T.R.
NİĞDE ÖMER HALİSDEMİR UNIVERSITY
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EFFECT OF DIETARY SUPPLEMENTATION OF BLACK CUMIN SEEDS (*NIGELLA SATIVA*) ON PERFORMANCE, CARCASS TRAITS AND MEAT QUALITY OF JAPANESE QUAILS

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MASTER THESIS

NİĞDE ÖMER HALISDEMIR UNIVERSITY
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Muhammad Umair Asghar tarafından **Prof. Dr. Sibel CANOĞULLARI DOĞAN** danışmanlığında hazırlanan **"Bıldırcın karma yemine çörek otu katkısının performans, karkas özellikleri ve et kalitesi üzerine etkileri"** adlı bu çalışma jürimiz tarafından Niğde Ömer Halisdemir Üniversitesi Fen Bilimleri Enstitüsü **Hayvansal Üretim ve Teknolojileri** Ana Bilim Dalı'nda Yüksek Lisans tezi olarak kabul edilmiştir.

The study titled **"Effect of dietary supplementation of Black cumin seeds (*Nigella sativa*) on performance, carcass traits, and meat quality of Japanese quails"** and presented by **Muhammad Umair Asghar** with the help of supervisor **Prof. Dr. Sibel CANOĞULLARI DOĞAN,** has been found as Master thesis by the jury at the Department of Animal Production and Technologies of Niğde Ömer Halisdemir University Graduate School of Natural and Applied Sciences.

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Supervisor

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September 2021

DECLARATION

I proclaim that all information present in this thesis is derived and compiled keeping in view the scientific and academic rules and that this study is jotted down considering academic rules and regulations. Moreover, any help and resources that i have seek in compiling this thesis are duly mentioned wherever required.

Muhammad Umair Asghar

SUMMARY

EFFECT OF DIETARY SUPPLEMENTATION OF BLACK CUMIN SEEDS (*NIGELLA SATIVA*) ON PERFORMANCE, CARCASS TRAITS AND MEAT QUALITY OF JAPANESE QUAILS

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September 2021, 99 pages

Current study was conducted to observe the effect of black cumin powder BCP (*Nigella sativa*) additive on the carcass characteristics and meat quality of quails. In this research, 240 quail chicks were divided into 4 groups with 4 replications. Treatments were 0, 1, 2 and 4 % of BCP to the mixed feed. When contrast to the other groups, 2% BCP supplemented group had higher live weight, body weight gain, and a better feed conversion ratio ($P<0.05$). BCP administration had no impact on carcass characteristics however BCP had a significant effect on thigh and breast meat. Lower thiobarbituric acid (TBA), pH, peroxide and total psychrophilic bacteria levels were found in the BCP added groups compared to the control group ($P<0.05$). When compared with the control, the sensory properties such as color, juiciness, softness and flavor were significantly higher in the BCP treated groups, especially at the 2% BCP supplementation level. It is concluded that BCP as additive to quail feeds had a significant effect on performance of quails and also on the shelf life of meat. In order to avoid health and environmental concerns, it was concluded that BCP can be used as a natural additive to replace synthetic antimicrobials and antioxidants at the level of 1-2% in quail compound feeds.

Keywords: Quail, performance efficiency, black cumin powder, natural-antioxidant, meat quality

ÖZET

BILDIRCIN KARMA YEMİNE ÇÖREK OTU KATKISININ PERFORMANS, KARKAS ÖZELLİKLERİ VE ET KALİTESI ÜZERİNE ETKİLERİ

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Bu çalışma, çörek otu tozu (*Nigella sativa*) katkısının bıldırcınların karkas özellikleri ve et kalitesi üzerine etkisini gözlemlemek amacıyla yapılmıştır. Bu araştırmada 240 adet bıldırcın civcivi dört tekerrürlü olarak dört gruba ayrılmıştır. Muameleler, karma yem için çörek otu tozu % 0, 1, 2 ve 4'ü idi. Diğer gruplarla karşılaştırıldığında, %2 çörek otu tozu ilave edilen grupta daha yüksek canlı ağırlık, canlı ağırlık artışı ve daha iyi yemden yararlanma oranı vardı ($P<0.05$). çörek otu tozu uygulamasının karkas özellikleri üzerinde hiçbir etkisi yoktu, ancak çörek otu tozu but ve göğüs eti üzerinde önemli bir etkisi vardı. çörek otu tozu eklenen gruplarda kontrol grubuna göre daha düşük tiyobarbitürik asit (TBA), pH, peroksit ve toplam psikrofilik bakteri seviyeleri bulundu ($P<0.05$). Kontrol ile karşılaştırıldığında, özellikle %2 takviye seviyesinde, çörek otu tozu ile muamele edilmiş gruplarda duyusal özellikler önemli ölçüde daha yüksekti Bıldırcın yemlerine katkı maddesi olarak çörek otu tozu 'nin bıldırcınların performansı ve ayrıca etin raf ömrü üzerinde önemli bir etkiye sahip olduğu sonucuna varılmıştır. Sağlık ve çevresel kaygılardan kaçınmak için çörek otu tozunun, sentetik antimikrobiyallerin ve antioksidanların yerini alacak doğal bir katkı maddesi olarak bıldırcın karma yemlerinde yüzde 1-2 düzeyinde kullanılabileceği sonucuna varılmıştır.

Anahtar Kelimeler: Bıldırcın, performans, çörek otu tozu, antioksidan, et kalitesi

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SYMBOLS AND ABBREVIATIONS

Symbols	**Abbrevations**
%	Percentage
℃	Degrees celsius
Cm	Centimetre
G	Gram
$K_2S_2O_8$	Potassium persulfate
Kg	Kilogram
KI	Potassium iodide
L	Litre
Mg	Miligram
Ml	Mililitre
Na_2Co_3	Sodium carbonate
ppm	Parts per milion

Abbreviations	**Descriptions**
BHT	Butyl Hydroxy Toulene
GAE	Gallic Acid Per Equivalent
PV	Peroxide Value
SE	Standard Error
SEM	Standard Error Mean
SOD	Super Oxide Dismutase
TBARS	Thiobarbituric Acid Reactive Substances
TEAC	Trolox Equivalent Antioxidant Capacity
TPC	Total Phenolic Contents
WHC	Water Holding Capacity.
LBW	Live Body Weight
FCR	Feed Conversion Ratio
BWG	Body Weight Gain
FI	Feed Intake

LDL	Low Density Lipids
ND	Newcastle Disease
IBD	Infectious Bursal Disease
DOC	Day Old Chick
LDL-C	Low Density Lipoprotein-Cholestrol
HDL-C	High Density Lipoprotein-Cholestrol
AST	Aspartate Aminotransferase
NOHU	Niğde Ömer Halisdemir University
RPM	Resolution Per Minute
TDS	Total Digestible Solvents
PCA	Plate Count Agar
BCP	Black Cumin Powder

CHAPTER I

INTRODUCTION

Quail farming has always been enthusiastically accepted because of its higher productive potentional along with a shorter incubation span of only 17 days. Quails are chosen for the tenacity of production over the other game birds due to its smallest size and fast growing rate. Quails are most oftenly habitated in Asia, America, Europe, and Australia but their remunerative breeds are raised for eggs and meat intention around the globe. Japanese quail (*Coturnix japonica*) is very popular for monetary use and it is receiving massive fame due to its higher production capacity. Among other quail strains, japanese quails having an ability to attain a liveweight of 200 grams within a 4 weeks of age. In a free range raring system, the reported weight of this strain is 100-160 gram (Ahmad, 2014). Regardless of the quality, quail farming is very expedient as it acquires least cost of maintaince, healthy production and a remarkable revenue ratio (Ray et al., 2014).

Japanese quails are massively crucial due to their lucrative value in egg development. If we are talking about the laying capacity of japanese quail is around 290-300 eggs in their first laying cycle (Jatoi et al., 2015). The different products obtaining from quails have shown numerous health profits and also helpful in treatment of different diseases like ulcers or gastratitis (Udeh et al., 2018). Several diseases like chlorosis, plague, asthma, low glucose level, white plague can be treated by using products of quail and extinction of heavy metals is also abetted by the application of quail products like meat of quail (Chi et al., 1982). They also helpful in crushing the stones present in gall bladder, kidney, and liver. Products obtaining from quails are also helpful in consolidation of heart muscles, rebust tonic contray to sexual vigor and rehabilitation of blood circulation after blood stroke, also shown antineoplastic effects (Udeh et al., 2018).

Poultry industry is one of the most lucrative sector among other sectors around the globe and having the ability to provide high biological value protein as the source of animal protein. People showed their devotion in investing in the poultry industry because people likely to earn in a faster way in contray to the other sectors. The survey reported that, the world population is going to be increased hastily which means population of the world is going to be reach ten billion in 2050 and further going to reach about 11 billion in 2100, which is a problem of numerous trepidations. As concurrently there is a present shortage of animal protein sources also going to be increased among different people. To overcome this protein gap, scientist are going to be used synthetic chemical stuffs in poultry sector. Antibiotics are widely used in broilers as a cradle of growth promoters, therefore antibiotics hold massive position in industry (Miles et al., 2006). Broilers are showing fast growth rate and short generation gap so antibiotics are anxiously used in broiler sector to execute effeciency and raise the quality of carcass collectively with less ratio of fat and over amount of protein in meat (Kinsella et al., 1990; Nettleton, 1991). Various zoonatic infectious culprits such as *Salmonella, E. Coli*, and *Enterococci* strains can abridged with the aid of synthetic chemicals in diet of the broilers. Birds were showing better enactment if these kind of antibiotics were added in the diet of broilers but the problem araises due to execcive usage of antibiotics, their residues come into meat and eggs (Issa and Omar, 2012) that showed problems regarding human health (Rahmatnejad et al., 2009). People of moderan area are interested to eat or preffer those kind of foodstuffs which carried enormous bioactive components alongwith better health advantages (Cofrades et al., 2008). Quality and quantity are embattled nowadays, concerning about the food ingredients.

Dietary insertion of antibiotics in poultry feed as a growth promoter most often lead to occurrence of cross resistance amid pathogens and also a cause of residues tissues of the animal body (Schwarz et al., 2001). As a result of this issue, European Union (EU) forbidden the routine practice of antibiotics as growth promoter in diet of the animal in January, 2006 (Toghyani et al., 2010). Antibiotic growth promoters (AGP) have been phased out of the diet of poultry, particularly broiler chickens, in favor of phytogenic feed additives (Jalal et al., 2019). Now, the scientist are in search of substitute natural growth promoter ingredients like essential oils, phytobiotics, various plants of medicinal origin, which are more prone to be advantageous due to their antimicrobial resistance (Elgayyar et al., 2001; Valero et al., 2003). Such kind of medicinal plants also showing stimulating special effects on digestive system of the animals (Jamroz et al., 2002; Jang et al., 2004; Ramakrishna et al., 2003).

Because of excessive intake of fat in the meat, the consumers are more prone to develop different kind of diseases like cardiovascular problems, cancer and overweightness (Hygreeva et al., 2014). There is an amplified amount of polyunsaturated fatty acids exists in meat of poultry, which are more prone to oxidative degradations. In meat cooking, processing and cold storage unit, oxidation of lipids is a main obstacle. Due to the oxidation of lipids in meat leads to decrease the shelf life of meat, deterorate taste, standards of the food and likewise also affects the organoleptic characteristics. To ensure the quality of food products should be maintain by adding some kind of antioxidants which don't permit the oxidation of lipids (Pawel et al., 2005). To hurries the shelf life of poultry feed, two different kinds of antioxidants (Natural and Synthetic) were used just to escaped from their oxidative desecration. Several different kind of synthetic antioxidants and antimicrobial agents are still used in underdeveloped countries just to avert unwanted reactions and increases the shelf life of foodstuffs.

Some people belief in using natural source of antioxidants instead of using synthetic origion antioxidants just because of their delterious effects on health (Capitani et al., 2015). Besides, antioxidants and antimicrobials of natural origin procurement from plants, animals and microbes that are verified to be protected, persuasive and acceptable which is frequently questioned (Hygreeva et al., 2014). Scientists devotes their attentions in search of knowing some natural origin stuff that can be added in in feedstuff without any detrimental effects on health of humans and animals and they are doing their work in this way by knowing each and every aspect related to health problems in mind. For the sake of getting high nutritious products, it is very crucial to acquire it from those type of ingredients which are proven to be healthful and decrease the utilization of those products which are proven to be unhealthful (Decker and Park, 2010). So its better to used natural origin products instead of using artificial or synthetic sources products due to their pureness and legitimacy of natural foodstuffs. Animal nutritionists are trying to make such kind of products which having low content of fat and sodium alongwith natural sources of antioxidants and antimicrobials, also inserted with omega-3 and omega-6 fatty acids (Hygreeva et al., 2014). Aromatic plants are playing a very crucial role in substituation of chemical products in animal feed, just because of their biological active compounds present in aromatic plants. Flavonoids are very persuasive in aromatic plants amid the other biological active compounds in plants (Shaidi et al., 1992). Aromatic plant essentail oils (EOs) are recognized to have a variety of physiologically active characteristics that can be used in current animal production. EOs enhance digestive enzymes, boost feed conversion ratio, alter ruminal fermentation, provide antioxidant qualities, and underpin animal immunology. The use of EOs in the feed has been shown to be a simple and effective way to improve livestock production (Akram et al., 2021).

Several plants contains different kinds of biological active compunds like garlic contains allicin, ginger contains gingirol, likewise oregano, parsley, black cumin, curcumin, cinnamon, rosemary, alovera etc. The main objective of using these kind of herbs is that they have reboust antimicrobial activities, antioxidative traits, lowering of cholesterol capability, strong positive effects on gastrointestinal tract, muscle relaxant effects and effects against epileptic disorder (Elgayyar et al., 2001; Botsoglou et al., 2002; Jmaroz and Kamel, 2002). Supplementation of phytobiotics and their tonics in animal feed causes reboust the whole proficiencies of the animals (Alcicek et al., 2003). Essential oils (EOs) are natural supplements that are derived from aromatic components and are crucial for biological actions such as antibacterial and antioxidant activity. Incorporating bio-active chemicals, particularly essential oils, either in food or edible/biodegradable food containers appears to improve the storage life and quality attributes of processed foods while also protecting customers from oxidative and bacterial degradation effects (Akram et al., 2019).

Each country has followed their own manners of living and their people adopt special approaches regarding the application of herbs as a treatment purpose or a precautionary measures. Aloe vera therapy demonstrated improved outcomes on growth performance metrics, immunological response, and coccidiosis in broiler chicken since it is a herbal medication and a replacement to antibiotic growth boosters as described by (Akram et al., 2019).

Nigella sativa (black cumin) specie has kinship to the *Ranunculaceae* which is renowned for its medicinal chattels. Seeds of black cumin contains alkaloids, volatile, oils and a diversity of pharmacologically bioactive stuffs like thymoquinone, dithymoquinone, carvacrol, thymol, nigellicine-N-oxide, nigellidine and α-hedrin (Al-homidan et al., 2002; Ghosheh et al., 1999; Nasir et al., 2005). Black cumin is also fortified with fat content of 35.6% (Babyan et al., 1978). Seeds of the black cumin contains volatile oil about 0.5-1.7%, fixed oil is 35.5- 41.5%, amino acids and protein is 22.6% (AL-Gaby et al., 1998). Therefore, seeds of the black cumin can be utilized in feed for versatile growth promoter and might be showing extraordinary effects on performance of the broilers (AL-Beitawi et al., 2009). Many scientist have observed astonishing consequences concerning the use of black cumin as an alternative to antibiotics and a cradle of nutrition in diet of the poultry.

Black cumin (*Nigella sativa L.*) is a recurrent and autogenously plant of kinship Umbelliferae, scientifically famous as Bunium persicum Boiss. Its natural territory is Central Asia, Western and Southeast Europe (Azimzadeh, 2009). Black cumin is a medicinal plant inherent to Southwest Asia, together with Iran, Pakistan and India. Black cumin having pale blue color shoots, white flowers and their growth height is about 40-71 cm (Amin and Hosseinzadeh, 2016). Seeds are very tinny in size about 2.5-3.6 mm length and a width of 1.5-2.0 mm. Seeds of this plant contains oil, alkaloids, protein, amino acids and saponins (Khan, 1999; Burits and Bucar, 2000; El-Ghorab, 2003). Extracts obtained from black cumin are conventionally used as it contains biological active compounds having antimicrobial, antioxidant characteristics. These kind of characteristics exerts astonishing physiological effects (Graig, 1999; Niwas and Sing, 2014; Attia et al., 2019; Baghban-Kanani et al., 2019; Khoobani et al., 2020). Black cumin also contains an extraordinary amount of carbohydrates, amino acids, proteins, lipids and calcium, potassium, phosphorus, magnesium minerals (Tauseef Sultan et al., 2009). Phytochemicals includes essential oils are showing astonishing effects and can be used to cure high level of cholesterol and glucose in the blood.

The oil extracting from black cumin is showing immune protector response and thymoquinone, unsaturated fatty acids present in the oils are strong antioxidants which can be used for the cure of various diseases like cancer (Hidayati and Inayati Habib, 2015). Amid 38 different kinds of volatile substances notorious in black cumin, thymocinone and p-cymenes are the fundamental bioactive components. The concentration level of these compounds are ominously increased by hot boiling and raises the level of perizins, furans, distressing the odor and taste of these compounds (Kiralan, 2012). There are 18 different kinds of compounds present in black cumin included 99.15% of the total essential oil and cumin aldehyde 23%, gamma-terpine (14.5%), acetic acid (10.9%) and 1,3,8-p-acetic acid (10.9%) and 1,3,8-p-menthatriene

(7.9%) (Jalilzadeh Amin et al., 2011). Black cumin holds 3% essential oil, and the fundamental component of its essential oil is carvone, which crafts about 66% of the oil. One more fundamental compound present in the oil is limonene, which accounts for 50% of the oil (Moghtader et al., 2009). Further fundamental compounds of black cumin are sabinene, carvon, carveol, flavonoids, polysaccharides, coumarin and cuminaldehyde, which showing effects against fungi (Yalcin et al., 2009), effects against bacteria (Oroojalian et al., 2010), effects against spasmodic (Jalilzadeh Amin et al., 2011), analgesic effects, effects against inflammation (Hajhashemi et al., 2011) and effects against convulsion disorder (Mandegary et al., 2012) characteristics (Thappa et al., 1991).

Amid phytobiotic plants, black cumin is a well notorious medicinal plant. Black cumin is infrequently used worldwide. Each country has its own tactic to be used this black cumin, as its powder is most frequently used as a spice or medicinal herb. Black cumin powder having capabilities to be work againt various bacterial diseases.

Therefore, the dietary addition of black cumin powder in quail’s diet could definitely showed positive impacts on the quality of meat. However, the literature showing effects of black cumin powder on the meat quality of quail’s is very fewer. Hence, the main objective to conduct this current study, to examin the impact of black cumin powder as a substitute to synthetic antibiotics as growth promoters in quails diet. Also examine its impact on performance, carcass characterisics, pH, colour of meat, oxidation of lipid and sensory chattels of quail meat.

CHAPTER II

LITERATURE REVIEW

2.1 General Information

Black cumin seed (*Nigella sativa*) basically a perennial in nature belongs to family Umbelliferae. It also termed as black cumin, black caraway seed, habbatul baraka (the blessed seed). For quite a long time, the black seed herbs and oil has been utilized by a large number of individuals in Asia, Middle East, and Africa to aid their health and also utilized for cure of health-related issues like respiratory, intestinal, kidney, liver, circulatory, immune system support.

It is a living species of Central Asia, Western and Southeast Europe (Azimzadeh, 2009). Amin and Hosseinzadeh (2016) elaborated that it is a medicinal plant that is domesticated in southwest Asia, together with the regions of Iran, India and Pakistan. It is heighted about 40-70cm and basically comprised of light blue shoots, whitish flowers. It contains oil, alkaloids, protein and saponins and seeds are tiny ranges from 2.5–3.5 mm in length and 1.5–2 mm of width (Khan, 1999; Burits and Bucar, 2000; El-Ghorab, 2003). It is also utilized for herbal extracts, that comprised of antibacterial and antioxidant characteristics, employing positive physiological properties (Graig, 1999; Niwas and Sing, 2014; Attia et al., 2019; Baghban-Kanani et al., 2019; Khoobani et al., 2020). Further, Tauseef Sultan et al. (2009) reported that black cumin comprised of substantial quantities of macromolecules including carbohydrates, proteins etc. Dark cumin seed oil is an immune defender, and unsaturated fats and thymoquinone present in the oil are powerful cell reinforcements for the avoidance of specific illnesses, like cancer (Hidayati and Inayati Habib, 2015). Thymocinone and p-cymenes are the main volatile components in cumin seeds along with other thirty-eight compounds. Roasting helps meaningfully elevated the worth of these components and the concentrations of perizins and furans enhances, affects the properties of these components (Kiralan, 2012). Limonene, for about 50% of the oil (Moghtader et al., 2009). Other important components contained about 99.14% of oil and cumin aldehyde 23.0%, gamma-terpine 14.5%, acetic acid 10.9% and 1,3,8-p-menthatriene 7.9% (Jalilzadeh Amin et al., 2011). Other main components are sabinene, carvon, carveol, flavonoids, polysaccharides, coumarin and cuminaldehyde, which have antifungal (Yalcin et al., 2009), antispasmodic (Jalilzadeh Amin et al., 2011), antibacterial (Oroojalian et al., 2010), pain killing, anti-inflammatory (Hajhashemi et al., 2011) and anticonvulsants (Mandegary et al., 2012) functions (Thappa et al., 1991).

In livestock and poultry nutrition the use of antibiotics is prevented because of the attaining of antibiotic-resistant bacteria and the likelihood of transmission to human. Moreover, researchers worked on several other materials. It has been proved that herbs enhanced feed conversion value (Lee et al., 2003), immunity (Akhtar et al., 2003) and digestion of nutrients (Toghyani et al., 2010). It had been utilized by the early Egyptians and Greek physicians for cure of headaches, asthma, allergies and enhancement of immune system (Dattner, 2003). Thymoquinine, thymohydroquinone, thymol and carvacrol are the main constituent of BCP (El-Fatatry, 1975; Morikawa et al., 2004). Thymoquinine is beneficial for curing of inflammatory ailments and cancer (Woo et al., 2012) and has anti-bacterial (Ferdous et al., 1992; Harzallah et al., 2011) and anticonvulsant effects (Akhondian et al., 2011) and also inhibitory effect on the end product of some biosynthetic pathways (Losso et al., 2011) and has positive effects on the gastrointestinal tract (Magdy et al., 2012). BCP is a source of essential fatty acids mainly linoleic acid and oleic acid (Nickavar et al., 2003), vitamins, minerals, essential amino acids and carbohydrates predominantly, glucose, xylose, arabinose and rhamnose (Al-Jassir, 1992). BCP has shown many pharmacologic effects such as antibacterial (Ferdous et al., 1992), antitumor (David et al., 1998), anti-inflammatory effects (Houghton et al., 1995; Mutabagani and El-Mahdy, 1997; Khanna et al., 1993), hypoglycemic (Al-Hader et al., 1993) and immune stimulating herb (Naz, 2011). BCP application has exhibited some properties on broiler (Al-Homidan et al., 2002; Guler et al., 2006; Ziad et al., 2008) and layer properties, egg quality (Akhtar et al., 2003) and quail’s performance and carcass traits and blood limitations (Al-Hader et al., 1993). But, the discoveries of diverse studies are inconsistent.

Feed added substances, for example, anti-microbials, probiotics and prebiotics are presently utilized in broiler foods to upgrade supplement usage by mean of different instruments. Because of potential perils and dangers of utilizing anti-microbials in poultry, the significance of utilizing prebiotics or normal feed added substances as an option has expanded like never before (Fuller, 1989). Thus, the utilization of anti-infection agents in poultry diets has been decreased in the most recent decade and researchers have looked for natural alternative development parameters and aromatic plants and basic oils separated from these plants are getting more significant because of their antimicrobial impacts (Singh et al., 2002) and their effect on digestive systems (Ramakrishna et al., 2003). Black cumin (*Nigella sativa*) is extensively cultivated in several areas around the globe as an aromatic plant. While its seeds have continuously to utilize to enhance wellbeing as diuretic, digestive stimulant, antihypertensive, antidiarrheal, analgesic, antibacterial, antitumor, anthelmintic antiparasitic, antidiabetic and appetite restorative (Zaoui et al., 2000; Gilani et al., 2004; Gilani et al., 2001; Khan et al., 1999; Chowdhury et al., 1998; El-Kamali et al., 1998; El-Tahir et al., 1993; El-Daly, 1998; Mahmoud et al., 2002; Al-Hader et al., 1993; Zaoui et al., 2000).

This plant has been used for many diseases over decades as natural cure. A number of researches have been done to explore the likelihood of utilizing black cumin seeds used as raw feed additive to poultry diets for enhancing the efficiency. It is generally believed that these seeds has no any harsh effects on the performance ranges about more than 30 g/kg for poultry, and in adverse environmental circumstances it could be added to diminishes the deleterious effects (Hermes et al., 2009). The use of black seeds, oil and its feed for enhanced growth efficiency, biochemical and mortality (Nofal et al., 2006). It can also found to relieve heat stress and antioxidants for poultry to different levels (Tollba and Hassan, 2003; Guler et al., 2007)

2.1.1 Chemical composition and properties of essential oils in black cumin seeds

Black cumin seeds (BCS) are known to be rich source of protein, raw fat, raw fiber and macro minerals. Its seed contains volatile oil comprised of carvone, an unsaturated ketone, terpene or limonene also called carvene, α-pinene, p-cymene and nigellone that ranges from 0.5- 1.6% yellow in colour. Hence, pharmacological ingredients of the volatile oil are thymoquinone, dithymoquinone, thymohydroquinone and thymol (Ghosheh et al., 1999), while selenium, DL-α-tocopherol, DL-γ-tocopherol and trans retinol are amongst significant antioxidants (Al-Saleh et al., 2006; Nasir et al., 2005). A fixed oil that ranges from 28-42%, proteins around 23-37%, ash 4.86-4.41%, carbohydrate 33-40% and several plant based chemicals (Ramadan, 2007; Cheikh-Rouhou et al., 2007). The seeds contains saturated and unsaturated fatty acids comprised of linoleic acid 50.3-49.2%, oleic acid 25.0-23.7%, palmitic acid 17.2-18.4% (Cheikh-Rouhou et al., 2007; Ramadan, 2007). Black cumin seeds exhibits antibacterial properties against bacterias (Gram positive and negative), antioxidants, immune and hepato protective (Hanafy and Hatem, 1991; Mariod et al., 2009; Al-Mufarrej, 2014; Kumar et al., 2017a; Daba and Abdel-Rehman, 1998) properties. Its essential oil can hinder the development of some important pathogenic bacterias *Escherichia coli*, *Bacillus subtilis* and *Streptococcus faecalis* (Saxena and Vyas, 1986). The availability of large amount of nutrients and active substances make cumin seeds suitable for the utilization in poultry feed.

Composition of phytochemicals in black cumin seeds (BCS) can differ to a excessive degree due to the source of origion. Al- Saleh et al. (2006) analysed samples for phytochemical arrangement from several sources from Ethiopia, India, Syria, Saudi Arabia and Sudan. It has been observed that they varies in values due to different black cumin seed sources having elevated levels of thymoquinone and thymol for an Ethiopian source ranging from 3.1 to 0.23 g/kg and bottommost in a Sudanese samples around 1.3 and 0.11 g/kg BCS with substantial sample variation. There is little detail on the structure of their bioactive compounds found in the BCS and used in foods. Consequently, the variations in the animal reactions identified between the experiments can be due to the varying amounts of active compounds found in BCS.

There is strong assumption that the use of black cumin seed and garlic as dietary supplements enhances the efficiency, wellbeing and immunity of poultry. Which also affect serum components and preserve the role of the liver and kidneys. It has been effective in lowering the concentrations of serum cholesterol levels, triglycerid, total serum lipids and liver cholesterol in broiler (Abdo, 1998; Mandour et al., 1995). It also decreased fat content, total serum lipids and serum cholesterol in ducks (Ghazala and Ibrahim, 1996).

2.1.2 Black cumin as an antibacterial agent

Black cumin is one of the medicinal plants of highest significance. It includes antimicrobial, antitoxic antifungal, and pharmacological substances (Galil et al., 1994).

In addition, clarified the antibacterial efficacy of black seed against various pathological bacteria (Durrani et al., 2007).

Black cumin oil (BCO) has shown the highest antibacterial properties against these two bacterial species *Escherichia coli* and *Salmonella enterica*. In the case of birds diet supplemented with BCO, 0.5 and 1.0 BCO g/kg, in contrast with the control diet, the ileal bacterial populations, e.g. total bacterial counts (TBCs) were significantly decreased. Black cumin compounds and their oil have various pharmacological features, including antimicrobials, antioxidants, anti-inflammatory effects and their use as nutritional supplement and as practical cosmetic products (Hanafy and Hatem, 1991; Hussein and Ahmed, 2016).

Many properties, such as food saving, improving feeding intake, gastrointestinal tract secretion and improving motility as well as bactericidal influence, are responsible for the principal function of essential oils as phytogenic additives (Gopi et al., 2014; Alagawany et al., 2015; Abd El-Hack et al., 2016). The cumin oil is therefore rich in a lot of bioactive phytosterols, tocopherols, oil and linoleic acids (Ramadan et al., 2003, 2010). The high level of polyphenolic compounds will serve as useful natural antimicrobial agent with plant sources (Alzoreky and Nakahara, 2003; Ahn et al., 2004; Luther et al., 2007). Non-typhoidal *Salmonella*, *Escherichia coli* and *Campylobacter* are primarily stored in food-producing animals (Carattoli, 2008). High-phenolic plant extracts and other bioactive compounds can be used as natural antimicrobials (Mahgoub et al., 2013; Hassanien et al., 2014). Standard microbial communities play a major role in sustaining bird health and efficiency in the gastrointestinal tract of poultry (Thongsong et al., 2008; Kaoud, 2010). Herbal products, even from black cumin, have typical antibacterial and antioxidant effects, as their bioactive compounds have beneficial physiological effects (Attia et al., 2019; Baghban-Kanani et al., 2019; Khoobani et al., 2020).

2.1.3 Therapeautic effects

P-cymene, α-terpinene, thymoquinone, β-pinene, carvacrol, terpinen-4-ol and longifolene are the major terpinenes found in black cumin. Black cumin oils hinder substantially the development of A-549 and DLD-1 cancer cells and activate antimicrobial action against *Staphylococcus aureus* and *Escherichia coli* (Bourgou et al., 2010). The anti-inflammatory and antioxidant effects of black cumin seed oil are inhibitory for cancer (Mei et al., 2010). The seeds have pain-reduction, antibacterial properties, increased growth, immunity, hepatosteroids, anti-inflammatory, antioxidants, and bronchodilatory characteristics and are also essential for blood pressure control and biliary irritation prevention. BCO are used therapeutically for several human and animal illnesses and diseases such as asthma, tobacco and bronchitis, lung inflammation, viral infections, fever, stomach complications, gastric ulcers, elevated blood pressure, neurogenic disorders, diabetes, allergy, obesity, diseases of the skin, anorexia, eye infections, rheumatism, amenorrhoea and immune syndromes (Abd El-Hack et al., 2016). The major cause of black cumin antibacterial activity are phenolic oils (Bourgou et al., 2010; Kirkpinar et al., 2011; Tufarelli et al., 2017). Their antioxidant activity levels were equivalently to or above butylated hidroxy toluene (BHT) and beta hydroxy acids (BHA) which are widely used in foodstuffs to resist oxidation. Their phenolic content was positive in black cumin extracts and their activities are antioxidant (Nejdet et al., 2010).

Black cumin essential oil can increase the shelf-life of food and is used in some countries as a spice (Ranjbarian et al., 2004). In the food industry, the essential oils of this plant have a flavor, including a reduction of blood glucose, a promotion of appetite and digestion, an alleviation of spasms in the stomach. The essential oil disrupts bacterial cell membrane and allows it much more permeable, contributing to the ion as well as other cell contents leakage. In particular, the greater the volume and the higher their antibacterial characteristics toward food bacteria in the essential oil (Burt, 2004). Black cumin antihistamine activity is due to its association with hitstamine receptors and therefore inhibits further acid secretion in the gastric wall (Boskabady and Shaikhi, 2000). Therefore, in various countries medicinal plants like black cumin are considered useful in enhancing livestock and poultry production and promoting livestock welfare (Azimzadeh, 2009; Dhama et al., 2015, Tahan and Bayram, 2011).

BCS has shown antibacterial activities against the gram positive and negative bacteria, antioxidant, antibacterial activity and hepatoprotective activities (Hanafy and Hatem, 1991; Daba and Abdel-Rehman, 1998; Mariod et al., 2009; Al-Mufarrej, 2014; Kumar et al., 2017a). BCS essential oil can interfere with the production of various pathogenic bacteria, such as *Escherichia coli, Bacillus subtilis, Streptococcus faecalis* (Saxena and Vyas, 1986).

2.1.4 Black cumin as an antioxidant agent

Black cumin seed oil is an immune protective agent, and unsaturated fatty acids and thymoquinones in the oil are powerful antioxidants, used for preventive medicine like cancer (Hidayati and Inayati Habib, 2015).

2.1.5 Antioxidant effects of black cumin (*Nigella sativa)*

The *N. Sativa* as an exceptional scavenger anion superoxide. Using ethanol extracts from black cumin to the maize oil avoided oxidative damage to triglycerides was documented by (Badary et al., 2003 and Bassim-Atta et al., 1998). The antioxidant property is linked to inhibition by cyclooxigenase and 5- lipooxigenase of eicosanide production and thromboxane B2 and leukotriene B4. As N_2 was apparent, the antioxidant potential of free radicals was caught. Pentylenetatrazol-induced sativa oil was supplied to the inflammatory mice (Ilhan et al., 2005). These symptoms can be caused by active ingredients such as thymoquinone, carvacole, anethole and 4-trepinol (Guler et al., 2007). The analysis on broilers indicated that the *N. Sativa* lowered peroxidation of the hepatic liver, increased production of many enzymes, including glutathione-s-transferase, catalase, myeloperoxidase and aminase, which all culminated in a reduction in the liver's oxidative stress, using black cumin at 3, 5, and 7% (Sogut et al., 2008).

Black cumin methanol extracts demonstrated important antioxidant properties under the *in vitro* method, such as syringic acid, hydroxybenzoic and pcumaric acid (Mariod et al., 2009). The diet treated with 0.5% and 1% black seed resulted in considerably lower levels of erythrocyte malondialdehyde (MDA), in lipid peroxidases, and in higher glutathione (GSH) than the control group in chicken. It indicates the defensive characteristics for oxidative stress injuries by suppression of free development of radicals and the control of oxidative stress preventing glutathione. Black seed will lower the development of aerobic respiration-generated hydrogen peroxide, hydroxyl and superoxide radicals (Tuluce et al., 2009).

2.1.6 Black cumin as an immunomodulator agent

Reports from several researches indicated that *N. Sativa* has shown excellent effects on the health and act as immunostimulants on broiler chicks (Al-homidan et al., 2002; Ghosheh et al., 1999; Nasir et al., 2005; Babyan et al., 1978). In the same background, Toghyani et al. (2010) and Khan et al. (2012) reported an improvement in the immune response of chicks in black seed dieting rates and a substantial rise in lymphoid body weight caused. Instead, El-Ghamry et al. (1997) observed that the blood plasma constituents do not have adverse effects when feeding the *Nigella sativa* food hens diet.

It is immune protective, and the unsaturated thymoquinone and fatty acids found in oil are important antioxidants for preventing diseases, particularly cancer (Hidayati and Inayati Habib, 2015). Thymocinone and p-cymenes are the main components of the 38 volatile materials found in black cumin. Roasting raises dramatically the levels of these compounds and the concentrations of perizins and furanes that influence the odor and taste of these compounds. The other main black cumin components include the antibacterial, pain-killing and anti-inflammatory, anti-spasmodic, anticonvulnerant, anti-bacterial as well as other major and key compounds of black cumin, sabinene, carvioline, flavonoids, polysaccharide (Oroojalian et al., 2010; Yalcin et al., 2009; Jalilzadeh Amin et al., 2011; Hajhashemi et al., 2011; Mandegary et al., 2012; Thappa et al., 1991).

2.1.7 Chemical composition of black cumin powder

Proximate analysis of BCP has shown that it contains moisture 3.8 to 8.7%, crude protein 21.70 to 31%, crude fibre 6.05%, Ether extract 29.46 to 40%, ash 3.7 to 4.50%, nitrogen free extract 29.70% and carbohydrate 24.5 to 40% (Khan et al., 2012; Atta, 2003; Cheikh-Rouhou et al., 2007; Ayasan, 2011).

2.2 Previous Research on Utilization of Black Cumin as a Feed Additive for Quails

Shirzadegan et al. (2015) were reported that the effects of using black cumin (*Nigella sativa*) seeds BCS in the diet of broilers and check their effects on performance, liver weight and broiler enzymes. The experiment was performed as a randomly constructed whole block. Two hundred and forty day-old unsexual broiler chicks (Cobb 500) were split into four classes of four replicates of 15 birds each allocated to four feeding treatments. Group 1 is known as an unsupplemented diet management group. Diet supplements with 5, 10 and 15 g/kg BCS were issued as groups 2, 3, and 4. No major influence ($P>0.05$) on live weight, food intake and organ mass was found by birds offered no supplemented diets with BCS, except for the liver ($P<0.05$). BCS supplemented diets have improved glucose and aminotransferase alanine (ALT) slightly relative to the control group ($P<0.05$). In comparison, the enriched diets supplemented with 5 and 10 grams/kg BCS were smaller than the controls of plasma aspartate aminotransferase (AST) and low density Lipoprotenine (LDL). The lowest bird feed conversion ratio ($P<0.05$) was found in 5 g/kg BCS group at the end of trial. The highest and lowest percentage of liver weight was found in 15 g/kg BCS supplemented group. Morover, this study revealed that, while it influenced some blood parameters, the BCS supplemented at different amounts had shown little positive effects on the growth outcomes of chickens.

Shewita et al. (2011) described the impact of dietary supplementation of several levels of *Nigella sativa* L. on the efficiency and immune response of broilers. A cumulative dedicated to 240 day broiler chicks was applied uniformly in six experimental classes of 1,2, 3, 4, 5 and 6 each having 0, 2, 4, 6, 8 and 10g/kg of black seed. The analysis was 42 days long. The dressing ratio, the weight of various body organs and the abdominal mass is defined by overall body mass, mass gain, growth parameters, feed transfer, antibody titer against Newcastle diseases, phagocytic activity and phagocytic index, certain blood specifications (GOT, GT, Glucose, Cholesterol, Triglycerides, total protein, Albumine, WBC, RBC, Hb and PCV). It's been discovered that the the treatment groups were greatly increased the final weight, total bodies gain and feed conversion ratio of group 2 and 3. Increased N stages. The chick's growth efficiency was not improved by Sativa. For Newcastle Titer, WBC counts, serum GOT, glucose content, dressing%, relative hepathelial, spleen, respiratory, and head percentages no major variations were found. Serum cholesterol, triglyceride and visible fat percent decreased with the addition of *Nigella sativa*, while serum GPT level increased with the addition of *Nigella sativa* considerably.

The study carried out by Kudo et al. (2010) has shown that there are considerably less buds in birds than in mammals and even fewer in chickens and hens that are broiler. The same authors said that birds have 'bitter' flavor, and because black cumin is a bitterly-good seed, Japanese quails seem to be conscious of this and therefore decrease feed consumption. The use of medicinal plants in food products has demonstrated an important influence to increase the weight of body in quails explained by Mansoub and Myandoab (2012). Alfalfa and black cumin, alone or even in combination, have been demonstrated in Japanese quails to boost growth parameters and blood metabolite. Yalçin et al. (2012) found no major effects on uric acid or total protein with black cumin in quail diets, but decreased triglycerides and serum cholesterol in contrast with the non-supplementing population. Different amounts of quail seeds of cumin and oil were provided to quail in a quarry analysis carried out by Tufan et al. (2015), which revealed the live weight in hens, 1 % black cumin seeds or 0.1 % black cumin oil, were greater than the other categories. The consumption, feed quality or carcass characteristics did not vary considerably. In comparison, birds fed 0.1 % black cumin oil at blood cholesterol levels were slightly lower than the control group compared with the levels of blood total protein, albumin, globulin, cholesterol, Ca or P treatment groups were not variable. The findings have endorsed a natural growing booster in quail diet, using 1 % black cumin seeds. Veisizadeh and Gudarzi (2015) analyzed in another analysis the influence in the Japanese quail diets of various amounts of black cumin 1%, 2% or 4% and showed that birds are the most fed and increased weight of 2% black cumin powder. Abd El-Hack et al. (2016) recently measured a substantial increase in weight, daily consumption and feed conversion ratio in feed quail of 0.5 g/kg black cumin oil in the diet. In addition, 0.5 percent black cumin oil was applied to the different quail carcass characteristics. Moreover, quail receiving black cumin oil has shown substantial improvements in liver function, antioxidant ability, fat profile and anabolic hormones, and has had the greater antimicrobial impact. .The salmonella and E. coli. In this way, a black cumin oil supplemented Japanese quail diet will increase both health and efficiency. Tahan and Bayram (2011) reported for the Japanese quail laying that use of dried black cumin and parsley has enhanced growth and improved output of eggs, but still no major impacts are observed on quality parameters, including egg weight, form indices and yolk weight.

Arif et al. (2019) concluded that the goal of this analysis was to determine the influence of a phytogenic dietary blend in the development of broiler. In a randomized design trial, four care group, groups of ten replicates were distributed randomly for a total of 400 days of unsexed Cobb broiler chick. The BMC included comparable ratios of black cumin, Moringa oleifera and chicory seed. T1, T3 and T4 were fed basal diets enriched with 0.2% of, 0.4% or 0.6% of, three BMC mixtures respectively. T1 fed the basal diet, and T2, T3 and T4. Results revealed that rising BMC in dietary conditions could entail a modest but substantial increase in body weight in relation to the control group and a change in food conversion ratio. Broiler improved diets decreased the gut microbial amount of coliforms, with 0.4 to 0.6 percent of the BMC blend. and E. Coli. both C. perfringens and intestinal pH, as against the control community. A modest but important decline in serum total cholesterol, low-density lipoprotein concentrations and concentrations of liver enzymes is associated with greater in BMC food mixture. However the concentration of glutathione peroxidases and superoxide dismutase in serum has risen in the high density of lipoprotein.

Abd El-Hack et al. (2018) reported that this research was undertaken to track the influence of dietary supplementation of antimicrobial black cumin oil on carcass characteristics, growth efficiency and biochemical constituents and ileal microbial communities of Japanese quails. The use of antibiotics in poultry diets, as increasing propellants, has adverse impact on consumers. Three hundred cultivated Japanese quails with three distinct therapies were used (0, 0.50 and 1.0 g BCO/g diet). Bishops fed the diet with 0.5 g BCO/kg of body weight relative to the monitoring and care groups reported a large improvement in body weight. The daily consumption and the exchange rate for feed have been dramatically improved alongside the rising amount of BCO in the diet. Maximizing the majority of carcass qualities by adding 0.5 g BCO/kg quail diet. In addition, dose-dependent enhancement of the BCO-treated diets has been demonstrated by hepatitis, antioxidant capacity, lipid profile and anabolic hormones. Escherichia coli and Salmonella enterica were the most antibacterial in the BCO. In comparison with the control diet, in birds supplemented with BCO between 0.5 and 1.0 BCO g/kg bird count, ileal bacterial populations - TB, coliform, Salmonella species and

Escherichia coli - is reduced. Based on the findings described above, it can be inferred that adding BCO to the quail's diet can increase the productivity and health aspects of birds.

Shokrollahi et al. (2018) was conducted a research in Japanese Quail. To evaluate the impact of *Nigella sativa* Seeds (NSS) on performance, blood parameters, carcass consistency, and production of antibodies against sheep's red blood cells in particular. A total of 240 one-day quails have been allocated into 4 dietary treatment (with four replicates of 15 quail chicks) groups: 4 different doses of NSS including basal diet with 0% NSS, basal diet with 0.5% NSS, basal diet with 1% NSS, and a basal diet with 1.5% NSS of the diet. For biochemical and hematological testing at 42 days of age, blood samples were taken. In all phases of the experiment, weight gain and feed conversion were slightly different (P<0.05). In contrast to other therapies, the feed intake was higher for 3 chicks at a time of 0-21 (P<0.05), but feed intake at 21-42 or at a time of 0-42 days (P>0.05) discrepancy was not seen. Treatments 2 and 3 (P<0.05) have greatly reduced their levels of cholesterol and triglycerides. In the chicks given NSS slightly lower LDL levels and higher RBC counts have been found in the control group (P<0.05). The NSS did not greatly impact the amounts of albumin, total protein, HDL, VLDL, Hb and PCV and the proportional weight of internal organs (apart from 42 days of Bursa) (P>0.05). The relative weight of SRBC titers and Bursa increased substantially at 42 days (P<0.05). NSS has greatly affected weight gain, FCR, LDL, RBC and bursa weight of cockroaches.

Abdou and Ghada (2015) observed the dietary inclusion of a mixture of black cumin seeds (BCS) and garlic powder (GP) in the feed of quails as natural feed additives and check their effects on performance, carcass traits and meat quality as well. A total of 160 one-day-old Japanese quails were randomely alocated into four treatment groups. Therapies included monitor (0%), 3% Black Seed, 3% Knob and 3% Black Seed + 3% Knob. Feed and water were provided *ad –libitum*. The visibility of birds was 16 hours light a day. The experiment lasted 10 weeks and took some efficient criteria in physiology and immunology. The findings showed that the body weight increased with black seed and garlic. The consumption of feed declined dramatically at 4, 5, 6 weeks of age and improved feed conversion, either alone or in combination. The use of black seed and garlic, egg weight and egg mass improved. In the treatment relative to the control sample, additions of black seed lowered serum cholesterol, LDL, HDL, and total lipids. The overall serum protein, albumin and globulin have been improved by both therapies. Both therapies were lowered in contrast to the placebo group, but yolk cholesterol, LDL, HDL and total lipids declined. In the garlic group the primary and secondary reactants were stronger than black seeds and control and experimental groups against Newcastle's infection. Relative weights of spleen, bursa and thymus have risen with black seed and garlic as well. It can be inferred that in quail's diets, the use of black seed and garlic increases the beneficial efficiency of Japanese quail and provides improved food to people and physiological and immunological parameters.

Khan et al. (2012) was conducted a research assessing the impact of three amounts of black cumin (BCS) on five hundred chicks (1,25, 2,5 or 5,0 %) was performed. In comparison to a basal diet, 0 , or 0.1 % of the antibiotic or three amounts of BCS were applied. The body weight gain in the 2,5% and 5% BCS (BWG) categories is substantially higher than the 1.25% BCS and antibiotic groups in days 28 and 42 of age. In contrast to the 1.25 % BCS group and controls, the feed quality in the same groups was greatly increased ($P<0.05$). The dressing percentage measurement at all ages revealed no substantial variation in BCS and antibiotics. BCS classes were 2.5 and 5.0 % more frequent than antibiotically or unsupplemented, respectively ($P<0.05$) in average protein and hematologic ($P<0.05$) values. The blood enzyme production in the BCS and antibiotic classes was lower ($P\cdot<0.05$) and the population in Escherichia coli and Caecal coliform reduced ($P<0.05$). The amount of BCS was declining in serum and tissue cholesterol ($P<0.05$). The BCS and antibiotic classes were still greater than the negative controls with geometrical mean hemagglutination inhibition titers. The mass weight of the negative control medium of lymphoid organs ($P<0.05$) was slightly smaller than the BCS and antibiotic classes. To conclude, the results, immunity, serum biochemical elements or hematological indexes of up to 2.5 to 5 percent BSC included in the diets of broilers have no damaging effect. In reality, cholesterol-free chicken meat can be made.

Szczerbinska et al. (2012) was conducted a research and reported that the sample flocks were divided in 5 groups, each of 15 females and 6 males, with a total of 105 birds. A full feed mix of the normal composition was fed into Group I. Control 1 feed combination was for Groups II and III with 4% and 7% flax seed (CFS), while control 1 was for Groups IV and V with 2% and 5% black cumin seed (BCS) accordingly. The intake and weight of egg along with deaths and slaughter were reported on a frequent basis from 6 to 40 days of quail-life. Egg content was measured and its morphologic formulation was calculated over the last week. A quail life of 26, 32 and 38 weeks of egg hatching took place. The best egg laying output (86%) was representative of quail groups that fed 4% CFS or 2% BCS while the control group was slightly lower (82 percent). No any consequence of the observational data on egg morphological structure was found, but that in quails obtaining 4% CFS in the diet the eggshell proportion was considerably lower. When feeding quails with feed mixes containing 7 % CFS the best egg fertilization was reached (95 percent). In quail classes obtaining food mix supplements with 7% CFS and 5% BCS were reported the better egg hatchability (approximately 90%). These quail groups showed different effects than the hatchability of the control group eggs (81 %).

Tahan and Bayram (2011) investigated the effect on body weight, the intake of food, feed conversionratio, egg production, egg content (Haugh unit, thickness and egg yolk cholesterol values) and hatchability of the quails laying in diets of black cumin (*Nigella sativa*) and dry parsley (Petroselinum crispum). At the age of 14 years, this experiment lasted for eight weeks and was done on 210 quail chicks (140 female; 70 male). Quails were assigned as a negative control category of seven nutritional therapies. others as Black Cumin 1.00% , Perseumon 1.00% , Black Cumin 1.50% , Perezzle 1.5% , Black Cumin 0.50% and Black Cumin 0.75% respectively, were assigned as a negative control group with no food supplements and Perezle 0.75% .The body weight variation between classes except for the feminine body weight ($p<.05$) was not statistically different. Whilst mean feed intakes were not different, the FCR values were different among groups ($p<0.05$). The FCR values were different. Egg production (percentage), weight, consistency (except yolk) and cholesterol levels were different among the categories. There were no variations between the eggs.

Al-Mufarrej (2014) claimed that the key goal of this work was to evaluate the impact on immune response, broiler output and lymphoid organ proportions of NDV, IBV and IBDV vaccines at different levels of the dietary Black Cumin Seed. A hundred and 61 day old grill chicks were distributed evenly to five groups of seven bird replicates per group and fed diet added with 0.7%, 1.4%, 2.1% or 2.8% Black Cumin. For 35 days after procedure all chickens have been bled weekly. Body weight, thymus, bursa and spleen proportion were calculated by 21 and 35 days by determination of bodily weight. The findings showed substantial body weight variations among all groups in comparison with the control group. At the third, five and sixth weeks of the experiments between treatied groups, Antibody titers against NDV also demonstrated major variations, although they varied considerably from the control group. Group C exhibited distinctly different antibody titers from the other treated groups at the fourth week. In the fifth and sixth weeks, however, IBV antibody titers were greatly differing from the control sample. This study found that a 1 percent or 1.4 percent dietary supplement of black cumin would improve immune reactions in broiler chickens.

Guler et al. (2007) was concluded that this research was undertaken to examine the possible antioxidant function as a nutritional supplement of black cumin seeds. Randomized split into five care classes of 60 birds each, 300, 3-day-old broilers were chickens. In the 42-day grilling ages, Black cumin seeds were added to the simple diet at 0,5%, 1%, 2 or 3%, and its consequences were assessed on malondialdehyde (MDA) and vitamin E concentrations. The black cumin MDA concentration of the serum ($P < 0.05$) was slightly decreased by 2% to 3% when the diet was enriched, compared with birds fed 1% and 0.5% black cumin seeds and regulated diet by the breast muscles ($p < .06$), liver($P < 0.06$) and cardiac muscle ($P < 0.05$). A black cumin diet complement has not greatly altered serum and tissue vitamin E levels. These findings indicated that black cumin seeds may be deemed a natural potential poultry antioxidant promoter, with 2% and 3% of incorporation as best responses.

CHAPTER III

MATERIALS AND METHODS

3.1 Material

The present research was conducted on birds at Niğde Ömer Halisdemir University's Ayhan Şahenk Agricultural Research Application and Research Center's quail section. Laboratory analysis was performed at Niğde Ömer Halisdemir University (NÖHU), Faculty of Agricultural Sciences and Technologies, Department of Animal Production and Technologies.

3.1.1 Housing and management

This research was carried out in a 3 x 5.5 m monitored quail growing room in the quail unit of (NOHU), Ayhan Şahenk Agricultural Research Application and Research Center. Before the chick's arrived, the experimental quail unit was cleaned, fumigated, and washed. A specialized sanitizer was used to disinfect the feeders, drinkers, and utensils. The birds were housed in a 5-storey octagonal structure measuring 120 x 92 x 45 cm and each level of floor was measuring 92 x 45 x 25 cm, with multi-deck cages developed specifically for quails and fitted with an automated (nipple drinker) and thermostat main equipment (Figure 3.1). The cages had plenty of natural light and it was very well ventilated. During the first two weeks, quail chick drinkers were installed in each box in particular instance the chicks couldn't reach the water. The birds had access to clean, fresh drinking water 24 hours a day, seven days a week.

a b c

Figure 3.1. Quail chicks cage (a), drinker (b) and thermostat machine (c)

3.1.2 Animal material

The hatchery in the quail unit of (NOHU), Ayhan Şahenk Agricultural Research Application and Research Center, provided 240 Japanese quail (Coturnix coturnix japonica) birds. According to a fully randomized design, the birds were evenly allocated into four treatment groups, each with four replicates of 15 birds. Individual live weights of quail birds were assessed using an electrical balance with a precision of 0.01 g, and mixed-sex groups were put in quail cage compartments (Figure 3.2). The average weight of the birds was kept constant.


a b

Figure 3.2. Hatching of day old quail chicks (a) and quail chicks placed in cage after hatching (b)

3.1.3 Feed material

Commercial broiler chick starter feed, obtained from a commercial company, was fed to all of the birds according to NRC (1994) recommendations, with a CP of 23% and ME of 3100 Kcal/kg supplemented with or without black cumin powder BCP (Figure 3.3). Quails were fed commercial broiler chick starter feed for 5 weeks, but four distinct mixed feed groups were formed by mixing 0, 1, 2 and 4% BCP to the feed. From days 1 to 35, four replicates of each group of quail birds were fed experimental diets. A nipple drinking device was used to deliver freshwater for 24 hours.

Table 3.1 Composition of basal diet

Raw materials	Percentage	Calculated nutrients (%)	
Corn	51.55	ME (Kcal/Kg)	3100
Soybean Meal	28.53	Crude Protein	22.98
Sunflower Meal	4.90	Dry Matter	89.321
Canola Meal	7.45	Raw oil	6.770
Rice Polish	4.09	Ash	5.514
Phytase	0.02	Crude fiber	5.370
$NaHCO_3$	0.98	Lysine	1.46
Lycine	0.45	Methionine	0.69
Methionine	0.31	Methionine + Cystine	1.085
Threonine	0.21	Calcium	0.92
Valine	0.04	Phosphorus	0.470
Salt (NaCl)	0.42	Valine	1.100
Monocalcium Phosphate	0.80	Sodium	0.20
Vit.Mineral Premix*	0.241	Isoleucine	0.96
Total	100.00	Cloride	0.16

One kg of Premix will provide per kg of diet: 10,1000 IU of vitamin A, 1100 IU vitamin D$_3$, 11 IU vitamin E, 1.1 mg vitamin K, 2.3 mg thiamin, 5 mg Riboflavin, 12 mg Ca Pantothenate, 2.2 mg vitamin B$_6$, 0.10 mg biotin, 1.56 mg folic acid, 12.2 µg vitamin B$_{12}$, 252 mg Choline cholride, 45 mg Nicotinic acid, 80.000 mg iron, 60,000 mg Zn, 8,000 mg Co, 506 mg iodine, 205 mg Cb, 160 mg Se.

a b c

Figure 3.3. Commercial black cumin powder (a), weighing of black cumin powder before mixing in basal feed (b) and (c)

3.2 Method

At the start of the experiment, 240 quail chicks were weighed using an electrical balance with an accuracy of 0.01 g, and the mean live weight in each group was intended to be uniform. The study included four groups of 15 chicks each, with each group having 0, 1, 2 and 4% black cumin powder (BCP). The thermostat radiator was used to set the temperature at 32-33°C for the first week, and afterwards the temperature was gradually reduced by 2-3°C each week until it was set at 24-25°C. With the air conditioner, the room temperature was set to a comfortable level for the quails, and also the temperature was monitored with a thermometer. The quail experiment was maintained for an estimated 35 days. Feed and water were accessible at any time, and natural and artificial illumination was used for a total of 24 hours.

3.2.1 Extraction of black cumin powder

For black cumin powder (BCP) extraction, a 10g of BCP was dissolved into 100 mL of 80% ethanol and agitated for 30 minutes in an ultrasonic water bath. Afterwards, the BCP was dissolved in a shaking machine for 24 hours at a temperature of 40°C and agitation speed of 500 resolution per minute (RPM). To get BCP extract, the saturated mixture was filtered with coarsely filter paper and thereafter ethanol was vaporized at 50 °C in a rotary evaporator (Figure 3.4). To evaluate the total phenolic material and antioxidant content, the extract was kept at -80°C.

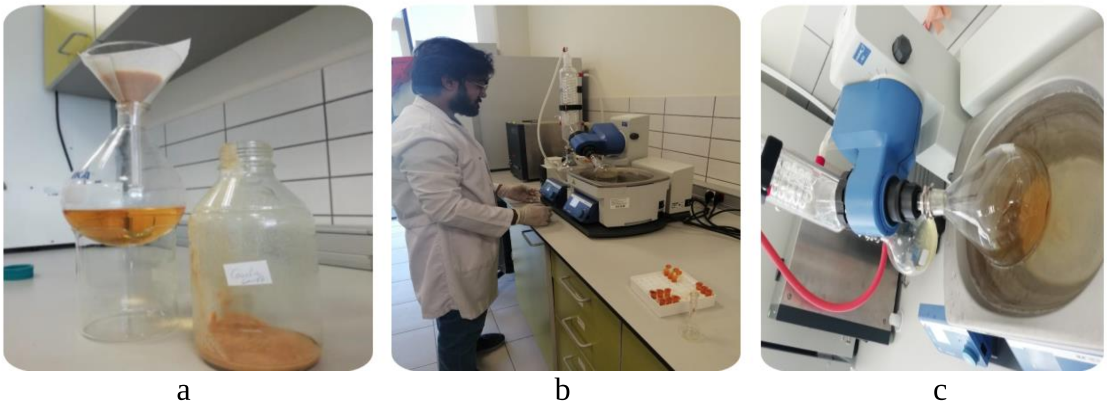
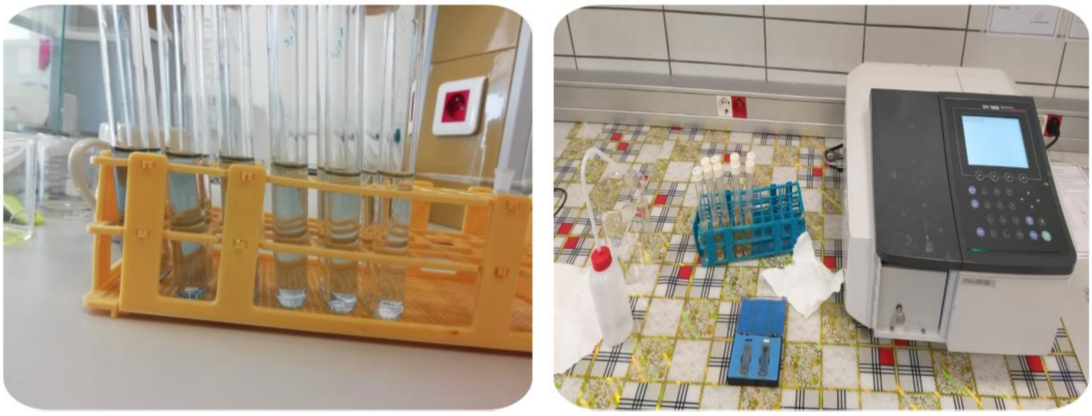


Figure 3.4. The process of filtering the BCP extract by filter paper (a), evaporating the ethanol from BCP extracts (b) and (c).

3.2.2 Determination of the total phenolic content of black cumin powder

The redox process during which phenolic compounds decrease the Folin-Ciocalteu reagent throughout the basic medium and convert to an oxidized state is used to determine total phenolic substance. A phenolic substance is involved in making the standard graphic for the gallic acid standard. The absorbance of different amounts of gallic acid in ethanol (1-0.5-0.25-0.125-0.0625-0.03125 mg / mL) is evaluated. A graph of absorbance vs concentration is formed. The total quantity of phenolic compound in ethanolic sample extracts is shown in the graph (Slinkard and Singleton, 1992). The total quantity of phenolic component in the extract from BCP was determined using the Folin Ciocalteu reagent. For this, 100 µl of the BCP extract solution was diluted with 900 µl of distilled water, 5ml of 0.2 N Folin-Ciocalteu reagent, and 4ml of saturated sodium carbonate (Na_2CO_3) solution (7.5 g/L). The content of total phenolics was measured as miligram gallic acid equivalent (mg gallic acid/1g) using an equation derived from the standard gallic acid graph after samples were held at room temperature in the dark for two hours, Subsequently samples were read in contray to the curve in the spectrophotometer at 765nm (figure 3.5). The findings were calculated using the gallic acid ribbon previously measured and expressed as mg gallic acid/g (Spanos and Wrolstad, 1990).



a b

Figure 3.5. Analysis of total phenolic content in BCP extract (a) and (b)

3.2.3 Determination of the antioxidant activity of black cumin powder

Antioxidants reduce the absorbance of the 2,2'-azinobis 3-ethyl-bezothiazoline 6 sulfonate (ABTS) radical cation in the Trolox Equivalent Antioxidant Capacity (TEAC) assay (Okan et al., 2013). First, an ABTS solution was made to evaluate the antioxidant activity of BCP. A radical solution (ABTS + •) was produced by keeping a 7mM ABTS solution with 2.45 mM potassium persulfate ($K_2S_2O_8$) at room temperature for 12-16 hours in the dark. A sequence of extract and trolox concentrations were produced to determine the antioxidant activity of BCP extract as a trolox response. A reduction in absorbance was seen in spectrometry for 6 minutes after 10 µl of the sample was introduced to 1ml ABTS +. The slope was obtained using graphs that plotted percent inhibition versus concentrations. The percentage of the slope of BCP to the slope of trolox amounts was used to assess the antioxidant activity of the antioxidant material as a 1mM trolox response (Re et al., 1999). Three parallels were formed at each initial concentrations while measuring antioxidant activity, and the readings in the spectrometer were taken at 30 °C with micro cuvettes. Example (slope / slope of trolox)

x dilution factor = TEAC value µM trolox

TEAC: Trolox Equivalent Antioxidant Capacity

3.3 Parameters Studied

In this biological experiment, these succeeding parameters were noted.

3.3.1 Growth performance

The performance of the birds was monitored on a weekly basis. The following measures were used to assess the overall performance of the birds' growth.

3.3.2 Determination of live weight gain of quail

The original (primary) weight of each day-old chick from the incubator was determined in addition with the help of a digital machine on the first day of the research. Then arranged the birds in the boxes, keeping in mind that such live weights in each group were identical. Overall live weight of the birds was assessed during the study by weighing each one separately using a digital balance with an accuracy of 0.01 g on the day the study began (Figure 3.6). By subtracting the starting mean body weight from the average final body weight, the weekly live weight gain of quails was calculated.The below formula was used to calculate the increase in body weight gain:

Body weight gain (g) = Final weight (g) – Initial weight (g)

a b

Figure 3.6. Determination of final body weight of quail bird (a) and (b)

3.3.3 Determination of quail feed intake

The feed was weighed every day during the study, and the quantity of feed provided was noted. The feed that dropped into the cage cells was gathered and placed in the back of the feeder. The feed was administered as ad-libitum during the experiment. The quantity of feed intake (FI) was calculated weekly for every replicate. The quantity of feed left in the feeder was subtracted from the total amount of feed supplied to each repeat of each group to determine FI. Divide the quantity of feed consumed in each repeat by the total number of quail in that repeat to calculate the weekly individual feed intake amount.

The below formula was used to determine feeding intake (FI):

Feed Intake (g) = Feed offered (g) – Feed refused (g)

3.3.4 Feed conversion ratio

Furthermore, feed conversion ratio (FCR) was calculated by dividing the quantity of feed consumed in grams by the body weight in grams. All of these measures were made under close scrutiny.

The following method was used to obtain the weekly feed conversion ratio:

$$\mathrm{FCR} = \frac{\text{Feed Consumed (g)}}{\text{Body Weight Gain (g)}} \tag{3.1}$$

3.3.5 Determination of carcass characteristics

After the experiment was completed, the live weight of the birds was measured, and the mean live weight value from each group (female and male individually) was calculated. Each repetition was assigned a wing number and the list of the group that owned to which repetition. Two female and two male quail, representing the female and male live weight average from each group, were obtained from each repetition and a wing number and the number of the group that owned to which repetition were tied. Before being slaughtered, quails starved for 12 hours. Quails with wing numbers were therefore transported to a slaughterhouse and slaughtered as usual. After being sliced and bled, the quails were transported to a hot boiler and plucking began. Immediately the quail feathers were clipped and just after internal organs were evacuated, the hot carcass weight was calculated. Following the weight of the hot carcass, the weight of belly fat and inner organs such as the heart, liver, and gizzard were measured. To study the cold carcass weight, the carcasses were maintained at +4°C for 24 hours. The weights of the carcass major parts (neck, back, thighs, breast, and wings) were weighed using a scale precision of 0.01g to calculate the ratios of the carcass major components in the carcass after the cold carcass weight was obtained. The fraction of each carcass cut was estimated by multiplying the weight of the carcass main sections by the carcass weight.

The following formulae were used to collect carcass features.

Carcass yield:

The carcass yield was estimated with the formula given below:

$$\text{Carcass yield \%} = \frac{\text{Dressed weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.2}$$

Thigh weight %

Thigh weight % was estimated with aid of the following formula:

$$\text{Thigh weight, \%} = \frac{\text{Thigh weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.3}$$

Breast weight %

Calculation of breast weight % with the aid of this formula:

$$\text{Breast weight, \%} = \frac{\text{Breast weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.4}$$

Neck weight %

Neck weight % was measured by the given formula:

$$\text{Neck weight \%} = \frac{\text{Neck weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.5}$$

Back weight %

Back weight % was estimated by the below formula:

$$\text{Back weight \%} = \frac{\text{Back weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.6}$$

Wing weight %

Wing weight % was measured by the given formula below:

$$\text{Wing weight \%} = \frac{\text{Wing weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.7}$$

Liver Weight %

Liver weight % was obtained by the given formula below:

$$\text{Liver weight \%} = \frac{\text{Liver Weight (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.8}$$

Gizzard Weight %

Gizzard yield % was measured by the proceeding formula:

$$\text{Gizzard weight \%} = \frac{\text{Gizard (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.9}$$

Heart Weight %

Heart weight % was measured by the given formula below:

$$\text{Heart weight \%} = \frac{\text{Heart (g)}}{\text{Live Weight (g)}} \times 100 \tag{3.10}$$

3.3.6 Determination of shelf life in breast meat samples

At the conclusion of the study, samples were kept at 4 degrees Celsius for 0, 3, 5, and 7 days, with various impacts on meat quality being studied. Each subgroup of quails had breast meat samples obtained, which were sliced and carcass traits assessed.

3.3.7 Oxidation analysis

3.3.7.1 Peroxide value analysis

To assess the oxidation state in the flesh, flesh samples from quails were maintained at 4°C for 0, 3, 5, and 7 days, or peroxide content analysis was conducted using the AOAC 965.33 technique (AOAC, 1995). The breast flesh was mixed for this purpose, then removed and fat was recovered after it was homogenized (figure 3.8). Estimated 1 ml oil was procured as a consequence of extraction process taken placed into 250 ml round bottom flask and 30 ml of chloroform-acetic acid solution (three parts of chloroform and two parts of acetic acid) has been added. After that, 1 mL of saturated potassium iodide (KI) solution was then added to it, which was mixed for 5 minutes in the darkness. Then 30 mL of clean water and 4 drops of the starch solution was then added, and also the sodium thiosulfate ($N_2S_2O_3$) solution was used to titrate. The titration was maintained until the bright color appeared, and the concentration of sodium thiosulfate used was noted (V2). The sodium thiosulfate volume (V1) consumed in the blank was measured by repeating the same operations with about the same reagents (Figure 3.7). The standard deviation of sodium thiosulfate is 0.01. The amount of peroxide in the fats of the quail was estimated using these data and the formula below.

$$\text{Peroxide analysis} = \frac{(\mathrm{V1}-\mathrm{V2})\times \mathrm{N}\times 100}{\mathrm{m\ (g)}} \qquad (3.11)$$

V1 = Amount of sodium thiosulfate consumed on the sample
V2 = Sodium thiosulfate amount consumed for the blank
N = Normality of sodium thiosulfate, N
m = the amount of sample taken.

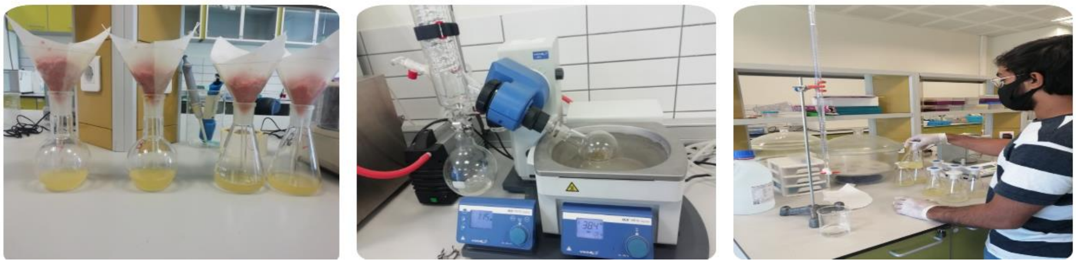

a b c

Figure 3.7. Fat extraction (a), titration process in breast meat samples for peroxide analysis (b) and (c)

3.3.7.2 Thiobarbituric acid number

The lipid oxidation status of two breast meat samples collected from each group at 4 C after 0, 3, 5, and 7 days of preservation was determined by thiobarbituric acid number analysis (TBA). After extracting oil from breast flesh samples, 0.04 g of oil was collected and put to a 10 ml flask, which was then filled to 10 ml by adding Butylated hydroxytoluene (BHT) solution. After that, the mixture was homogenized with the assistance of an ultra-thorax homogenizer. The homogenous liquid was then put into the beaker and poured to the tubes in 5 ml increments, with 5 ml of thiobarbituric acid added to each tube and stirred once more with the mixer. The combinations in the formed tube were maintained at 95 °C for 2 hours in a boiling water bath. Finally, samples were measured using a spectrophotometer at 530 nm (figure 3.8) The following formula was used to calculate the quantity of TBA in meat. To avoid oxidation mostly during study, BHT was employed as the perchloric acid extraction solution.

TBA = 50 x (Absorbance of oil sample - Blank absorbance) / sample weight (mg)


a b c

Figure 3. 8. Samples for TBA analysis (a), (b) and reading in spectrophotometer (c)

3.3.7.3 Microbiological analysis (total psychrophilic bacteria counts)

Total psychrophilic counts of quail breast flesh samples were conducted at 4 °C for 0, 3, 5, and 7 days. For this, 10g of quail breast flesh samples were homogenized for 1 minute in 90 ml of 0.1 percent peptone water. Diluting the homogeneous mixture with 0.1 percent peptone water and percent ringer solution yielded serial dilutions. In total psychrophilic live count study, plate count agar (PCA) medium was employed. Powder PCA media was dissolved in 22.5 g/L distilled water to make the medium. That medium was then sterilized in an autoclave for 25 minutes at 121°C with all components to be utilized. The medium was then put onto 12.5 mL Petri plates after this procedure. The cast plate method was used to determine the total amount of psychrophilic bacteria (Figure 3.9). For 7 days, petri dishes were incubated at 7 degrees Celsius. Log CFU / g is the unit of measurement for the number of microbiological bacteria.

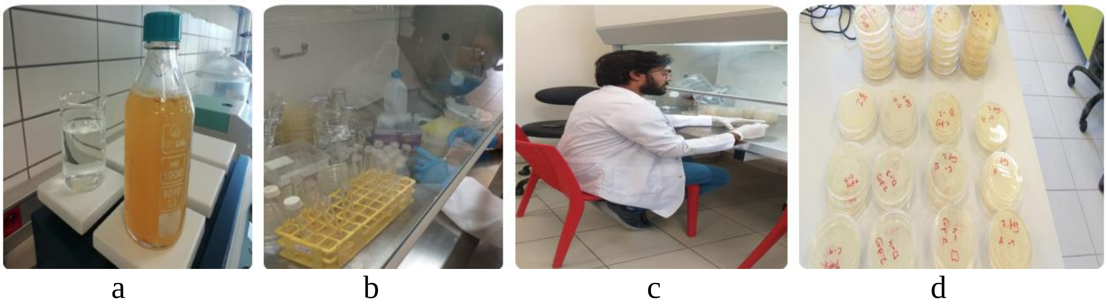

a b c d

Figure 3. 9. Microbiological analysis of breast meat samples: preperation of media (a), serial dilutions (b), petri plates (c) and (d)

3.3.8 Determination of pH in meat

Two samples of breast flesh were obtained from each subgroup at the end of the experiment, and the pH level of the breast flesh was tested at 0, 3, 5, and 7 days. On day 1, a Testo 205 meat and food pH meter was used to detect the pH level. Measurements were taken from three separate regions of the breast flesh for this goal, and the mean of these results was computed. The breast flesh was processed through some kind of blender and combined with purified water after taking a 5 g sample and homogenized to measure the pH value after 0, 3, 5, and 7 days of storage at +4 ° C in the refrigeration. The resulting homogenous liquid was filtered, and the pH of the breast flesh was determined using a pH meter with probe (Hunt et al., 1991).


a b c

Figure 3.10. pH determination of breast meat samples (a), preperation of meat samples (b) and ph analysis meter (c)

3.3.9 Colour measurement

Following the experiment, the color of quail breast and thigh flesh was measured using a Konica Minolta Chromometer model CR-300 colorimeter equipment. A colorimeter was used to take measurements from two separate regions of the thigh and breast (Figure 3.10). Meat values were assessed using a chromometer (L* measures comparative lightness, a* measures comparative redness, and b* measures comparative yellowness) (Hunt et al., 1991). Calibration was done with the black and white plates prior to actually beginning the measurement.

Figure 3.11. Colour measurment of breast and thigh meat

3.3.10 Sensory evaluation

On the first day, an 10-member panel assessed the sensory quality of quail thigh and breast flesh. Nide Omer Halisdemir University faculty and students were among the panelists. Each sample was covered in aluminum foil and cooked for 75 minutes at 175°C (Eltazi et al., 2014) (Figure 3.11). Panelists were offered breast meat items in enclosed serving plates labeled with 3-digit random numeric values.

A 9-point hedonic scale was used to evaluate sensory characteristics such as color, aroma, juiciness, and tenderness. 9 indicates that something is extremely desirable; 8 indicates that something is desirable; 7 indicates that something is moderately desirable; 6 indicates that something is slightly desirable; 5 indicates that something is neither desirable nor undesirable; 4 indicates that something is slightly undesirable; 3 indicates that something is moderately undesirable; 2 indicates that something is undesirable; 1 indicates that something is extremely undesirable (Table 3.1). The panellists' scores were averaged, and the overall sensory quality was determined by adding the average values for each feature.

Table 3. 2. Sensory evaluation form

Sample Code	Smell	Colour	Texture	Appearance

On a scale of one to nine, the following sensory attributes were assigned to the grades: (9) extraordinarily desirable, (8) desirable, (7) desirable relatively, (6) mildly desirable, (5) neither desirable nor undesirable, (4) slightly undesirable, (3) moderately undesirable, (2) undesirable, (1) extraordinarily undesirable.

a b

Figure 3.12. Meat from the thigh of a quail for sensory assessment (a) Before roasting, cover the quail breast and thigh flesh with aluminum foil (b)

3.4 Statistical Analysis

The SPSS 18 program was being used to statistically assess all the data collected at the conclusion of the experiment. To identify differences between the treatment means, the Duncan multiple range test was used (Bhat et al., 2013). $P < 0.05$ was selected as the statistical significance level.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Total Phenolic Content and Antioxidant Activity of BCP

Phenolic compounds (PCs) have long been known for their nutritional and physiological benefits, including as antioxidant and antibacterial properties. The total phenolic content (TPC) and antioxidant activity of BCP extract were investigated in this work using 80 percent ethanol and 20% water. Because of their health impacts and sensory-nutritional characteristics in food items, as well as their industrial uses, several phenolic compounds found in oil seeds have gotten a lot of attention. In this study, the total phenolic content of BCS water extract was determined to be 955.77 mg/kg. Phenolic chemicals are known as natural free radical scavengers because they may effectively prevent lipid oxidation. Total phenolics in BCS (*N. sativa L.*) oil were 450.66 16.21 mg/kg. Phenolic chemicals are renowned as natural free radical scavengers, for the reason that they may effectively prevent lipid oxidation. Total phenolics in BCS (*N. sativa L.*) oil were 450.66 16.21 mg/kg, according to Soleimanifar et al (2019). Total phenolics in black cumin powder were highest in the methanolic extract (790.79±31.67 mg GAE/100 g) at 50 minutes, reported by (Iqbal et al., 2019). BCP has an antioxidant activity of 83.80 mol trolox/g, and its total phenolic component concentration is 89.53µg gallic acid equivalent (GAE)/g, according to (Thilakarathne et al., 2018). Black cumin seeds cited the highest IC50 value (2.935 ± 0.02) and lowest total antioxidant capacity (4.887 ± 0.044mg GAE/g) while yielding a moderate value for TPC (8.45 ± 1.81 mg GAE/100g of dry weight), reported by (Wijewardhana et al., 2019). Black cumin total phenolic content (mg GAE/100g) 8.45 ± 1.81 and total antioxidant capacity (mg GAE/g) 5.136 ± 0.636. The discrepancy in TPC and antioxidant activity between this study and prior literature might be attributed to differences in genotype, agricultural methods, and growing seasons among black cumin cultivars. The amount of phenolics in a product varies depending on how it was extracted.

4.2 Effects of BCP on Performance

4.2.1 Live Body weight

At the start of this study, the mean weight of each bird was endeavoured to be identical. The body weight of the birds assorted from 9.10 g to 9.20 g. Table 4.1 shows the weekly LBW of quails feed supplemented with three different doses of BCP (0, 1, 2, and 4 percent). The results showed that during the first, second, and third weeks, there was no significant difference in live weight between the feeding groups ($P > 0.05$). In the fourth and fifth weeks, there was a significant change ($P < 0.05$). In the fifth week of this experiment, however, 2% BCP supplemented group (296.17 ± 5.10) and a control group (289.96± 5.30) had greater LBW than 1% BCP supplemented group (280.21± 4.12) and a 4% BCP supplemented group (282.67± 3.82). When compared to the control and other treatment groups, birds fed a supplemented diet with 20 g BCP/kg diet were the heaviest. The inclusion of a combination of unsaturated fatty acids, particularly linolic and linoleic (present in BCP), which have been hypothesized to be important, might be the cause of the improvement in body weight of the birds. Furthermore, several active chemicals found in BCP, including as p-Cymene, thymoquinone, dithymoquinone, thymol, and carvacrol, have been shown to increase feed digestibility and nutrient absorption by activating digestive enzymes (Salam et al., 2013). The current findings support those of Abd El-Hack et al. (2018), who found that feeding quail diets supplemented with BCP increased digestive enzyme production, improving nutrient digestibility and growth performance. Morover, BCP has additional pharmacologically beneficial impacts on performance. The content of volatile oil or essential oil has biological activities that might work not only as antibacterials and antioxidants, but also as a stimulant of digestive enzymes in the intestinal mucosa and pancreas, therefore improving dietary nutrient digestion (Abdou et al., 2015). Another researcher Osman (2002), observed that broilers diet supplemented with BCO has increased the BWG and FCR while lowering the FI. Our finding was contradict with Abbas and Ahmed (2010), who found that birds fed a meal enriched with 1 or 2 percent black cumin had considerably reduced BWG and unchanged FCR. With the exception of blood, liver, heart, and intestinal weight, no significant changes were found for the majority of carcass characteristics (Durrani et al., 2007).

Table 4.1. Effect of BCP supplementation in different levels on weekly live body weight (LBW)

Weeks		Groups				SEM	P
		Control	1% BCP	2% BCP	4% BCP		
DOC		9.08 ± 0.11	9.10 ± 0.12	9.20 ± 0.14	9.21 ± 0.12	0.125	0.566
1		41.36 ± 0.81	41.25 ± 0.61	41.83 ± 0.69	41.67 ± 0.84	0.739	0.160
2	M	102.83 ± 2.10	100.93 ± 1.58	105.75 ± 1.96	103.92 ± 2.28	1.981	0.418
	F	101.72 ± 2.78	98.32 ± 2.14	99.60 ± 2.16	101.49 ± 2.08	2.295	0.560
	Mean	102.35 ± 1.67	99.81 ± 1.28	102.54 ± 1.52	102.92 ± 1.59	1.520	0.460
3	M	185.97 ± 4.58	178.39 ± 2.77	185.13 ± 3.63	180.88 ± 3.44	3.609	0.349
	F	179.37 ± 2.60	179.23 ± 2.64	176.03 ± 5.11	180.87 ± 2.74	3.277	0.700
	Mean	182.20 ± 2.48^{a}	178.83 ± 1.89^{b}	179.84 ± 3.37^{ab}	180.87 ± 2.15^{ab}	2.477	0.001
4	M	252.72 ± 4.91	242.45 ± 3.75	249.05 ± 4.69	244.86 ± 4.52	4.471	0.376
	F	245.48 ± 3.15	240.83 ± 3.52	250.18 ± 3.63	247.83 ± 3.61	3.482	0.274
	Mean	248.75 ± 2.83^{ab}	241.60 ± 2.54^{b}	249.72 ± 2.85^{a}	246.41 ± 2.84^{ab}	2.767	0.016
5	M	286.75 ± 5.73	288.21 ± 4.34	291.46 ± 3.52	282.32 ± 6.10	4.927	0.086
	F	289.96 ± 5.30^{ab}	280.21 ± 4.12^{b}	296.17 ± 5.10^{a}	282.67 ± 3.82^{b}	4.587	0.046
	Mean	288.51 ± 3.85^{ab}	284.03 ± 3.01^{b}	294.26 ± 3.34^{a}	282.52 ± 3.37^{b}	3.396	0.050

The means with different superscripts on the same line are significantly different from each other ($P < 0.05$). SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

The antibacterial effects as well as the high content of fatty acids in BCP (Abdou et al., 2015) which plays a dynomic significant role in the performance and improving their metabolic process of quail birds. Essential oil of BCP contains 60-80 percent nigellone which has been proven to have antibacterial and antifungal properties, causing growth rate depression (Nadia, 2003; Shokri, 2016).

4.2.2 Body Weight Gain

Impact of distinct levels of BCP supplementation on BWG (g) in quail is presented in Table 4.2. Statistically, the difference was found in weight gain between groups in 4th and 5th weeks of the study. While, BWG was non-significant between groups during 1st , 2nd and 3rd weeks. However, highest BWG was recorded in group 2% BCP supplemented group followed by 4% BCP, 1% BCP supplemented groups and a control group.

Table 4. 2. Effect of BCP supplementation in different levels on weekly body weight gain (BWG)

Weeks	Groups				SEM	P
	Control	1% BCP	2% BCP	4% BCP		
1	32.28 ± 0.61^{a}	32.15 ±0.52^{a}	32.64 ± 0.61	32.47 ±0.81^{a}	0.639	0.953
2	60.98 ± 1.71^{a}	58.55 ±0.37^{a}	60.70 ± 2.31	61.25 ± 2.06^{a}	1.621	0.703
3	79.75 ± 0.44^{a}	79.02 ±0.42^{a}	77.31 ± 2.43	77.95 ± 1.21^{a}	1.123	0.618
4	66.60 ±1.01^{ab}	62.77 ±3.83^{ab}	70.03 ± 3.11^{a}	65.54 ± 0.92^{b}	2.224	0.029
5	39.90 ±1.86^{ab}	42.43 ±2.56^{ab}	44.69 ±2.24^{a}	36.11 ± 2.37^{b}	2.255	0.058

The means with different superscripts on the same line are significantly different from each other (P <0.05). SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

Table 4.3 shows the effect of BCP supplementation on BWG in quail over the course of a week. The results showed that there was a statistically significant difference in BWG across groups in 1-5 weeks and 3-5 weeks. In 0-2 weeks, however, there was no significant change (P >0.05). In comparison to 1% BCP supplemented group (274.93±2.31 g) and 4% BCP supplemented group (273.31±3.55 g), 2% BCP supplemented group (285.38±5.51 g) and a control group (279.52±1.83 g) had substantially larger total weight increase. The increased BWG of quail have given BCP might be attributed to the active components in BCP that improve the performance of intestinal bacteria, resulting in better digestion and utilization. These findings are consistent with those of Abd El-Hack et al. (2016), who found that quail fed dietary BC had substantially more BWG than those fed a control diet. Furthermore, Tahan and Bayram (2011) discovered that supplementing broiler chicks with dried black cumin enhanced their BWG. At the age of 42 days, Erener et al. (2010) discovered that BCS (10 g/kg) enhanced BWG compared to control. At 28 and 42 days of age, the BCS-fed groups (25 and 50 g/kg) had significantly higher BWG than birds fed 12.5 g/kg BCS and antibiotic diets, according to (Khan et al., 2012). According to Yatoo et al. (2012), all treatment groups had higher BWG than the control, with the 0.5 percent BCS group having the largest increase. BCS supplementation (20, 30 and 40 g/kg food) enhanced BWG of hens in a research by Durrani et al. (2007) as compared to the control. Seidavi et al. (2020) reported that the supplementing quail diets with black cumin (2 percent as seeds or 0.5 percent as oil) enhanced performance (growth and egg production) while also reducing pathogenic bacteria in the gut. Our trial findings are in agreement with

Veisizadeh and Gudarzi (2015) investigated the effect of different amounts of BCP (1 percent, 2 percent, or 4 percent) in Japanese quail diets and found that birds given 2 percent black cumin powder had the highest feed intake and weight growth. Jarari (2011) found that feeding BCP to quail (1 percent, 1.5 percent, or 2 percent) increased BW, breast production, and FCR. These findings contradict those of Abbas and Ahmed (2010), who found that birds fed a meal enriched with 1 or 2 percent black cumin had considerably reduced BWG and unchanged FCR. In contrary to our current findings, non-significance difference was observed between BCP supplemented groups with the control in broilers by (Khan et al., 2012). Moreover, Aydin et al. (2008) reported that there was no significant influence in the BWG and FCR in layers by the dietary supplementation of BCP in layers.

Table 4.3. Effect of BCP supplementation in different levels on body weight gain (BWG)

Groups	**Weeks**		
	0-2	3-5	0-5
Control	93.26 ± 2.16^{a}	186.25 ± 2.35^{ab}	279.52 ± 1.83^{ab}
1% BCP	90.70 ± 0.67^{a}	184.23 ± 2.08^{ab}	274.93 ± 2.31^{ab}
2% BCP	93.34 ± 2.84^{a}	192.04 ± 3.49^{a}	285.38 ± 5.51^{a}
4% BCP	93.71 ±2.76^{a}	179.60 ± 3.66^{b}	273.31 ± 3.55^{b}
SEM	2.111	2.896	3.301
P	0.778	0.052	0.013

The means with different superscripts in the same column are significantly different from each other (P <0.05). SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.2.3 Feed intake

Table 4.4 shows the influence of BCP supplementation on FI (g). All of the groups' FI was found to be non-significantly different. In the fifth week of the trial, 4% BCP supplemented group (220.25 ± 7.22 g) had the lowest feed intake compared to the groups control (228.73 ± 5.92 g), 2% BCP (233.77 ± 4.17 g), and 1% BCP (234.02 ± 7.52 g).

Table 4.4. Effect of BCP supplementation in different levels on weekly feed intake (FI)

Groups	**Weeks**				
	1	2	3	4	5
Control	47.23 ± 1.10	105.84 ±3.34	157.25 ± 4.14	213.59 ± 6.69	228.73 ± 5.92
1% BCP	46.27 ± 0.44	102.16 ± 1.23	158.11 ± 2.17	207.32 ± 7.08	234.02 ± 7.52
2% BCP	45.61 ± 0.62	105.93 ± 3.53	169.16±12.37	207.30 ± 3.65	232.77 ± 4.17
4% BCP	47.00 ± 1.52	105.89 ± 3.35	157.25 ± 2.33	208.62 ± 3.58	220.25 ± 7.22
SEM	0.918	2.860	5.257	5.254	6.213
P	0.672	0.767	0.542	0.560	0.443

SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

Table 4.5 shows the effect of dietary supplementation of BCP in different concentrations and weeks on FI in quails. In all of the feeding groups, the FI was found to be non-significant. In the 0-5 week, however, 2% BCP supplemented group (760.77 ± 16.14 g) ingested more feed than groups control (752.64 ± 18.0 g), 1% BCP (747.88 ±16.94 g), and 4% BCP (739.00 ± 15.67 g). Our trial findings are in agreement with Veisizadeh and Gudarzi (2015) investigated the effect of different amounts of BCP (1 percent, 2 percent, or 4 percent) in Japanese quail diets and found that birds given 2 percent black cumin powder had the highest feed intake (FI) and weight growth. Similar observations was reported by Abd El-Hack et al. (2016) that no significant differences in FI between control and BCP supplemented groups. Our result findings are in agreement with Tufan et al. (2015) who reported that there was no significant differences between control and BCP supplemented groups in quail birds. Contrary to our findings Edmonds et al. (2014) observed that dietary addition of BCP in the broilers diet causes improvment in the feed consumption in comparison from the control. Moreover, opposite to our findings, another researcher Sogut et al. (2012) stated that dietary addition of BCP in the broilers diet causes improvment in the FI as compared from control.

Table 4.5. Effect of BCP supplementation in different levels on feed intake (FI)

Groups	Weeks		
	0-2	3-5	0-5
Control	153.07 ± 3.91	599.57 ± 14.82	752.64 ± 18.00
1% BCP	148.43 ± 1.40	599.45 ± 15.64	747.88 ± 16.94
2% BCP	151.54 ± 3.32	609.22 ± 16.41	760.77 ± 16.14
4 % BCP	152.89 ± 3.97	586.12 ± 12.43	739.00 ± 15.67
SEM	3.157	14.831	16.692
P	0.744	0.751	0.827

SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.2.4 Feed Conversion Ratio

Table 4.6 shows the effect of different concentration levels of dietary addition of BCP as feed additives on weekly FCR in quail. The FCR was not substantially different (P > 0.05) across the groups in any of the weeks, according to the findings. FCR was found to be non-significantly different among groups control (1.97 ± 0.05), 1% BCP (2.00 ± 0.01), and 4% BCP (2.01 ± 0.03) in the third week of this investigation, but these groups were shown to be substantially different versus group 2% BCP (2.20 ± 0.19).

Table 4.6. Effect of BCP supplementation in different levels on weekly feed conversion ratio (FCR)

WEEK	Groups				SEM	P
	Control	1% BCP	2% BCP	4% BCP		
1	1.46 ± 0.01	1.44 ± 0.01	1.39 ± 0.03	1.44 ± 0.04	0.027	0.487
2	1.73 ± 0.01	1.74 ± 0.01	1.75 ± 0.03	1.73 ± 0.01	0.020	0.509
3	1.97 ± 0.05^{a}	2.00 ± 0.01^{a}	2.20 ± 0.19^{b}	2.01 ± 0.03^{a}	0.033	0.055
4	3.21 ± 0.13	3.33 ± 0.14	3.98 ± 0.14	3.18 ± 0.07	0.120	0.300
5	5.77 ± 0.32	5.57 ± 0.36	5.24 ± 0.23	6.16 ± 0.36	0.324	0.300

The means with different superscripts in the same line are significantly different from each other (P <0.05). SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

Table 4.7 shows the effect of dietary BCP supplementation at various concentration levels and times on FCR in quails. During the 0-2 weeks, 3-5 weeks, and 0-5 weeks, the feed utilization rate was found to be non-significantly different in all groups. During 3-5 weeks and 0-5 weeks, 2% BCP and a control group had a significantly higher FCR than 4 and 1% BCP supplemented groups. The substantial improvement in FCR might be attributed to BCP's antibacterial properties, which promote nutrient absorption in the gut of birds, resulting in a better FCR. Our result findings are in agreement with Khan et al. (2012) who reported that the high oils in black cumin and higher nutrient digestibility are likely to have improved BWG and FCR by increasing the digesta staying time in the gizzard. This enhances the digestion of nutrients and feed efficiency, resulting in a faster growth development rate. Similar findings were reported by Shokrollahi et al. (2018) the treatment group have showen lower FCR in comparison from the control. Moreover, the result findings of Aydin et al. (2008) were also in consistent with our findings that there was no significant difference between BCP supplemented groups with the control. In contrast to our findings, Mahgoub et al. (2018) reported that there was a significant difference between BCP supplemented groups in comparison from the control.

Table 4.7. Effect of BCP supplementation in different levels on feed conversion ratio (FCR)

Groups	**Weeks**		
	0-2	3-5	0-5
Control	1.64 ± 0.01	3.22 ± 0.11	2.69 ± 0.06
1% BCP	1.63 ± 0.01	3.25 ± 0.05	2.72 ± 0.04
2% BCP	1.62 ± 0.02	3.17 ± 0.12	2.67 ± 0.07
4% BCP	1.63 ± 0.01	3.26 ± 0.07	2.70 ± 0.03
SEM	0.014	0.092	0.055
P	0.750	0.597	0.601

SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.3 Effects of BCP Supplementation on Carcass Characteristics and Relative Organ Weight

The quails were weighed at the end of the five-week experiment, and the average weight of female and male quails in each group was determined. They were slaughtered by selecting two females and two males from each subgroup who were close to the average live weight, and the carcass values are showed below.

4.3.1 Carcass Characteristics

At the conclusion of the experiment, quails were sacrified on the 35th day. The influence of feeding various concentration levels of BCP on quail carcass characteristics is shown in Table (4.8). In the case of general hot carcass weight, statistical differences were seen between the groups. In comparison to groups control (213.04 ± 2.07 g) and 1% BCP (214.75 ± 2.74 g), groups 2% BCP (221.66 ±2.83 g) and 4% BCP (219.17 ± 3.56 g) had the highest hot carcass average values of groups 2% BCP (221.66 ± 2.83 g) and 4% BCP (219.17 ± 3.56 g). Male and female hot carcass average mean values, on the other hand, were found to be non-significantly different ($P>0.05$). The supplementation of BCP in the feed of quails did not enhance cold carcass weight considerably ($P>0.05$) when compared from control diet group, Despite the fact that BCP supplemented groups statistically differ from the control group. Furthermore, no significant variations in overall carcass efficiency values were identified across the groups ($P > 0.05$), despite the carcass efficiency of group 2% BCP (76.02 ± 0.41) being greater than that of groups 4% BCP (75.99 ± 0.53 g), control (75.81 ± 0.31 g), and 1% BCP (75.50 ± 0.45 g). Our trial findings were consistent with those of Tufan et al. (2015) and Khan et al. (2012), who found that BCP supplementation had no effect on the dressing percentage values of quails and broilers, respectively (but their values numerically varry from eachother). Furthermore, the current findings are consistent with Erener et al. (2010), who reported no significant differences in carcass efficiency of birds given varied doses of BCP. Another research by Ghasemi et al. (2014) revealed that giving BCP-containing meals had no effect on the carcass characteristics of quail. Durrani et al. (2007), Majeed et al. (2010), Al-Beitawi and El-Ghousein (2008) reported that dietary BCP addition had no influence on carcass dressing percentage.

In contrast to our findings, Kumar et al. (2018) found that increasing the amount of BCS in feed had a greater carcass output than the other experimental groups. Furthermore, Saleh et al. (2014) reported a significant difference in average dressing % across the feeding groups. In addition, Abd El-Hack et al. (2018) did a study to see how dietary inclusion of black cumin cold pressed oil affected productive performance and carcass features in quail birds, and their findings were significant in terms of carcass traits, dressing weight, and edible offal weight. While the general mean value of hot and cold carcass weight in this investigation was statistically non-significant. The results for hot and cold dressing percentages are consistent with Ferket et al. (2002) findings, which found that BCP supplementation had no influence on hot and cold dressing percentages. In contrary to present findings, Patra et al. (2014) found that as compared to the control, the cold and hot dressing percentages were considerably raised and greatest in birds fed on a diet with increasing dietary BCP ($P < 0.05$).

Table 4.8. Effect of BCP supplementation in different levels on carcass characteristics

Groups		Live weight (g)	Hot Carcass weight (g)	Cold Carcass weight (g)	Carcass efficiency (%)
Control	Mean	283.21 ± 2.98	213.04 ± 2.07^{b}	214.65 ± 1.95	75.81±0.31
1% BCP	Mean	283.28 ± 3.01	214.75 ± 2.74^{ab}	213.93 ± 2.94	75.50±0.45
2% BCP	Mean	292.04 ± 3.61	221.66 ± 2.83^{a}	221.91 ± 2.34	76.02±0.41
4% BCP	Mean	289.01 ± 4.19	219.17 ± 3.56^{ab}	219.61 ± 3.38	75.99±0.53
SEM		1.917	1.202	1.187	0.306
P		0.660	0.039	0.991	0.657
Control	M	276.51 ± 3.35	209.24 ± 2.96	212.07 ± 2.88	76.69 ± 0.32
1% BCP	M	275.16 ± 2.63	210.75 ± 3.00	208.59 ± 3.55	75.77 ± 0.74
2% BCP	M	285.00 ± 3.63	215.48 ± 2.48	217.53 ± 2.46	76.33 ± 0.31
4% BCP	M	286.43 ± 7.16	219.25 ± 5.82	219.11 ± 5.71	76.50 ± 0.62
SEM		4.191	3.567	3.653	0.493
P		0.210	0.251	0.214	0.650
Control	F	289.91 ± 3.75	216.84 ± 2.35	217.23 ± 2.48	74.94 ± 0.32
1% BCP	F	291.39 ± 3.65	218.75 ± 4.30^{a}	219.28 ± 4.02	75.22 ± 0.55
2% BCP	F	299.08 ± 5.35	227.85 ± 4.15	226.29 ± 3.44	75.71 ± 0.78
4% BCP	F	291.60 ± 4.69	219.09 ± 4.54	220.10 ± 4.04	75.49 ± 0.86
SEM		1.457	1.398	1.466	0.436
P		0.360	0.855	0.920	0.629

The means with different superscripts in the same column are significantly different from each other ($P < 0.05$), SEM: Standard Mean Error, P: Significance, M = Male, F = Female, BCP: black cumin powder

4.3.2 Carcass organs ratios

Table 4.9 shows the organ percentage of quail as a ratio of cold carcass weight. The results showed that there was no significant difference in organ proportions such as back and wings percentages between the groups ($P > 0.05$). In the cases of the thigh, breast, and Male Neck, significant outcomes were seen among the groups ($P < 0.05$). When compared to the other treatment groups, control group had the greatest thigh percentage. However, control group (32.98 ± 0.23) had the greatest overall mean values of thigh % compared to groups 1% BCP (32.21 ± 0.47), 2% BCP (32.04 ± 0.22), and

4% BCP (31.79 ± 0.26). Moreover, the general mean value of breast % were observed in group 4% BCP (36.36 ± 0.43) as compared to the groups 1% BCP (35.29 ± 0.38), 2% BCP (34.90 ± 0.38), and a control group (34.22 ± 0.44). The results of this study revealed that carcass cuts (wings, neck, and back) were the same in all experimental groups of quail birds, whereas (breast, and thigh) were substantially different. These findings support the findings of Khan et al. (2012), who found that the value of dressing percent enhanced in the highest fed BCP addition group. Furthermore, Majeed et al. (2010) found that using BCP had no effect on carcass organ proportions such thigh and breast. According to El-Ghammry, the percentage of dressings has deduced. When compared to birds given a control or a diet supplemented with 2% BCS, Abbas and Ahmad (2010) discovered that birds fed a food supplemented with 1% BCS had a much lower dressing percentage. At 1.5 percent BCS meal in the diet, Jahan et al. (2015) observed no significant variations in average body weight, dressing yield, thigh meat, wing meat, heart, gizzard, and liver, but variances were identified in breast meat, drumstick meat, abdominal fat, and skin of broiler chickens.

Table 4.9. Effect of BCP supplementation in different levels on the commercial cut of quail carcass (%)

Groups		Thigh (%)	Breast (%)	Back (%)	Wings (%)	Neck (%)
Control	Mean	32.98 ± 0.23^{a}	34.22± 0.44^{b}	14.39 ±0.41	8.91 ± 0.14	6.73 ±0.19^{a}
1%BCP	Mean	32.21 ± 0.47^{b}	35.29±0.38^{ab}	14.38 ±0.39	9.17 ± 0.22	6.44±0.26^{ab}
2% BCP	Mean	32.04 ± 0.22^{b}	34.90 ±0.38^{b}	14.47 ±0.25	9.29 ± 0.17	6.52±0.13^{ab}
4 % BCP	Mean	31.79 ± 0.26^{ab}	36.36 ±0.43^{a}	14.14 ±0.26	9.09 ± 0.16	6.05 ±0.17^{b}
SEM		0.295	0.409	0.327	0.172	0.185
P		0.055	0.004	0.908	0.475	0.010
Control	M	32.71 ± 0.39	34.17±0.58^{ab}	14.08 ±0.56	8.79 ± 0.23	7.05 ±0.27^{a}
1% BCP	M	32.62 ± 0.66	34.86±0.54^{b}	14.25 ±0.62	9.35 ± 0.32	6.98 ±0.37^{a}
2% BCP	M	32.25 ± 0.19	34.08±0.63^{ab}	14.75 ±0.43	9.22 ± 0.31	6.70±0.15^{ab}
4% BCP	M	31.93 ± 0.28	36.73 ±0.51^{a}	13.77 ±0.27	9.04 ± 0.21	5.96 ±0.22^{b}
SEM		0.376	0.560	0.472	0.270	0.252
P		0.536	0.008	0.564	0.524	0.026
Control	F	33.24 ± 0.23^{a}	34.28±0.71^{b}	14.69 ±0.61	9.02 ± 0.16^{b}	6.41 ±0.22
1% BCP	F	31.80 ± 0.69^{b}	35.74±0.53^{ab}	14.52 ±0.50	8.98 ± 0.31^{ab}	5.90 ±0.26
2% BCP	F	31.83 ± 0.39^{b}	35.73±0.22^{ab}	14.18 ±0.27	9.36 ± 0.15^{a}	6.34 ±0.20
4% BCP	F	31.64 ± 0.46^{b}	35.99 ±0.71^{a}	14.50 ±0.41	9.13 ± 0.25^{a}	7.16 ±0.26
SEM		0.446	0.326	0.235	0.140	0.380
P		0.054	0.069	0.519	0.039	0.144

The means with different superscripts in the same column are significantly different from each other ($P < 0.05$), SEM: Standard Mean Error, P: Significance, M= Male, F=Female, BCP: black cumin powder

Similar findings were made by Seidavi et al. (2020), who reported that adding a BCP to the diet had no effect on carcass characteristics. Another study by Jarari et al. (2011) found that supplementing quail with black cumin seeds (1 percent, 1.5 percent, or 2 percent) increased body weight, breast yield, and feed conversion ratio compared to the control group. They also found no statistically significant differences between the groups when it came to carcass cuts like the breast, thigh back, and neck. Abd El-Hack et al. (2016) observed that dietary BCP up to 0.5 percent had no effect on the dressing percentage or relative weight of giblets. Broiler chicks fed diets with modest amounts

(0.2 and 0.4 percent) of crushed BCS showed a substantial drop in dressing percentage, according to El-Ghammry et al. (2002). Our findings, which were corroborated by Abbas and Ahmed (2010), showed that birds fed a meal supplemented with 1% whole crushed BCS had a significantly lower dressing percentage ($P<0.05$) than those fed control or 2 percent dietary group. In contrast to the current findings, Khan et al. (2012) found a significant difference between the dietary treatment groups in the ratio of carcass commercial slices such as breast, thigh, and drumstick. They discovered that supplementing with 4% BCP enhanced breast percentage considerably but had no impact on thigh percentage. Durrani (2007) also discovered that chickens given BCP had higher breast weight than the control group, and that adding 4 percent black cumin to the broiler diet enhanced the weight of the thigh and breast, consequently there is a higher dressing percentage.

4.3.3 Edible internal organ and abdominal fat proportion

Table 4.10 shows the edible internal organs and belly fat ratios of the mixed fed groups. In terms of both the overall mean values of the groups and distinct male and female groups, the heart, liver, gizzard, and abdominal fat ratios did not differ substantially ($P<0.05$). Despite the lack of a significant difference, groups control and 4% BCP had a greater abdominal fat ratio (2.06%) than the other groups, while group 1% BCP had the lowest (1.91 percent). The results of this study revealed that BCP supplementation had no effect on the selected edible organs or belly fat. These findings are in line with those of prior studies. There was a statistical difference was observed between control group showing higher % in term of gizzard% as compared from the other BCP treated groups. In the reaction to a BCP supplemented diet, Erener et al. (2010) found no significant differences in edible organ features or belly fat. The lowest abdominal fat ratio was observed in the diet containing 1% BCP in the current investigation, which might be related to the action of BCP, which has been shown to decrease fat deposition influence. These findings agree with those of Khan et al. (2012), who found no significant differences in carcass characteristics between dietary supplemented and unsupplemented BCP groups. In the research of Ismail et al. (2011) there were no significant effects of dietary BCS or BCS extract on the dressing percentage, edible inner organs, or belly fat in chickens. According to Abaza et al. (2008), feeding 1 g BCS oil kg1 diet to hens reduced the percent of belly fat. Furthermore, Sogut et al.

(2012) found that dietary addition of BCP at rates of 3 and 5% had no significant effects on relative weights of carcass, fat pad, or digestive organs between treatments, with the exception of the small intestine. The findings of Ferket et al. (2002) were likewise consistent with our findings. In contrast to the control group, they found no significant differences in heart, liver, or gizzard weight. Hassanien et al. (2014) also discovered that there was no significant change in edible internal organ rate between the BCP supplemented and control groups (heart, liver, and gizzard). Furthermore, Shewita and Taha et al. (2011) investigated the effect of BCP supplementation on broiler growth performance, carcass characteristics, and meat quality, finding no significant effects of the dietary supplemented BCP on the percenage of edible offal and meat cuts.

Table 4.10. Effect of BCP supplementation in different levels on giblet proportion and abdominal fat (%)

Groups		Heart (%)	Liver (%)	Gizzard (%)	Abdominal Fat (%)
Control	Mean	1.24 ± 0.05	3.03 ± 0.11	2.55 ± 0.13^{a}	2.06 ± 0.16
1% BCP	Mean	1.22 ± 0.04	3.28 ± 0.17	2.41 ± 0.06^{ab}	1.91 ± 0.15
1% BCP	Mean	1.21 ± 0.04	3.09 ± 0.14	2.26 ± 0.07^{b}	2.05 ± 0.07
4% BCP	Mean	1.23 ± 0.03	3.29 ± 0.13	2.38 ± 0.09^{ab}	2.06 ± 0.14
SEM		0.045	0.045	0.086	0.134
P		0.986	0.986	0.180	0.843
Control	M	1.25 ± 0.08	2.74 ± 0.10	2.37 ± 0.22	2.19 ± 0.22
1% BCP	M	1.33 ± 0.06	3.22 ± 0.23	2.38 ± 0.10	2.17 ± 0.25
2% BCP	M	1.22 ± 0.05	3.92 ± 0.23	2.16 ± 0.07	2.05 ± 0.13
4% BCP	M	1.23 ± 0.04	3.09 ± 0.10	2.33 ± 0.12	2.10 ± 0.19
SEM		0.059	0.167	0.127	0.197
P		0.615	0.272	0.656	0.957
Control	F	1.22 ± 0.07	3.32 ± 0.12	2.72 ± 0.11^{a}	1.93 ± 0.23
1% BCP	F	1.10 ± 0.04	3.34 ± 0.27	2.45 ± 0.08^{ab}	1.65 ± 0.16
2% BCP	F	1.21 ± 0.07	3.26 ± 0.15	2.37 ± 0.09^{b}	2.05 ± 0.08
4% BCP	F	1.22 ± 0.06	3.50 ± 0.22	2.43 ± 0.14^{ab}	2.06 ± 0.24
SEM		0.064	0.190	0.109	0.176
P		0.515	0.849	0.140	0.448

The means with different superscripts in the same column are significantly different from each other ($P < 0.05$), SEM: Standard Mean Error, P: Significance, M= Male, F=Female, BCP: black cumin powder

Kumar et al. (2017), on the other hand, disagreed with our findings. Excessive feed intake combined with higher fat and carbohydrate digestibility may have resulted in high belly fat in broiler hens on BCS diets. Except for the heart percentage, they found that feeding BCP at varied doses had a significant ($P<0.05$) impact on the growth of edible organs (liver, gizzard, and belly fat) in broilers. The weight of the liver, abdominal fat, thigh, breast, wings, and neck of chickens when they were fed BCS at a rate of 10 g/kg feed (Guler et al., 2006).

4.4 Effects of Storage on Breast Meat Lipid Peroxidation, Microbiological Load and pH

4.4.1 Breast meat peroxide value

Table 4.11 shows the changes in peroxide values in breast meat after 0, 3, 5, and 7 days of storage at 4 °C in the refrigerator. The initial peroxide value of breast flesh was 0.182 meq/kg, which increased with time in all samples. On days 1, 3, 5, and 7, the peroxide value of the breast flesh dropped when the BCP amount was raised. When compared to the other dietary groups, control group had the greatest peroxide value on all days. When compared to the other groups, 4% BCP supplemented group had the lowest peroxide value in breast flesh. After 7 days of storage, peroxide values were found to be 6.00±0.00, 4.500±0.49, 3.48±0.50, and 2.50±0.49 in groups control, 1, 2 and 4% BCP supplemented groups, respectively. To everyones information, this is the very first investigation to suggest that BCP has an oxidative protective effect on quail meat, as well as the utility of peroxide value as a quick and sensitive method for detecting changes in poultry meat storage deterioration.

Table 4.11. Breast meat peroxide value (meq/kg)

Groups	**Days**			
	0	3	5	7
Control	2.00 ± 0.00^{a}	3.50 ± 0.50^{a}	4.47 ± 0.50^{a}	6.00 ± 0.00^{a}
1% BCP	1.00 ± 0.00^{b}	2.49 ± 0.49^{ab}	3.50 ± 0.50^{ab}	4.50 ± 0.49^{ab}
2% BCP	1.00 ± 0.00^{b}	1.99 ± 0.00^{bc}	2.50 ± 0.50^{b}	3.48 ± 0.50^{bc}
4% BCP	0.50 ± 0.50^{b}	1.00 ± 0.00^{c}	2.00 ± 0.00^{b}	2.50 ± 0.49^{c}
SEM	0.125	0.248	0.377	0.375
P	0.00	0.00	0.00	0.01

Means with different superscripts (lowercase) letters in the same column differ significantly ($P < 0.05$), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

These findings are consistent with those of Kumar (2018), who utilized BCP as an antioxidant source in earlier research. The peroxide value was found to be considerably lower in the addition groups than in the control group. Various research have sought to improve the nutritional content of meats by dietary interventions, particularly employing plant bioactive chemicals and vegetable oils (Patra, 2014; Mandal et al., 2014a). Poultry meat offers a number of nutritional advantages, including high levels of poly unsaturated fatty acids (PUFA) and a low lipid content (Mandal et al., 2014b). Dietary fatty acid composition and anti-oxidant compounds have an impact on muscle fatty acid composition (Crespo and Esteve-Garcia, 2001; Ertas et al., 2005). The impact of BCS or its oil on antioxidant capacity in chickens is unknown, however supplementation has been shown to enhance ferric reducing antioxidant power (FRAP) in blood serum, thigh, and breast meat (Kumar et al., 2017b). Guler et al. (2007) added BCS in the meals at four different dosages (5, 10, 20, and 30 g/kg) and found that incorporating BCS in the diets (10, 20, and 30 g/kg, but not at 5 g/kg) reduced malondialdehyde (MDA) concentrations (an indication of lipid peroxidation) in breast meat. BCS reduced MDA contents in serum (10 to 30 g/kg, but not at 5 g/kg), liver (5 to 30 g/kg), and heart (10 to 30 g/kg, but not at 5 g/kg) in this research. In comparison to the control group, giving BCS (10 and 20 g/kg of food) to broiler chickens reduced MDA concentrations by 24% and 28%, respectively, and enhanced antioxidant activity (glutathione peroxidase and superoxide dismutase) in thigh muscle, according to Rahman and Kim (2016).

4.4.2 Breast Meat Thiobarbituric Acid Value

TBA levels in breast meat were measured after storage at 4°C for 0, 3, 5, and 7 days. Table 4.12 summarizes the findings. The TBARS value of the control group's breast meat sample was 0.182 mg MDA/kg at 0 day, and it rose in all samples throughout storage. On all days, the control group had the greatest TBA value. When compared to the other groups, group D (4 percent BCP level) had the lowest breast flesh TBA value ($P<0.05$). On all days, the TBA value of the breast meat dropped as the level of BCP increased. The findings indicated that the antioxidant capacity of the BCP utilized in the study was efficient in avoiding oxidation in the quail breast flesh. The results we got for the TBA value of breast meat were in agreement to those of (Khadr et al., 2006). Zwolan et al. (2020), When compared to control, birds fed a BCP-supplemented diet exhibited lower meat and liver TBA values, indicating higher oxidative stability than samples collected from birds on a control diet. The results of this study show that dietary NS can increase the storage duration of meat by influencing the oxidative stability of muscle and liver in broiler chicks. The TBARS and induction time of N.

sativa seed extracts were evaluated in order to establish their efficiency in preventing adverse changes in lipids that occur during the storage of vacuum-packed chicken meatballs. During the storage period, the greater BCS supplemented group had lower TBARS levels than the control group. On the first day, there was a significant difference ($p < 0.05$). The TBARS levels in all of the chicken meatballs variations increased after 7 days of storage when compared to the results on day 1. The larger concentration of extractable compounds with antioxidative characteristics, such as flavonols, in EE may explain its superior efficacy in preventing lipid oxidation compared to WE. The EE of Nigella sativa seeds was shown to have higher TPC values as well as DPPH radical scavenging activities. The oxidative stability of fat isolated from poultry meatballs with EE was greater than MBC and MBWE due to the increased concentration of these components with antioxidant capabilities in EE. During the 14-day storage in refrigerated circumstances, the incorporation of EE to the meatballs led to a delay in the lipid oxidation process compared to the control product (MBC). Lower TBARS readings and a substantially longer lipid induction time were found in chicken meatballs, indicating this.

Furthermore, the current findings are consistent with those of Udeh et al. (2018), who discovered that using black cumin in the meatball preparation significantly reduced TBARS values in chicken flesh compared to the control group samples ($p < 0.05$). The TBARS levels of the samples dropped as the rate of black cumin use rose. The phenolic component in black cumin was thought to be responsible for its antioxidant impact on TBARS value. It is well recognized that phenolic compounds' antioxidant activity is connected to their high redox potentials, which allow them to serve as reducing agents and hydrogen donors (Singh et al., 2014).

According to Rahman et al. (2021), adding BCP to the broielers' diet enhanced the antioxidant capacity of stored or refrigerated beef. Throughout the storage period, TBARS values were substantially ($p<0.05$) lower in the BHA and black cumin extract treatments compared to the control group. Furthermore, in 0.3 percent black cumin extracts (T4) treated patties, the growing trend of TBARS value was very modest and stayed lowest (0.51 mg malonaldehyde per kg sample) until 15 days of storage. In all treatment groups, the amount of TBARS rose considerably ($p<0.05$) with extended storage time. The degree of malondialdehyde formation in the control samples was greater than the degree of malondialdehyde development in the antioxidant-formulated treatment groups. Zwolan et al. (2020) studied the antioxidant impact of BC oil in mixed feed by storing breast and thigh meat in the refrigerator for 0, 3, 6, and 9 days and measuring lipid oxidation at the conclusion of the time. MDA levels in raw and cooked leg and breast meat were shown to be lower when birds' diets were supplemented with more BC oil. BCP has been demonstrated in the literature to extend the shelf life of refrigerated meat, which might be related to the presence of flavonoid and phenolic chemicals, which help to inhibit lipid oxidation.

Table 4.12. Breast meat thiobarbituric acid (TBA) value (mg MDA/kg)

Groups	**Days**			
	0	3	5	7
Control	0.260±0.02^{a}	0.360±0.00^{a}	0.411±0.00^{a}	0.545±0.00^{a}
1% BCP	0.245±0.001^{ab}	0.325±0.00^{b}	0.356±0.00^{b}	0.485±0.01^{b}
2% BCP	0.222±0.00^{ab}	0.310±0.00^{b}	0.345±0.00^{b}	0.377±0.01^{c}
4% BCP	0.205±0.01^{b}	0.277±0.01^{c}	0.337±0.00^{b}	0.372±0.00^{c}
SEM	0.01	0.00	0.00	0.00
P	0.00	0.00	0.00	0.00

Means with different superscripts (lowercase) letters in the same column differ significantly ($P < 0.05$), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.4.3 Breast meat microbiological analysis

Table 4.13 shows the total number of psychrophilic bacteria found at the conclusion of storage in quails fed different doses of BCP for 0, 3, 5, and 7 days at 4°C. With increasing storage duration up to day 7, the quantity of psychrophilic bacteria in all samples increased continuously. At 0, 5th, and 7th days, the total number of psychrophilic bacteria in the breast flesh revealed a statistically significant difference ($P<0.05$) between the groups. The overall number of psychrophilic bacteria in each group grew as storage duration increased, but dropped as BCP inclusion amount increased. Control group (3.65±0.04) exhibited a substantially larger ($P<0.05$) number of psychrophilic bacteria after seven days of storage than groups 1% BCP (3.33±0.01), 2% BCP (3.27±0.01), and 4% BCP (3.23±0.03). Meat microbial load is one of the most critical variables affecting meat preservation quality. If the meat has an antibacterial component, it may be able to keep it for a longer amount of time without it rotting. In fact, it has been proven that utilizing herbal sources with antibacterial characteristics as additives can lower the quantity of germs in meat (Gümüş et al., 2017). The present findings corroborate those of earlier research. Reduced caecal coliform numbers in broilers fed dietary BCS might be due to BCS' antibacterial action against a variety of harmful bacteria (Durrani et al., 2007). Nigella sativa possesses antibacterial, antioxidant, and anti-inflammatory properties that may contribute to its positive benefits on immunity and growth performance (Al Saleh et al., 2006). Which also has an impact on the intestinal microbiota, which plays an important role in the protection of the animals (Guo et al., 2004). Because the number of beneficial bacteria has risen, the host's health has been maintained by inhibiting the colonization of microbial infection. NSO's antimicrobial action is connected to its components, particularly flavonoids and volatile oils, which have therapeutic action against bacteria including Staphylococcus and E. coli (Ishtiaq et al., 2013; Gessner et al., 2017). According to Abd El-Hack et al. (2018), BCO concentrations of 0.5 and 1.0 g/kg had the most inhibitory impact on pathogenic bacteria. As a result, in all future studies, these concentrations (0.5 and 1.0 g/kg) were chosen. TBC and TFC levels in the control basal diet rose over time, beginning after the first day of treatment. TBC and TFC growth were slowed when BCO was added to the basal diet at a concentration of 0.5 or 1.0 g/kg. In the baseline diet supplemented with BCO, there was a substantial lowering impact on coliform and E.coli ($P<0.05$), where these bacteria were beneath limit of detection. Moreover, the antibacterial activity of the BCO, which is mostly attributable to its chemical properties with high phenolic content, resulted in a delaying in the onset of spoiling in the fortified basal diet containing oil. Hassanien et al. (2014) hypothesized that black cumin seed oil was high in phenolics and other bioactive components that may serve as potential antibacterial agents. The inclusion of BCO in the diet, from the other hand, led to the reduction in the population of harmful microorganisms. According to the research, essential oils have no substantial influence on the beneficial bacterial community in the guts of broiler chickens (Jang et al., 2004).

Selim et al. (2013) investigated the effects of powerful antioxidant resources such as ginger ethanolic extracts, beetroot extract, and tomato puree in broilers fed. They discovered that adding ginger root extract and tomato puree as a natural antioxidant addition to refrigeration and freezing broiler meat reduced the number of bacteria and Staphylococcus. Satılmış (2019) found that the total population of psychrophilic microbes rose as the storage duration of the thigh meat rose and reduced with the addition of liquorice powder mostly on days of analysis. Gümüş et al. (2017) looked at how varying amounts of thyme essential oil in quail feed affected the microbiological characteristics of breast meat and found a reduction in microbial load. The antibacterial activity of the BCP utilized in the study was efficient in inhibiting microbial development in the quail breast flesh samples, according to the findings. The antibacterial activity of BCO is related to its chemical makeup, which contains a high phenolic concentration.

Table 4.13. Breast meat total psychrophilic bacteria count (log cfu g-1)

Groups	**Days**			
	0	3	5	7
Control	2.10±0.025^{a}	2.29±0.015	2.64±0.005^{a}	3.65±0.04^{a}
1% BCP	1.18±0.025^{b}	2.12±0.025	2.44±0.015^{b}	3.33±0.01^{b}
2% BCP	0.95±0.054^{c}	2.04±0.495	2.39±0.011^{bc}	3.27±0.01^{b}
4% BCP	0.74±0.04^{d}	1.58±0.005	2.35±0.035^{c}	3.23±0.03^{b}
SEM	0.035	0.135	0.016	0.022
P	0.000	0.343	0.001	0.001

Means with different superscripts (lowercase) letters in the same column differ significantly ($P < 0.05$), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.4.4 pH values of breast meat

At the end of the trial, three breast flesh samples were collected, and pH values were determined at 0, 3, 5, and 7 days at 4°C. Table 4.14 shows the impact of storing on the pH of breast flesh. The pH value of the breast flesh discovered rose with storage time, peaking at day 7. Over all days, the BCP-supplemented groups (1, 2 and 4%) exhibited lower pH values than that of the control group. Following 7 storage period, 4% BCP group (5.77 ± 0.01) had the lowest pH value, preceded by 2% BCP (5.88 ± 0.00), 1% BCP (5.96 ± 0.02), and a control group (6.13 ± 0.00). Naimati (2019), who employed quinoa seed extract as an anti - oxidant resource in the quail diet, found similar results.

Following storage at 4°C including all days, she noticed that the pH value of breast flesh in the quinoa seed extract supplied groups was considerably lower than the control group. Our findings are consistent with those of Chandralekha et al. (2012), who found that the increase in pH following storing was considerably lower in all treated groups than in the control group. This conclusion is consistent with Rahman et al. (2021), who found that sensory characteristics and pH value were substantially reduced ($p<0.05$) in different treatments when compared to control. In contrast to our findings, Aksu et al. (2014) found that the pH of the cold carcass was greater in groups that received thyme oil treatment. The presence of polyphenolic compounds in BCP may cause a drop in the pH of quail breast flesh.

Table 4.14. The effect of storage on breast meat pH values

Groups	**Days**			
	0	3	5	7
Control	5.95 ± 0.015^a	6.01 ± 0.00^a	6.10 ± 0.035^a	6.13 ± 0.00^a
1% BCP	5.89 ± 0.011^b	5.92 ± 0.027^b	5.94 ± 0.025^b	5.96 ± 0.025^b
2% BCP	5.78 ± 0.022^c	5.83 ± 0.021^c	5.85 ± 0.011^c	5.88 ± 0.00^c
4% BCP	5.62 ± 0.015^d	5.72 ± 0.000^d	5.73 ± 0.00^d	5.77 ± 0.01^d
SEM	0.015	0.015	0.019	0.010
P	0.000	0.000	0.000	0.000

Means with different superscripts (lowercase) letters in the same column differ significantly ($P < 0.05$), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.5 Effect of BCP on breast and thigh meat colour and pH

Quail thigh and breast flesh pH and color, such as L* (brightness), a* (redness), and b* (yellowness), were examined in the cold carcass at the conclusion of the research (Table 4.15). In terms of a* (redness) and b* (yellowness) of thigh meat, there was no significant difference between the different treatments, but L* (brightness) and a* (redness) value of thigh skin in the cold carcass ($P>0.05$). In the case of L* (yellowness) values of thigh meat and b* (yellowness) values of thigh skin, there was a significant difference between the dietary regimens ($P<0.05$). In the case of thigh meat, 4% BCP group had the lowest b* (yellowness) rating. 1% BCP group had the highest b* (yellowness) rating in thigh meat. In comparison to the control and other treated groups, 1% BCP supplemented group had the highest L* (yellowness) values of the thigh meat.

Table 4.15. Effect of BCP supplementation on thigh meat and skin colour in cold carcass

Groups	Thigh meat			Thigh skin		
	L*	a*	b*	L*	a*	b*
Control	53.76 ± 0.66^{ab}	2.18±0.35	6.46±0.42	58.57±1.25	1.96±0.28	6.36 ± 0.47^{a}
1% BCP	56.08 ± 0.57^{a}	2.33±0.39	7.14±0.46	57.90±0.68	1.65±0.19	5.61 ± 0.31^{b}
2% BCP	55.48 ± 0.56^{b}	1.33±0.23	6.48±0.34	57.27±0.99	1.13±0.20	5.06 ± 0.32^{b}
4% BCP	55.89 ± 0.39^{b}	1.76±0.31	6.31±0.27	57.01±0.84	1.67±0.41	4.82 ± 0.49^{ab}
SEM	0.551	0.327	0.377	0.945	0.271	0.404
P	0.019	0.154	0.426	0.670	0.227	0.050

Means with different superscripts (lowercase) letters in the same column differ significantly (P < 0.05), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder, L*measures relative lightness, a*relative redness and b*relative yellowness

Table 4.16 shows the findings of the skin color L* (brightness), a* (redness), and b* (yellowness) values of quail breast meat and skin. In terms of L*, a*, and b* values in breast flesh, there was no statistically significant difference between the groups (P>0.05). In the case of a* (redness) scores, however, there was no significant disparity in breast skin across the groups. In the case of breast skin L* (lightness) and b* (yellowness), however, there was a significant difference between experimental groups (P<0.05). Despite this, a statistical significance variation in breast flesh pH was detected between the different treatments.

The color scores deteriorated over time, possibly due to pigment, protein denaturation, particularly of myofibrillar proteins (actin and myosin) (Chaijan et al., 2008), and lipid oxidation and non-enzymatic browning caused by reactions between lipid oxidation product offerings and amino acids (Chandralekha et al., 2012). Kandeepan et al. (2010), Singh et al. (2011), and Bhat et al. (2013) found a declining tendency in color ratings of beef products with extended storage time. Antioxidant contents in processed meat were also linked to color stability (Insani et al., 2008). According to Sanchez Escalante et al. (2003), antioxidants have a direct influence on metmyoglobin synthesis, ensuring color stability. The strong antioxidant contents of black cumin seed extract, which prevents autoxidation of myoglobin contents beef patties, may explain why color ratings were substantially ($p<0.05$) higher in 0.3 percent black cumin seed extract administered patties.

Zwolan et al. (2020), who investigated the influence of dietary changes, reported similar results to our findings. The inclusion of N. sativa seed extracts had no influence on the L* and b* color parameters on chicken quality meat after 14-day storage ($p > 0.05$). They discovered that the mean values of L*, a*, and b* in chicken breast meat were not significantly different between treatment groups. Furthermore, as the BCP concentration in the diet rose from 0 to 4g/kg, the pH value decreased. Furthermore, these findings are consistent with Hong et al. (2012), who observed no significant change in the L, a, or b values of breast or thigh meat as in oregano, anise essential oil, and peel powdered supplemented group. In contrast to the present results, Zwolan et al. (2020) found that adding pulverized N. sativa seeds considerably changed the color of the completed product.

Kirkpinar et al. (2014) found a difference in the L* and a* values of breast meat whenever birds were given 150 mg oregano and garlic essential oil or 300 mg combined together. The ph range of quail breast flesh decreased in this study, and all these findings are consistent with those of Shilpa et al. (2019), who found a linear fall in pH with greater doses of feeding BCP in contrast to the control category. This is critical since the color of processed meat is a critical quality characteristic that might influence a customer's buying choice (Al-Hijazeen et al., 2016).

Table 4.16. Effect of BCP supplementation on breast meat and skin colour

Groups	breast meat			breast skin		
	L*	a*	b*	L*	a*	b*
Control	62.31±0.67	4.01±0.38	10.74±0.34	68.06±0.42^a	3.75±0.30	9.79±0.46^b
1% BCP	60.35±0.80	3.67±0.37	10.21±0.30	68.69±0.66^a	3.83±0.54	12.46±1.20^a
2% BCP	62.11±1.10	3.65±0.31	10.68±0.22	68.59±0.55^a	3.34±0.23	9.86±0.25^b
4% BCP	60.60±0.77	3.75±0.29	10.55±0.29	65.51±0.83^b	3.80±3.33	9.60±0.48^b
SEM	0.733	0.436	0.444	0.752	0.247	0.547
P	0.395	0.077	0.793	0.002	0.347	0.025

Means with different superscripts (lowercase) letters in the same column differ significantly ($P < 0.05$), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder, L*measures relative lightness, a*relative redness and b*relative yellowness

4.6 Sensory Evaluation

The effects of dietary supplementation of BCP at various inclusion levels on quail breast and thigh meat sensory qualities were examined in this present research. The sensory properties of quail thigh and breast meat were studied on day one. The effects of dietary BCP supplementation on perceived quail meat breast and thigh ratings are shown in Table (4.17). The treated groups had substantially greater values of color, juiciness, tenderness, and flavor of thigh, breast meat than the control group ($P<0.05$).

The sensory evaluations of the control group thigh meat were poorer than those of the other treatments. The differences in tenderness of breast flesh between the treatments and control group were determined to be non-significant ($P>0.05$). Color, juiciness, and flavor of breast meat were observed to be differ significantly ($P<0.05$) between the control group and the other BCP augmented groups. Color, juiciness, and flavor numerical values were lower in control group than 1, 2 and 4% BCP supplemented groups.

Singh et al. (2019) found a similar conclusion, stating that dietary regimens substantially ($P<0.05$) impacted the sensory characteristics investigated, with the exception of meat juiciness. When compared to control, BCP supplementation substantially enhanced the look, color, flavor, tenderness, and overall acceptance of the meat ($P<0.05$). Adegbeye et al. (2020) who found identical research findings, concluding that the meat of birds given the BCP diet had the greatest sensory score. These findings agree with those of Rahman et al. (2021), who found a statistically significant influence of different plants feeding on the sensory attributes of chicken meat. On the other hand, Onibi et al. (2009) discovered no significant differences in sensory features of cooked broiler meat, except for enhanced palatability of meat samples with higher garlic supplementation. In another study, Gardzielewska et al. (2017) showed no significant change in meat juiciness, however sensory panelists rated BCP augmented samples as having greater firmness and flavor. The sensory attributes of cooked breast muscles revealed a favorable impact of administered supplementation on muscle softness in birds fed small concentrations of this seed (3 percent BCP) and a negative effect on meat organoleptic in birds at larger doses (5 percent BCP). Supplementation had a detrimental effect mostly on broth made from breast muscles both in the 3 percent and 5 percent BCP groups. The administered supplementation had no influence on the underlying sensory properties of the broth produced from breast and leg muscles. We didn't notice any changes in the meat's fragrance during the trial. In another trial on broilers Toghyani et al. (2010), supplementing meat with *Nigella sativa* seeds had no effect on meat flavor. Chandralekha et al. (2012) investigated the effects of different BCP different doses on carcass characteristics and the organoleptic qualities of served Japanese quail meat. They discovered that at 1.5 percent BCP supplementation, there was a substantial significant change ($P<0.01$) in flavor and overall acceptance when compared to the control group. The major variables that impact the sensory quality of meat are aroma and flavor (Resconi et al., 2013). Even though sensory panelists scored superior sensory scores in the thigh and breast meat from quail fed dietary BCP, these data imply that supplementing BCP in the quail diet could improve sensory attributes.

Table 4.17. Sensory characteristics of cooked meat of Japanese quail as influenced by dietary BCP

Parameters	Control	1% BCP	2% BCP	4% BCP	SEM	P-value
			Colour			
Thigh	6.68 ± 0.33^{c}	7.31 ± 0.20^{b}	8.43 ± 0.16^{a}	7.81 ± 0.14^{b}	0.130	0.000
Breast	6.75 ± 0.42^{b}	7.12 ± 0.38^{b}	8.37 ± 0.18^{a}	7.50 ± 0.17^{ab}	0.180	0.006
			Juiciness			
Thigh	6.86 ± 0.34^{c}	7.43 ± 0.23^{bc}	8.50 ± 0.11^{a}	8.00 ± 0.17^{ab}	0.138	0.000
Breast	6.24 ± 0.23^{b}	6.75 ± 0.50^{ab}	7.87 ± 0.33^{a}	6.51 ± 0.51^{b}	0.200	0.052
			Tenderness			
Thigh	6.92 ± 0.28^{c}	7.43 ± 0.19^{bc}	8.18 ± 0.17^{a}	8.07 ± 0.16^{ab}	0.124	0.001
Breast	6.76±0.45	6.75±0.48	7.87±0.26	7.50±0.24	0.200	0.123
			Flavour			
Thigh	6.82 ± 0.27^{b}	7.51 ± 0.27^{a}	8.07 ± 0.14^{a}	7.51 ± 0.14^{a}	0.115	0.002
Breast	6.14 ± 0.29^{b}	6.38 ± 0.53^{b}	8.51 ± 0.26^{a}	6.82 ± 0.35^{b}	0.240	0.001

The means with different superscripts in the same rows are significantly different from each other (P <0.05), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

4.7 Proximate Analysis of Quail Breast and Thigh Meat

The effects of dietary supplementation of BCP at various inclusion levels on quail breast and thigh meat proximate analysis was done in this present research. The proximate analysis of quail thigh and breast meat were studied on day one. The effects of dietary BCP supplementation on perceived quail meat breast and thigh results are shown in Table (4.18). The treated groups had substantially greater values of DM, CP, EE, and fat of thigh and breast meat than the control group (P<0.05).

The proximate analysis of the control group thigh meat were poorer than those of the other treatments. The differences in DM of breast flesh between the treatments and control group were determined to be significant (P<0.05). DM, CP, and EE of breast meat were observed to be differ significantly (P<0.05) between the control group and the other BCP augmented groups. CP, DM, EE and CA numerical values were lower in a control group than 1, 2 and 4% BCP supplemented groups.

Table 4.18. Effect of BCP supplementation on chemical composition (Proximate %) of thigh and breast meat of quail birds

Parameters	Control	1% BCP	2% BCP	4% BCP	SEM	P-value
Dry Matter (DM)						
Thigh	31.46±0.00^{a}	31.81±0.50^{a}	29.75±0.92^{b}	30.97±0.00^{b}	0.173	0.044
Breast	32.48±0.63^{b}	34.51±1.01^{ab}	36.26±0.29^{a}	37.80±1.27^{a}	0.204	0.048
Crude Protein (CP)						
Thigh	14.56±0.38^{ab}	13.92±0.04^{b}	15.11±0.09^{a}	14.96±0.39^{ab}	0.128	0.012
Breast	14.60±0.05^{c}	18.24±0.15^{a}	16.39±0.11^{b}	14.75±0.01^{c}	0.084	0.000
Ether Extract (EE)						
Thigh	2.16±0.01	2.28±0.03	2.36±0.04	2.29±0.17	0.066	0.267
Breast	2.06±0.01	2.15±0.05	2.19±0.06	2.17±0.08	0.055	0.463
Crude Ash (CA)						
Thigh	0.75±0.09	0.89±0.0.05	0.94±0.22	0.85±0.10	0.110	0.704
Breast	1.76±0.21^{a}	1.64±0.09^{ab}	1.59±0.03^{c}	1.48±0.11^{b}	0.113	0.053

DM; Dry matter, CP; Crude Protein, EE; Ether extract, CA; Crude ash, The means with different superscripts in the same rows are significantly different from each other (P <0.05), SEM: Standard Mean Error, P: Significance, BCP: black cumin powder

Our result findings are in contrary to this research which claimed that by proximate analysis, the dry matter, crude protein, crude fat, and crude ash contents of eight meat samples from left breast fillets were determined for each treatment (Nofal et al., 2006). Meat samples enriched with E (*Echinacea purpurea*) and N (*Nigella sativa*) had substantially lower crude protein (P<0.001) and dry matter (P<0.05) than meat samples from control and EN treated birds, according to the results of proximate analysis. Meat samples from broilers supplemented with N had a significantly greater ash percentage (P<0.001) than meat samples from broilers treated with control and E. The amount of crude fat in meat samples did not change substantially. In this study, EN supplementation resulted in substantially greater crude protein content (P<0.05) than either E or N supplementation independently, which might be owing to the synergistic effects of both substances' active components, resulting in improved protein metabolism (Ramadan et al., 2003). Regular supplementation of 1 percent EP herb through feed had no significant influence on broiler meat quality, according to Gardzielewska et al. (2017). Similarly, Kandeepan et al. (2010) found no influence of EP extract (supplemented gradually with the increase of 560 mg/kg feed from 22 to 42 days of age) on fatty acid compositional variations in broiler meat throughout frozen storage. The NS supplemented group had substantially greater crude ash levels, showing that NS seeds supplementation improved mineral availability.

The chemical properties of the breast and leg muscles was unaffected by the inclusion of *Nigella sativa* seed in the quail diet (Gardzielewska et al., 2017). Shewita and Taha (2011) found that this seed has a positive effect on the content of dry matter and protein in the right thigh and breast muscles of broilers, but their findings contradict those of Shewita and Taha (2011), who found that this seed has a beneficial impact on the composition of dry mass and protein in the right thigh and breast musculature of broilers. Supplementation with *Nigella sativa* seed (3 percent and 5 percent) had no influence on the quail breast and leg muscles' fundamental chemical makeup.

Our result findings are in agreement with this researcher findings who claimed that in both the thigh and breast muscles, DM and CP contents were greater (p =.02 to <.001) and EE contents were lower (p <.001) for antibiotic (AB) treated group than for control (Kumar et al., 2018). Both in thigh and breast muscles, total ash content was unaffected by AB when compared to the control. The BCS groups had higher DM and CP contents in thigh muscle than the control and AB groups, which rose quadratically (p <.001) with increasing BC dosages and were greatest in the MBC group. EE and total ash contents in the thigh muscle rose gradually with increasing BCS percentages in diets, and were similarly higher in the BCS groups than that of the AB group. Except for EE concentration in the LBC group, the BCS groups had higher DM, EE, and CP concentrations in the breast muscle than the CON group. With increasing BCS contents in the meals, DM concentrations climbed linearly, CP and EE concentrations were higher quadratically in the breast meat. The amount of total ash with in breast muscle was similar in both groups. The AB group's EE level in the breast meat was less than the CON and BCS groups.

In comparison to the control and AB groups, BCS supplementation raised DM, CP, and EE levels in thigh and boneless chicken breast Kumar et al. (2018), these findings are in agreement with our study. There are just a few studies that can be compared to the results of this one. When hens were fed a meal containing 15 g BCS kg1 diet, elevated levels of DM and CP in breast muscle were observed, but not in thigh meat, but additional high concentrations of BCS in the diets had no effect on the CP and DM components of chicken breast meat (Al-Beitawi & El-Ghousein, 2008). Likewise to this study, Al-Beitawi and El-Ghousein (2008) found that increasing BCS concentrations (20 to 30 g BCS kg1) enhanced EE content in chicken breast and thigh flesh. Increased consumption of digestible CP and EE might explain the elevated amounts of CP and EE in breast and thigh meat (Kumar et al., 2017). Several studies have demonstrated that feeding BCS increases feed intake and apparently total tract retention of nutrients (Durrani et al., 2007; Kumar et al., 2017). Protein concentrations in diets influence the chemical composition (DM, CP, and EE) of chicken meat in this way (Gardzielewska et al., 2017). When contrast to a low protein (160 g/kg) diet, high protein supplementation (200 g/kg diet) enhanced the concentration of CP (223 vs. 204 g/kg) in chicken thigh flesh (Gardzielewska et al., 2017). Supplementing with BCS or its EO constituents may alter thyroid gland activity by raising blood thyroid hormone levels, which are linked to protein biosynthesis and energy consumption in the body (Hermes et al., 2009). In this study, the slaughter BW of chickens was higher in the BCS diets supplemented. Pranav et al. (2018) found that the concentration of DM, CP, and EE in chicken meat is affected by the slaughter BW, which might explain variations in meat chemical components.

CHAPTER V

CONCLUSION

Because of the negative effects of antibiotic growth promoters on living cells, such as teratogenic effects, carcinogenic effects, mutagenicity, toxic effects, and hypersensitivity concerns, the European Union banned their use within animal feed in 2006. As a result, a series of studies were launched to find an alternative to synthesized natural antioxidants that do not endanger health of human beings and do not leave pollutants. The purpose of this study was to determine how meat quality changes over time, and also the impact of using BCP, a natural feed addition containing high antioxidant activity and phenolic contents, in quail mixed meal as an organic feed additives.

For this study, quails were fed commercial broiler chick starting feed during 5 weeks, but four distinct mixed feed groups were created by adding 0, 1, 2, and 4% BCP to the diet. Except for feed intake, BCP had a substantial favorable effect on live body weight, body weight gains, and feed conversion ratio just at end of the trial.
The effects of BCP on carcass features including carcass yield, wings, neck and back ratio, abdomen fat, heart and liver ratio from internal organs were determined to be non-significant ($P > 0.05$). However, there were variations in the overall thigh, breast, and male neck ratios between all the groups ($P<0.05$).

At +4 ° C, the pH, lipid oxidation, and bacterial load of flesh (meat) were measured at 0, 3, 5, and 7 days after the storage period ended. The groups receiving BCP supplements had substantially ($P<0.05$) lower breast meat pH values than the control group on all days (0, 3, 5, and 7) and the pH value fell as the quantity of BCP increased. Across all days of measurement, the additive groups' thiobarbituric acid value and principal oxidation product, peroxide value were determined to be lower than the control ($P<0.05$). These findings revealed that BCP's antioxidant-active phenolic compounds are efficient in preventing or delaying meat oxidation and may be utilized as just a natural antioxidant in feeding.

The total number of psychrophilic bacteria in the control group is substantially greater than the additive groups (P<0.05), indicating that microbial load (total number of psychrophilic bacteria) has risen with storage time. However, the overall quantity of psychrophilic bacteria in the control group is substantially greater than the additive groups, according to analyses performed at the conclusion of each storage period.

Mostly in cold carcass, there was no significant change in breast meat color L*, a*, or b* values, but in the BCP treated group, breast skin L* and b* values were substantially different from the control. However, the L* value in thigh meat increased as the concentration of BCP increased, whereas thigh skin colors dropped as the additives increased. Mostly in cold carcass, there was really no significant difference between the treatments in terms of a* and b* (redness) values of thigh meat and thigh skin L*, a* (P > 0.05). In the case of b* (yellowness) values of thigh skin and L* value of thigh meat (P<0.05), there was a significant difference between the treatment groups.

At day one, the sensory properties of quail thigh and breast flesh were examined. The treatment groups had substantially greater values of color, juiciness, tenderness, and flavor of thigh meat than the control group (P<0.05). The sensory values of the control group's thigh meat were lower than those of the experimental groups. Color, juiciness, and flavor of breast meat were found to differ significantly (P<0.05) between both the control group and that the other BCP augmented groups.

As a consequence of the study's findings, it was found that BCP had a substantial influence on quail performance and meat shelf life, and that it may be utilized in poultry diets as a natural antioxidant to prevent or postpone meat lipid oxidation.

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CURRICULUM VITAE

Muhammad Umair Asghar, was born on......November ...... in .... He completed his higher secondary school education from Al-Haram College Faisalabad, in 2012. He completed his Doctor of Veterinary Medicine from University of Veterinary & Animal Sciences, Lahore Pakistan. After graduation he was enrolled as Master student in the same university where he addressed "Effect of *Zingiber Officinale* on the performance, carcass characteristics and gut morphology of broilers". During his Master studies he gained knowledge about livestock production, poultry nutrition, dairy herd health, rumen physiology, animal feed resources, formulation and conservation, dairy cattle nutrition, calf nutrition, and it's management. Later he availed the opportunity to enhance his research skills to work with International research group. Therefore he joined Department of Animal Production and Technologies at Nigde Omer Halisdemir University Turkey, to pursue his second Master program under the supervision of Prof. Dr Sibel CANOĞULLARI DOĞAN where he observed the effect of dietary supplementation of black cumin seeds (*Nigella sativa*) on the performance, carcass traits and meat quality of Japanese quails". During his Master program, he was awarded ERASMUS to work as a research scholar at Wroclaw University of Environmental and Life Sciences Poland (Erasmus 2020/2021). He participated in several ongoing projects under the supervision of Prof. Dr. Barbara Krol. He was responsible for lab experiments (Batch culture technique and Hohenheim gas system) to evaluate the in-vitro digestibility of *Galega Orientalis* and *Medicago sativa* silages. He analyzed total gas production, methane production, ammonia production, fatty acid and volatile fatty acid profiles, as well as protozoa, count in rumen fluid after fermentation in vitro using batch culture experiment and Hohenheim gas production system. Currently, he has published 5 research articles and actively participated in research projects as a research associate.