T.R.
ERCIYES UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF AGRICULTURAL SCIENCES AND TECHNOLOGIES

EFFECT OF SOME HERBAL ESSENTIAL OIL SUPPLEMENTATION TO SALMON TROUT FISH DIETS ON GROWTH PERFORMANCE AND MEAT TRAITS

Prepared by
Yazen Wisam HASAN

Supervisor
Prof. Dr. Yusuf KONCA

M. Sc. Thesis

February 2020
KAYSERİ

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SCIENTIFIC ETHICS SUITABILITY

ImYazenWisam HASAN, hereby declare that this piece of work is the result of my research and that this work has never been submitted anywhere for any degree. All the sources of information used were obtained in accordance with academic ethics and have been duly acknowledged.

YazenWisam HASAN

COMPLIANCE WITH GUIDE

This master's thesis writeup on the topic "**Effect of Herbal Essential Oil Supplementation to Salmon Trout Fish Diets on Growth Performance and Meat Traits**" was prepared with accordance Erciyes University's graduate Thesis Writing Directive

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Prof. Dr. Yusuf KONCA danışmanlığında **Yazen Wisam HASAN** tarafından hazırlanan **"Effect of Herbal Essential Oil Supplementation to Salmon Trout Fish Diets on Growth Performance and Meat Traits"** adlı bu çalışma jürimiz tarafından Erciyes Üniversitesi Fen Bilimleri Enstitüsü Tarım Bilimleri ve Teknolojileri Anabilim Dalında **yüksek lisans** tezi olarak kabul edilmiştir.

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Kayseri, January 2020

EFFECT OF SOME HERBAL ESSENTIAL OIL ON SALMON TROUT FISH DIETS ON GROWTH PERFORMANCE AND MEAT TRAITS

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Erciyes University, Graduate School of Natural and Applied Science
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ABSTRACT

This experiment was conducted to determine effects of oregano and cinnamon essential oil (EO) supplementation to trout (*Oncorhynchusmykiss*) for 50 days on fish performance and meat quality. A total of 96 trout fish weighing 20 g were placed in 12 controlled laboratory ponds. The fish remained for one week for the purpose of adapting to the temperature and water quality. After that, the experiment started and the water temperature was (14-15 ° C), the amount of oxygen was 12.2 mg/litre for each tank and the water exchange system worked 24 hours/day. Each aquarium containing 8 fish (2.25) was given two meals daily. To prepare of experimental diets, control diet (no supplementation), and for essential oil groups, 1 kg feed was weighed and 100 mg/kg oregano and cinnamon essential oil (EO) sprayed on feeds. Performance traits, livability, activity in tanks, meat traits, blood components and meat fatty antioxidant activity were determined. The addition of cinnamon and oregano EO did not have a significant effect on body weight, weight gain and feed intake. Feed conversion ratio had a significant difference between groups. There was no statistical significant effect among the groups in terms of movement of fish in tank to interest to feeding and for staff.The best survival rate was in the cinnamon essential oil group. The addition of essential oils of cinnamon and oregano did not affect the characteristics of the carcass traits and chemical analyzes of fish meat (dry matter, crude protein, fats, ash and fatty acid content). No significant difference were observed fish meat color (L*: lightness, a*: redness, b*: yellowness), pH,cooking and thawing loss.No significant effect was recorded in the blood lipid profile, glucose, AST and ALT,butin the EO supplemented groupsserumlipid total protein ratio was lower than control group.

Keywords: Fishes, Essential Oils, Trout, Cinnamon, Oregano, Performance, Fishers

BAZI BİTKİSEL ESANSİYEL YAĞLARIN ALABALIK RASYONLARINA KATILMASININ BÜYÜME PERFORMANSI VE ET KALİTESİ ÜZERİNE ETKİLERİ

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ÖZET

Bu çalışma, kekik ve tarçın esansiyel yağ (EY) ilavesinin alabalık (*Oncorhynchusmykiss*) rasyonlarına ilavesinin performans ve et kalitesi üzerindeki etkilerini belirlemek için yapılmış ve deneme 50 gün sürdürülmüştür. Araştırmada, toplam 96 adet 20 g ağırlığında alabalık yavrusu 12 kontrollü laboratuvar havuzuna yerleştirildi. Balıklar sıcaklık ve su kalitesine uyum sağlamak amacıyla bir hafta adaptasyon yemlemesine tabi tutuldular. Bundan sonar deney başlatıldı ve su sıcaklığı (14-15 °C), oksijen miktarı her tank için 12.2 mg/litre idi ve su değişim sistemi 24 saat / gün çalıştı. Toplam 8 balık için her akvaryuma günde iki öğün yem (2.25 g) verildi.

Muamele grupları: Kontrol grubu (ilave esansiyel yağ içermeyen grup), ve esansiyel yağ grupları için 1 kg ticari alabalık yavru yemi tartılmış ve yemlere 100 mg / kg kekik ve tarçın esansiyel yağları (EO) püskürtülmüştür. Çalışmada, performans özellikleri, yaşama gücü, tanklardaki haraketlilik, et özellikleri, kan bileşenleri ve et yağı antioksidan aktivitesi belirlenmiştir. Tarçın ve kekik EY eklenmesinin vücut ağırlığı, canlı ağırlık artışı, ve yem alımı üzerinde önemli bir etkisi yoktu. Yem dönüşüm oranı gruplar arasında anlamlı farklılık göstermiştir. Gruplar arasında tanktaki balığın beslenmeye ve personele ilgisi açısından istatistiksel olarak anlamlı bir etkisi yoktu. En iyi yaşama gücü oranı tarçın esansiyel yağ grubunda oldu. Tarçın ve kekik esansiyel yağlarının eklenmesi, karkas özelliklerini (kurumadde, protein, yağlar, kül, yağ aside içeriği) etkilemedi. Balık eti rengi (L*: parlaklık, a*: kırmızılık, b*: sarılık), pH, nem etin pişirme ve çözdürme kaybı üzerinde anlamlı bir etkisi yoktu. Muamelelerin kan lipid profile, glukoz, AST, ve ALT değerleri üzerine etkisi önemsiz olmuş ancak EY ilave edilen gruplarda kan toplam protein oranın kontrol grubundan önemli derecede düşük bulunmuştur.

AnahtarKelimeler: Alabalık, Uçucuyağlar, Tarçın, Kekik, Performans, Karkas, Et kalitesi

CONTENTS

EFFECT OF SOME HERBAL ESSENTIAL OIL SUPPLEMENTATION TO SALMON TROUT FISH DIETS ON GROWTH PERFORMANCE AND MEAT TRAITS

SCIENTIFIC ETHICS SUITABILITY i
COMPLIANCE WITH GUIDE ii
ACCEPTANCE AND APPROVAL iii
ACKNOWLEDGEMENT iv
ABSTRACT v
ÖZET vi
CONTENTS vii
TABLES xi
FIGURES AND PICTURES xii

CHAPTER 1

INTRODUCTION 1

CHAPTER 2

LITERATURE REVIEW

2.1. Fish Production and İmportance of Fish in Animal Products 5
2.2. Fish Production in Some Countries 6
2.2.1. Fish production in Turkey 7
2.2.2. Fish production in Iraq 8
2.3.The Fishes 9
2.4. Herbal Essential Oils, Benefits and Mode of Action in Animal Nutrition 12
2.5. Description of Cinnamon 14
2.5.1. Benefits of cinnamon 15
2.5.2. Activechemicalcompounds in cinnamon 15
2.5.3. Effect of cinnamon on fish and other animals 16

2.6. Description of Oregano 19

2.6.1. Benefits of Oregano 20

2.6.2. Active chemical compounds in Oregano 21

2.6.3. Effect of oregano on fish and other animals 22

CHAPTER 3

MATERIALS AND METHODS

3.1. Placeand Time Tocarryouttheexperiment 24

3.2. Source of Fish and Feed 24

3.3. Source of Essential Oils 25

3.4. Experimental Design 25

3.5. Administer the Fish in the Laboratory 26

3.6. Fish Feeding 26

3.7. Study Attributes 27

3.7.1. Productive parameters: 27

3.7.1.1. Body weight 27

3.7.1.2. Weight gain 27

3.7.1.3. Feed consumption 27

3.7.1.4. Food conversion efficiency 27

3.8. Determination of carcass traits 28

3.8.1. Hot and cold carcass yield 28

3.8.2. PH 28

3.8.3. The color of the carcass 28

3.9. Meat Characteristics 29

3.9.1. Cooking loss (%) 29

3.9.2. Thawingloss (%) 29

3.10. Chemical Composition 30

3.10.1. Dry matter (%) 30

3.10.2. Humidity (%) 30

3.10.3. Crude protein (%) 31

3.10.4. Crude ash (%) 31

3.10.5. Crude fat 32

3.11. Analysis of Blood Biochemistry 33

3.12. Essential Oil Components 33

3.12.1. Essential oil components of oregano 33

3.12.2. Essential oil components of Cinnamon .....

3.13. Statistical analyses 34

CHAPTER 4

RESULTS

4.1. Fish Performance 35

4.1.1. Body Weight (g) 35

4.1.2. Daily respond to experimental diets 36

4.1.3. Daily activity before and after feeding (%) 36

4.1.4. Daily interest in and attraction to feeding 37

4.1.5. Survival 39

4.2. Productive parameters 39

4.2.1. Carcass quality 39

4.2.2. Meat characteristics 40

4.2.3. Blood constituents 41

4.2.4. Fatty acid analysis 41

CHAPTER 5

DISCUSSION

5.1. Performance Traits (BW, BWG, FI, FCR), and Mortality 43

5.2. Carcasstraits, Hot and Cold Carcass Yield % 44

5.3. Meat Chemical Composition 45

5.3.1. Dry Matter of meat 45

5.3.2. Protein of meat **45**

5.3.3. Fat of meat **45**

5.3.4. Ash of meat **46**

5.3.5. PH of meat **46**

5.3.6. Color of meat **46**

5.4. Meat Analysis During Cookingloss, Thawingloss **47**

5.5. Activity of the Fish **47**

5.6. Fatty Acid Composition **48**

5.7. Blood Parameters **48**

CHAPTER 6

CONCLUSION **49**

REFERENCES **50**

CURRICULUM VITAE **70**

TABLES

Table 3.1. Chemical analysis of experimentalfeeds 26

Table 3. 2. Essential oil components of oregano 33

Table 3.3. Essential oil components of Cinnamon 34

Table 4. 1. Growth performance of experimental fish units 35

Table 4. 2. Behavioral responses of fish during the experiment period 36

Table 4. 3. Fish carcass yield 40

Table 4. 4. Effects of cinnamon and oregano essential oil addition on fish meat characteristics 40

Table 4. 5. Effects of cinnamon and oregano essential oil addition on fish blood constituents 41

Table 4. 6. The effects of cinnamon and oregano essential oil addition to trout fish diet on fatty acid composition of fish (%) 42

FIGURES AND PICTURES

Figure 2.1. Fish production in Turkey 8
Figure 2.2. Fish production in the Republic of Iraq 9
Figure 2.3. Cinnamon plant 14
Figure 2.4. Oregano plant 20

Picture 3.1. Aquatic laboratory 25
Picture 3.2. PH meter 28
Picture 3.3. Cooking loss device 29
Picture 3.4. Memmert UFP 500 Universal Laboratory Drying 30
Picture 3.5. Dumas nitrogen analyzer 31
Picture 3.6. Oven used forcrude Ash 32
Picture 3.7. Solvent Extractors for crude fat 32

CHAPTER 1

INTRODUCTION

Fish of all kinds and forms, aquatic animals, transformed their bodies in particular, which helps them to live in the water (Dunn et al., 2014). They represent a world of living things. Most of fish live in fresh water, rivers, lakes, and some live in saltwater and few can live in both freshwater and salt (Greene, 1998). There are many species of fish more than 27,000 species making them the most versatile vertebrates. The fish have flakes, fins and single gills (breathing). Some fish are small, 1 cm long or less and others are large and long, up to 15 meters long and weighing 15 tons, as in sharks and whales. Most species of fish are considered a staple food for humans. Fish, whether produced from aquaculture or aquaculture activities from marine land stocks or from nutrient storage, are a major source of protein and staple food (Aldemaro, 2001). There is increasing recognition of their nutritional and health benefits. Fish are among the most effective in transforming food into high-quality fish. Fish is a resource of importance to humans throughout the world and the most important species are a staple food for humans (Abbott et al., 2007).

The researchers began to find new ways in the fish industry to reach the best production and the least number of problems facing these breeds, including the use of natural additives for nutrition, such as medicinal plants and herbs because of their significant effect on improved feed utilization rates and then increase body weight when marketing (Velasco and Williams, 2011).

Over the past years, many studies have made positive results for the use of vegetable essential oils being a dietary supplement in many farm animal kinds (Sutili et al., 2018).These feed alternatives have been evaluated and good results have been obtained in fish production in terms of promoting disease resistance and preventing disease

strikes, develop aquatic growing, animals health, and fodder use (Tanabe and Yoshida, 2003).

Herbs and their oils have been utilized as conventional medication and the strengthening of human immunity for many years in all world. Herbal and their extract are combined to animals feed rather than to chemical products to promote or activate vital processes, resulting in rapid increase, higher-yielding and best feed efficiency(Ghazalah and Ali, 2008). In general, natural plant feed supplements are thought to be healthier, safer and less vulnerable, medicinal plants are also employed as antioxidantsto preserve the quality status of the fishes meats (Tepe et al., 2004), which is easily exposed to oxidation and bad appearance of odours and flavours (Rajaian et al., 2014). Medical plants carrying essential oils own the potential to restrain the growth of microorganisms on a large scale because of a complex mix of volatile particles (Bozin et al., 2006; Kalemba and Kunicka, 2003).Essential oils also inhibit the activity of enzymes that have a role in the bacterial cell's harmful life processes (Al-Rubiay et al., 2008; Kumar et al., 2014).

Oregano also called oregano or wild marjoram is a perennial aromatic herb related to the family of mint (Lamiaceae) and is characterized by its dried leaves with flavours and flowering tops (Meyers, 2005). The original home of Oregano is the hills of the Mediterranean and Western Asia and has been implanted in parts of Mexico and the United States. The grass is used as a staple in cooking and has long been widely used in many foods (Nordqvist, 2017). Like Greek or Italian spices, it has a strong aroma and a warm tart taste. Ornamental varieties are more flavorful and do not suit cooking (Jon, 2017).Oregano is usually grown as an evergreen sub tree in temperate climates. All varieties contain essential oil, the principal components of which are thymol and caravacrolhave been recognized for an extended time as a popular medication. The essential oil of oregano has antioxidant (Couladis et al., 2003; Tepe et al., 2004), antibacterial (Ugur and Duru, 2009; Vági et al., 2005), antifungal (Bouchra and Achouri, 2003; Müller-Riebau and Berger, 1995), Cytotoxicity (Sivropoulou et al., 1996; Wilson et al., 2007), repeller (Traboulsi et al., 2002). Properties mainly due to the primary constituents including p-cymene, thymol, carvacrol and, α- terpinene. Chemical structure of essential oils varies from one plant species to different, depending on the plant parts, climate, soil structure.

Cinnamon bark is the external crust of a long, evergreen tree correlate to the Lauraceae family, which carries substantial quantities of biologically active molecules including the essential oils that cinnamon is anti-inflammatory (Singh, 2007), antioxidants (Lee et al., 2003; Matan et al., 2006) and antimicrobial (Kwon et al., 2009; Qin et al., 2003). Cinnamon has a wide range of biological actions and activity because it includes large amounts of biologically active molecules, including essential oils (cinnamidealdehydes, cinnamal aldehyde), polyphenols, tannins, sapphones, flavonoids and carbohydrates (Kwon et al., 2009).There are biologically energetic properties of cinnamon in a wide range of biological capacities like anti-inflammatory (Gruenwald and Freder, 2010),antioxidants (Rozi, 2016), and antimicrobial (Lee et al., 2005).Thus, the use of cinnamon or either of its derivatives as a natural dietary addition has become beneficial to fish as it has promoted fish growth, fodder use or resistance to pathogenic bacteria (Turan, 2007).

In earth, there are many kind essential oil-bearing plant, however, until now there is not enough experiment carried out to determine their effectiveness in fish diet. Therefore this experiment wsconducted to determine the effect of oregano and cinnamon essential oil addition to trout fish diet on performance, carcass, meat traits, and blood parameters.

CHAPTER 2

LITERATURE REVIEW

Hunger, poor nutrition and malnutrition still amid the most common awkwardness that remain linked to the poor and third world countries, and they still control the well being and health of the world's poorest countries (Cirauqui, 2016). In addition, there are growing problems about the long-term sustainability and production period of many current food production practices, like natural fish farms and aquaculture, to fill the growing comparative need and demand in the future (Hussan et al., 2016). Aquaculture and fisheries are one of the most important and the best, fastest-growing food creation systems in the world (Finegold, 2009), including the largest production in developing countries, with the expectation that aquaculture will remain to offer to maintain food security and increasing the financial economy of developing countries (Anthony and Richard, 2016). Most aquaculture practices around the world contribute important cultural, economic and nutritional advantages, with limited or no cost. Though, an increase in current efforts in this area is necessary for the future expectation benefit of aquaculture in all countries (Tidwell and Allan, 2001). Aquaculture practicing in emerging countries has largely concentrated on the production and enhance of low-nutrient varieties, such as capture fisheries such as rivers and lakes, and aquaculture in advanced countries have been largely focused on breeding and cultivation of high nutrient and big value carnivorous species (Tacon et al., 2010).Global aquaculture and fisheries production and practising has developed in modern years, and aquaculture is expected to provide seafood significantly. However, there are many important issues in aquaculture in relation to the safety and health of food, nutrition and aquaculture (Ahmed and Thompson, 2019). Identity of the common major issues in aquaculture is nutrition, many of which are associated with cultivated fish. Those feeding case should continue considered in order to achieve stability, productive security plus continued

aquaculture (Hixson, 2014). Some issues in fish nutrition need breeding, improvement and development, like feed efficiency, nutrients used, over-nutrition, natural and industrial additives, natural and industrial feed substitutes, fish health, and the use of biotechnology (Hixson, 2014; Tidwell and Allan, 2001).

2.1. Fish Production and İmportance of Fish in Animal Products

Over the centuries, fish has been an important ingredient of the diet of people in much of the world. Fish farms have increased rapidly over the past 100 years due to the use of modern technology, which has many tools and inputs for production. This has led to an increase in over-fishing which has caused a decline in wild fish stocks worldwide. As a result, the growth of fish farms stalled about 20 years ago. The need to increase fish production through agriculture has become a necessity (Beard et al., 2011; Tidwell and Allan, 2001).

Aquacultureis the culture of all aquatic organisms such as fishes, molluscs, arthropods, crustaceans, aquatic plants, algae and other organisms. Aquaculture is based on saltwater and freshwater aquaculture below certain controlled circumstances. Agriculture consists in the form of interference in the management method to promote production, such as proper storage, nutrition, shield from predators, etc (Dudgeon et al., 2006). Fish farming is the most common form of aquaculture. It consists of commercially regulating fish farming in natural and artificial lakes, aquifers, aquariums or ocean containers, usually for food consumption. The main types of fish used in aquaculture are, respectively, carp, salmon, tilapia, and catfish (Albala and Smith, 2015). Fisheries and aquaculture are critical to the economy of developing countries and coastal communities, providing food security (Garcia and Rosenberg, 2010), access to employment, access to hard currency and strengthening livelihoods. Fish products are one of the important vital origins of high-quality protein at a low price (Karataş, 2017). Today, fish provide more than 1 billion poor people with a high amount of animal protein daily. Fish in some poor countries is the main source of nutrition (Lauria et al., 2018; Metian, 2013). Currently, more than 250 million personalities are straight dependent on aquaculture and fisheries for their livings and millions serve in various sectors of the fish farming industry such as manufacturing or marketing. Therefore,

maintaining the industry's longevity and sustainability is not only politically and socially important but also of economic and ecological significance (Lynch et al., 2016).

Fish constitute the largest group of animal kingdoms utilized for the manufacture of animal foods. Only around 1,000 of these varieties are caught and used commercially for meat production (Mohanty, 2015). Fishes establish a large part of animal protein consumption in many sections of the population world. Fish are consumed as dried, salted, frozen, fresh smoked or canned fish. Many fishes kinds lead to significant economic products and outputs in many countries (Peirson et al., 2001). It is known that different fish products provide large amounts of factors and nutrients (Gormley, 2006). It is an important source of a group of saturated and unsaturated fatty acids, particularly omega-6 and omega-3, which have protective characteristics in some human diseases (Khalili Tilami, 2018). These fatty acids have the potential to prevent heart disease and immune problems (Simopoulos, 2008). In addition to large amounts of important nutritional parts such essentially dietary and digestive proteins that contain high and large levels of essential amino acids like (lysine, methionine) (Venugopal, 2017), fat-soluble vitamins (likeDandA). That the human body needs. The minerals found in fish are phosphorus, selenium, fluorine, zinc, iodine, calcium and iron. These metals have a huge biological abundance. It can be easily consumed by the body (Pal et al., 2018).

2.2. Fish Production in Some Countries

According to FAO, world fish production exceeded 150 million tons in 2016, Aquaculture products were of two parts, the first being salable as food, while others were used for non-food purposes. The first revenue from fisheries and aquaculture sales was more than 300$ US billion in 2016, about 230$ US billion was from aquaculture and fisheries production. Aquaculture is responsible for the continued livelihood of all aquaculture dedicated to human food (Sergio, 2014). Between 1961 and 2016, the yearly average improvement in the world consumption of fish used for feeding, and the population growth rate was (3.2%), exceeded the population growth percentage (1.6%), the meat consumption increase of all animals kinds (2.8%) (Anthony and Richard, 2016). According to a study, fish meat reached a record level of more than 66 million tons, compared including the result of beef meat about 63 million tons (Larsen and Roney, 2013).The per capita share of fish products increased. Food consumption of

fish increased in the last years, at an average rate of approximately 1.5 % per year. primary calculations for 2016 and 2017 indicate that the total amount of fish produced globally is expected to develop by 15.2% from 168 million tones in the base period to 194 million tons by the end of the forecast. As in the past, the vast majority of this will come from Asia, whose share increases from 71 to 73% of global production (Hanry, 2016). In recently, fishes estimated about 17% of the animal proteins used through the world's population. In addition to saving about 3.2 billion people, 20% of the average per person consumption of animal proteins (Dinçer, 2017).

2.2.1. Fish production in Turkey

Aquaculture production, particularly in Turkey, began in the early 1970s with the cultivation of carp and rainbow salmon. In the mid-1980s, there were many attempts at mariculture in the seas around Turkey (Cfri, 2004),such as the Aegean and the Mediterranean. These attempts accelerated in 1990 in the cultivation of many species of fish (Karataş, 2017). The main species farmed and grown are rainbow trout (Oncorhynchusmykiss) with 52% in inland waters, sea bass (Dicentrarchuslabrax) with 29% and 18% fish on marine farms. Besides these species, carp (Cyprinuscarpio) and rainbow trout are produced on marine farms and mussels (Mytilus spp.) But in smaller quantities in marine waters (Doğan, 2010; Önder and Okumu, 2004). In the light of developments and technology that have taken place in the world and in Turkey, the results of aquaculture have shown rapid and significant progress (Diler et al., 2017), where the results of increases in a number of institutions for the purpose of production compared to previous years. Companies operating in the fish and inland aquaculture industry increased by 37% in 2009 compared to 2002. The number of water production enterprises increased from one in 1971 to (1832 for aquaculture) in 2009 (Dogan, 2015),where 1482 establishments produce 96 842 tons / year of rainbow trout and carp. There are currently 350 companies involved in marine aquaculture producing 114 420 tonnes / year of sea fish and marine fish. In addition to the number of companies that produce blue tuna are 980 of the institutions of sea fish farming. At present, companies engaged in marine aquaculture increased by 56% (Fao, 2013). Laboratory studies and practical applications are being carried out for the cultivation of new species in addition to rainbow trout, inland carp culture, rainbow trout, etc. and the development of seas farming (Şahin, 2015).



Figure 2.1. Fish production in Turkey

https://www.researchgate.net/publication/298722650_A_Review_on_Current_Status_of_Aquaculture_in_Turkey

2.2.2. Fish production in Iraq

Aquaculture activity started in the 1950s, the total field of aquaculture production in Iraq is determined at 7,500 hectares. The principal types of cultured are silver, grass carp, common carp. Carp species have been introduced for the purpose of scientific experiments (Crumlish, 2015). Aquaculture in Iraq depends on the Tigris, Euphrates and Shatt al-Arab rivers and on the availability of water, good soil and suitable location, including the country's tributaries, swamps, dams and reservoirs. Despite the availability and availability of water resources, the aquaculture sector is owned both publicly and privately. These sectors are widely distributed in the central and southern parts of Iraq (Fao, 2013).Due to the security situation in Iraq, this industry was not developed due to many political and economic conditions that led to the deterioration and discontinuation of the industry. As a result, progress in the development of freshwater aquaculture has been hampered by undernutrition and lack of diversity. And others (Ali al-Azzawi, 2015; Nadia El Hajou, 2016).

The average annual production for 1986-1997 was 4000 tons. In 1998, a significant increase in production was estimated at about 7,500 tons. More than 1500 aquaculture fish farms have been licensed, each operated in the common area (companies and individuals). There were ten relatively large farms (about hundred ha each), but the average for each farm was about 4-5 ha. The only method used for aquaculture in

earthen pools. Information intimates that the total fish cultivations in Iraq about 1900 farms (Ali, 2015). Although most of them are near clearwater sources. These are earthen lakes are made by traditional way, only the Babylon Farm belong to the government, is a fully isolated and well-equipped integrated farm, established on an area of 500 hectares. Other farms are smaller, owned and worked by individual companies. Production ability for each area is low in most fish farms, extending from 1400 to 2000 kg/ha. This is mainly due to the lack of enough fish feed. After 2004, production increased from previous years, with aquaculture production for 2004 exceeding 13,000 tons and in 2010 it increased to 20,000 tons until in 2017 it reached more than 31,000 tons of freshwater aquatic products (Dale, 1994).

Today the fish sector is one of the best growing sectors in Iraq because of the use of many modern methods in the process of breeding and aquaculture.

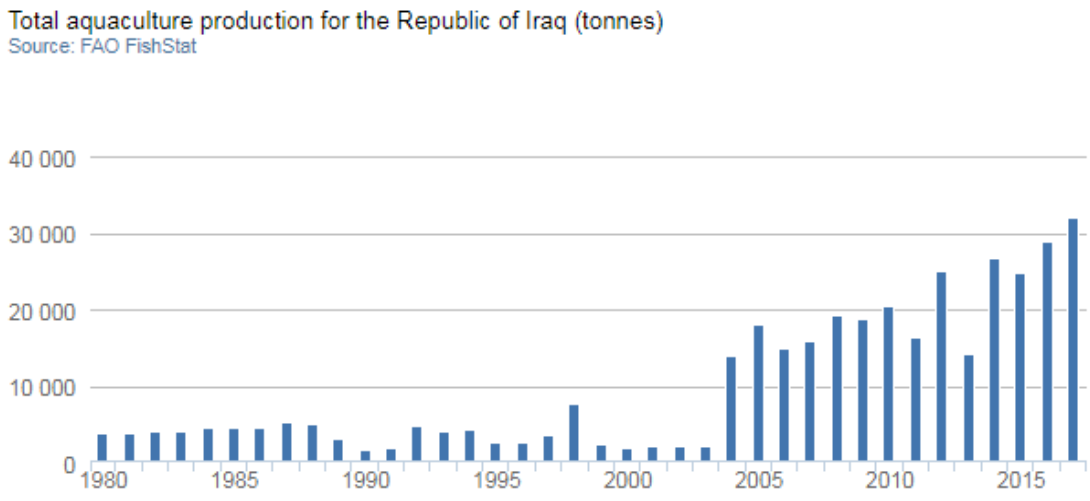


*Figure 2.2.*Fish production in the Republic of Iraq

(FAO Fisheries & Aquaculture - National Aquaculture Sector Overview – Iraq)

2.3.The Fishes

A fish is any member of that group of semi-brilliant organisms that includes all aquatic animals (Van Der Laan and Eschmeyer, 2014).Tuna can retain a higher internal temperature than ambient heat (Goldman, 1997). Fish are available in most water bodies. It can be found in all aquatic environments.Fish are characterized by the

presence of gills that act on the process of gas exchange and respiration (Lynch et al., 2016), The fins to guide, balance and move the fish in the water. There are two types of fins the first type (chest and pelvic) (Westneat and Thorsen, 2004). The second (caudal, dorsal, ventral) varies from fish to fish in size, shape and performance. There are also crustaceans in the species (lamellar, rhombic, metatarsal, disc) (Cranshew, 1980). In addition to jaws for the purpose of catching prey and nutrition. Fish has a pivotal structure (Farrell, 2011). The vital organs are located at the front of the fish's abdomen (Eissa, 2016). The back, which is located behind the body cavity, consists mostly of muscles and its main function is to push the fish into the water and called the tail or guilt (Altringham and Ellerby, 1999).The body of the fish is often covered with scales. Fish skins also cover a layer of mucous material that complements the protective functions of the crusts. They surround the fungi and germs that may attach to the body of the fish and paralyze the movement, sliding and falling without damage (Westneat and Thorsen, 2004). If the fish loses part of its scales, the microbes can reach the naked part, which is free of mucous matter, and the fish is exposed to many diseases. Most fish species have bones and some other species such as sharks have no real bones but are cartilaginous (Carpenter, 1996).

Fishes have a private closed circulatory system. Where the heart is pumping blood into one circle during the body. The circulatory system in the fishes consists of the heart and blood vessels and the shape and formation of the heart types relates to the fish species (Sari and Andriani, 2018). In the bony fish, it consists of 3 pockets: an intravenous sinus and atrium, both thin-walled and then a thick-walled triangular ventricle under the atrium, while in cartilaginous fish it takes an S-shape and consists of 4 compartments (venous sinus, atrium, ventricle, arterial cone). Four parts, including two rooms, entrance and exit (Farrell, 2007). The heart pumps blood or blood lymph in a circular motion, bringing oxygen (contained in the gills) to all cells of the body in a contract phase (Systole) and a relaxation or filling phase (diastole) for gaseous exchange to expel carbon dioxide (from cells).The venous blood is oxygen-poor and goes directly from the body to the gills (or lungs) and then flows back into the body in the arterial blood (Sandblom, 2013)(Skov and Steffensen, 2003).

The digestive system starts with the mouth and buccal cavity of the respiratory and digestive tract (Govoni and Boehlert, 1986). The gut in most fish after hatching or birth

is a simple tube, and after the absorption of yolk and the beginning of feeding quickly divided this tube until the gut is formed. Fish feed on many types of concentrates that fit their digestive tract and the main difference between them is the complete length of the digestive tube. Herbivorous fish have a much longer digestive tube than carnivorous species (Ray and Ringø, 2014). The digestive system in the fish starts from the mouth and the areas around it significantly in terms of concentration, shape and number. The buccal lining of the buccal cavity consists of a mucous epithelium applied to a thick basement membrane with dense dermis that binds to the bone or muscle (Emdork, 2005). The mouth opening in fish is usually surrounded by thick, non-muscular lips. Mouth opening sites vary consist on the nature of feeding and the tongue of the fish may be absent and maybe small undeveloped and usually immobile. There is no separation between the mouth and the pharynx (Erdogan and Alan, 2012). The size of the mouth varies greatly in terms of eating habits, there is a small hole in small crustacean eaters such as white fish, while in the barricades such as cracks have a wide aperture, and Plankton eaters that require swallowing large amounts of water has a wide mouth, and fish such as sturgeon has a wide mouth opening of the width Strip in her body (Eryalcin, 2018).There are three types of teeth in bony fish divided according to their location, which is the maxillary, oral and pharyngeal teeth. About the mutation of the fifth pair of arches (Jernvall and Thesleff, 2012).Different numbers and types of teeth in fish depending on the nature of nutrition and food type (Constantinescu et al., 2015). Fish that feed on phytoplankton and microorganisms have mouths free of teeth, fish that feed on worms, molluscs and hard-living organisms use pharyngeal teeth to crush their food (FAO, 2013).The esophagus in fish is a short muscular organ that has great ability to expand longitudinally and transversely because of its composition, connecting the esophagus between the pharynx and the stomach. The esophagus can expand the size of the prey, so fish rarely suffocates because of ingestion of large prey (Govoni and Boehlert, 1986).

The stomach is a member of the main digestion and sizes and shapes vary according to the nature and quality of feeding.The predatory fish stomach developed and long as in the fish of the pike, while the mixed-feed fish is cystic and similar to the stomach, such as running fish and be cassia and work the work of grinding member as in the thickness of coarse. Not all fish have a real stomach. Most of the carp family fish mutate the

upper part of the intestine into a swollen acidic secretion. The tissue structure of the lining differs from the rest of the intestines. This part acts as the stomach in these types of fish, such as carp (Sagar and Nair, 2019).

The digestive system digests the food and the small intestine, followed by the large intestine, a place where a lot of digestion and absorption of food occurs. In fish and converted into liquid substances simple composition to be absorbed by blood and transported throughout the body. Non-digestible substances go out and get rid of the body through muscle cramps (Ray and Ringø, 2014). The digestion process is done in two ways, the first is the mechanical method, where the walls of the gastrointestinal tract shrink by their involuntary muscles and work to crush, grind and blend food (Celi et al. 2017). The second is the chemical method, where the glands attached to the gastrointestinal tract, such as the pancreas, liver and some digestive enzymes, as well as the enzymes in the walls of the gastrointestinal tract itself, secrete nutrients into simpler structures (Rønnestad et al., 2013).

2.4. Herbal Essential Oils, Benefits and Mode of Action in Animal Nutrition

Herbal essential oils are profoundly concentrated volatiles obtained of different sections of some plant species, each specific therapeutic, medicinal and biological influences (Cagiltay and Diler, 2011). These volatile liquid substances are highly complicated molecular materials (Naeem et al., 2018). Essential oils had been used since old times as a food preservatives, alternative and traditional medicine where essential oils are used in aromatherapy, a type of folk traditional alternative medication in which the healing impacts are attributed to aromatic compounds (Reeds, 2000). It is the main material that gives distinctive smells to different plant species. They are also known as volatile oils, because most of them evaporate at room temperature, so we distinguish the scents of flowers and fruits from afar (Hamid and Aiyelaagbe, 2011). Essential oils are extracted by distillation or pressure on plant organs (stem, leaves, flowers, root, wood) and other parts of the plant are distilled by these processes leading to an aromatic concentration and a real origin of active materials. Essential oil is more known as volatile oil or ethereal oil (Adekunle, 2012; Bansal, 2017).

The chemical structure of essential oils are very complex and each plant has diverse varieties of elements and substances that are essential oils and the principal ingredients

can be section of the aromatic, aliphatic and turbine chain (Çagiltay and Erkan, 2013; Dhifi et al., 2016). In common, essential oils contain three-layer substances and are rarely quadruple. The volatile product consists of turbines, aromatic, volatile acids, phenols, ketones, esters, aldehydes, etc (Bouchra and Achouri, 2003; Mohamed, El-Emary, 2010). Essential oils are complicated solutions and mixtures that contain a lot of chemical elements. Most of the substances are mono-cisco and citrine, also carry aromatic composites, often including phenylpropane derivatives, and a few deterbine (Butnariu and Sarac, 2018).

Essential oils have many uses in recent years in the medical and life field (Prakash and Gupta, 2005). It was used by Egypt for the purpose of mummification for thousands of years. Essential oils interfere with medicine and had been used as an alternative medicine, using aromatic compounds as a stimulant and catalyst for major drugs (Ali and Al-Wabel, 2015). It has a vital effectiveness in combating natural pests where some oils have been shown to have a variety of deterrent effects on pests (Isman, 2000).

Essential oils have many properties, including activity and effectiveness against viruses of various plant species derived from them. Essential oils have different mechanisms to inhibit viral activity (Ali and Al-Wabel, 2015).This activity is related to the evidence that there are components in the structure of essential oils that change the nature and components of structural viral proteins or glycoproteins or inhibition of specific processes (Ocazionez and Meneses, 2010). Essential oils are composed of many components and these ingredients have the potential to inhibit bacterial activity where they act as an antibacterial action (Nazzaro et al., 2013; Orozco Hernández and Olmedo Sánchez, 2009).These components have different mechanisms and patterns in inhibition, for example the work of irreparable defect to the membrane of bacterial cells and thus the loss of the contents of the bacterial cell, death and decomposition, or work to prevent and inhibit the mechanisms of toxin production in bacteria (Djilani and Dicko, 2012). Essential oils have the ability to act as an antifungal, inhibiting and stopping the fungal activity by the same mechanisms used in bacteria in addition to the work of pH unsuitable for fungi and the arrest and disruption of cell components (Hammer and Carson, 2003). Most essential oils have the ability to act as an antioxidant (Yahaya and Yelwa, 2018). As the oxidation factor has the effects and help to stimulate diseases and the use of essential oils have an effective inhibition of oxidative stress

(Reddy, 2019). The components contain molecules that keep cells from being damaged by free radicals (Bashir et al., 2019).

2.5. Description of Cinnamon

The scientific name for cinnamon is (*Cinnamomumzeylanicum*) it is a bark extracted from the evergreen trees of the type Cinnamomum from the Lauraceae family. Its original source Sri Lanka but also planted in South America, Southeast Asia and West India (Frank, 2019). The upright tree stalk is 3 - 5 meters high, the leaves are successively compound, the flowers are small yellow, and the fruit resembles a small carnation. The cinnamon peel includes volatile oils of up to 4% it has been largely mentioned in Chinese texts since 4000 (Hary, 2014). It is used in the science of medicine and toxicology as well as uses as a spice where it has been used for centuries (Gruenwald and Freder, 2010). Cinnamon essential oil contains (cinnamaldehyde) Richly which has antimicrobial, inflammatory, fungicidal and bacterial properties (Nabavi et al., 2015).



Figure 2.3. Cinnamon plant

www.mygardenofdelights.com/cinnamomum-zeylanicum-cinnamon-tree-tropical-plant.html

2.5.1. Benefits of cinnamon

Cinnamon has long been used as a traditional spice in many countries because of its antibacterial and antifungal properties. Cinnamon is used in many industries where it is used in cosmetics (Gruenwald and Freder, 2010). The parts of cinnamon oil have uses in perfumes and in medicines due to its many activities and activities (Thomas et al., 2012). Cinnamon has many uses and applications where it has been used in many countries as an ancient folk medicine to treat many diseases as it has the therapeutic ability to treat gastrointestinal diseases (Barceloux, 2009). Cinnamon has the properties of lowering the blood sugar content, reducing blood cholesterol and reducing the risk of developing diabetes (Khan et al., 2003). Cinnamon has the potential to heal wounds (Kamath and Chowdhury, 2003), A property in cinnamon and its essential oils as an anti-inflammatory due to the presence of cinnamaldehyde, an active compound and the main cinnamon where it works to inhibit radioactivity (Lee and Balick, 2005). It has a property and activity against bleeding as it acts as an anticoagulant (Rao and Gan, 2014).Cinnamon and its oils have recently been used as additives and supplements to feed animals (Bento et al., 2013).Cinnamon oils improve feed properties depending on chemical composition as there is antimicrobial and antioxidant effect on feed which improves feed shelf life and feed safety (Emadi and Mokhayer, 2014; Fernández and Viuda, 2018).

Cinnamon and its oils improve digestion and performance and stimulate overall animal performance by reducing intestinal flora or high enzymatic activity, thus better absorption of digestible food and improved immunity by reducing pathogens (Bhatt, 2015).

2.5.2. Activechemicalcompounds in cinnamon

There are chemical differences due to species, plant age, extraction methods, climatic conditions and plant health conditions (Chakraborty and Sankaran, 2015). Cinnamon bark essential oil contains cinnamaldehyde (55-76%), eugenol (5-18%), and safrole (about 2%) (Abdelwahab et al., 2010). More than 94 volatile compounds were found in cinnamon bark (Gong and Liang, 2004). Cinnamon bark contains up to 4% of essential oils consisting mainly of *cinnamaldehyde* (60-75%), *eugenol* (1-10%), *cinnamon acetate* (1-5%), *β-caryophyllene* (1-4%), *linalool* (1-3%), and *sinol* (1-2%) (Paranagama

et al., 2001). The leaves include *eugenol* more than (70%), *trans-cinnamaldehyde* (16.25%), *linalool* (0.14%) (Wang and Yang, 2009). Cinnamon zeylanicum flower oil contains 26 compounds with *cinnamyl acetate*, *alpha-bergamotene*, and caryophyllene oxide (Jayaprakasha and Rao, 2011). Bud oil (*Cinnamon zeylanicum*) contains more than 30 compounds consisting of turbine hydrocarbons and oxidized terpenoids, with alpha-bergamotine and alpha-cobain as the main compounds (Jayaprakasha and Sakariah, 1997). The oil in the fruit stems Cinnamon zeylanicum contains more than 27 compounds, including (E) - cinnamyl acetate and (E) - carovillin as the main compounds (Jayaprakasha and Sakariah, 2003).

2.5.3. Effect of cinnamon on fish and other animals

(Ahmad et al., 2011)in an experiment carried on Nile tilapia three concentrates used from cinnamon (0.5%, 1.0% or 1.5%) contracted 1% concentration of cinnamon an increase in efficiency ratio Nutrition, feed conversion ratio, growth rate, apparent protein, and protein efficiency ratio, there was no meaningful variance in dry matter, protein and fat. (Bloch, 2018)confirmed in an experiment using cinnamon for a practical diet containing (0.0, 0.5, 1.0%) cinnamon bark powder was employed. The results revealed that a diet including 1% of cinnamon resulted in improved growth rate and survival rate alive. While a menu comprising 0.5% of cinnamon led to a larger condition factor and a lower FCR.

(Setiawati et al., 2016)mentioned that the use of cinnamon and its powder in the diet is effective in improving and developing the performance of catfish growth.Use of cinnamon extract and powder (0, 0.1 and 1%) for 60. The results revealed an improvement in fish growth measure, feeding efficiency, protein retention, cholesterol and triglycerides significantly reduced, high-density lipoprotein increased and liver fat reduction compared to control diet.

(Dairun et al., 2018)mention the problem of growth concerning catfish can be enhanced by using cinnamon leaf powder and shrimp head powder. Four servings containing 1 meal, 1% cinnamon powder, 45% shrimp head powder, and a mixture of cinnamon powder and shrimp head were made together for 60 days. The results were that the use of cinnamon leaves and shrimp head led to an increase of the specified growth rate of 1.67-1.70% / day, feeding efficiency (57.55–57.67%) and protein retention (55.61%)

compared with the control (P <0.05). The grade of triglycerides, cholesterol and blood HDL was (416.00-524.05 mg / dL), (139.65-156.68 mg / dL), (73.18-103.70 mg / dL) (P> 0.05), respectively.

The nutritional inclusion of cinnamon in specific measurements significantly improved BW and FCR and suggested that it could be practiced as an alternative to antibiotic growth promoters in fattening (Toghyani et al., 2011). Because cinnamon has antibiotic properties that command, curb the growth and colonization of many pathogenic and non-pathogenic bacteria in the chicken intestine, that may lead to higher efficiency in food use (Mehdi et al., 2018).

(Ahmad and Qotbi, 2016)in the study of the influence of cinnamon powder on the performance, microbial content and blood of broiler chickens Ross at concentrations (0.1,3,5) for six weeks. The results registered that the use of various levels of cinnamon had significant effects on eating, average everyday gain and feed conversion ratio (P <0.05). The results also determined that the amount of Lactobacillus and Escherichia coli did significantly affected by experimental treatments (P <0.05).

(Funda and Damla, 2016)in the study was led on the impact of rosemary extract on growth performance, feed utilization and composition of African catfish. Fish were fed in various concentrations (0, 0.25 and 0.5%) of rosemary extract in the diet for 60 days. At the completion of the experiment, the highest rates of weight gain, specific growth rate, and food conversion rate in the rosemary extract dose group were 0.5%. The highest survival rates were 100% in the Rosemary extract dose groups 0.25%. No significant differences were seen in whole-body protein and fat content between dietary treatments.

(Mehdipour et al., 2013)in the study, the impact of dietary additives with cinnamon powder, cinnamon. and gonad extract as growth-stimulating promoters on growth performance and high quality of 420 Japanese quail. Dietary methods consisted of no-additive control, 200 mg of virginiamycin/kg, 200 mg of cinnamon oil, and 1 or 2 grams/kg of cinnamon powder. A supplementary effect of 200 mg of cinnamon oil/kg and virginiamycin developed the bodyweight of quail (P¼0.003). Feeding 200 mg of cinnamon oil/kg and virginiamycin improved the feed conversion ratio. Food intake was not affected by dietary therapies; substances including diphenobarbituric acid from

Japanese quail fed on 200 mg of cinnamon oil/kg. The water retention capacity in nutritious quail was increased by 200 mg of cinnamon oil/kg. Cooking loss, dripping loss, and pH of meat was not influenced by treatments. (Breed, 2019)confirmed that it is used as a catalyst for growth and weight gain of Japanese quail.

(Santos et al., 2016)in the study of the inclusion of cinnamon oil, cinnamon powder in Nile tilapia diets, animals were fed for 71 days with a diet containing cinnamon powder extruded at different levels (0.5, 1, 1.5, 2%) and cinnamon essential oil (0.05, 0.1, 0.15; 0.2%) and probiotics (0.4%) results showed that the blood balance did not change after exposure to air and enhanced response and immune activity of fish causing an increase of 0.5% globulin grade.

(Torki et al., 2014)mentioned in his experience about the use of zinc and cinnamon in essential oil and its impact on the blood and productivity characteristics of broiler chickens for 56 days. The results showed that there were significant interactions in cinnamon and zinc at the level of serum glucose and triglycerides as well as zinc concentration in plasma, thus decreased serum glucose and triglyceride content and increased plasma content of zinc in diets feeder diets including cinnamon and zinc (Together) compared to those that fed the basic diet.

(Kholif et al., 2012)in the study about the impact of cinnamon, garlic and ginger oil on damask goats were studied seven days after birth for 90 days to study at groups of 2 ml/day per animal per operation. The results registered that the additives produced significantly improved milk production, protein and non-fat solids matched with associated with control but reduced the rate of lipids and protein-free nitrogen fats. Total solids and ash were not impressed by additives. Unsaturated fatty acids in milk were developed and (omega-3 and omega-6) with cinnamon treatment compared with other treatments. Volatile fatty acids and propionate dimensions were increased, rumen acetate and ammonia nitrogen group decreased with other additives. Plasma proteins and glucose concentrations were developed. (Kesbiç, 2019)support this result in has research.

(Kim and Hyun, 2006)transcribed in his study that cinnamon extract has a managerial function in blood sugar and fat level, may also reach to the impact of blood glucose decrease by developing insulin responsiveness or reducing the absorption of

carbohydrates in the small intestine (Aryaeian and Sedehi, 2017). Cinnamon extract was produced in various treatments (50, 100, 150, 200 mg/kg) for 6 weeks. It was observed that blood glucose group decreased significantly in a dose-dependent mode ($P < 0.001$) with the highest number in the 200 mg/kg group compared with control. In addition, serum insulin levels and HDL cholesterol levels were significantly higher ($P < 0.01$) and the collection of triglycerides, total cholesterol and intestinal glycosidase activity were significantly lower after 6 weeks of administration. because the compounds who have a hight polyphenols could be one dietary therapy for the opposition and control of Type 2 diabetes (Kim and Keogh, 2016).

2.6. Description of Oregano

The Oregano (*Organumvulgare*) is a plant of the labiatae family that has been cultivated for centuries in the Mediterranean region and is also a type of spice. Oregano is used for traditional medical treatment by using key parts such as leaves, flowers and stem (Singletary, 2010). Its active substances are volatile oils, turbines and carries a variety of biologically effective composites that have a significant antimicrobial and antioxidant effect. These compounds are thymol, carvacrol, ter-terpenin and P-simin (Bampidis et al., 2006). Oregano is a herbaceous plant of very strong chemical nature Oregano has strong antimicrobial and antioxidant properties, because it contains a basic compound called "carvacol". Bone growth, support of bone mass and production of blood clotting proteins (Harini, 2014). Oregano volatile oils can be obtained through steam distillation and contain more than 20 ingredients, mostly phenolic oxidants (Parra-sald et al., 2019).



*Figure 2.4.*Oregano plant

(https://morningchores.com/growing-oregano/)

2.6.1. Benefits of Oregano

Oregano has long been accepted as a popular spice in the Mediterranean area and has been used as a traditional folk remedy because of its properties against respiratory and intestinal diseases, bacterial and anti-inflammatory problems, menstrual cycle and diabetes (Morshedloo et al., 2017). It has health-promoting benefits associated with cardiovascular disease, reducing stroke, and reducing cancer prevalence (Widmer and Flammer, 2014). It also has a mixture of health-promoting properties like antioxidants, anti-inflammatory, analgesic and antimicrobial (Teixeira et al., 2013). Use as analgesics and their properties in the field of biocides such as antiparasitic and worms (Gendy et al., 2015). Carvacrol and monoterpenoid phenol are responsible for many essential oil properties, as well as p-cymene and terpinene. They all have carvacol as a key ingredient in their essential oils (Dadalioğlu and Evrendilek, 2004). Recently, Oregano has been used in animal nutrition because of its beneficial qualities and properties and ineffective animals.

(Carvalho et al., 2020)in his study stated that oregano extract can maintain physical and chemical states, and diminish oxidation of fat and protein in mutton after frozen storehouse after 120 days. In addition to preserving the chemical and physical properties of meat. These results recommend that oregano to utilize a variety of extraction processes may be a promising alternative to synthetic food preservatives (Veenstra and Johnson, 2019).

(Roofchaee et al., 2011)in the study of the impressions of oregano oil on chicken feed meat and evaluate the growth performance at a concentration of oil 300, 600 and 1200 mg/kg. The results revealed that 600 mg/kg of oil in the diet produced in a meaningful improvement in body weight gain compared to the control group ($P < 0.05$) and significantly improved feed conversion rate compared with the control group in the overall experimental and farmer periods ($P < 0.05$). The numbers of Escherichia coli were significantly lower in the first and second treatments at the conclusion.

2.6.2. Active chemical compounds in Oregano

The chemical compounds of Oregano varies according to agriculture, genetics and varieties of the same plant, but it was found that there are common compounds in it (Nurzyńska-Wierdak, 2009).The foremost ingredients of oregano oil are carvacrol (63%), p-cymene (12%) and linalool (3%). The main components were carvacrol (42%), o-cimene (17%), linalool (9%), and carovillin oxide (5%). Ter-terpenin (4%), cariophylline (2%) and borneol (2%) (Özkan and Güney, 2017). Oregano oil and essential oils have shown an ideal antimicrobial activity against all probiotic organisms and have been found to have antimicrobial activities (Teixeira et al., 2013). The basic compounds of oregano are carvacrol and thymol, which make up more than seventy percent of the oil components.It has been found to have microbial control properties such as monocarbon hydrocarbons and eimin and terbine, which often make up about 5 and 7% of the total essential oils respectively (Adam et al., 1998). Oregano was used as an antifungal, anti-inflammatory and antibacterial. The essential oil contains carvacrol and thymol compounds as the main ingredients that gave it the effect of acting as an antibacterial and thus reduce and erase the pathogen (Ertas et al., 2005). (Mabrok and Wahdan, 2018) confirmed that the essential oil of Oregano plant varieties has a selective effect on bacteria as it was found to have activity against germs, intestinal salmonella,

pathogenic intestinal bacteria and less activity against beneficial bacteria. In the study, (Masood et al., 2007) said that Oregano is an economic source of natural antibacterial compounds and additives that can make a significant difference in the control of pathogenic microorganisms and a safe and natural alternative to health for treating infectious diseases.

2.6.3. Effect of oregano on fish and other animals

In the new world, herbal additions enter in aquaculture proceedings because characteristics who found are represented by the of the capacity to promote growth, weight and tonic to improve the immune system, as an appetite stimulant. Without any environmental and serious obstacles. Concrete results were obtained from the test of herbal compounds such as phenol, polyphenols, alkaloids, quinone and terpenoids (Citarasu, 2010), where results confirmed by (Yilmaz and Ergün, 2013) in a study to investigate the effects of common thyme, rosemary, fenugreek as a feed additive on total liver fat levels and biometric indicators of Sea Bass Dicentrarchuslabrax. The first four were formulated 0% (control) and (1% of thyme, rosemary, or fenugreek). In a 45-day feeding experience. The results indicated that the nutritional level of 1% for thyme, rosemary and fenugreek can improve some physiological parameters.

Where (Marcinčák et al., 2008) stated that herbal essential oils derived from oregano have impacts on growth and improve the efficiency in feed consumption, causing an improvement in weight gain.

(El-Hawarry and Mohamed, 2018) in his study the effect of using oregano essential oil on growth and behavioral response of Nile tilapia. It was found that growth performance and tilapia health improved. Oxidative stress, as well as aggressive behavior of tilapia for males, increased the survival rate.

(Yilmaz and Ergün, 2015) studied the used of carvacrol on growth performance, feed use, immunochemical and non-specific biochemical parameters in rainbow trout (Oncorhynchusmykiss) for 60 days, 240 trout were used. The fish were separated into four groups before being fed using (0, 1, 3, 5 g / kg) carvacrol. The results of this study showed that dietary additions of 3 g / kg of carvacrol in commercial diets can develop some non-chemical and biochemical status in the rainbow.

(Haghighi et al., 2018) refers that the use of oregano in feeding trout as a feed additive improves and improves immune responses.The increase in the number of red blood cells and white blood is due to the effect of oregano and its components (Hassan and Alaqil, 2014).

(Rewatkar et al., 2019) found that the use of oregano as auxiliary food additives leads to an improvement in blood characteristics. Where biochemical tests indicate no harmful effects on the components of blood when eating some medicinal herbs.

(Scanes, 2015) reported that improvement in colloidal serum was due to the presence of active ingredients in thyme and other herbs known as polyphenols, which may increase the level of serum globulin.

(Haghighi, 2018) reported that *Origanumvulgare* extract was employed at a rate of 1% / kg of feed weight to evaluate its influences on immune replies and blood parameters of (600 fish) trout. The results showed improvement and differences in total protein in serum, albumin, globulin, phagocytosis activity and blood lysozyme activity in the group containing oregano extract.

(Stelter and Frahm, 2013) in testing the proportions of dried oregano in pig feed and its effect on health and performance, with special emphasis on the immune system. 80 male weaning castrated pigs were adopted for 5 weeks. The results explained no oregano effects on performance, but the oregano diet altered the ratio of lymphocytes and T cells as well as the concentration of triglycerides in the serum of non-stimulating and stimulated pigs.

(Aylin, 2014) in the study of the addition of oregano oil and its effect on performance, carcass traits and some blood profile for 36 lambs weighing 22 kg. The results explained that serum whole low-density, high-density, lipoprotein triglyceride and cholesterol lipoprotein concentrations were not affected.

CHAPTER 3

MATERIALS AND METHODS

3.1. Placeand Time Tocarryouttheexperiment

The experiment was conducted in the field of fish, Department of Aquatic Sciences, Veterinary College, Erciyes University, Kayseri. The laboratory experiment was conducted between 2/9/2019 to 21/10/2019.

3.2. Source of Fish and Feed

A total of 150 hundred Solomon trout fry fish with 2 months old were obtained from a private commercial company (Lezita Ltd. Co. Kayseri, Turkey, “38.757767”and “36.457821”)far from 106 km distance (Pınarbaşı town). Fish were carried with big size (50x100 cm dimensions) nylon bags, 20 lt water and oxygen filled and was banded. Then immediately moved to experimental unit in Veterinary Faculty. The fish experimental unit consist 12 tanks with 200 lt volume and furnished with two filter system, cooler, pump and oxygen device. During the experiment water temperature was 14-15 C. In the experiment a commercial feed was used. The feed was produced for fry salmon trout fish in Abalıoğlu Co. located in Izmir.The feed chemical composition is given in Table 3.1.



Picture 3 1. Aquatic laboratory

3.3. Source of Essential Oils

Essential oils for oregano and cinnamon were bought from the Turkish Botalife Ltd. Co. in Isparta province, Turkey.

3.4. Experimental Design

Fish was raised in laboratory ponds at the Faculty of Veterinary Medicine with 12 ponds. It was weighed and distributed according to their body weight in 3 groups for each group of four replicate. Oregano and cinnamon oilsweremixed1 ml / kg with sunflower oil 9 ml \ kg and sprayed on the 1 kg of control feed. The control feed also was sprayed 10 ml sunflower oil and protected in nylon bagand banded. When the experimental feed give to fish the nylon bags was opened and kept with zibir bag in the Faculty laboratory. The feed was placed in tightly sealed bags and the feed was shaken for the purpose of homogenizing the added oil and feed. The feed was kept in freezer at a temperature of (+4 °C).

Table 3.1. Chemical analysis of experimentalfeeds

	Feeds		
Analysis	**Control**	**Cinnamon**	**Oregano**
Dry matter, %	90.61±0.159	90.66±0.121	90.58±0.081
Protein, %	48.54±0.155	48.25±0.613	48.17±0.947
Fat, %	18.93±0.377	18.77±0.069	18.60±0.242
Ash, %	10.31±0.012	10.49±0.049	10.23±0.019
Metabolisable energy*			

*Metabolizable energy calculated acc…….Ask company

3.5. Administer the Fish in the Laboratory

A total of 96 fish were placed in the veterinary laboratory of the Faculty of Veterinary Medicine upon arrival from the fish farm. Where the temperature was 14 degrees Celsius for all ponds by a central cooling system that works to cool water and distribution to all ponds and water switch works 24 hours a day and after placing the fish in the ponds randomly and left three days without feeding for the purpose of adaptation to the new laboratory environment. An oxygen pump system was used for all ponds with a quantity of 12.2 mg / L per pond. The ponds were cleaned every two days and a weekly cleaning of all pumps in addition to the work of brine and added to the main basin, which is responsible for the distribution of water in addition to work on the distribution of water on mechanical filters and return to the ponds. The daily dietary requirements of fish were measured as each fish needs (4.5 g).

According to the equation measure the amount of feed needed by the fish every day = average weight of fish in each pond * fixed number by temperature \ 100.

3.6. Fish Feeding

The fish were fed free of any additives for a week for the purpose of adapting to the quality of the food. After that, a diet containing essential oil of cinnamon and oregano was given with a diet to control where the daily intake was (52-54g) for all diet was nutrition and twice a day by two meals the first at 10 am and the second at 4 pm. Each aquarium contains 8 fish consumed 4.5 g / day, where each meal 2.25 based on body weight, where feed requirements were measured at 3% of the fish's body weight (FAO,

1986). Feeds were given a specific measurement using a test tube measuring weight and divided into four sections each section indicating 2.25 g.

3.7. Study Attributes

3.7.1. Productive parameters:

3.7.1.1. Body weight

The fish was weighed at the beginning of the experiment by an electronic balance where all fish replicates were weighed. The fish was divided according to the total weight so that there was a weight consistency for all the fish and the weighted average was found according to the following equation.

Average vivo fish weight [g] = total fish weights [g] per iteration / total number of fish in iteration

3.7.1.2. Weight gain

The development of weight gain was determined according to the following equation:

Weight gain [g] = live body weight at the end of the experiment [g] – live body weight at the beginning of the experiment [g]

3.7.1.3. Feed consumption

The amount of feed consumed per week was calculated

At the end of each week, the feed was weighed weekly for the purpose of knowing the feed consumed per week according to the following formula:

Quantity of food consumed during the period = amount of food at the beginning of the week [g] - amount of food remaining at the end of the week [g]

3.7.1.4. Food conversion efficiency

FCR= Amount of feed consumed in a period [g] / The body weight gain in the same period [g]

3.8. Determination of carcass traits

At the end of the experiment, 50 days a fish was taken from each group randomly, weighed individually through an electronic balance, then the fish were dissected and the carcasses were weighed and cleaned and the inner viscera was isolated.

3.8.1. Hot and cold carcass yield

The carcass was weighed after cleaning and removing the viscera [hot weight] and then placed in the refrigerator for 24 hours and then weighing [cold weight]. Hot and cold carcass ratios were calculated as follows: carcass weight/body weight ×100.

3.8.2. PH

The pH of the carcass was estimated using distilled water and the pH was measured through the lateral muscles of the fish body. A lateral incision was made in the lateral muscles from the beginning of the head to the tail.



Picture 3.2. PH meter

3.8.3. The color of the carcass

The meat color was determined in the new cross-section of fish at slaughter using Chroma Meter (CR-400, Minolta Co. Ltd. Japan); with a 50 mm color measurement area in the CIE L * a * b * color scheme. L * represents lightness, ranging from 0 for

black to 100 for perfect white. a* and b* are color coordinates (+ A * = redness, - A * = green, + B * = yellow, - B * = blue). The device is calibrated using Minolta calibration tiles (L * = 93.8, a * = 0.3136, b * = 3192).

3.9. Meat Characteristics

3.9.1. Cooking loss (%)

Samples were balanced at different weights after being cut regularly and put in closed nylon bags. It was then installed in a water bath 80 °C for an hour and the cooking loss elicited was measured according to the following equation (Honikel, 1998):

Cooking loss = weight after cooking/weight before cooking * 100

Percentage of cooking loss% = 100 - loss of cooking.



Picture 3.3. Cooking loss device

3.9.2. Thawingloss (%)

Samples of fish meat were measured at different weights and frozen for 24 hours and then quoted for the measuring (Honikel, 1998).

Thawing loses = weight after freezing / weight before freezing * 100

Melting loss ratio% = 100-melting loss.

3.10. Chemical Composition

The meats chemical composition (dry matter, crude protein, fat and ash, %) were determined according to process of AOAC (1990).

3.10.1. Dry matter (%)

Samples of the fish meat were balanced in various weights (about 5 gr) and placed in aluminium pots, where the weight of these cups was included and then put in the laboratory oven (UFP 500 Universal Laboratory Drying, Memmert Ltd. Co. Germany) (cups + fish meat samples) for 72 hours under the temperature of 70˚C.And after extraction, the weight of meat was measured after drying according to the following equation:

Weight of meat after drying = total weight of meat and cup - cup weight

After obtaining the weight of dry meat, the dry matter ratio was measured according to the following equation:

Dry matter ratio% = weight of meat after drying/weight of meat before drying * 100



Picture 3.4. Memmert UFP 500 Universal Laboratory Drying

3.10.2. Humidity (%)

Humidity was estimateutilizing the following equation

Humidity ratio% = 100 - Dry matter ratio

3.10.3. Crude protein (%)

The protein was detected by the Dumas nitrogen analyzer (NDA 701, VELP Scientifica Ltd. Co.Italia), where samples were prepared with an average weight of 0.400 mg and placed in a special aluminum sheet and then placed in the place designated for them in the device. And writing weights in the application of the device for the purpose of detecting protein**.**



Picture 3.5. Dumas nitrogen analyzer

3.10.4. Crude ash (%)

After drying and grinding the samples as stated earlier, the weight of the samples (0.450-1000 mg) was taken and placed in small ceramic vessels of different weights where the weights of these vessels were taken and then placed in the incinerator to detect ash under a temperature of 550 meters for 10 hours. The ceramic vessels were taken out and left to cool and then the ceramic vessels were placed in the glassware for the goal of drying out the moisture in the room and the glassware are glass containers that prevent air from entering and then the jars weighed in ash and the ash content was obtained according to the formula:

Ash% = ash weight / sample weight before burning * 100



*Picture 3.6.*Oven used forcrude Ash

3.10.5. Crude fat

To determine fat content of fish, The SER 148 Series - Solvent Extractors device was used to extract the fat in the meat by preparing samples with a weight (3-3.5 g) and put them in cotton cups and covered with cotton and attached to the device and a 50 ml petroleum ether solution was added in the device's glass flasks. After 90 minutes, the jugs were separated and weighed to determine the percentage of fat.



Picture 3.7. Solvent Extractors for crude fat

3.11. Analysis of Blood Biochemistry

Twelve samples of blood were obtained for each group of four fish by taking blood from the abdominal area at the end of the body in terms of the tail where the blood was drawn from the area that existed before the rear fin and after the opening of the exit and some samples drawn blood by cutting the tail and leave the fish Perpendicular until blood drips in 51 of the experiment. The samples were then placed in a special intubation containing heparin that keeps blood from clotting. Total serum protein, glucose, triglycerides, total cholesterol, high-density lipoprotein [HDL] levels were measured using a combination of the same manufacturer with a auto-analyzer.

3.12. Essential Oil Components

3.12.1. Essential oil components of oregano

Essential oil components of oregano are given in table 3.2. Forty four essential oil components were detected from the analysis of Origanumvulgare essential oil. Five major essential oil components greater than 1% was detected from Oregano essential oil. The major essential oil components were carvacrol (66.08%), β- terbipnenbenzene (14.69%), 1-methyl-2- (1-methylethyl) (3.60%), α-terpinene (2.25%), α-myrcene (1.77%), α-thujene (1.51%).

Table 3.2. Essential oil components of oregano

No	Component name	Component quantity (%)	No	Component name	Component quantity (%)
1	Camphene	0,40	11	Linalyl acetate	0,44
2	*Beta*-pinene	0,25	12	Terpinene-4-ol	0,89
3	Myrcene	0,86	13	*Beta*-caryophyllene	1,08
4	*Alpha*-terpinene	0,58	14	*Apha*-Terpineol	0,31
5	Limonene	0,23	15	Borneol	1,70
6	Eucalyptol	0,97	16	*Beta*-Bisabolene	1,76
7	*Gama*-terpinene	1,66	17	Caryophyllene oxide	0,63
8	*Para*-cymene	2,57	18	Thymol	1,26
9	Camphor	0,31	19	Carvacrol	78,64
10	Linalool	5,45			

3.12.2. Essential oil components of Cinnamon

Essential oil components of Cinnamon are given in Table 3.3. Thirty five essential oil components were detected from the analysis of Cinnamonessentialoil (Table 4.2). Eleven major essential oil components greater than 1% was detected from mint essential oil (Table 4.2). The major essential oil components were β-Pinene (1.26%), 1,8-Cineole (2.15%), β-phellandrene (5.60%), menthone (29.60%), isomenthone (4.70%), menthofuran (7.40%), neomenthol (3.20%), menthol (28.16%), menthol acetate (4.41%), β-caryophyllene (3.15), germacrene D (1.89%) .

Table 3.3. Essential oil components of Cinnamon

No	Component name	Component quantity(%)
1	Myrcene	1.2
2	P-cymene	0.9
3	Linalool	3.4
4	Beta caryophyllene	3.4
5	Safrole	Trace
6	Cinnamic aldehyde	68.0
7	Cinnamyl acetate	6.9
8	Eugenol	5.9
9	Benzyl benzoate	2.0

3.13. Statistical analyses

The research carried out in the trial randomized design and the obtained data analyzed in SPSS package One-Way-Anova procedure and Duncan test applied to determine the differences between the groups. The significance level will be considered at $P < 0.05$.

CHAPTER 4

RESULTS

4.1. Fish Performance

Effect of oregano and cinnamon essential oil on trout body weight and body weight gain are provided in Table 4.1.

4.1.1. Body Weight (g)

Effects of cinnamon and oregano essential oil addition to fish diet on the body weight and body weight gain of fish are provided in Table 4.1. Experimental treatments did not have significant effects on body weight of fish, however, body weight of fish was superior in the cinnamon-supplemented group.

Table 4.1. Growth performance of experimental fish units

	Control	Cinnamon	Oregano	Average	p
BW, g	22,10±0,54	22,31±0,66	22,19±0,80	22,28±0,35	0,977
BW-last, g	48,23±2,30	46,63±0,58	48,09±1,01	48,50±1,01	0,460
BWG, g	0,52±0,05b	0,49±0,02b	0,60±0,02a	0,53±0,02	0,889
Total feed intake, g/fish	27.69±0.112	28.57±0.133	28.00 ±0.336	28.089±0.159	0.056
Daily feed intake	0.55±0,002	0.57±0,002	0.56±0,006	0.56±0,003	0.056
Feed conversion ratio, g feed/g BWG	1.105±0.113	1.207±0.031	0.952±0.019	1.088±0.047	0.076
Survival, %	87.5±8.83	100±0	90.62±3.12	92.71±3.24	0.286

BW: body weight, BW-last: body weight last, BWG: body weight gain, P: probability

4.1.2. Daily respond to experimental diets

There were no significant differences in the amount of feed consumed, but there were differences in the feed consumed by fish. Whereas, the best group of feed supplemented with cinnamon oil is followed by the feed group supplemented with oregano oil, the control group was less consumed than these two groups.

Table 4.2. Behavioral responses of fish during the experiment period

Tests	Control	Cinnamon	Oregano	Average	p
Activity before feeding, %	54.65±5.17	67.79±8.89	61.48±11.93	61.31±5.02	0.610
Activity after feeding, %	45.25±2.97	57.81±12.44	58.76±12.86	53.94±5.77	0.612
Interesting before feeding, %	56.54±8.38	73.47±7.41	62.95±10.39	64.32±5.06	0.426
Attraction to feeding, %	60.56±10.57	68.11±10.38	65.96±12.49	64.87±5.92	0.887
Respond to the provided feed, %	70.75±6.27	93.25±2.49	80.12±4.91	81.33±3.75	0.028*

P: probability

4.1.3. Daily activity before and after feeding (%)

Daily activity was mixed between the groups. The cinnamon oil group was better in terms of movement, activity and nutrition. The oregano group was less active than the first group. The control group was less active and limited before feeding. The Figure 4.1. shows the differences in daily activity before feeding.

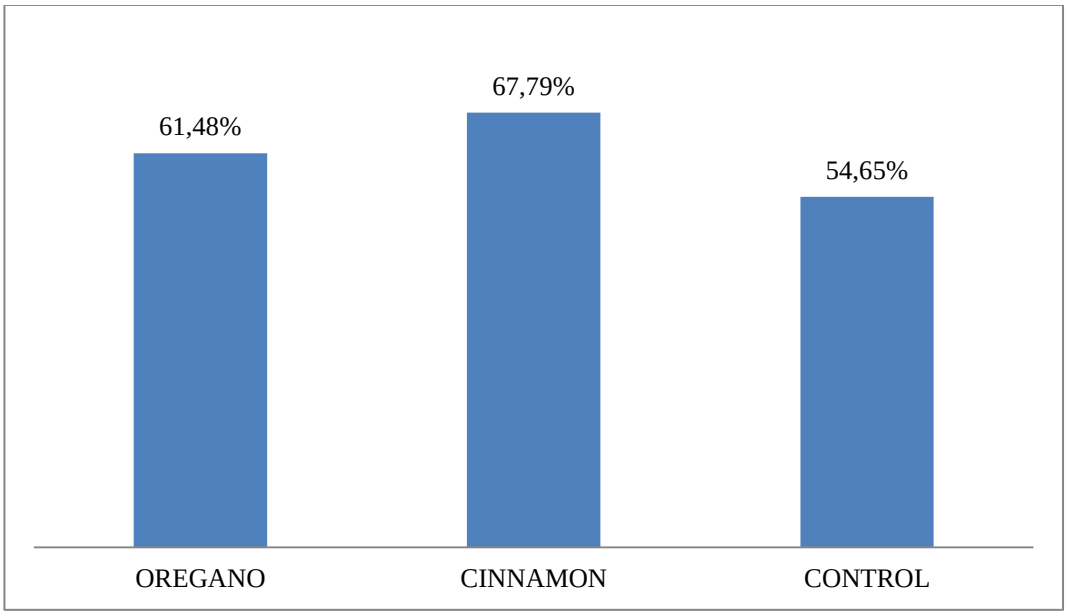


Figure 4.1. Daily activity before feeding, %

Daily activity was different between the groups. The oregano oil group was better in terms of movement and activity because some fish were searching for food. The cinnamon oil group was close to the first group in activity because the fish fed quickly and settled. The control group was less active and limited after feeding and feeding less for the group fish. Figure 4.2 shows the differences in daily activity after feeding.

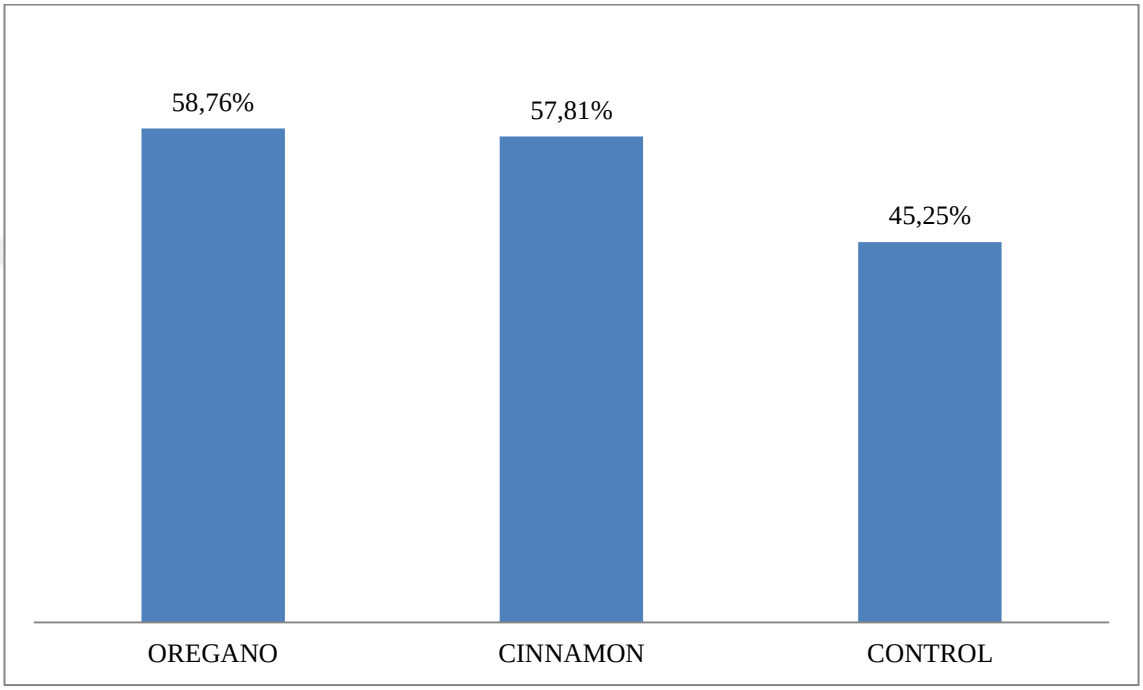


Figure 4.2. Daily activity after feeding, %

4.1.4. Daily interest in and attraction to feeding

The daily external response effects were uneven among fish groups. Cinnamon oil group was the best group in terms of responding to external influences issued, the group of oregano oil was less responsive to external influences issued from the first group, the control group had less pay attention to external influences compared with anther groups.

The figure shows the differences in daily external influences before feeding:

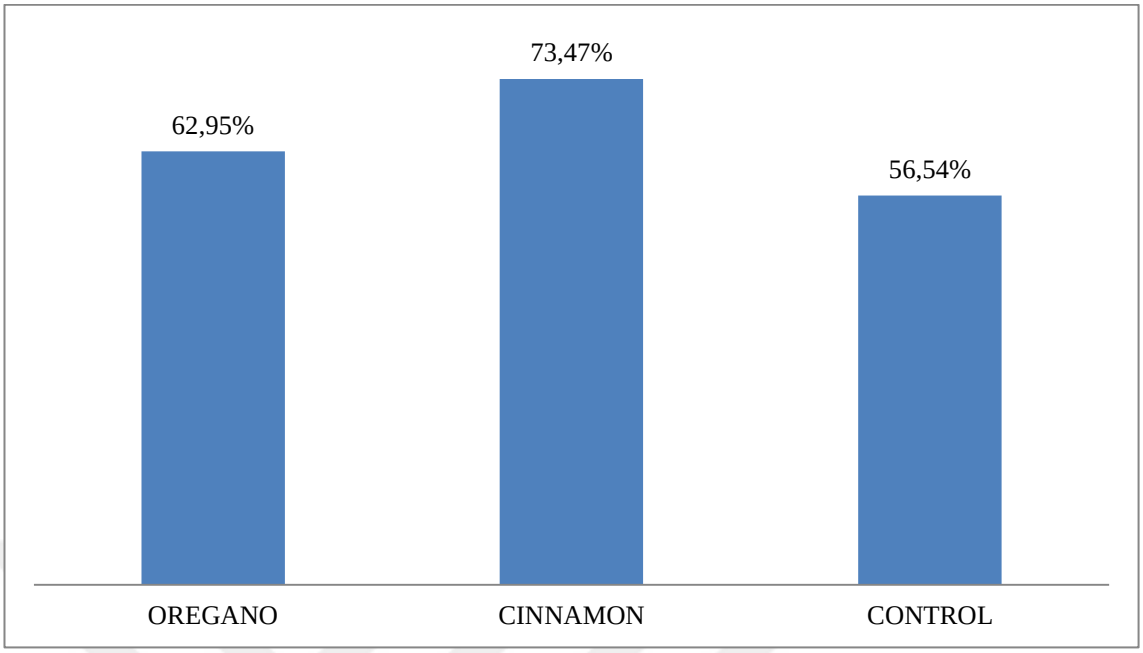


Figure 4.3. Daily interest before feeding, %

Effects of attraction to feeding were different among the fish groups. The cinnamon essential oil group was the best group in terms of attraction to feeding. The oregano essential oil group was slightly less responsive to the attraction for feeding than the first group. The control group had a less rate of interest in natural effects as compared to attraction to feeding of the first and second groups. Figure 4.4. shows the differences in daily attraction to feeding of fish.

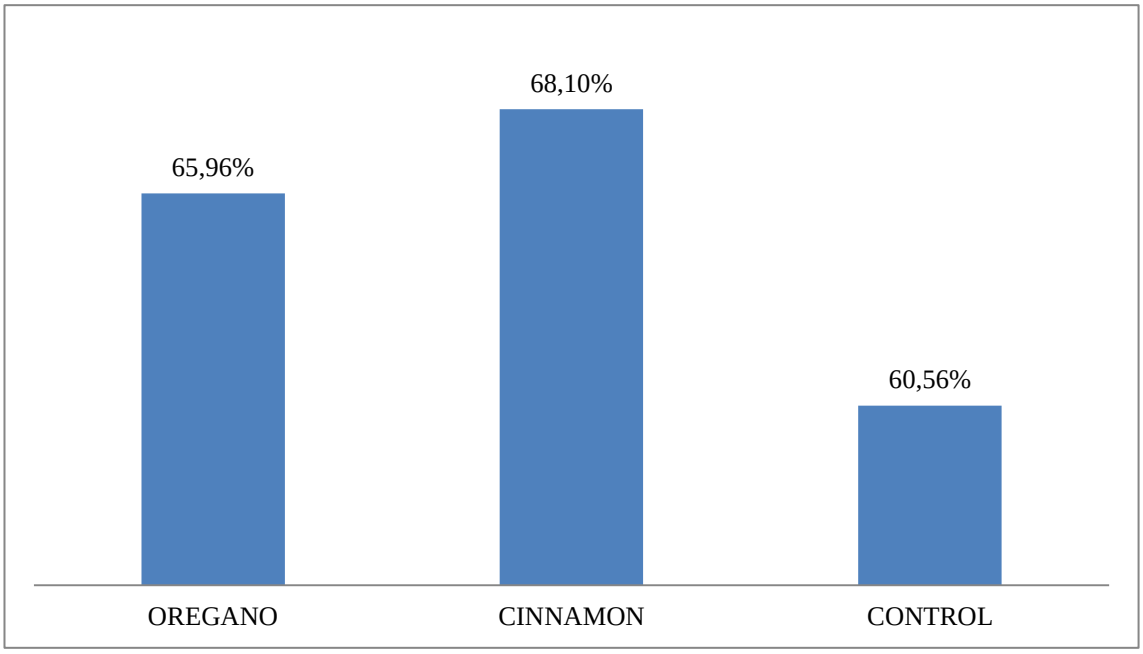


Figure 4.4. Daily attraction to feeding, %

4.1.5. Survival

At the beginning of the experiment, 96 fish were randomly distributed over 12 ponds, where 8 fish were placed in each pond. During the trial period, many deaths occurred due to lack of activity, lack of adaptation to feed quality, water quality, competition for food, jumping from the pelvis, in some cases fin being eaten by weak fish by strong fish as this leads to inability to move and thus cannot feed. The supplement group with cinnamon oil was the best group, as the survival rate was 100% at the end of the experiment. The group supplemented with oregano oil was less than the first group as the survival rate was 90% as 3 deaths occurred. The control group was the weakest with a survival rate of 87% as it recorded 4 deaths.

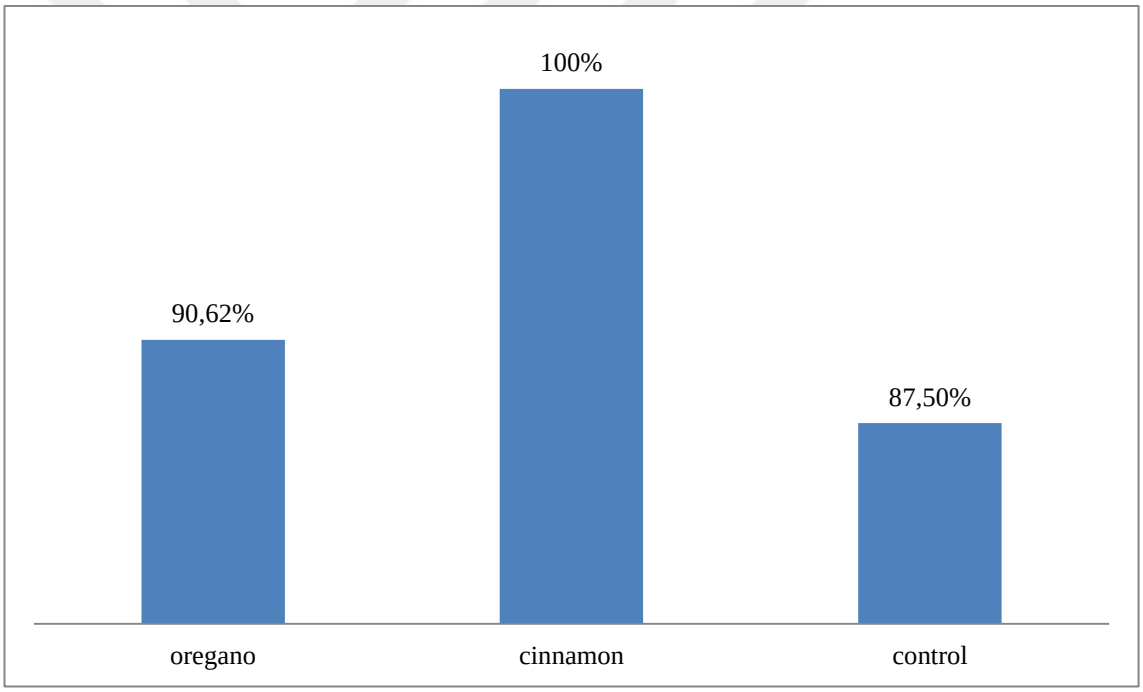


Figure 4.5. Survival rates during the experiment, %

4.2. Productive parameters

4.2.1. Carcass quality

There were no significant differences between the carcass weight, the cold carcass weight, the hot carcass weight and the carcass loss of the experimental treatments.

Table 4.3. Fish carcass yield

Carcass tests	Control	Cinnamon	Oregano	Average	
Wight carcass, g	45.49±1.241	45.86±0.627	45.92±1.882	45.76±0.707	0.971
Hot carcass, g	73.02±0.894	73.30±0.257	72.38±0.925	72.90±0.412	0.691
Cold carcass, g	71.62±0.974	72.08±0.411	71.19±0.997	71.63±0.451	0.761
Loss of carcass, g	1.92±0.138	1.66±0.214	1.65±0.175	1.74±0.101	0.523

P: probability

4.2.2. Meat characteristics

There are no significant differences between in fish meat dry matter, ash, fats, protein, pH and moisture of the experimental treatments. There were no significant differences in meat color parameters (a*, redness; b*, yellowness; L*, lightness). There were no significant differences in cooking and thawing loss.

Table 4.4. Effects of cinnamon and oregano essential oil addition on fish meat characteristics

Meat	Control	Cinnamon	Oregano	Average	p
Dry matter, %	25,26±0,72	24,98±0,26	25,69±0,98	25,31±0,39	0,675
Ash, %	8,50±0,75	6,85±0,22	7,60±0,40	7,71±0,30	0,61
Protein, %	76,43±1,98	77,40±1,01	75,24±1,67	76,42±0,88	0,643
Fat, %	11,26±0,65	12,19±1,62	12,66±1,28	12,04±0,68	0,517
Color of meat	**Control**	**Cinnamon**	**Oregano**	**Average**	**P**
L*	58,80±1,59	59,62±1,75	58,14±2,97	58,85±1,16	0,893
a*	-1,15±0,17	-0,16±0,87	-1,23±0,70	-0,85±0,37	0,470
b*	4,59±1,43	6,73±0,637	3,97±0,50	5,10±0,61	0,153
Physical tests	**Control**	**Cinnamon**	**Oregano**	**Average**	**P**
pH meat	7,47±0,01	7,49±0,03	7,54±0,06	7,47±0,01	0,592
Cooking loss, g	31,09±0,85	26,84±0,62	35,29±1,01	37,07±0,69	0,266
Thawingloss, g	8,16±0,98	8,94±1,21	8,29±1,34	8,46±0,63	0,883

P: probability, L*: lightness, a*: Redness, b*: Yellowness

4.2.3. Blood constituents

The effects of cinnamon and oregano essential oil addition on fish blood serum components are provided in Table 4.5. There were no significant differences among the treatment groups in terms of examined serum components (P>0.05), except for serum total protein. The serum protein level of the control group was greater than the cinnamon and oregano essential oil supplemented groups.

Table 4.5. Effects of cinnamon and oregano essential oil addition on fish blood constituents

Item	Control	Cinnamon	Oregano	Average	
Glucose, mg/dL	73.25±4.13	74±3.54	66.75±4.29	71.33±2.31	0.407
HDL cholesterol, mg/dL	47.15±9.29	46.22±4.70	41.87±7.47	45.08±3.93	0.867
Triglycerides, mg/dL	407.5±73.85	320.25±36.01	316.5±39.57	348.08±30.27	0.42
Cholesterol, mg/dL	404.0±40.21	378.0±14.93	357.5±25.67	379.83±16.12	0.544
Total protein, g/dL	4.19±0.29[a]	3.47±0.17[b]	3.50±0.06 [b]	3.718±0.14	0.048*
LDL cholesterol, mg/dL	190.52±58.97	176.1±49.85	254.7±22.03	207.10±26.31	0.473
ALT, u/dL	7.50±2.5	11.00±2.48	8.25±0.85	8.91±1.18	0.489
AST, u/dL	343.5±68.86	337.5±20.56	276.5±38.12	319.16±26.17	0.558

ALT: alanine aminotransferase AST: aspartate aminotransferase, P: probability, *, [a, b]: the means indicated with different letters in the same row were significantly different at P<0.05.

4.2.4. Fatty acid analysis

The effects of cinnamon and oregano essential oil addition to trout fish diet on fatty acid composition of fish are given in Table 4.6. There was no significant difference among the treatment groups in terms of fatty acid composition of meat. Most abundant fatty acid was linoleic and second one was oleic acid.

Table 4.6. The effects of cinnamon and oregano essential oil addition to trout fish diet on fatty acid composition of fish (%)

Fatty acid	Control	Cinnamon	Oregano	Average	p
Myristic Acid, 14:0, %	1.12±0.022	1.10 ± 0.014	1.12±0.023	1.12±0.011	0.708
Palmitic Acid, 16:0, %	17.13±0.69	16.65±0.346	16.68±0.143	16.82±0.246	0.713
Stearic Acid, 18:0, %	4.41±0.363	4.702±0.0705	4.44±0.18	4.51±0.1302	0.649
Palmitoleic Acid, 16:1, %	2.03±0.131	1.9±0.097	2.02±0.112	1.98±0.062	0.669
Oleic Acid, 18:1, ω-9, %	32.16±0.251	32.39±0.472	32.39±0.431	32.31±0.21	0.897
Linoleic Acid, 18:2, ω-6, %	33.85±1.093	33.99±0.357	34.51±0.518	34.12±0.389	0.800
α-LinolenicAcid, 18:3, ω-3, %	2.54±0.074	2.54±0.083	2.65±0.063	2.57±0.041	0.507
Arachidic Acid, 20:0, %	0.74±0.042	0.77±0.0379	0.78±0.09	0.76±0.032	0.883
Eicosadienoic Acid, 20:2, %	1.39±0.112	1.51±0.057	1.44±0.128	1.44±0.056	0.750
Eicosapentaenoic Acid, 20:5, ω-3, %	0.80±0.197	0.59±0.061	0.53±0.025	0.64±0.071	0.312
Docosahexaenoic Acid, 22:6, ω-3, %	3.79±0.162	3.83±0.405	3.41±0.348	3.68±0.177	0.612
ΣMUFA	34.20±0,33	34,30±0,55	34,42±0,47	34,30±0,40	0.947
ΣPUFA	42,38±1,05	42,47±0,69	42,55±0,38	42,46±0,40	0.988
ΣSFA	23,41±1,02	23,23±0,39	23,04±0,22	23,23±0,34	0.919

P: probability, MUFA: monounsaturated fatty acid, PUFA: poly-unsaturated fatty acid, SFA: saturated fatty acid.

CHAPTER 5

DISCUSSION

5.1. Performance Traits (BW, BWG, FI, FCR), and Mortality

There was no statistical significance in terms of body weight, body weight gain, but there was statistical significance in feed intake and feed efficiency of fish. Essential oils have some properties to contribute to animals like antimicrobial and antioxidant effects. Also, they can promote secretion of digestive fluids in intestinal system. They may contribute to animal body by restricting competitive pathogenic bacteria in the intestine and help a better immunity against microorganisms. Similar results were found by (Yilmaz and Ergün, 2015) using 3 g carvacrol/kg feed in trout feed and by (Abdel-Tawwab et al., 2018) using 3 gcinnamonnano particles/kg feed and by (Zheng et al., 2009) using 0,05% cinnamon/ kg feed in Nile fish. In contrast to present findings, Yilmaz (2013) reported that 1% addition of oregano and rosemary powder per kg feed caused an increase in BW and BWG of sea bass.

The FCR values was highest in the cinnamon oil group and there is significant effects between a group of treatment groups (oregano oil and cinnamon oil) were significantly different from the control treatment.. Similar to present findings, (Bloch, 2018) used 5% kg of cinnamon for catfish and reported significant improvements in FCR values and such improvements were mainly attributed to presence of ingredients in the essential oil of cinnamon like cinnamaldehyde, which is responsible for the greater part of the benefits of cinnamon oil. This compound has the ability to act as a bacterial and fungicide anti-disease (Saleh, 2010) and (Santos et al., 2016) mentioned that it worked to improve the immune system where the body is in a good immune role and vital processes and activities are better. Ibrahim (2018) confirmed that using essential oil of

oregano at 2ml / kg improved the nutritional conversion rate significantly due to the ingredients of oregano as it works as a health supporter (Widmer et al., 2014).

There were differences in feed intake values of the experimental treatments, but their differences were found to be significant for the cinnamon oil group compared with other groups. Present findings on feed intake comply with the findings of (Álvarez et al., 2012) where 500 mg was used in Spares fish reporting insignificant effects of experimental treatments on feed intakes of treatment groups. (Setiawati et al., 2016) used 5% cinnamon powder per kg feed in catfish diets and reported again insignificant differences in feed intakes of treatment groups. (Khorrami et al., 2014) reported that there were no significant differences in feed intakes of fish with the addition of cinnamon and oregano at 500 mg / kg.

There were 4 mortalities in the control group, 3 mortalities in oregano essential oil group and there was no mortality in cinnamon essential oil group. There were no significant differences in mortality of the experimental groups. Present findings were similar with the results of (Bloch et al., 2018) reporting positive effects of 1% cinnamon powder per kg on survival rates and decreased survival rates at 0.5% of cinnamon powder. There are also similarities with the results of Mohamed (2018) adding 2 ml/kg and reporting increasing survival rates in Nile tilapia.

There were significant differences in response to the feed provided, the amount of feed consumed daily, feed intake and feed conversion ratio for the cinnamon essential oil group, due to the fact that the feed treated with cinnamon essential oil had greater palatability by the fish.

5.2. Carcasstraits, Hot and Cold Carcass Yield %

No significant difference was detected in the treatments used. There was no significant difference between the treatments in terms of carcass weights. There was no significant difference between treatments related to hot and cold carcass weights. Present findings were similar to the results of (Setiawati et al., 2016), where it was reported that the use of 1% of cinnamon per kg strengthened some traits of catfish and did not affect the carcass weights significantly. (Ahmad et al., 2011) mentioned the opposite results for Nile tilapia fish, since adding 1% of cinnamon per kg resulted in improved cold and hot

carcass weights. Present findings comply with the results of (Tan, 2014) adding 0.05% oregano to catfish and reporting insignificant effects of experimental treatments on carcass traits. (Bhatt, 2015) used herbs and extracts as a substitute reported that nutritional herbs and spices not only acted as appetizers and stimulants for digestion, but also had positive impacts on physiological functions, aide in maintenance of good health and well-being and improved animal performance.

5.3. Meat Chemical Composition

5.3.1. Dry Matter of meat

There was no significant difference in meat dry matter and moisture content of cinnamon and oregano oil treatment groups. Present findings were similar to results of Rohani (2018) where it was stated that 1% of oregano did not affect meat moisture and dry matter significantly. Rezayatmand (2016) confirmed that the use of 32 mg/ml increased the action of antifungal agents, but in return reduced the growth and development and impaired vital processes because of the compounds found in cinnamon (Lanka, 2002).

5.3.2. Protein of meat

There was no significant difference in fish meat protein or no significant differences between the experimental groups. Present findings were similar to that of El-hawarry (2018) where it was stated that the use of 1% of cinnamon per kg did not affect the amount of protein in sea bass meat. (Abdel-tawwab et al., 2017) reported that protein content of tilapia fish that was fed with cinnamon supplemented (3 g / kg of feed) diets was greater than the control group. (Sönmez et al., 2015) also reported that 1% oregano supplementation did not effect meat protein ratios of trout significantly.

5.3.3. Fat of meat

There was no significant difference between the percentage of fats in meat and the quantity extracted from the samples. These values are similar to the study of (Ahmad et al., 2011), as adding 1% of cinnamon did not affect meat fats. Wahdan (2018) emphasized that adding 3 g / kg of carvacrol in meals can improve some non-chemical and biological status in rainbow trout and does not affect the amount of fats in meat.

Similar results also confirmed (Adekunle, 2012) that medicinal herbs do not affect the carcass components of protein, fat, ash and dry matter.

5.3.4. Ash of meat

There were no significant differences in meat ash content of experimental treatments and similar results appeared in the study of (Sary et al., 2018), where it was stated that the use of 0.35 g / kg of cinnamon essential oil did not affect meat ash significantly. Mabrok (2018) used 1 g / kg of oregano essential oil on tilapia zillii and reported insignificant effects of experimental treatments on meat dry matter, fat, protein and ash contents. Flores (2009) stated that herbs improved some meat traits and others did not have significant effects on investigated traits.

5.3.5. PH of meat

There was no significant difference between the pH of meat samples of all treatments. Present findings comply with the results of Ergün (2015) indicating insignificant effects of 3 g / kg carvacrol on meat pH values of trout. (Sary et al., 2018) used 0.35 g / kg of cinnamon oil and reported insignificant changes in meat pH of Nile tilapia with the experimental treatments. Similarly, Damla (2016) used 0.5% rosemary extract per kg for catfish and showed no changes in meat pH with the experimental treatments.

5.3.6. Color of meat

There was no significant difference in meat color parameters (lightness, L *; redness, a* and yellowness, b*). Similar results were also reported by (Dairun et al., 2018) where it was stated that 1% cinnamon did not result in significant differences in meat color parameters of catfish due to the fact that the herbal substances affected the different activities and limited antibiotic action. Present findings matched with the results of (Diler et al., 2016), where it was mentioned that 2.5 mg of oregano did not yielded any significant effects on carcass traits and flesh color parameters of trout, but improved the antioxidant activity well (Rozi, 2016).

5.4. Meat Analysis During Cookingloss, Thawingloss

There was no significant difference between the meat samples during the measurement of cooking loss and there was no significant difference in the meat samples during the measurement of thawing loss. These results were similar to findings of (Abdel-tawwab et al., 2017), where it was reported that using cinnamon nano particles at 3 grams per kg did not affect or give a significant result for cooking and thawing loss. (Tan, 2014)mentioned that adding 0.05% of oregano to each kg of catfish did not affect the cooking and thawing loss, but it worked on some characteristics such as antioxidants and muscle protein deposition.

5.5. Activity of the Fish

In the daily activity, differences were found between the groups due to eating food and movement processes, but there were no significant differences between the groups fed on cinnamon oil, oregano oil and the control treatment. There were no significant differences between activity before and after feeding, there was no significant difference in external responses after and before feeding between the groups. These results were similar to findings of (Dairun et al., 2018), where it was reported that 1.5% of cinnamon powder per kg of feed did not have significant effects on daily activity of catfish throughout the experimental period. (Dicentrarchus, 2013) asserted that 1% oregano and rosemary per kg of feed did not have significant effects on daily activity of sea bass.

The feed response of fish was significantly influenced by cinnamon and oregano oil supplementations ($P < 0.05$). The greatest response was observed in cinnamon oil group and it was respectively followed by oregano oil and control groups. Experimental treatments had significant effects on daily feed intakes ($P < 0.05$) with the greatest value in cinnamon oil group. (Sönmez et al., 2015) indicated similar results, as it gave 1% of oregano oil and led to an increase in nutrition activity and the amount of feed consumed. (Abd et al., 2018)confirmed that adding 1 g / kg of oregano gave an increase in the survival rate and different responses. (Kesbiç, 2019) mentioned similar results that adding 4 mL / kg feed positively affected the nutrition and overall performance of trout. (Setiawati et al., 2016)confirmed that using 1% cinnamon leaf powder in catfish diet improved growth performance, feed response and feed consumption.

5.6. Fatty Acid Composition

There were no significant differences in fatty acid composition of experimental groups. These results were similar with the results of (Adekunle, 2012), where it was stated that the use of herbal powder at 10 g / kg feed for tilapia Nile fish did not cause significant changes in fatty acid compositions. The opposite happened in (Dikel, 2018) where it was reported that 1% of black cumin oil for every kg of feed increased linoleic acid contents of trout fish. Present findings comply with the results of (Yilmaz and Ergün, 2015) where it was reported that 3 g / kg of carvacrol decreased blood triglyceride levels of trout, but did not have significant effects on fatty acid compositions. (Sary et al., 2018) mentioned that adding cinnamon oil by 0.7% reduced oxidative stress in meat and did not significantly affect the fatty acid compounds of tilapia. (Ahmad, 2011) confirmed that adding 1% of cinnamon extract did not affect the formation of fatty acids in the meat of Nile tilapia.

5.7. Blood Parameters

There were no significant differences in the blood parameters of the experimental groups, except for total protein content. Significant differences were observed in total protein contents of the treatment groups. Present findings were identical with the results of (Santos et al., 2016) where it was reported that cinnamon oil and cinnamon powder supplementation Nile tilapia diets did not have any significant effects on blood parameters. Ergün (2013) stated that adding 1% of oregano to each kg of sea bass fish did not affect the blood content. (Kesbiç, 2019) found good results by adding 4 ml / kg cinnamon oil to trout diets and reported decreasing blood glucose, triglyceride and cholesterol levels and increasing total protein and albumin contents with the experimental diets. According to (Khrystenk et al., 2015) use of 1% of oregano in trout diets did not have significant effects on blood parameters.

CHAPTER 6

CONCLUSION

In this experiment there were no significant difference among the treatment groups in terms of performance, carcass traits and meat quality. However, until now, there were some positive results of herbal essential oil on animal performance, carcass traits and meat quality. In this experiment we couldn't evaluate antimicrobial activity of fish due to water circulation system which it was a central system and joint each either. Therefore, when fish eat feed EO worked at fish body. In contrast to finding in this experiment we got valuable observation related to fish health and appearance and their activity. Unfortunately, the positive observations did not respond on performance and carcass traits, only they reflected on livability of fish.Especially, cinnamon essential oil can be used in fish feed trout as a supporter and regulator of vital processes and reduced mortality with 100% survival rate and in oregano essential oil lower mortality than control group. The overall activity, the feed consumption ratio, and the response to the provided feed, the daily consumed feed for the cinnamon essential oil group were better compared to other groups.

In conclusion, cinnamon and oregano essential oil can be used in fish production. There is lacking information on different essential oil and their dose in fish. Therefore, new experiments should design to get more information about different essential oil in different dose and their effect on performance, carcass, neat and blood components and antioxidant activity.

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