.12^{a}	.046
C17:0	0.52±0.04	0.45±0.01^{b}	0.39±0.01^{a}	0.51±0.04^{b}	.019
C18:0	6.94±0.09	7.69±0.05^{b}	7.08±0.11^{a}	8.00±0.12^{c}	.006
C20:0	0.98±0.06	1.01±0.01^{b}	0.86±0.01^{a}	1.09±0.10^{b}	.038
C21:0	0.02±0.01	0.05±0.01^{a}	0.02±0.01^{a}	0.03±0.01^{a}	.486
C22:0	0.57±0.03	0.49±0.01^{a}	0.51±0.01^{a}	1.62±0.37^{b}	.010
C23:0	0.11±0.06	0.14±0.02^{b}	0.07±0.01^{a}	0.10±0.02^{ab}	.047
C24:0	0.51±0.06	0.60±0.01^{b}	0.32±0.01^{a}	0.60±0.10^{b}	.047
ΣSFA	24.61±0.46	25.27±0.10^{b}	24.49±0.25^{a}	26.56±0.57^{c}	.019
C14:1	0.17±0.02	0.19±0.01^{a}	0.17±0.01^{a}	0.22±0.01^{b}	.045
C15:1	0.06±0.01	0.06±0.01^{a}	0.06±0.01^{a}	0.07±0.01^{a}	.189
C16:1	0.43±0.06	0.41±0.01^{a}	0.40±0.01^{a}	0.55±0.04^{b}	.045
C17:1	0.47±0.06	0.45±0.01^{a}	0.45±0.01^{a}	0.63±0.04^{b}	.046
C18:1n-9c	20.83±0.72	25.88±0.09^{c}	17.33±0.35^{a}	23.45±0.38^{b}	.023
C18:1n-9t	2.59±0.28	2.69±0.02^{b}	2.88±0.19^{c}	1.41±0.28^{a}	.009
C20:1n-9c	3.74±0.80	1.18±0.01^{a}	2.29±1.71^{b}	3.44±0.70^{c}	.048
C22:1n-9	2.02±0.54	4.55±0.02^{c}	0.09±0.01^{a}	2.09±0.78^{b}	.020
C24:1	0.88±0.11	1.29±0.01^{c}	0.65±0.04^{a}	0.80±0.01^{b}	.005
ΣMUFA	31.19±0.73	36.70±0.08^{c}	24.31±1.13^{a}	32.65±0.72^{b}	.011
C18:2n-6t	0.46±0.01	0.51±0.01^{b}	0.43±0.02^{a}	0.57±0.04^{b}	.047
C18:2n-6c	15.06±0.03	13.15±0.18^{a}	13.21±0.03^{a}	13.48±0.29^{a}	.360
C18:3n-3	6.72±0.07	6.74±0.10^{a}	6.82±0.02^{a}	6.99±0.01^{a}	.871
C18:3n-6	0.63±0.01	0.62±0.10^{a}	0.69±0.01^{b}	0.73±0.04^{b}	.037
C20:2	3.54±0.03	3.42±0.05^{b}	3.31±0.02^{a}	3.39±0.03^{b}	.032
C20:3n-3	1.69±0.04	2.00±0.02^{b}	1.47±0.01^{a}	1.94±0.09^{b}	.047
C20:3n-6	1.13±0.03	1.45±0.12^{c}	0.39±0.02^{a}	1.02±0.22^{b}	.024
C20:4n-6	1.53±0.01	1.21±0.01^{a}	1.41±0.34^{ab}	1.67±0.11^{b}	.040
C20:5n-3	3.95±0.03	3.40±0.04^{a}	3.93±0.04^{c}	3.73±0.06^{b}	.010
C22:2	0.065±0.01	0.04±0.01^{a}	0.06±0.03^{b}	0.03±0.01^{a}	.048
C22:6n-3	9.27±0.08	6.86±0.09^{a}	7.06±0.02^{a}	7.40±0.22^{b}	.040
ΣPUFA	44.02±0.51	39.38±0.62^{ab}	38.79±0.30^{a}	40.93±0.21^{b}	.042
Σn-3	21.63±0.04	19.00±0.25^{a}	19.28±0.07^{ab}	20.05±0.20^{b}	.048
Σn-6	18.79±0.46	16.94±0.32^{ab}	16.13±0.30^{a}	17.47±0.13^{b}	.040
Σn-9	29.18±0.63	33.49±0.81^{b}	34.30±0.07^{b}	30.38±0.72^{a}	.036
n3/n6	1.15±0.03	1.12±0.01^{a}	1.20±0.02^{b}	1.15±0.02^{a}	.040
n6/n3	0.87±0.01	0.89±0.01^{b}	0.84±0.02^{a}	0.87±0.01^{a}	.042
EPA/DHA	0.43±0.01	0.50±0.01^{a}	0.56±0.01^{b}	0.51±0.02^{a}	.049
EPA+DHA	13.22±0.09	10.25±0.13^{a}	10.99±0.06^{b}	11.12±0.18^{b}	.035
AI	0.32±0.01	0.33±0.01^{a}	0.34±0.01^{a}	0.30±0.03^{a}	.599
TI	0.24±0.01	0.26±0.01^{a}	0.26±0.01^{a}	0.25±0.01^{a}	.801
PUFA/SFA	1.79±0.02	1.56±0.03^{a}	1.58±0.03^{a}	1.54±0.03^{a}	.763
HH	3.54±0.02	3.57±0.06^{a}	3.55±0.06^{a}	3.57±0.03^{a}	.947

Each value means mean±standard error. Values expressed with different exponential letters on the same line are statistically different from each other (p<0.05).
∑Omega-3 (n-3) = C18:3n-3+C20:3n-3+C20:5n-3+C22:5n-3+C22:6n-3; ∑Omega-6 (n-6)= C18:2n-6t + C18:2n-6c+ C18:3n-6+ C20:4n-6+ C20:3n-6; ∑Omega-9 (n-9)= C18:1n-9c+ C18:1n-9t+ C20:1n-9c+ C22:1n-9;

Table 7. The average L*, a*, b*, C*, and Hue values of large rainbow trout fillets and skins at the initial and end of the study

Çizelge 7. Deneme başı ve deneme sonunda büyük gökkuşağı alabalığı filetolarının ve derilerinin ortalama L, a*, b*, C* ve Hue değerleri*

		Initial	***Final***			***p value***
			R	*D*	*E*	
Skin	*L**	72.01±0.95	74.57±4.13[a]	93.15±0.97[b]	79.27±1.71[a]	0.040
	*a**	0.19±0.10	1.29±0.71[c]	-0.10±0.19[a]	0.76±0.22[b]	0.005
	*b**	3.66±0.25	5.07±0.56[b]	3.29±0.41[a]	3.81±0.32[a]	0.041
	*C**	7.32±1.19	5.71±0.48[b]	3.35±0.40[a]	8.97±0.32[c]	0.032
	Hue	0.03±0.09	0.87±0.27[b]	-0.44±0.44[a]	0.17±0.16[a]	0.039
Fillet	*L**	54.53±0.41	50.54±1.45[b]	48.33±1.24[a]	47.38±0.52[a]	0.040
	*a**	8.57±0.22	15.49±0.61[a]	15.16±0.68[a]	17.09±0.42[b]	0.035
	*b**	10.66±0.24	18.04±1.20[a]	17.66±0.99[a]	20.84±2.14[b]	0.017
	*C**	13.98±0.39	23.89±1.23[a]	23.36±1.11[a]	27.69±2.13[b]	0.041
	Hue	0.89±0.01	0.85±0.02[a]	0.85±0.02[a]	0.82±0.02[a]	0.538

Each value represents the mean±standard error. Values expressed with different exponential letters on the same line are statistically different from each other ($p<0.05$).

DISCUSSION

In aquaculture, feeding techniques are crucial because feeds and feeding account for approximately 60 % of production costs, and both underfeeding and overfeeding can have a negative impact on production (Ntantali et al. 2023). Thus, effective farming is heavily reliant on feed management (Chatzifotis et al. 2011). Many feeding approaches, such as ad libitum feeding, restricted feeding, and intermittent feeding, are used to find the ideal eating plan for each species and developmental stage (Da Silva et al. 2016) This study used various feeding regimens to investigate the impact of large rainbow trout (*Onchorchynus mykiss*) raised in net cages in the Black Sea on growth performance, fillet color and meat quality ratings, and economic conversion rates.

Fish nutrition is critical to the production cycle since it is the most essential growth component and the largest operating cost in aquaculture. Aquaculture has long sought to improve growth; for example, fasting and refeeding regimes, which have been used to increase growth, have been well evaluated. Compensatory growth within a certain period is thought to be much faster than the growth rate of fish that have not been subjected to feed deprivation. Although the large rainbow trout had an average weight of 1045.12±43.51 g at the beginning of the study and were of similar weight in the groups fed every day (R) and fed for 6 days (E) at the end of the study (3769.80±226.89 and 3770.60±127.51 g, respectively, p= .049), they were fed for one day. It was determined to be less in the one-day fasting (D) group (3445.03±102.12 g, p= .049). The trial end weights of all three groups are in accordance with the harvest policy of the enterprise. The majority of the overall production costs were made up of feed costs. In aquaculture, feeding expenses are crucial as they account for 40% to 50% of overall production costs (Abowei & Ekubo 2011). In this study, when calculating economic conversion rates, fixed costs (cost depreciation, labor, electricity, equipment, building, etc.), which represent a small part of total costs, were counted equally for each group. The only income for the enterprise includes the sale of fish. Intermittent fasting has been proposed to achieve compensatory growth in a variety of economically important fish species in different studies, including Atlantic salmon (*Salmo salar*) (Stefansson et al. 2009), rainbow trout (*Oncorhynchus mykiss*) (Nikki et al. 2004), Nile tilapia (*Oreochromis niloticus*) (Ali et al. 2016), European seabass (*Dicentrarchus labrax*) (Chatzifotis et al. 2011; Adaklı et al. 2015) and gilthead seabream (*Sparus aurata*) (Bavčević et al. 2010; Peres et al. 2011). The current study found that Group E, which was fed for 6 days and fasted for 1, was the best group when all costs were held constant, and the economic conversion rate (ECR) and economic profit index (EPI) were taken into consideration. The first thing that comes to mind here is the feed conversion rate (FCR), which comes into play in calculating economic transformation and is known to be directly proportional to the economic conversion rate. When the FCR was examined, it was found that the groups with the best rate were the E group (1.57±0.04), which was fed for 6 days fasting for 1 day, and the R group (1.59±0.01), which was fed every day. These rates were very close to each other in these groups, the ECR of the E group was also better at the same rate depending on the FCR value.

In the current study, the crude protein (CP) ratios of the groups fed every day (R) and every other day (D) increased compared to the beginning of the experiment, while the protein ratios of the fish fed for 6 days and fasted for one day (E) decreased (Table 3). The crude lipid (CL) ratio of fillets rose in all groups compared to the beginning of the study, however, the CL ratio of the fillets in every other day fed group (D) reduced compared to the other groups (p= .046). Most restricted feeding or starvation studies have suggested that during fasting lipids and glycogen are mobilized primarily to provide energy, while muscle protein is largely spared (Jørgensen et al. 2013, Barreto-Curiel et al. 2017; Shirvan et al. 2020; Xu et al. 2022). Bowzer et al. (2011) reported that *Morone chrysops × M. saxatilis* fillets protein was depleted faster than lipid at the end of the 14-day fasting phase. In the current study, although the decrease in the CL ratio of fish fillets belonging to group E is supported by the mentioned literature, it is thought that the reduction of the CP ratio of group D is due to the increase in the body water content of the fish.

The study determined that the total amino acid values of fish fillets applied to different feeding regimes increased compared to the total amino acid values of the initial fish fillets. The daily fed group (R) had greater total amino acid levels, essential amino acid values, and EAA/NEAA ratios than the other groups (D and E). Fillets from group D had the highest non-essential amino acid levels. According to McCarthy and Brown (2016), amino acids contribute to protein metabolism as well as tissue protein synthesis. In addition to this literature, it reported that other amino acids such as non-essential ones are also used as energy substrates to maintain metabolic activity in fish (Duan et al. 2016). As a result, animals require amino acids not only for development but also for energy supply (Kasozi et al. 2019). Different studies reported that it can use amino acids as an energy source (Moughan 2003; Cui et al. 2006), and some fish prefer to use glutamic acid and alanine instead of lysine and arginine as energy sources (Rønnestad et al. 2001; Conceiçao et al. 2002). At the end of the current study, the glutamic acid, lysine, and arginine values of groups D and E decreased compared to group R, and this result was similar to the mentioned literature, except for the alanine value. The most significant source of essential amino acids found in muscle proteins are the branched-chain amino acids (BCAAs), which include leucine, isoleucine, and valine, and these amino acids make up an average of 30–40 % of total amino acids in muscle proteins (Nie et al. 2018). The BcAA values of fish fillets in this study, except for group D (28.78 %), group R (32.58 %), and group E (31.70 %), were in line with the values reported by Nie et al. (2018).

Fillet fatty acids influence fillet quality. Previous investigations have shown that starving and re-feeding have a considerable impact on fatty acid composition (Arslan et al. 2021; Yang et al. 2021). Additionally, fatty acids in fish are known as essential energy sources, which are vital for their growth, survival, and several physiological mechanisms (Tocher et al. 2019). Although the fatty acid content of fish fillets is often reflected in the profile of fatty acids found in diets (Matani Bour et al. 2018; Roohani et al. 2019), in our study, feed restriction had an impact on the fatty acid composition of large rainbow trout fillets. This research found a total of 32 fatty acids, with C18:1n9c having the greatest value across all groups. Additionally, there were statistically significant variations between the groups in terms of saturated (SFA), monounsaturated (MUFA), and polyunsaturated fatty acids (PUFA). Although there was a statistical difference, the numerical values of total fatty acids were close to each other. Different feeding regimes effectively increased the fillet n-3 and n-6 polyunsaturated (PUFA) levels (ARA, EPA, and DHA), and Σ n-3/Σ n-6 ratio of large rainbow trout. There have also been reports of other teleosts' fish preservation of PUFAs during periods of dietary restriction (Luo et al. 2009; Ölmez et al. 2015; Barreto-Curiel et al. 2017; Ding et al. 2017). Asadi et al. (2021) reported that different protein restrictions in the diet had no negative effects on fatty acid profiles in fish fillets. Considering the literature and at the end of the analyses of fatty acids, it was shown that large rainbow trout fed a restricted diet were able to maintain a balanced metabolism of fatty acids. Indicators of the relationship between saturated and unsaturated fatty acids that are employed in the evaluation of cardiovascular disorders include atherogenicity (AI) and thrombogenicity index (TI) (Ghaeni et al. 2013). According to Łuczynska et al. (2017), AI and TI values for human health shouldn't be higher than 1.00. The hypocholesterolemic/hypercholesterolemic index indicated the fatty acid ratio based on cholesterol metabolism and foods with high H/H ratios (>3) have been reported as more beneficial to human health. (Fernandes et al. 2014). The AI, TI, and H/H values of large rainbow trout fed with varying feeding strategies were within the appropriate range for human health and comparable to those found by Devadawsaon et al. (2016) and particularly to those found in studies on large rainbow trout in the Black Sea (Kaya Öztürk et al. 2019; Kaya Öztürk 2024).

According to Ocaño-Higuera et al. (2009), color is one of the most crucial factors taken into account when assessing the caliber of fishing goods. The distinct coloration of large rainbow trout, characterized by red, orange, yellow, green, and blue hues, is highly beneficial in characterizing their skin tone. Customers love the worldwide look of red-pink fillet of rainbow trout. Color values (L*, a*, b*, C*, and Hue) of skin and fillets of large rainbow trout applied to different feeding regimes are shown in Table 7. Throughout the study, fish were fed the same amount of feed containing astaxanthin (50 mg/kg) (Table 1) however, at the end of the trial, there were differences, in the color parameters of the fillets. Regarding sensory analysis of fillet colors, Einen and Thomassen (1998a; 1998b) found no definite advantages or disadvantages in their starvation study with Atlantic salmon. According to research by Montero et al. (2005), Rørå et al. (2005) and Rincon et al. (2016), lipid concentrations in feed and fillet have an impact on L*, a*, and b* values. After the study, diet and fillet lipid rates had an indirect effect on color parameters, whereas other feeding tactics had a direct impact. When evaluated in terms of consumer satisfaction, it was concluded that the E group—which was fed for six days and fasted for one day—had higher redness and yellowness ratings

CONCLUSION

The study assessed the growth performance, meat quality, and economic conversion rates of various feeding regimens administered to large rainbow trout cultivated in the Black Sea under identical conditions (same environmental parameters, diets, and ages). When the enterprise's harvest policy was considered, the study found that the feeding limitation had no detrimental effects on fish weight (<3kg) and growth performance. The study's most important emphasis is on the FCR and ECR rates of the E group, which was fed for 6 days after fasting for 1 day. By using this feeding regimen, businesses that produce huge rainbow trout might lower their feed expenditures. Furthermore, this article has demonstrated that large rainbow trout raised commercially in the Black Sea and fed on a variety of diets are healthy, nutrient-dense, and of high quality for human consumption. It has also demonstrated the existence of a "Turkish salmon" that is competitive with Atlantic salmon on the domestic or international market

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Authors’ Contributions

DKO: Supervisor, Writing – review and editing; RD: data collection, methodology, sampling, and writing. All authors read and approved the final manuscript.

Competing Interests

The authors have no competing interests to declare that are relevant to the content of this article.

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