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ARAŞTIRMA MAKALESİ **RESEARCH PAPER**

The Effect of Different Proportions of Rosehip (*Rosa canina*, L.) Oil Added to Rainbow Trout (*Oncorhynchus mykiss*, L.) Feed on Growth Growth Performance [*]

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Abstract: In this study, the effects of rosehip (*Rosa canina* L.) oil added to the diets of juvenile rainbow trout (*Oncorhynchus mykiss* W.) at different rates on the growth performance, feed efficiency and survival rate of fish were investigated. For this purpose, rosehip oil in 4 different concentrations (0, 2, 4 and 6 ml / kg) was added to the feed of juvenile trout with an initial average weight of 1.7 ± 2.8 g, for 90 days (pH 7.15-8.33, temperature 12.3-15.9 °C and dissolved oxygen in the range 6.85-10.8 mg / l). The experimental groups were planned with 2 replications and 200 juvenile fish were placed in each tank and a total of 1600 fish were studied. At the end of the experiment, the highest increase in live weight was obtained in the IV. group in which 53.71 ± 1.12 g and 0.71 ± 0.02 feed conversion rate and 6 ml / kg rosehip oil was added and the difference was statistically significant compared to the other groups (P <0.05). As a result; in this study, it was determined that the addition of Rosehip oil to juvenile trout feeds increased the rate of feed efficiency to fish and had a positive effect on the development of fish.

Keywords: Rainbow trout, *Oncorhynchus mykiss*, rosehip oil, *Rosa canina*, growth performance.

Gökkuşağı Alabalığı (*Oncorhynchus mykiss*, L.) Yemlerine Eklenen Farklı Oranlardaki Kuşburnu (*Rosa canina*, L.) Yağının Büyüme Performansına Etkisi

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Öz: Bu çalışmada yavru gökkuşağı alabalığı (*Oncorhynchus mykiss* W.) yemlerine farklı oranlarda ilave edilen Kuşburnu (*Rosa canina* L.) yağının, balıkların büyüme performansı, yemden yararlanma ve yaşama oranı üzerine etkileri araştırılmıştır. Bu amaçla, başlangıç ortalama ağırlıkları 1,7±0,11 g olan yavru alabalıkların yemlerine 4 farklı konsantrasyonda 0 ml/kg, 2 ml/kg, 4 ml/kg ve 6 ml/kg olacak şekilde Kuşburnu yağı ilave edilerek 90 gün boyunca (pH 7,15-8,33, sıcaklık 12,3-15,9 °C ve çözünmüş oksijen 6,85-10,8 mg/l aralığında) beslenmiştir. Deneme grupları 2 tekerrürlü olarak planlanmış ve her bir tanka 200 adet yavru balık konularak toplamda 1600 adet balıkla çalışma yürütülmüştür. Deneme sonunda en yüksek canlı ağırlık artışı (53,71±1,12 g) ve (0,7±0,02) yem dönüşüm oranı ile 6 ml/kg Kuşburnu yağı ilave edilen IV. grupta elde edilmiş ve diğer gruplara göre istatistiksel olarak fark önemli çıkmıştır (P<0,05). Sonuç olarak; bu çalışmada, kuşburnu yağının yavru alabalık yemlerine ilave edilmesi ile balıkların yemden yaralanma oranının arttığı ve balıkların gelişmelerinde de olumlu etkiye sahip olduğu tespit edilmiştir.

Anahtar kelimeler: Gökkuşağı alabalığı, *Oncorhynchus mykiss*, kuşburnu yağı, *Rosa canina*, büyüme performansı.

[*] *This study was produced from the master thesis.*

INTRODUCTION

Aquaculture is the fastest growing food producing sector in the world and especially it has made very rapid progress in the last 30 years. The global population is increasing, thus, the demand for aquatic food products is also increasing. With capture fisheries becoming increasingly unsustainable due to excessive and unconscious fishing, aquaculture is expected to overtake capture fisheries in supplying the world's protein requirements in the future. Fish and other aquaculture supply at least 20% of the animal protein source of people in developing countries and more than 50% of people in poor countries of Africa and South Asia (Awad & Awaad, 2017). The intensification of rearing methods and systems has created a stressful environment in the fish that can cause suppression of the immune system and increase the susceptibility of the fish to infectious diseases. In addition, many negative factors such as high stocking density, aquaculture practices, temperature, poor water quality and insufficient feeding, cause stress in the fish and increase the risk of catching a disease (Elumalai et al., 2020, Hoseinifar et al., 2020).

A wide variety of antibiotics and chemicals are used to control infectious diseases in fish farms. Although antibiotics are generally successful in treating diseases, they cause the accumulation of antibiotic residues in either the environment or fish tissues and the emergence of antimicrobial resistant species (Rossolini et al,, 2014; Santos & Ramos, 2016). Vaccines used in fish farms are expensive and have a specific action against only one pathogen (Harikrishnan et al., 2011; Sakai, 1999). Therefore, there is a global trend towards the use of medicinal plants and their derivatives in aquaculture as an alternative method to prevent or control fish diseases (Harikrishnan et al., 2011; Reverter et al., 2014; Van Hai., 2015, Elumalai et al., 2020; Hoseinifar et al., 2020).

In aquaculture, some feed additives are often added to feeds to increase feed efficiency, growth performance and survival rates. As feed additives, yeasts, colorants, amino acids, antioxidants, enzymes, probiotics, prebiotics, algae, lipid derivatives, nutraceuticals, vitamins, plant extracts and certain organic acids / salts, carnitine, hormones and aromatic compounds can be listed (Kıvrak, 2017; Yazıcı & Mazlum, 2019; Mazlum et al., 2021). However, intensive and semi-intensive practices of aquaculture cause an increase in disease outbreaks and cause partial or total losses in fish production (Awad & Awaad, 2017). That is why in recent years, researchers and fish farmers have started to use in fish feed some plants and oils obtained in fish feed some plants and oils obtained from plants. It has been understood that these herbal products are beneficial for humans and fish as well as for the environment. Some plants have been used as an inexpensive protein source instead of the protein in fish meal and it has been found that they are effective in this regard and positively affect the growth and immune system (Ngo, 2015; Ramasamy et al., 2011; Reverter et al., 2014; Hoseinifar et al., 2020).

Studies have proven that medicinal and aromatic plants have growth-promoting and stress-reducing properties in fish. First of all, medicinal and aromatic plants have started to be used because they are natural and cheap, as well as increasing the survival rate and development of aquatic animals by purifying digestive enzymes (Ngo, 2015).

Turkey in medicinal and aromatic plants has an extremely rich flora (Akalın, 2020). Rosehip (*Rosa canina* L.) plants and is one of the most important of these plants are abundant on each side of Turkey. While it has been widely used for fruit juice, jam, marmalade and tea for many years (Ercişli, 1996; Ercişli & Güleryüz, 2005), it is a plant that has been processed for its oil in recent years (Valeron et al., 2015; Kıralan & Yıldırım, 2019). Rosehip plant is a rich source of vitamin C and is also rich in anthocyanins, phenolic ingredients and carotenoids. Used in a variety of food products as well as in the perfume and cosmetic industries. It is traditionally used to treat influenza, inflammation, and chronic pain (Guimaraes et al., 2010). In addition, phenolics are considered as phytochemicals responsible for the antioxidant activity of plant materials, so they are known as the most effective remedy against hemorrhoids and diabetes in Turkish folk medicine (Jamaa et al., 2017; Deliorman et al., 2007). Rosehip is also rich in polyunsaturated fatty acids (Szentmihalyi et al., 2002). The lipid fraction of rosehip seed contains more than 50% of polyunsaturated fatty acids, and Rosehip seed oil is used in cosmetics due to its therapeutic effect on skin ailments (İlyasoğlu, 2014). It has a rich mineral source (potassium, phosphorus), vitamins (vitamin C), carotenoids and aroma components (Shnyakina & Malygina, 1975; Oszmianski & Chomin, 1993).

Although the rosehip plant well-documented the positive effects on the nutrition and immune systems of humans and animals. There is very limited information about its used as a feed supplement in aquaculture. It was studied in sturgeon "*Huso huso*" (Dadras et al., 2016), rainbow trout "*Oncorhynchus mykiss*" (Sahan et al., 2017), Russian Sturgeon "*Acipenser gueldenstaedti*" (Duman and Sahan, 2018), common carp "*Cyprinus carpio"* (Dogru et al., 2018). This is the first research to use rosehip oil in fish as feed additive. The present study, therefore aims to investigate the growth, survival rate and feed conversion

rates of fish by adding oil obtained from Rosehip plant to juvenile trout feeds.

MATERIAL AND METHOD

This research was carried out in Sapanca Inland Fisheries Production Research and Application Unit affiliated to Istanbul University Faculty of Aquatic Sciences. The trial period was planned as 90 days and was conducted between 18 February and 18 May 2020. In the research, 1,600 rainbow trout (*Oncorhynchus mykiss*, W.) with an average weight of 1.7 ± 0.11g were used. 200 fish were stocked in 8 cylindrical tanks with a capacity of 350 liters with 2 replicates. Attention was paid to ensure that the selected fish for the experiment were unvaccinated before and apparently healthy fish with no prior history of any diseases. Fish health conditions were checked visually by observing the body and fins of the fish, the absence of disease symptoms, as well as regular movements.

Before the experiment, the fish were hand-fed daily for 2 weeks with commercial trout feed until they were apparent satiation for adaptation to the experimental environment. The proximate analysis of the control feed used in the trial was done according to AOAC, 1998 (Table 1). Uneaten food and fish wastes were regularly cleaned daily. During the research, the stream water used in the unit was supplied to the tanks. Water temperature, pH and dissolved oxygen values were measured weekly and It was recorded that the pH was between 7.15-8.33, temperature 12.3-15.9 ºC and dissolved oxygen 6.85-10.8 mg / l.

Table 1.Analysis of trout feed used in research*
Tablo 1. Araştırmada kullanılan alabalık yeminin analizi*

Feed Analysis	%
Ash	14.65
Crude protein	54.58
Crude fiber	0.63
Raw oil	12.05

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The rosehip oil used in the experiment was previously market researched and the oils purchased from different brands were analyzed, and as a result of this analysis, it was decided to use the best oil in the trial. Analysis of rosehip oil was made according to TS EN ISO 12966-2 standard (TS EN ISO 12966-2, 2017). Analysis results of rosehip oil used in the experiment are given in Table 2.

4 different treatments groups were prepared. Rosehip oil was first diluted in alcohol and sprayed on the feed so that it was mixed thoroughly to assure homogeneity. Rosehip oil was supplemented to basal diet as 0 mg / kg (I. Group), 2 ml / kg (II. Group), 4 ml / kg (III. Group) and 6 ml / kg (IV. Group). In the first month of the experiment, the fish were hand-fed 7-8 times a day, 5-6 times a day in the second month and 4-5 times a day in the last month until they were apparent satiation.

Table 2. Analysis results of Rosehip oil used in the trial*
Tablo 2. Araştırmada kullanılan kuşburnu yağının analiz sonuçları*

Fatty acids	(%)
Lauric acid/Dodecanoic acid C12:0	0.10
Myristic/Tetradecanoic acid C14:0	0.05
Palmitic/Hexadecaoic acid C16:0	3.78
Palmitoleic acid C16:1	0.08
Stearic/Octadecanoic acid C18:0	2.05
Oleic acid C18:1	24.43
Linoleic acid C18:2	49.02
Linolenic acid C18:3	18.74
Arachidic acid C20:0	0.89
Elcosanoic (Gadoleic) acid C20:1	0.40
Docosenoic/Eucic acid C22:1	0.16
Behenic acid C22:0	0.21

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Growth Performance Calculations

Live weight (g) measurements of the fish were made every end of month during the experiment. Fish weights were made with a scale with 0.01 g precision.

The parameters were measured according to the following formulas (Çilingir, 2017).

Average live weight (ALW)= W/N
Live weight gain (LWG) = W_1 - W_0
Specific growth rate (SGR)=(ln W_t −lnW_0)/t×100
Relative growth rate (RGR)=(W_t −W_0)/W_0 /t×100
Survival rate (SR) (%) =N_t/N_0×100
Feed conversion rate (FCR)=IT/(W_t −W_0)

Where W is the total weight of fish, N is the number of fish, W_t is the body weight (g) on the specific sampling day, W_0 is the initial body weight (g) at the beginning of the trial, t is feeding duration in days from the beginning of the trial until the specific sampling day, IT is the total dry diet intake (g) from the beginning of the trial to the specific sampling day, Lt is fish length (cm) on the specific sampling day.

Statistical Analysis

The data obtained in the experiment were evaluated with the one-way Anova test. While comparing the importance of various parameters examined in the experiment, the results are given as mean value and standard deviation. The distinction between groups was determined by analysis of variance and comparison of groups by Duncan multiple comparison test, and the significance level was chosen as P = 0.05 (Özdamar, 2001).

RESULTS

Growth performance parameters are listed in Table 3. In the I. Group where Rosehip oil was not added, the average live weight of the fish was 1.67 ± 0.02 g at the beginning of the experiment were increased to 52.03 ± 2.38 g after 90 days, fish in the II. Group (2 ml / kg) from 1.93 ± 0.01 g to 52.44 ± 1.44 g, the fish in the III. Group (4 ml / kg) from 1.88 ± 0.04 g to 52.25 ± 0.04 g and It was

determined that the fish in the IV. Group (6 ml / kg) reached from 1.84 ± 0.09 g to 55.55 ± 1.02 g. The average weight gains were also found to be 50.36 ± 2.36 g, 50.51 ± 1.44 g, 50.37 ± 0.07 g and 53.71 ± 1.12 g in the groups, respectively. Relative growth rates in the groups were determined as 3015 ± 103%, 2617 ± 85%, 2679 ± 64% and 2919 ± 63%, respectively (Table 3).

When looking at the specific growth rate values in groups I. Group, II. Group and III. While the values obtained in the group were the same (0.56 ± 0.02), the highest value (0.60 ± 0.01) was IV. Group (6 mg / kg) (Table 3). Considering the feed conversion ratio values, I. Group, II. Group and III. Group while 0.8 ± 0.01 in the group, ıt was found to be 0.7 ± 0.02 in the IV. Group. Feed consumption and total live weight gain are given in Table 3. The survival rate (SR) value in the groups was determined 98.5 ± 1.41%, 97% ± 1.41, 98.5 ± 0.35% and 98.5 ± 0.07% respectively (Table 3).

Table 3. Different growth parameters of trial groups.
Tablo 3. Deneme gruplarına ait farklı büyüme parametreleri.

	I.Group	II.Group	III.Group	IV.Group
İnitial average live weight (g)	1.67±0.02	1.93±0.01	1.88±0.04	1.84± 0.09
Final average live weight (g)	52.03±2.38	52.44±1.44	52.25±0.04	55.55±1.02*
Average weight gain (g)	50.36±2.36	50.51±1.44	50.37±0.07	53.71±1.12*
Relative growth rate (%)	3.015±103	2.617±85	2.679±64	2.919±63
Specific growth rates (%)	0.56±0.02	0.56±0.02	0.56±0.02	0.60±0.01*
Survival rate (%)	98.5±1.41	97.0±1.41	98.5±0.35	98.5±0.07
Total feed consumption (g)	7.875	7.725	7.815	7.475
Total live weight gain (g)	9.915±0.32	9.787±0.13	9.892±0.02	10.732±0.23*
Feed conversion rate	0.8±0.01	0.8±0.01	0.8±0.00	0.7±0.02*

(*)Values marked with * are statistically significant from other groups (p <0.05)

DISCUSSION AND CONCLUSION

In this study, the effect on growth and feed utilization of rainbow trout (*Oncorhynchus mykiss*) juveniles fed with feeds containing different ratios of rosehip oil (*R. canina*) survival rate was firstly examined and discussed in comparison with previous studies.

Ahmad et al., (2016) reported that rosehip plant contains 3.78% palmitic acid, 0.08% palmitoleic acid, 24.43%, oleic acid, 49.02% linoleic acid, 18.74% and 18.74% linolenic acid in the chemical composition. Analysis results of Rosehip oil that we used in our study were found to be 3.54%, 0.06%, 20.30%, 51.67% and 19.08%, respectively, according to the above values, and these results are close to the results found by Ahmad et al., (2016).

Studies on adding medicinal and aromatic plants to fish feed have been gained importance in recent years. When some medicinal and aromatic plants and extracts obtained from them are added to fish feeds, positive effects such as weight gain, specific growth rate and increase in feed efficiency ratio and reduction in feed conversion ratio have been determined (Aly, et al., 2008; Aly & Mohamed, 2010; Immanuel et al., 2009; Ji et al., 2007; Nya & Austin, 2009a, 2009b; Punitha et al., 2008; Shalaby et al., 2006). It has been reported that garlic, onion, marjoram, cumin, basil, anise, fennel, icoria, black cumin and fenugreek stimulate the growth of fish (Sivaram et al., 2004). Mahdavi et al., (2013) reported that the addition of aloe vera extract in different ratios (0.1, 0.5 and 2.5%) to carp (*Cyprinus carpio*) fish feeds had a positive effect on the development of the fish as a result of feeding for 8 weeks and had an appetite-enhancing feature. Zheng, (2009) reported that feed conversion ratio decreased, weight gain, specific growth rate and survival rates increased in catfish fed with feeds with added marjoram (*O. vulgare*) essential oil. Gabor et al., (2011) reported that they added 1% ginger, 2% garlic, 1% thyme and 2% echinacea to rainbow trout feed, and a significant increase was observed in the final weight value, bodyweight, specific growth rate and proportional growth rates of fish. Acar, (2018) also suggested that St. John's Worth Oil (*Hypericum perforatum*) supplemented to the carp diet at the rate of 5 g / kg in the ration can be used without any negative effects on growth performance and blood parameters.

In our study, it was observed that the addition of rosehip oil to rainbow trout diets positively affected their development. The best growth rate was obtained in the group to which 6 mg / kg (IV. Group) rosehip oil was added and this value was found to be statistically significant compared to the control group (P <0.05). Whereas, Dadras et al., (2016) found that rosehip (*Rosa canina*) and safflower (*Carthamus tinctorium*) was added to juvenile Huso huso feeds in different proportions and there were no significant differences in feed conversion ratio (FCR), specific growth rate (SGR) and condition factor (K) but they found that there are significant differences in white blood cell (WBC) and hemoglobin (Hb) values. The best results were obtained in the group with 2% rosehip and safflower added and these results were observed to be significant compared to the control groups. In our study, it was determined that the rosehip oil plays an important role in the development of fish due to the use of oil instead of the plant.

Çilingir, (2017) reported that amber (*Hypericum perforatum*) oil added to rainbow trout (*Oncorhynchus mykiss*) diets had an effect on growth performance, some environmental stress parameters and antioxidant activity. Kıvrak, (2017) observed that rosemary (*Rosmarinus officinalis*) oil has effects on the growth performance, hematological and biochemical parameters in rainbow trout, and that the addition of rosemary oil is not effective in fish feed intake. In our study, it was determined that the addition of rosehip oil plant to trout feed, it was effective in the increase in live weight and specific growth rates in fish, but not in the survival rate.

In conclusion, it is well-known that the use of suitable feed for feeding during the juvenile period of rainbow trout has a positive contribution to the development and survival rates of fish. In recent years, with the addition of natural additives to fish feed, there has been an increase in fish development, survival rate, feed evaluation and increasing the immune system. This research has been a preliminary study on the use of rosehip oil in fish feed. It has been determined that the oil obtained from the rosehip plant has a positive effect on the growth and feed utilization rate of fish with the addition of the feeds of rainbow trout. Additionally, studies need to be carried out on the use of rosehip oil in different ratios to different fish species feed. Further studies can also be carried out to determine the hematological parameters, immune parameters, and resistance of diseases of fish fed with rosehip oil or rosehip.

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