http://www.egejfas.org
Ege Journal of Fisheries and Aquatic Sciences, 34(3): 321-326 (2017)

Su Ürünleri Dergisi (2017)
DOI: 10.12714/egejfas.2017.34.3.11

RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

The effects of the fig *(Ficus carica)* extract and onion (*Allium capa*) extract addition to *Cyprinus carpio* feeds in different amount on the growth performance

İncir (*Ficus carica*) ekstraktı ve soğan (*Allium capa*) ekstraktının *Cyprinus carpio* balıklarının büyüme performansı ve yem dönüşüm oranı üzerine etkisi

Ebru Yılmaz* ● **Deniz Çoban** ● **Fatih Bayar**

Adnan Menderes University, Faculty of Agriculture, Department of Aquaculture Engineering, Aydın, Turkey
* *Corresponding author: ebruyilmaz@adu.edu.tr*

Received date: 03.04.2017 *Accepted date: 22.06.2017*

How to cite this paper:
Yılmaz, E., Çoban, D. & Bayar, F. (2017). The effects of the fig *(Ficus carica)* extract and onion (*Allium capa*) extract addition to *Cyprinus carpio* feeds in different amount on the growth performance. *Ege Journal of Fisheries and Aquatic Sciences,* 34(3): 321-326. doi:10.12714/egejfas.2017.34.3.11

Abstract: The study was conducted to investigate the effects of dietary fig extract and onion extract supplementation in diet on growth performance, feed utilization, biometric indexes in common carp (*Cyprinus carpio*). For this purpose, fig and onion extract were added to experimental diets at the rate of 1,3,5 g / kg respectively. Fishes were fed with trial feed for 90 days. At the end of the trial period, weight increase and specific growth rate of the fishes fed with the feed containing 1.3 g/kg fig extract and 1.3 g/kg onion extract were found to be higher than the control group; food conversion ratio was found to be lower than the control group ($p<0.05$). Hepatosomatic index and viscerosomatic index amounts of the fishes fed with fig extract and onion extract feeds were found to be lower than the control group; and spleen somatic index was found to be higher than the control group ($p<0.05$). The amount of visceral organ fat index was found to be lower among the fishes fed with the feed containing fig and onion extracts compared to the control group ($p>0.05$). These results indicate that dietary supplementation of 1.3 g/kg fig extract in the commercial diets could improve some biometric indexes.

Keywords: *Cyprinus carpio, fig extract, onion extract, growth performance, feed utilization*

Öz: Bu çalışmada incir ekstraktı ve soğan ekstraktının sazan balığı (*Cyprinus carpio*) yemlerine eklenmesinin büyüme performansı, yem değerlendirme ve biyometrik ölçümlere etkisi araştırılmıştır. Bu amaçla iki tıbbi bitki ekstraktı deneme yemlerine sırasıyla 1,3,5g/kg oranlarında ilave edilmiştir. Balıklar 90 gün boyunca deneme yemleriyle beslenmiştir. Deneme sonunda 1,3 g/kg incir ve 1,3 g/kg soğan ekstraktı içerikli yemlerle beslenen balıkların ağırlık artışı ve spesifik büyüme oranı kontrol grubundan daha fazla, yem dönüşüm oranı ise kontrol grubundan daha düşük bulunmuş ve istatistiksel olarak önemli bir fark çıkmıştır ($p<0,05$). İncir ekstraktı ve soğan ekstraktı yemiyle beslenen balıkların hepatosomatik indeks ve visserosomatik indeks miktarı kontrol grubundan düşük, spleensomatik indeks miktarı kontrol grubundan yüksek bulunmuştur. Gruplar arasında istatistik fark vardır ($p<0,05$). İç organ yağ indeksi miktarıda incir ve soğan ekstraktı yemiyle beslenen balıklarda kontrole göre düşük bulunmuş fakat gruplar arasında istatistik fark gözlenmemiştir ($p>0,05$). Sonuç olarak yemlere 1,3,5 g/kg oranında incir meyvesi ve soğan ekstraktları ilavesi bazı biyometrik ölçümleri geliştirmiştir.

Anahtar kelimeler: *Cyprinus carpio, incir ekstraktı, soğan ekstraktı, büyüme performansı, yem dönüşümü*

INTRODUCTION

By means of the conducted studies all over the world, it has been known for ages that medical plant extracts and volatile oils have antimicrobial effects on some bacteria and fungi (Kivanc and Akgul, 1986; Digrak et al., 2002). Onion, *Allium cepa* L., is known to have antibacterial and antioxidant effects (Ramos et al., 2006; Jeong et al., 2009). *Ficus carica*, is known to have antimicrobial (Ryu and Jung, 1999) and antioxidant effects (Yang et al., 2009). Recently, several studies have been conducted about the usage of medical plant extracts as prophylactic products as a result of their usage as feed additive in the general animal products and aquaculture, of increase in the growth, and of achievement of positive results (Goda, 2008; Zheng et al., 2009; Yilmaz et al., 2015). Nowadays in aquaculture, there is a need for specifying the *in vivo* effective doses of alternative agents, which are natural, reliable, antimicrobial, and not giving any harm to the ecosytem, and adding them to the sector. Feed additives are supplements that are used to increase the utilization of the feed, increase the quality and quantity of the animal products, protect the health of animals and to cut down on the costs of the product the

animal provides. In addition, new approaches which bring the use of alternative feed additives into the forefront began to be adopted because of the problems arising from the extensive use of antibiotics in recent years. New alternative additives that are used in practice are: enzymes, organic acids, probiotics, oligosaccharides (prebiotics) and plant extracts (Kahraman, 2009). It is a worldwide topic that alkaloid, flavonoid, pigments, phenolic contents, terpenoids, steroids, and volatile oils are used by being added to feed. These products are seen as alternative to synthetic chemicals (Yigitarslan et al., 2011).

In the limited number of researches carried out with the aim of determining the opportunity of using plants and the active agents they contain in the cultivation, it has been reported that plant extracts added to the feed and water enhance the feed consumption, feed conversion, and growth and carcass quality (Simsek et al., 2005; Immanuel et al., 2009; Oskoii et al., 2012). Several studies have reported that oral administration of fig and onion extract in *Paralichthys olivaceus* (Cho, 2011), fig in *Paralichthys olivaceus* (Lee et al., 2015) improved growth performance.

The aim of this study is to make fig extract and onion extract utilisable in practice for the aquaculture sector. An increase in our country's medical plants' added value is aimed through a better growth performance and feed efficiency. It is aimed for the aquaculture sector that data to be acqured from feed efficiency and growth performance will be transferred to the sector.

MATERIALS AND METHODS

Fish and Experimental Protocol

Cyprinus carpio were obtained from a local private fish farm in İzmir, Turkey. Fish were divided into 200 L aquariums. In the trial, 840 *Cyprinus carpio* which has average weight of ±SD = 2.48±0.20 g was used. Fish were fed with an experimental diet two times a day at 08:00 a.m. and 16:00 p.m. at a rate of 2% of their body weight. During the experimental period water quality remained as follows: temperature 20.10±0.23°C, pH 7.47±0.01 and dissolved oxygen 7.37±0.01 mg/L. During the trial, water quality parameters were measured daily. Fish experiments were performed in accordance to the guidelines for fish research from the animal ethic committees at Adnan Menderes University.

Fig extract (Talya herbal product) and Onion extract (Talya herbal product) were added to a commercial trout feed (Kılıc Feed Company, Turkey, pellet size:2 mm, Table 1) at a dose of 0 (Control), 1 (F1), 3 (F3), 5 (F5), 1 (O), 3 (O), 5 (O) g/kg by mixer. The addition of extracts to the feed was carried out with alcohol via spraying method. With the aim of protecting the activities of the components in plant extracts, feeds were prepared on a weekly basis and stored in glass flacons at +4ºC. Fish were divided into seven groups before being fed for 90 days with 0 (control), 1 (F1), 3 (F3), 5 (F5), 1 (O), 3 (O), 5 (O) g/kg of fig extract and onion extract. Additionally, a control group was fed a diet without herbal extract supplementation (Sonmez et al., 2015). With the aim of adapting the fishes used in this study to the trial environment, they were fed with commercial trout feed for 15 days. Each trial group was carried out with 3 repetitions. Trial lasted for 90 days. Relevant analyzes were carried out at the Tarbiyomer Laboratories of the Adnan Menderes University Faculty of Agriculture by me.

Table 1. Commercial trout extruder feed (pellet size:2 mm) ingredients

Parameters	Values
Proximate analyses	
Crude Protein (%)	50
Crude Lipid (%)	16
Crude Cellulose (%)	1,2
Crude Ash (%)	9,7
Moisture (%)	10
Macro elements (%)	
Calcium %	1,9
Total Phosphore %	1,3
Sodium	0,5

Ingredients: Fish meal, fish oil, soybean and by products, wheat and by products, yeast and by products, amino acids, vitamins and minerals.

Growth Performance and Proximate Analyses

Growth performance and feed utilization were calculated according to the formulae given below. Proximate analyses of the diets were performed using standard methods (AOAC, 1998). Moisture was detected after drying at 105˚C until a constant weight was achieved. Crude protein was analyzed by the Kjeldahl method, and crude ash by incineration at 525˚C in a muffle furnace for 12 h. Crude fat was analyzed by methanol/chloroform extraction (Folch et al., 1957).

WG (g)= final weight (FW) (g) – initial weight (IW) (g)

SGR = (%/d) [(ln final weight (g) -ln initial weight (g)) / days]x100

FCR = feed intake (g) / weight gain (g)

CF=body weight(g)/total lenght ^{3} x 100

Visceral fat index (VFI) = {wet weight of visceral fat (g)/[wet body weight (g) − wet weight of visceral fat (g)]} × 100

Hepatosomatic index (HSI) = {wet weight of liver (g)/[wet body weight (g) − wet weight of liver (g)]} × 100

Viscerosomatic index (VSI) = {wet weight of viscera and associated fat (g)/ [wet body weight (g) − wet weight of viscera andassociated fat (g)]} × 100

Spleen–somatic index (SSI) = {wet weight of spleen (g)/[wet body weight (g) − wet weight of spleen (g)]} × 100.

Statistical Analysis

Each value was expressed as mean ± standard error of mean (SEMs) for each parameter measured. Statistical significance was determined by one-way analysis of variance (ANOVA) followed by a DUNCAN multi comparison test with SPSS 21.0 package software. Statistical significance was established at P<0.05.

RESULTS

The two diets were equally accepted by the fish and there was no disease in any treatment. In the trial, while the best live weight increase was obtained in F3 and O5 groups, the lowest was obtained in the control group. With respect to the food conversion ratio, the highest was F5 and the lowest was F3 (p<0.05) (Table 2.3).

With respect to the specific growth rate, the highest was F5 and the lowest was F3 (p<0.05) (Table 2.3).

At the end of the trial, with respect to the condition factor, the highest was O5 group and the lowest was O1 group (p>0.05) (Table 2.3). Growth data are presented in Table 2 and 3.

Table 2. Growth performance and feed utilization in *Cyprinus carpio* that were fed diets containing different levels of fig extract (0 (Control), 1, 3, or 5 g/kg of feed; for 90 days)

	Control	F1	F3	F5
Initial fish weight (g)	2.54±0.060^{a}	2.42±0.081^{a}	2.42±0.02^{a}	2.42±0.10^{a}
Final fish weight (g)	6.73±0.07^{a}	6.75±0.30^{a}	7.09±0.07^{a}	6.67±0.39^{a}
Weight gain (%)	166.40±6.43^{b}	173.33±10.60^{ab}	186.80±3.55^{a}	170.00±18.81^{ab}
FCR	1.32±0.01^{ab}	1.31±0.05^{ab}	1.24±0.01^{b}	1.33±0.07^{a}
SGR (%/d)	0.87±0.03^{b}	0.92±0.03^{ab}	0.96±0.01^{a}	0.91±0.08^{ab}
Initial CF	1.81±0.10^{a}	1.75±0.27^{a}	1.74±0.07^{a}	1.68±0.03^{a}
Final CF	3.78±0.51^{a}	3.73±0.24^{a}	3.72±0.30^{a}	3.60±0.10^{a}

Values are mean ±SE (n=6). Within a row, means with different letters are significantly different (P< 0.05).

Table 3. Growth performance and feed utilization in *Cyprinus carpio* that were fed diets containing different levels of onion extract (0 (Control), 1, 3, or 5 g/kg of feed; for 90 days)

	Control	O1	O3	O5
Initial fish weight (g)	2.54±0.06^{a}	2.49±0.05^{a}	2.52±0.06^{a}	2.56±0.13^{a}
Final fish weight (g)	6.73±0.07^{a}	6.99±0.10^{a}	6.89±0.15^{a}	6.66±0.21^{a}
Weight gain (%)	166.40±6.43^{b}	180.26±2.66^{ab}	174.66±3.40^{ab}	186.80±3.55^{a}
FCR	1.32±0.01^{ab}	1.26±0.02^{ab}	1.28±0.02^{ab}	1.32±0.04^{ab}
SGR (%/d)	0.87±0.03^{b}	0.92±0.02^{ab}	0.90±0.00^{ab}	0.85±0.02^{b}
Initial CF	1.81±0.10^{a}	1.69±0.14^{a}	1.84±0.07^{a}	1.74±0.10^{a}
Final CF	3.78±0.51^{a}	3.26±0.27^{a}	3.75±0.37^{a}	3.82±0.23^{a}

Values are mean ±SE (n=6). Within a row, means with different letters are significantly different (P< 0.05).

There was not any significant differences were detected related to crude protein, crude lipid, crude ash and crude moisture between the experimental group and the control group. (Table 4, Table 5; P>0.05).

The whole-body proximate compositions of fish presented in Table 4 and Table 5.

Table 4. Whole-body proximate composition (%) of *Cyprinus carpio* fed diets with different levels of fig extract for 90 days

Composition (%)	Control	F1	F3	F5
Crude Protein	14.76±0.91^{a}	13.74±0.16^{a}	15.08±0.75^{a}	14.11±0.92^{a}
Crude Lipid	3.89±0.39^{a}	3.99±0.45^{a}	4.01±0.94^{a}	4.31±0.63^{a}
Crude Ash	2.00±0.53^{a}	2.18±1.00^{a}	2.23±0.38^{a}	2.32±0.24^{a}
Moisture	71.74±1.30^{a}	72.90±1.06^{a}	73.19±0.26^{a}	71.44±0.69^{a}

Values are mean ±SE (n=6)

Table 5. Whole-body proximate composition (%) of *Cyprinus carpio* fed diets with different levels of onion extract for 90 days

Composition (%)	Control	O1	O3	O5
Crude Protein	14.76±0.91[a]	13.98±1.03[a]	14.63±1.15 [a]	13.45±0.83 [a]
Crude Lipid	3.89±0.39[a]	4.38±0.32[a]	3.97±0.21 [a]	4.08±1.21 [a]
Crude Ash	2.00±0.53[a]	2.64±0.40[a]	2.13±0.83 [a]	2.77±0.09[a]
Moisture	71.74±1.30[a]	71.36±1.68[a]	71.55±2.20 [a]	72.18±0.84[a]

Values are mean ±SE (n=6).

Table 6. Viscerosomatic index (VSI), Hepatosomatic index (HIS), Spleen somatic index (SSI) and Visceral fat index (VFI) of *Cyprinus carpio* fed different diets containing fig extract for 90 days

Diets	Control	F1	F3	F5
VSI	10.80±0.48[a]	8.17±0.33 [c]	8.57±1.06 [bc]	8.47±0.75[bc]
HSI	0.81±0.11[a]	0.59±0.08 [c]	0.55±0.02 [c]	0.66±0.08[bc]
SSI	0.058±0.06[b]	0.078±0.08 [ab]	0.076±0.03 [ab]	0.080±0.07[a]
VFI	2.63±1.09[a]	1.80±0.48 [a]	2.04±0.56 [a]	2.33±0.37[a]

Values are mean ±SE (n=6). Within a row, means with different letters are significantly different (P < 0.05).

Table 7. Viscerosomatic index (VSI), Hepatosomatic index (HIS), Spleen somatic index (SSI) and Visceral fat index (VFI) of Cyprinus carpio fed different diets containing onion extract for 90 days

Diets	Control	O1	O3	O5
VSI	10.80±0.48[a]	10.00±1.13[abc]	9.66±0.94 [abc]	10.31±1.97 [ab]
HSI	0.81±0.11[a]	0.59±0.05[c]	0.67±0.03 [bc]	0.74±0.01 [ab]
SSI	0.058±0.06[b]	0.065±0.02[ab]	0.062±0.12 [ab]	0.070±0.07[ab]
VFI	2.63±1.09[a]	2.33±0.37[a]	2.33±0.68 [a]	2.62±0.36[a]

Values are mean ±SE (n=6). Within a row, means with different letters are significantly different (P < 0.05).

At the end of 90 days, VSI and HSI values were found lower in the group fed with fig and onion extract compared to the control group and statistically there is difference. VFI value was found lower in the group fed with fig and onion extract compared to the control group but there is statistically no difference (Table 6.7 P>0.05). SSI value was found higher in the group fed with fig and onion extract compared to the control group and statistically there is difference (Table 6.7 P<0.05).

DISCUSSION

Cho (2011) conducted an experiment with *Paralichthys olivaceus*, fed with a basal diet containing 1 g/100g fig and onion extract meal for 6 weeks, and he found that the use of 1 g/100g onion extract meal improved the fish performance (weight gain and specific growth rate). In another study, it was determined that there is no change in the survival rate, weight increase and specific growth rate of *Paralichthys olivaceus* (6.5 g) that was fed with a diet containing %2,5 fig (*Ficus carica*) (Lee et al., 2015)

It was generally observed through the nutritional value and growth performance analyses that fig and onion addition to the feed with the rate of 1,3 g/100g had positive results. These differences could be explained by the different application time of feeding and fish species, or the level of fig and onion extract in the diets. Biometric indices may increase or decrease due to factors such as unhealthy conditions (Hadidi et al., 2008), feeding levels, or feeding ration (Company et al., 1999). However, in the present study, no mortality or disease in fish from any of the treatments were observed.

It can be said that with the decrease in HSI amount, liver can function in a healthier way. The use of medical plants in fishes in this field is new; in a conducted study, it was reported that fig extract, onion extract and indian fig have no effect on the condition factor and HSI (Cho, 2011). It was reported in a study conducted among channel catfishes that a type of oregano (*Origanum heracleoticum L.)* decreased HSI and VSI amounts (Zheng et al., 2009). In the same study, decrease in HSI amount in parallel with VSI amount might be resulted from oregano's effect in reducing the liver fat. Decrease in HSI amount were acquired through the use of (*Quillaja saponin, Astragalus radix + Lonicera japonica* and green tea) in different studies carried out among fishes (Francis et al., 2002; Zakes et

al., 2008; Cho et al., 2007). When the low level of HSI amount is linked to the fat rate in liver, it can be said that the used vegetable sources reduce liver fat among carps. These results showed that undesirable VFI in *Cyprinus carpio* could be decreased through fig and onion extracts. In a study carried out among Japanese quails, it was reported that oregano extract oil significantly reduced abdominal fat and the percentage of abdominal fat (Denli et al., 2004). The results acquired by the researchers are similar to the findings acquired from carps. Therefore, it can be said that plant extracts can be used to reduce organ adiposity in the fishes fed with fatty feeds. The spleen is considered to be the main organ in fish where neutrophils, erythrocytes and granulocytes are produced and mature (Anderson, 1974). It appears that the spleen plays a vital role in the immune response in fish and is responsible for the high production of melano-macrophages (Kumaran et al., 2010). Studies have reported a positive relationship between increase in spleen weight and resistance to disease in fish (Hadidi et al., 2008; Wiens and Vallejo, 2010). SSI values significantly increased in both plant extract groups and they are respectively positive changes for easier digestion and higher immunity. Based on the results acquired from the study, the effects of fig and onion in different sized *Cyprinus carpio* and in different periods from larval period to the portion-sized period can be researched in future studies. The use of these plants in feeds of densely cultivated fishes in our country such as rainbow trout, gilthead seabream, and European seabass can be researched. The total production of these plants, which hold an important place in world trade, has a value of 6.5 million tons and 2.8 billion dollars.Spice exports in the world have reached to 3.3 billion dollars and Turkey ranks 13th with 68 million dollars among the spice exporting countries (SADC, 2005). In addition, as of 2009, Turkey's total export value of medicinal plants and spices has reached to 96 million dollars (Çakıroğlu, 2010). The amount of production of fig and onion from plants cultivated in our country is 305.450 tons and 2.120.581 tons respectively (TSI, 2016). In our country, Abundance in the amount of fig and onion is also related to the price, while cereals and other herbal products are at 2.12 TL / kg and 0.76 TL / kg respectively as production value (TSI, 2011). Fig and onion are among the most common, cheap, and easy to find sources in our country. Significant reductions in plant prices when supplied in high quantities are necessary for fish meal production companies for an economic formulation. In addition to this, based on the positive results acquired from *Cyprinus carpio* as also from many animals and people, both plant extracts, particulary fig, can be used by feed companies.

ACKNOWLEDGMENT

We would like to thank the Adnan Menderes University Research Fund for financial assistance (the project number ADU BAP ZRF-15037) and KILIC Company for providing research facilities.

REFERENCES

Anderson, D.P. (1974). *Fish Immunology* (ed. Snieszko S.F. ve Axelrod H.A.), T.F.H Puplications, W. Sylvania. 239.

AOAC. (1998). Official methods of analysis of AOAC international. VA: Association of Official Analytical Chemists, Gaithersburg.

Cho, S.H. (2011). Effects of Putative Growth or Health-Enhancing Dietary Additives on Juvenile Olive Flounder, *Paralichthys olivaceus*, Performance. *Journal of the World Aquaculture Society,* 42(1): 90-95. doi: 10.1111/j.1749-7345.2010.00447.x

Cho, S.H., Lee, S.M., Park, B.H., Ji, S.C., Lee, J., Bae, J. & Oh, S.Y. (2007). Effect of Dietary Inclusion of Various Sources of Green Tea on Growth, Body Composition and Blood Chemistry of The Juvenile Olive Flounder, *Paralichthys olivaceus*. *Fish Physiology and Biochemistry*, 33: 49–57. doi:10.1007/s10695-006-9116-3

Company, R., Calduch-Giner, J.A. Kaushik, S. & P´erez-S´anchez. P., (1999). Growth performance and adiposity in Gilthead Sea Bream (*Sparus aurata*): risks and benefits of high energy diets. Aquaculture 171:279–292. doi : 10.1016/S0044-8486(98)00495-5

Çakıroğlu, D.G. (2010). Herbs & Spices. *İGEME – Export Promotion Center of Turkey*. 14.

Denli, M., Okan, F. & Uluocak, A.N. (2004). Effect of Dietary Supplementation of Herb Essential Oils on the Growth Performance, Carcass and Intestinal Characteristics of Quail (*Coturnix coturnix japonica*). *South Africa Society for Animal Science,* 34: 174-179.

Digrak, M., Bagci, E. & Alma, M.H. (2002). Antibiotic Action of Seed Lipids from Five Tree Species Grown in Turkey. *Pharmaceutical Biology*, 40(6), 425-428. doi:10.1076/phbi.40.6.425.8445

Folch, J., Lees, M. & Sloane-Stanley, G.H. (1957). A Simple Method for the Isolation and Purification of Total Lipides from Animal Tissues. *The Journal of Biological Chemistry*, 226: 497-509.

Francis G., Makkar, H.P.S. & Becker, K. (2002). Effects of Cyclic and Regular Feeding of a *Quillaja* Saponin Supplemented Diet on Growth and Metabolism of Common Carp (*Cyprinus carpio* L.). *Fish Physiology and Biochemistry* 24: 343–350. doi: 10.1023/A:1015047208108

Goda, A.M.A.S. (2008). Effect of Dietary Ginseng Herb (Ginsana G115) Supplementation on Growth, Feed Utilization, and Hematological Indices of Nile Tilapia, *Oreochromis niloticus* (L.), Fingerlings. *Journal of the World Aquaculture Society*, 39(2): 205-214. doi: 10.1111/j.1749-7345.2008.00153.x

Hadidi, S., Glenney, G.W., Welch, T.J., Silverstein, J.T. & Wiens, G.D., (2008). Spleen Size Predicts Resistance of Rainbow Trout to Flavobacterium psychrophilum Challenge. The Journal of Immunology, 180: 4156-4165. doi: 10.4049/jimmunol.180.6.4156

Immanuel, G., Uma, R.P., Iyapparaj, P., Citarasu, T., Punitha Peter, S.M., Michael Babu, M. & Palavesam, A. (2009). Dietary Medicinal Plant Extracts Improve Growth, Immune Activity and Survival of Tilapia *Oreochromis mossambicus, Journal of Fish Biology*, 74(7): 1462-1475. doi: 10.1111/j.1095-8649.2009.02212.x

Jeong, C., Heo, H.J., Choi, S. & Shim, K. (2009). Antioxidant and anticancer properties of methanolic extracts from different parts of white, yellow and red onion. *Food Science and Biotechnology,* 18: 108–112.

Kahraman, Z. (2009). Herbal Extracts and Their Usage in Laying Hen Diets, *Poultry Research Journal*, 8(1): 34-41.

Kivanc, M. & Akgul, A. (1986). Antibacterial Activities of Essential Oils from Turkish Species and Citrus. *Flavour and Fragrance Journal,* 1: 175-179. doi: 10.1002/ffj.2730010409

Kumaran, S., Deivasigamani, B., Alagappan, K.M. & Sakthivel M., (2010). Infection and Immunization Trials of Asian Seabass (*Lates calcarifer*) Against Fish Pathogen *Vibrio anguillarum*. *Journal of Environmental Biology,* 31: 539-541.

Lee, J., Jung, W.G., Cho, S.H. & Kim, D.S. (2015). Effect of various sources of dietary additive on growth, body composition and serum chemistry of juvenile olive flounder (*Paralichthys olivaceus*). *Aquaculture Research*, 46: 2194–2203. doi: 10.1111/are.12388

Oskoii, S.B., Kohyani, A.T., Parseh, A., Salati, A.P. & Sadeghi, E. (2012). Effects of dietary Administration of *Echinacea purpurea* on Growth Indices and Biochemical and Hematological Indices in Rainbow Trout (*Oncorhynchus mykiss*) Fingerlings. *Fish Physiology and Biochemistry*, 38(4):1029-1034. doi: 10.1007/s10695-011-9587-8

Ramos, F.A., Takaishi, Y., Shirotori, M., Kawaguchi, Y., Tsuchiya, K., Shibata, H., Higuti, T., Tadokoro, T. & Takeuchi, M. (2006). Antibacterial and antioxidant activities of quercetin oxidation products from yellow onion (*Allium cepa*) skin. *Journal of Agricultural and Food Chemistry*, 54: 3551–3557. doi:10.1021/jf060251c

Ryu, S.R., & Jung, S.T. (1999). The preparation and synthesis of antifungal agents using biological activity compounds separated in figs. *Applied Chemistry* 3: 165–168.

SADC. (2005). Trade Information Brief Spices. *TİPS,* 56 p.

Simsek, U.G., Guler, T., Ciftci, M., Ertas, O.N. & Dalkilic, B. (2005). The Effect of an Essence Oil Mix (Derived from Oregano, Clove and Anise) on Body Weight and Carcass Characteristic in Broiler. *Journal of Veterinary faculty*, 16 (2): 1-5.

Sonmez, A.Y., Bilen, S., Alak, G., Hisar, O., Yanik, T. & Biswas, G. (2015). Growth performance and antioxidant enzyme activities in rainbow trout (*Oncorhynchus mykiss*) juveniles fed diets supplemented with sage, mint and thyme oils, *Fish Physiology and Biochemistry*., 41: 165-175, doi: 10.1007/s10695-014-0014-9.

TSI. (2011). Prime Ministry Turkey Statistical Institute.

TSI. (2016). Prime Ministry Turkey Statistical Institute.

Wiens, G.D. & Vallejo R.L. (2010). Temporal and pathogen-load dependent changes in rainbow trout (*Oncorhynchus mykiss*) immune response traits following challenge with biotype 2 *Yersinia ruckeri. Fish & Shellfish Immunology,* 29: 639-647. doi: 10.1016/j.fsi.2010.06.010

Yang, X.M., Yu, W., Ou, Z.P. , Ma, H.I., Liu, W. & Ji, X.I. (2009). Antioxidant and immunity activity of water extract and crude polysaccharide from *Ficus carica* L. fruit. Plant Foods for Human Nutrition 64: 167–173. doi: 10.1007/s11130-009-0120-5

Yigitarslan, K.D., Azdural, K., Yavuz, U. & Turan, F. (2011). Phytotherapy Practices in rainbow trout. *Turkish Scientific Review Journal*, 4 (1): 63-68.

Yilmaz, E., Ergun, S. & Yilmaz, S. (2015). Influence of carvacrol on the growth performance, hematological, non-specific immune and serum biochemistry parameters in rainbow trout (*Oncorhynchus mykiss*). *Food and Nutrition Sciences,* 6: 523–531. doi:10.4236/fns.2015.65054

Zakes, Z., Kowalska, A., Zakes, K. D., Jeney, G. & Jeney, Z., (2008). Effect of Two Medicinal Herbs (*Astragalus radix* and *Lonicera japonica*) on the Growth Performance and Body Composition of Juvenile Pikeperch (*Sander lucioperca* (L.)). *Aquaculture Research*, 39: 1149-1160. doi: 10.1111/j.1365 2109.2008.01977.x

Zheng, Z.L., Tan, J.Y.W., Liu, H.Y., Zhou, X.H., Xiang, X. & Wang, K.Y., (2009). Evaluation of Oregano Essential Oil (*Origanum heracleoticum* L.) on Growth, Antioxidant Effect and Resistance against *Aeromonas hydrophila* in Channel Catfish (*Ictalurus punctatus*). *Aquaculture*, 292: 214-218. doi: 10.1016/j.aquaculture.2009.04.025