بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Sudan University of Science and Technology

College of Graduate Studies

Response of Broiler Chicks fed on Dietary of cardamom Essential oils as Natural Growth Promoter

استجابة كتاكيت اللاحم المغذاة على زيت الهيل كمحفز طبيعي للنمو

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الآية

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

قال الله تعالى ((وَفَاكِهَةٍ مِمَّا يَتَخَيَّرُونَ (20) وَلَحْمِ طَيْرٍ مِمَّا يَشْتَهُونَ (21) وَحُورٌ عِينٌ (22) كَأَمْثَالِ اللُّؤْلُؤِ الْمَكْنُونِ (23) جَزَاءً بِمَا كَانُوا يَعْمَلُونَ))

صدق الله العظيم

سورة الواقعة (20 - 23)

Dedication

To those who graciously taught me the patience of my precious mother

To those who stood by my side and gave me the motivation to complete the studies of my dear wife.....

To my dear father, whom I had hoped to be beside me

To my teachers and dear friends

I guide this research

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In the first I thank God Almighty who gave me knowledge, science and patience to complete my studies and thank my professors who gave me everything scientifically and morally..... And thank my dear professor ***Prof. Dr. Kamal Abdel Baqi*** *who stood beside me to complete my work where there are no words I can describe them*

I extend my thanks to the University of Sudan for Science and Technology - College of Agricultural Studies professors and staff who hosted me and gave me everything scientifically, morally and humanely and I wish them success and success .... I also thank my professors in Iraq ***Dr. Jassim Manati and Dr. Ibrahim Al Moussawi*** *for standing beside me to complete this experiment.*

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Abstract

This experiment was conducted to evaluate the response of broiler chicks fed on graded levels of cardamom essential oil as natural growth promoter alternative to antibiotic. Experimental parameters covered growth performance, carcass dressing percentage, subjective meat quality and economical appraisal. The experimental design used the complete randomized design (CRD). A total number of (140), 7 days old, 170 gm initial weight unsexed (**Ros *308***) strain of broiler chicks were randomly divided into four experimental groups with five replicates, each of seven chicks. The first group (A) fed on basal diet without feed additives (control group) , the other groups B , C and D were fed basal diet supplemented with different cardamom oil. (Essential oil) at levels of 50 ml / ton, 100 ml / ton , 150 ml / ton. The basal diet was formulated to meet the nutrients requirements of broiler chicks according to **(NRC, 1994**). Experimental diets were fed for 6 weeks.

The results obtained showed that the addition of cardamom oil to feed resulted in a significant increase ($p < 0.05$) in feed consumption and body weight gain. The birds fed (150 ml) of cardamom oil showed the highest value for body weight gained, final body weight and better feed conversion ratio.

The result indicated that there were no significant differences among all treatment groups in the percentage of carcass dressing , giblets (heart , gizzard and liver) commercial cuts (breast , drumstick and thigh) and their percent of separable tissues . The addition of cardamom oil resulted in a significant decrease in blood serum cholesterol ($p < 0.05$) .No mortality was recorded throughout the experimental period.

Economical appraised values was profitability ratio (2.80) of group D (150 ml / ton cardamom oil) was the highest in the tested groups.

ملخص الدراسة

أجريت هذه الدراسة لتقييم مدى استجابة كتاكيت الدجاج اللاحم المغذاة على مستويات متدرجة من زيت الهيل كمحفز طبيعي للنمو بديلا للمضادات الحيوية . شملت قياس التجربة الأداء الإنتاجي , نسبة تصافي الذبيحة , الصفات الانطباعية النوعية للحم والتقييم الاقتصادي . صممت هذه التجربة باستخدام النظام العشوائي الكامل . تم استخدام 140 كتكوت عمر 7 أيام بوزن ابتدائي 170 غم غير مجنسة من سلالة (**Ros 308**) , تم تقسيمها إلى أربعة مجموعات تجريبية , كل مجموعة ضمت خمسة مكررات , بكل مكرر سبعة كتاكيت , تمت تغذية المجموعة الأولى (A) على عليقة أساسية بدون أي إضافة (عليقة قياسية) , أما المجموعات الأخرى B , C , D فقد تمت تغذيتها على العليقة الأساسية مضافا إليها زيت الهيل بنسبة (50 مل, 100مل , 150 مل) لكل طن علف على التوالي . تم تكوين العليقة القياسية لتقابل الاحتياجات الغذائية للدجاج اللاحم الصادر من (**NRC 1994**) . تمت التغذية على العلائق التجريبية لمدة 6 أسابيع . أثبتت النتائج المتحصل عليها إن إضافة زيت الهيل إلى العلف أدى إلى زيادة معنوية ($p < 0.05$) في استهلاك العلف ووزن الجسم المكتسب حيث إن الطيور التي غذيت على 150 مل من زيت الهيل أظهرت أعلى قيمة لوزن الجسم المكتسب ووزن الجسم النهائي, الكفاءة التحويلية للعلف أما نسب التصافي, الأعضاء الداخلية (القلب, الكبد و القانصة) والقطع التجارية (الساق, الصدر والفخذ) ونسبة لحم كل قطعة لم تتأثر معنويا بزيت الهيل ($p > 0.05$) علاوة على ذلك فإن إضافة زيت الهيل أدى إلى نقصان معنوي في نسبة الكولسترول في مصل الدم ($p < 0.05$). لم تسجل أي حالات للنفوق خلال فترة التجربة.

اظهر التقييم الاقتصادي ربحية نسبية (2.80) من مجموعة الاختبار D (150 مل / طن زيت الهيل) كانت الأعلى بين المجموعات المختبرة

CHAPTER ONE

INTRODUCTION

Poultry is one of the most successful and fast growing industry that provides high quality protein at economical price. Since ancient times, different strategies have been applied to improve animal productivity and profitability. Most important of them were always directed towards maintaining health, reducing disease outbreak and improving general immunity (**Visek, 1978**). Poultry meat is considered to be one of the most nutrition's food of the protein easy digestible by (20 – 25 %) and the egg products are also used in the preparation of pharmaceutical products (**ناجي, 1992)**. The fast growing nature of broilers and their short generation interval has been associated over the years with the use of antibiotic growth promoters at sub-therapeutic doses in animal feeds in order to improve performance through controlling the zoonotic pathogens in the gut **(Dieumou *et al*., 2009***)***.

Essential oils are aromatic and volatile liquids obtained from plant materials, including flowers, roots, bark, leaves, seeds, peel, fruits, weed and whole plants. The applications of essential oils for different purposes are varied and include not only their use in cooking to enhance the taste and health benefits of food, but also their application in the manufacture of perfumes and cosmetics, (**Hyldgaard *et al*., 2012**).The fruit of cardamom, (*Elettaria cardamomum*) is usually used as a flavoring agent in Arabian coffee throughout the Arabian countries and as spices in many countries. They are medicinally used for flatulent indigestion and to stimulate the appetite in people with anorexia. The present study was conducted to evaluate the combined therapeutic effect of cardamom oil (*Elettaria cardamomum*) on the growth performance and subjective meat quality attributes of broiler chicks (**Al- Zuhair *et al*., 1996**). Cardamom (*Elettaria cardamomum*) is primarily cultivated in Southern India, Sri Lanka, Tanzania, Guatemala and

Morocco. *Elettaria cardamomum* have antibacterial, gram-negative bacterium. In Indian medicine cardamom is used as a digestive aid and for the treatment of intestinal gas.

Antibiotic have been added to poultry diets to maintain health and production efficiency in the past 80 years. Various mechanisms have been proposed which are included:

a. The nutrients are more efficiently absorbed and less is utilized by the gut.
b. More nutrients are available to the host because of reduced intestinal micro flora.
c. There is a reduction in harm full gut bacterial.
d. Production of growth suppressing toxins or metabolites is reduced.
e. Microbial de – conjugation of bile acids is decreased **(Roozbeh *et al.*, 2012).**

Therefore the objective of the present study was to evaluate the effect of dietary cardamom oil on broiler performance and to assess the effect of cardamom oil on serum cholesterol and subjective meat quality of broiler chicks.

CHAPTER TOW

LITRATURE REVIEW

2.1 Feed additive:

Feed additives are products used in animal nutrition for purposes of getting better the quality of feed and the quality of food from animal origin, or to improve the animals' performance and health. The early use of antibiotics in diets arose from the discovery in the late 1940's, in the United States, that including the fermentation products of Streptomyces aureofaciens (a strain of bacteria) in the diets of single-stomached animals, such as pigs and poultry (**Frost, 1991**).Feed is major components, affecting net return from the poultry business, because 80% of the total expenditure in term of cash is spent on feed purchase *(***Javed *et al*., 2009***)*. The term "additive" is applied by the feed compounder, in abroad sense, to all products other than those commonly called feed stuffs that may be added to the ration with the object of obtaining some special effects. Additives are usually included in the feed mixture in very small quantities and require very careful weighing, handling and mixing. Those of special interest in formulation of poultry feeds include amino acids, antioxidants, and antibiotics, drugs to prevent or control disease, pigments, trace elements and vitamins *(***Ray and Fox, 1979***)*.

Keeping farm animals healthy is necessary to obtain healthy animal products. For the last decade the use of additives of natural origin in animal and human nutrition has been encouraged. Numerous researches focused on the clarification of the biochemical structures and physiological functions of various feed additives like probiotics, prebiotics, organic acids and plant extracts. Herbs, spices and their extracts were already used thousands of years ago in Mesopotamia, Egypt, India, China and old Greece, where they were

appreciated for their specific aroma and various medicinal properties (**Greathead, 2003**).

Feed supplements with growth promoting activity increase stability of feed and beneficially influence the gastrointestinal ecosystem mostly through growth inhibition of pathogenic microorganism's growth. Due to improved health status of digestive system, animals are less exposed to the toxins of microbiological origin. Consequently herbs and spices help to increase the resistance of the animals exposed to different stress situations and increase the absorption of essential nutrients, thus improving the growth of the animals (**Windisch *et al.*, 2008**). How to replace antibiotic growth promoters is also a question for the poultry industry. Some studies on plant extracts are showing promising results. (**Çabuk *et al.*, 2006**) measured production parameters of broilers which were supplemented by a mixture of oregano, laurel, sage, anis and citrus essential oils. The mixture of essential oils significantly improved feed conversion, what can be attributed to more effective availability of nutrients due to the changes in intestinal ecosystem (**Lippens *et al.*, 2005**). Plant extracts, more commonly known as essential oils, have been used for centuries in Chinese herbal medicine. They have been used for many years also in human food, but now more and more they find their way into animal nutrition as possible alternatives for AGP's, although with inconsistent results (**Vogt *et al.*, 1989; Langhout, 2000; Smink, 2000),** the diet of animals and humans contain a wide variety of additives. However, in poultry diets these additives are primarily included to improve the efficiency of the bird's growth and/or laying capacity, prevent disease and improve feed utilization. Any additives used in feed must be approved for use and then used as directed with respect to inclusion levels and duration of feeding. They are also specific for the type and age of birds being fed. These guidelines are maintained by a government committee (Product Safety and Integrity; Australian Government Department of Agriculture, Fisheries and Forestry). Although birds raised

with this feed additive achieved good performance, their potential side effects became a real public health problem worldwide (**Bager, 1998; Donoghue, 2003**) and led to the ban of these products by the European Union in January 2006.

2.2 Antibiotics:

Antibiotics are substances or compounds that kill or inhibit bacterial growth. Antibiotics belong to a wide range of micro-microorganisms. It is described as any substance produced by microorganisms that is contrary to the growth of other microorganisms in a very diluted medium. Antibiotics have been used for decades in poultry feeding to reduce pathological injury and to improve their productive performance. However, consumer fears of antibiotic-resistant bacterial strains and the accumulation of antimicrobial residues in animal products have prompted organizations to use feed additives from plant origin **(Nasir and Grashorn, 2006).**

Antibiotics have been successfully used in poultry production for more than fifty years for treatment of diseases, prevention from diseases by group medication in case of existing or potential disease. Antibiotics have also been continuously applied at sub therapeutic levels (as antibiotic growth promoters – AGP) in feeds of livestock species for maintenance of health and improving performance. AGP were supposed to increase growth rate as a result of improved gut health, resulting in better nutrient utilization and improved feed conversion efficiency (**VISEK, 1978**).

Antibiotics are used in the poultry industry whether for the purpose of treatment or prevention or elimination of harmful microbes, in addition to poultry diets to reduce coronary infections (ie before the onset of symptoms) and add to drinking water to prevent widespread diseases and the natural balance between beneficial and harmful bacteria in the stomach The Bird and His Body (**Griggs and Jacob, 2005**). . The real value of antibiotics has

dropped sharply today because of the misuse of these drugs and as people become more aware of these side effects caused by the use of these antibiotics and so they started looking for alternatives and where studies have shown that some medicinal plants have a good antimicrobial effect As compared to modern antibiotics, and this volatile oils showed a good antimicrobial effect (**Sahin *et al*., 2002**). And natural antibiotics are the best option compared to traditional antibiotics where there has been no undesirable effect and is one of the main factors of this choice.

The use of antibiotics in poultry for several purposes, including:

1. Prevention: intended to prevent bacterial diseases epidemiological and prevent the introduction of poultry at least on the farm to reduce their problems.
2. Treatment: Intended for the use of antibiotics in the treatment of bacterial diseases that appear in barns and are diagnosed such as diseases of salmonella and cola
3. Improving production rates: The goal here from adding antibiotics to poultry diets is to increase the productive efficiency of poultry and to improve their growth rates and increase production by reducing the quantities of pathogenic microbes in the intestines of poultry and improving the absorption rates of food and the use of poultry from proteins, vitamins and feedstuffs, Increase growth rates to (5-10%)
4. Defective treatment: In cases of low immunity to the herd and weakened as a result of exposure to environmental pressures such as difficult transport or immunization or high or low temperature than the appropriate rates and includes treatment vitamins and minerals (**Miles *et al*., 2006**). The natural growth rate of broilers and short-lived generation was observed to be associated over the years with the use of antibiotics for growth stimuli (**Dieumou *et al*., 2009**). All antibiotics control growth and proliferation of microorganisms; however, all

antibiotics do not accomplish this control by the same mechanism (**Ferket, 2004**).

2.3 Essential oil:

The term "essential" was adapted from the theory of "Quinta essential", first proposed in the 16th century by Paracelsus von Hohenheim, who believed that this substance was the active ingredient in medical preparation (**Oyen and Dung, 1999**).

The term "essential oil" can be considered a poor specific term through pharmaceutical products in the middle Ages and for this reason the term "volatile oils" has been proposed as an alternative (**Hay and Waterman, 1993**). . Most essential oils are classified as GRAS (generally recognized as safe) but their use in food as preservatives may be limited by flavor considerations (**Lambert *et al.*, 2001**). Essential oils can be derived from plants with antimicrobial activity, where toxic effects are present in poultry only when administered with high doses and the flavor properties of essential oils play an important role in the performance of poultry and digestive stimuli (**Lee *et al.*, 2004**). The main substances of essential oils have the ability of anti-inflammatory substances and these substances inhibit inflammatory metabolism and some anti-inflammatory plants such as chamomile, licorice, plum and anise (**Craig, 2001**).

Antimicrobial activity in essential oils has been detected (gram and gram-bacteria) with high antibacterial activity (**Panghal *et al.*, 2011**). Most essential oil consists of mixtures of compounds such as phenolics, polyphenols, terpenoids, esters, flavones, tannins, and non – volatiles residues and their chemical composition and concentration of compounds is variable. These compound have many effects as antimicrobial, stimulating animal digestive system, antioxidants, anticoccidial increase production of digestive

enzyme and improve utilization of digestive product by en hancing liver function (**Ziarlarimi *et al.*, 2011**).

Essential oil is volatile components of plants that have been used in food preparation since antiquity. Many essential oil components are generally recognized as safe by the food and drug administration of the US and have been used as artificial flavoring and presser votives (**Charlwood and Charlwood, 1991**). Essential oils (EOs) (also called volatile or ethereal oils; (**Guenther, 1948**) are aromatic oily liquids obtained from plant material (flowers, buds, seeds, leaves, twigs, bark, herbs, wood, fruits and roots). They can be obtained by expression, fermentation, effleurage or extraction but the method of steam distillation is most commonly used for commercial production of EOs. An estimated 3000 EOs are known, of which about 300 are commercially important— destined chiefly for the flavors and fragrances market (**Van and Leijten, 1999**). However, in the course of the 19th and 20th centuries the use of EOs in medicine gradually became secondary to their use for flavor and aroma (**Guenther, 1948**). Although, as mentioned previously, a small number of food preservatives containing EOs is commercially available, until the early 1990s very few studies of the activity of EOs in foods had been published (**Board and Gould, 1991**). However well EOs performs in antibacterial assays in vitro, it has generally been found that a greater concentration of EO is needed to achieve the same effect in foods (**Shelef, 1983; Smid and Gorris, 1999**).

Essential oils are very complex natural mixtures which can contain about 20–60 components at quite different concentrations. They are characterized by two or three major components at fairly high concentrations (20–70%) compared to others components present in trace amounts **(Croteau *et al.*, 2000; Betts, 2001; Bowles, 2003; Pichersky *et al.*, 2006).**

In this context, plant essential oils 6 are gaining interest for their potential as preservative ingredients or decontaminating 7 treatments, as they have GRAS status and a wide acceptance from consumers (**Burt, 2004**). The antimicrobial components are commonly found in the essential oil fractions and it is well established that many have a wide spectrum of antimicrobial activity, with potential for control of L. monocytogenes and spoilage bacteria within food systems (**Smith *et al*., 1998; Hammer *et al*. 1999**). Another aspect for the optimized application of EOs in foods is the impact on sensory acceptability. If high concentrations are required to achieve useful EOs antimicrobial activity, unacceptable levels of inappropriate flavors and odors may result. Were rejected by panelists as they perceived strong chemical odors from these samples (**Gutierrez *et al*. 2008**).

2.4 Cardamom (*Elettaria. cardamomum*)

2.4.1 Scientific classification:

According to ***Wikipedia*** **(2017)** the cardamom is classified scientifically as follow:

Kingdom:	plantae
Clade:	Angiosperm
Clade:	Monocots
Order:	Zingiberales
Family:	Zingiberaceae
Genu:	. Amomum
	. Elettaria
Species:	Elettaria cardamomum

There are two types of cardamom:

a. True or green cardamom (or, when bleached, white cardamom) comes from the species *Elettaria cardamomum* and is distributed from India to Malaysia. **(Bhide and Monica, 2010**).
b. Black cardamom, also known as brown, greater, large, longer, or Nepal cardamom, comes from species *Amomum subulatum* and is native to the eastern Himalayas and mostly cultivated in Eastern Nepal, Sikkim and parts of Darjeeling district in West Bengal of India, and Southern Bhutan. **(Katzer and Gernot, 2017)**.

By the early 21st century, Guatemala had become the largest producer of cardamom in the world, with an average annual yield between 25,000 and 29,000 tonnes. The plant was introduced there in 1914 by Oscar Majus Kloeffer, a German coffee planter. India, formerly the largest producer, since

2000 has been the second worldwide, generating around 15,000 tonnes annually**. (Batres and Alexis, 2012**).

Small cardamom (*Elettaria cardamomum*) belongs to family zingiberaecae, is a sweet spice and is employed as a medicinal flavoring agent, and it has been reported to possess antioxidant, anti-inflammatory, for indigestion, appetite stimulant, carminative and it has positive effects when used as feed additive for poultry **(Archana *et al.*, 2005; Alharthi, 2006; Gurdip *et al*., 2007; Verma, *et al.*,2009)**. Anti microbial and essential oil content (**Agaoglu *et al*., 2005; Tekeli *et al*., 2007; Smaranika *et al*., 2010).**

2.4.2 Plant Description:

The cardamom plant is a 2-4 m tall herbaceous perennial with branched subterranean rhizomes from which several leafy shoots arise, forming a clump. Leafy shoots have a limited life span; the first year is mainly for vegetative growth, the second year for reproductive growth (flowers and fruits), and the third year a senescence and death stage. New buds are formed from the base of the old shoots in the first and second year and thus, in a clump of old shoot The leaves are lanceolate in shape, and lamina tapers into a sharp tip, 25-90 cm long and 5-15 cm wide. Leaves are dark green and shiny on the upper surface and pale green on the lower surface. The lower surface of the leaf could be smooth (glabrous) or pubescent (hairy) depending on the variety Flowers have an attractive petalloid labellum which is made of modified stamens, about 1.8 cm long with an undulating edge. (**Weiss, 2002**).

The fresh large-cardamom capsules contain about 70 –80% moisture (on wet basis) depending upon the maturity level of the capsule at the time of plucking. Unlike the practice in southern India, where only matured capsules are plucked, the whole cardamom capsule bunch is plucked in Sikkim. Later on, each capsule is separated from the bunch= ower and cleaned for drying. In order to achieve longer storage life and also to bring out its aroma, it has to be

dried to reduce the moisture content to a level below 10% (on wet basis). There are two methods by which cardamom is dried **(Mande *et al*., 1999**).

2.4.3 Constituents of bulb (clove):

The chemical composition of cardamom varies considerably with variety, region and age of the product. The content of volatile oil in the seeds is strongly dependant on storage conditions, but may be as high as 8%. The volatile oil contains about 1.5% α-pinene, 0.2% β-pinene, 2.8% sabinene, 1.6% myrcene, 0.2% α- phellandrene, 11.6% limonene, 36.3% 1,8-cineole, 0.7% γ-terpinene, 0.5% terpinolene, 3% linalool, 2.5% linalyl acetate, 0.9% terpinen 4-01, 2.6% α-terpineol, 31.3% α- terpinyl acetate, 0.3% citronellol, 0.5% nerd, 0.5% geraniol, 0.2% methyl eugenol and 2.7% trans-nerolidol (**Korikontimath *et al*., 1999**). The basic cardamom aroma produced by a combination of the major components, 1,8-cineole and α- terpinyl acetate (**Lawrence, 1979**).

The chemical composition of cardamom powder dry matter, ether extract, crude protein, crude fiber, ash and nitrogen free extract were 77.19, 10.87, 13.83, 17.65, 15.50 and 42.15 per cent, respectively in cardamom powder (**Elamin *et al*., 2011**) .

2.4.4 Used:

2.4.4.1 Used cardamom

Cardamom in action, it is aromatic, cardiac, carminative, deodorant, digestive, diuretic, expectorant, purgative, stimulant, thirst reliever and tonic. Useful in asthma, burning sensation, cold and cough, diseases of bladder and kidney, flatulence, heart weakness, indigestion, scanty urine and piles .The seeds are aromatic, acrid, sweet, cooling, stimulant, carminative, stomachic, diuretic, cardiotonic, abortifacient and are useful in bronchitis, hemorrhoids, stangury, renal and vesical calculi, anorexia, dyspepsia, gastropathy and

vitiated condition of vata (**Dwy , 1994**). The seed is fragrant tonic to the heart, stomachic, laxative, lessens inflammation, useful in headache (**Govil, 1998).**

2.4.4.2 Medicinal properties of aromatic compounds of cardamom:

The most significant component of cardamom, as spice, is the volatile oil with its characteristic aroma, described generally as comphoraceous, sweet, aromatic spicy. The cardamom oil has little mono- or sesquiterpenic hydrocarbons and is dominantly made up of oxygenated compounds, all of which are potential aroma compounds. While many of the identified compounds (alcohols, esters, and aldehydes) - are commonly found in many spice oils (or even volatiles of many different foods), the dominance of the ether, 1,8- cineole and the esters, oc-terpinyl and linalyl acetates in the composition, make the cardamom volatiles a unique combination **(Lewis *et al*., 1966 ; Salzer, 1975**). The aroma differences in different sources of cardamom are attributed to the proportion of the esters and 1,8 cineole (**Korikanthimath *et al*.,1997; Wijesekera and Jayawardena ,1973**).

Cardamom seeds are widely used for flavoring purposes in food. Medically, they are used for flatulent indigestion, and to stimulate the appetite in people with anorexia. Moreover, the seeds were prescribed in Ayurvedic medicine for coughs, colds, bronchitis, asthma and indigestion (**Miriam and Christopher, 1992**).Furthermore cardamom oil has antibacterial properties (**Pruthi, 1980**). it is used as a powerful aromatic, antiseptic, stimulant, carminative, stomachic, expectorant, antispasmodic and diuretic**(Korikontimath *et al* ., 1999).**

2.4.4.3 Antioxidant effect:

Natural antioxidant components, such as phenolic compound, used as natural antioxidant and antibacterial are of great importance, due to their benefits for human health, decreasing the risk of degenerative diseases by the reduction of oxidative stress and inhibition of macromolecular oxidation

(Silva *et al*., 2004; Pulido *et al*., 2000; Tseng *et al*., 1997). In addition to antioxidant activity, several studies demonstrated the antimicrobial activity of phenols and/or phenolic extracts making them a good alternative to antibiotics and chemical preservatives. **(Fernandez *et al*., 1996; Hoult and Paya, 1996)** . found the clove ethanolic extracts with high content of total phenolics compounds (243.91 mg/g) exhibited also good reducing power. Cardamom has philolic compounds and antioxidant action **(Badei *et al*., 2002).**

2.4.4.4 Antimicrobial effect:

Cardamom, often referred to as queen of spices because of its very pleasant aroma and taste, has a history as old as human race. It is especially common in the Indian subcontinent and is known for its delicious aroma, aphrodisiac properties and also as a common folk remedy to treat stomach aches **(Kubo *et al*., 1991).**The oil extracted from cardamom seeds is a combination of terpene, esters, flavonoids and other compounds. Cineole, the major active component of cardamom oil, is a potent antiseptic that is known to kill bacteria producing bad breath and other infections **(Ratika, 2012).** Recently explore the antimicrobial effects of cardamom extracts on oral bacteria, it was found that cardamom extracts are effective against oral pathogenic bacteria like *Streptococcus mutans* and *Candida albicans* **(Aneja and Radhika, 2009).** Studies have revealed its use as an effective skin penetration enhancer for certain drugs, anticarcinogenetic agent, anti ulcerogenic agent and anti microbial and anti convulsant agent **(Dhulap *et al*., 2008).** The antimicrobial activity of cardamom extracts (methanol, ethanol and aqueous) was examined against the most resistant isolate of both S. aureus and P. mirabilis. Methanolic extract of cardamom showed to be the most inhibitor extract against the tested isolates of both species, and this return to methanol solvent which extracts the most active components that found in plant **(Salah, 2007).** There is an extended interest in using natural antimicrobial compounds, as the consumer's pressure on food industry

augments, to avoid chemical preservatives and due to increasing resistance to antibiotics **(Cowan, 1999; Oliveira *et al*., 2007).**

2.4.4.5 Ethno Pharmacology:

Cardamom is traditionally used in various gastrointestinal, cardiovascular and neuronal disorders.Maharsi Carak has categorized E.cardamom as svasahara – anti-asthmatic, angamarda prasamana – relieves body ache and as sirovirecana – useful in cleansing nasal therapy. Cardamom is one the commonly used major constituent in many classical formulations of Ayurveda. Some important classical preparations are Eladi curna, Eladi kvatha , Eladi modak, Eladi vati, Eladyarista, Sitopaladi curna, Aravindasava , Avipattikara curna **(Dhulap *et al.*, 2008)**

2.4.4.6 Other Benefits:

Both forms of cardamom are used as flavoring agents in both food and drinks, as cooking spices and as a medicine. E. cardamomum (the usual type of cardamom) is used as a spice, a masticator, and in medicine; it is also smoked sometimes. Green cardamom is broadly used in South Asia to treat infections in teeth and gums, to prevent and treat throat troubles, congestion of the lungs and pulmonary tuberculosis, inflammation of eyelids and also digestive disorders. It is also used to break up kidney stones and gall stones, and was reportedly used as an antidote for both snake and scorpion venom. Amomum is used as a spice and as an ingredient in traditional medicine in traditional Chinese medicine. Cardamom is a popular traditional flavoring agent for baked goods and confectionery (**Mobacken and Fregert ,1975; Vasudevan *et al*., 2000**).

2.5 Effect of cardamom oil on broiler performance:

Elamin *et al*., (2011) evaluated of response of broiler chicks to dietary cardamom (*Elettaria cardamomum*) as a feed additive. They were supplemented with four levels of cardamom (0.0%, 0.15%, 0.30% and 0.45%). The study lasted for six weeks. Results showed that the dietary cardamom supplementation had significantly (P<0.05) increased feed intake and body weight gain. Birds fed 0.15% and 0.45% cardamom obtained the highest body weight gain. Final body weight, feed conversion ratio FCR and internal organs percent were not influenced by cardamom. Moreover, the treatment had significantly (P<0.05) decreased blood total lipids and glucose. However, there was no significant (P>0.05) effect on blood total protein.

Omidi *et al*., (2014). The conducted study to investigate the impact of dietary supplementation of cardamom essential oils (CEO) and powdered cardamom seeds (PCS) on the growth performance, plasma biochemistry, hematological characters, immune response and meat acceptability in broilers (Ros 308). Dietary treatments included the basal diet as control, CEO-supplemented diets with an inclusion level of 50 (CEO_1) or 100 (CEO_2) mg/kg, and PCS-supplemented diets with an inclusion level of 3 (PCS_1) or 6 (PCS_2) g/kg. Feeding PCS_1 diet improved ($P < 0.05$) bodyweight gain and feed conversion ratio (FCR) of broilers during the grower period (11–28 days). Moreover, broilers fed the CEO_2 diet had the lowest ($P< 0.05$) FCR during the whole growth period (0–42 days). Higher bursa index ($P < 0.05$) was detected in chickens receiving CEO_1 and CEO_2 CEO_2 diets; additionally, higher spleen index ($P < 0.05$) was recorded in the CEO_1 group at 42 days of age. . By contrast, CEO_1 and CEO_2 diets decreased ($P < 0.05$) the low-density lipoprotein cholesterol (LDL-C) concentrations compared with control diet. Plasma cholesterol level was also lower ($P < 0.05$) in the CEO_1 group at 42 days of age. Sensory evaluation of meat samples indicated no differences ($P >$

0.05) among treatments for appearance, flavour, texture and overall acceptability.

Sonali *et al*., (2017) evaluated of Effect of cardamom (*Elettaria cardamomum)* and Ginger (*Zingiber officinale)* powder supplementation on growth performance and economic analysis in broiler. chicks were divided into six dietary treatments viz., T0: control diet (no additive), T1: Basal diet supplemented plus 1% cardamom powder, T2: Basal diet supplemented plus 2% cardamom powder, T3: Basal diet supplemented plus 3% cardamom powder, T4: Basal diet supplemented plus 1% ginger powder, T5: Basal diet supplemented plus 2% ginger powder and T6: Basal diet supplemented plus 3% ginger powder with four replication and seven birds have each replication. Results of experiment showed significant difference (P<0.05) in feed intake, live weight, body weight gain and feed conversion ratio between treatments. The study concluded that supplementation of cardamom powder at the rate of 1 percent in broiler diet improved growth performance of broiler and economical and profitable for broiler production.

Sonali *et al*., (2016) evaluated of Effect of ginger (*Zingiber of_icinale*) and cardamom (*Elettaria cardamomum*) on physiological and heamto-biochemical parameters of broiler. The bird divided in to seven dietary treatments consisting of 24 birds per treatment with 6 birds per replicate in a feeding trial that lasted for a period of 42 days. Zingiber officinale and Elettaria cardamomum at 0%, 1%, 2% and 3% were added to the basal diet. Results showed that serum HDL cholesterol, serum LDL cholesterol, serum protein, serum glucose, total cholesterol, body temperature and respiration rate of broilers were significantly influenced by 1 per cent cardamom powder. The results of this investigation therefore, demonstrate that the inclusion of cardamom at 1 per cent level reduced serum cholesterol.

CHAPTER THREE

MATERIALS AND METHODS

This experiment was conducted during winter season (25th October - 5 December 2017). This ambient temperature average 25 C^o – 10 C^o during the experimental period for 6 weeks.

3.1 Experimental chicks:

A total number of 140 one day-old commercial unsexed broiler of ***Ros 308*** strain from local commercial hatchery and transported to the student poultry premises , faculty of Agricultural , Al – muthana university , Iraq , Samawa . The chicks were adapted to the premises and fed of over 7 days before start of the experiment at the end of adaptation period, all chicks were weighted with an average initial weight of 170 gm. The chicks were then assigned randomly into four dietary treatment groups (A, B, C, and D) in completely randomized design (CRD). Each group was divided into five replicates, each of 7 chicks cages / rearing system was adapted for 6 weeks experimental period. The birds were vaccinated against Infectious Bronchitis (IBD), New castle disease (ND) and avian influenza at first day in Hatcher.

3. 2 Housing:

A semi – closed system poultry house was used. The house was construction on concrete floor with corrugated metal sheets roof (Sandwich Panel) and a solid western – eastern wall up to 5 meter. Each pen was equipped with one feeder and drinker to allow adlibitum consumption of feed and water. The cages were made of aluminum and each cage is divided into four replicates and the area of each replicates is 1/2 square meter. Light was provided approximately 24 hours in a farm of natural light during the day and

artificial light during the night. Five bulbs (60 watt) were used for this purpose the house was cleaned and well disinfected before the commencement of the experiment.

3.3 Experimental rations:

Cardamom oil (essential oil) was used in this experiment were purchased from Al-samawa market, republic of Iraq, the chicks were fed on 4 dietary treatments. The first group A fed on basal diet without growth promoters (control group). The other groups B, C, and D were supplemented with cardamom oil as natural growth promoter, at levels 50 ml, 100 ml, and 150 ml per ton respectively.

The ingredients percent compositions and the calculated chemical analysis of the experimental diets were present in Table (1, 2). Experimental diets were fed for 6 weeks.

3.4 Data collected:

3.4.1Performance data:

Average body weight, weight gain, and feed intake (gm) for each group were determined weekly throughout the experimental period. Health of the experimental stock and mortalities were closely observed and recorded daily.

3. 4. 2 Slaughtering procedure:

At the end of the experiment five chicks were selected randomly from each group and weighted individually after an overnight fasting with only water allowed, and then they were slaughtered by severing the right and left carotid and jugular vessels, trachea and esophagus. After bleeding they were scalded in hot water, hand – plucked and washed. The head was removed closed the skull, feet and shanks were removed at the hock joint. Evisceration was accomplished by posterior ventral cut to completely remove the visceral

organs the hot carcasses were weighted for calculation the dressing percentage. The legs were separated from each then they were deboned, the meat was frozen and stored for sensory evaluation.

3.4.3 The taste panel:

Frozen deboned legs cut were thawed at (5 – 7 $C^{o)}$ before cooking for sensory evaluation. The meat was trapped in aluminum foil, Placed in roast pan and cooked at (176.7 C^{o}) in conventional preheated electrical oven to about (80C^{o}) internal muscles temperature. The cooked meat was allowed to cool to temperature for about 10 minutes. The samples were kept warm until served. Trained panelists were instructed to eat crackers drink water between sample testing to clear the plate and pause for 30 seconds between all samples evaluated. Flowing recommended procedure (**Hawrysh *et al*., 1980).** The sensory panel evaluated the chops for tenderness, flavor, color and juiciness using and eight – point scale **(Appendix 9)**.

3.5 Experimental design and statistical data analysis:

Completely randomized design was used in this experiment the data were tabulated and subjected to one – way Analysis of Variance (**ANOVA**) by using the SPSS computer program (**SPSS 2007)**. The significant difference (LSD) was used for treatment means separation as outline by using **Steel and Trri (1986**). All values were present as means and standard error.

Table (2): The ingredients percent composition of experimental diets:

Ingredients	**Diets**			
	A	**B**	**C**	**D**
Dura (corn)	62.13	62.13	62.13	62.13
Soya bean	25.00	25.00	25.00	25.00
*Super Concentrate	5.00	5.00	5.00	5.00
Lysine	1.35	1.35	1.35	1.35
Methionine	0.53	0.53	0.53	0.53
Meth + systin	0.89	0.89	0.89	0.89
Dicalcium	0.80	0.80	0.80	0.80
Phosphorus	0.40	0.40	0.40	0.40
Salt	1.00	1.00	1.00	1.00
Fat	2.90	2.90	2.90	2.90
Total	100	100	100	100
Feed addatives				
Cardamom oil	-	50 ml/ton	100 ml/ton	150 ml/ton

*crude protein 40% ; crude fat 3.90% ; crude fiber 1.44% ; calcium 10% ; available phosphorus 6.40% ; energy 1950 K cal/Kg ; Methionine 3% ; Methio + cystin 3.3% ; lysine 10 – 12 % ; crude minerals 39.30% ; sodium 2.77% ; linoleic acid 0.24% ; Nacl 6% ; Vitamins: vit. A 200.000 I.U/Kg ; D3 70.000 I.U/Kg ; Experiment 400 mg/Kg ; K3 30mg/Kg ; B1 50 mg/Kg ; B2 150 mg/Kg ; B6 50mg/Kg ; B12 180 mcg/Kg.D Pantothenic acid 155 mg/Kg ; Niacine 440 mg/Kg ; folic acid 8 mg/Kg ; choline chloride 5.800 mg/Kg ; Antioxydant (BHT) 1000 mg/Kg .

Trace Elements; Manganise 1600 mg/Kg ; zinc 1600 mg/Kg ; Iron 580 mg/Kg ; copper 450 mg/Kg ; Iodine 55 mg/Kg ; selenium 8 mg/Kg ; Cobalt 9 mg/Kg ; Molbden 20 mg/Kg.

Table (2) Calculated chemical analysis of experimental diets

Components	Diets			
	A	B	C	D
Dry matter	94.85	94.85	94.85	94.85
Crude protein	22.70	22.70	22.70	22.70
Crude Fiber	04.35	04.35	04.35	04.35
Ether Extract	03.35	03.35	03.35	03.35
Ash	04.65	04.65	04.65	04.65
Nitrogen.Free Extract	59.80	59.80	59.80	59.80
Calcium	01.06	01.06	01.06	01.06
Total phosphorous	00.79	00.79	00.79	00.79
Available phosphorous	00.50	00.50	00.50	00.50
ME.cal/kg	3117	3117	3117	3117

***** *Calculated according to Ellis (1981).*

CHAPTER FOUR

RESULTS

4.1 Response of broiler chicks to diet containing cardamom essential oil:

4.1.1 Performances:

Effects of various levels of the dietary cardamom oil (essential oil) on the performance of broiler chicks are shown in the Table (3). All groups, weight started between (170 gm to 174 gm).

The result showed that treatment effect on weight gain was significant ($p < 0.05$).Chicks in group B, C and D gained more weight than that obtained by group A. Significant differences ($p<0.05$) was observed between the treatment groups in feed intake. Groups B, C and D were consumed significantly more feed compared with group A. The feed conversion ratio (FCR) was better significantly ($p<0.05$) in groups B, C and D than that of group A.

4.1.2 Carcass measurements:

4.1.2.1 Carcass and non carcass yield:

The results showed no significant differences ($p>0.05$) between all treatment groups in carcass dressing percentage and giblets (gizzard , liver and heart) as shown in Table (4). No mortality was detected in all treatment groups all throughout the experimental period

4.1.2.2Commercial cuts

Commercial cuts (drumstick, breast and thigh) percentage are presented in Table (5), there was no significant ($p>0.05$) treatment effect in drumstick, breast and thigh percentage values and all treatment groups mean values were

Similar. The treatment group values of meat expressed as percentage from total weight of selected commercial cuts are given in Table (6). No significant ($p > 0.05$) effect was observed between the treatment groups in the meat of breast, drumstick and thigh.

4.1.3 Panel test (subjective meat attributes):

The effect of dietary treatment on subjective meat attributes is shown in the Table (7). Meat quality score values of tenderness, juiciness and flavor of leg cuts (thigh and drumstick were higher significantly ($p<0.05$) in groups fed on the diet B,C and D compared with those fed control diet . No significant differences ($p>0.05$) were observed among the various treatment groups in the color.

4.1.4 The level of cholesterol in the blood:

The results as shown in Table (8) indicated that level lower of blood serum cholesterol was significantly ($p< 0.05$) in groups B,C and D compared with control group (A). However, group D was recorded the lowers percentage of the cholesterol compared to the other treatment groups.

4.1.5 Economical appraisals:

The total cost , returns , net profit and profitability ratio per head of broiler chicks fed different levels of cardamom oil (essential oil) for 6 weeks are shown in table (9) . Chicks purchase management and feed cost values (IQD) were the major in put considered. The selling values of meat are total revenues obtained profitability ratio (2.80) of test group D (150 ml / ton cardamom oil) was the highest of the tested groups.

Table (3): The effects of various levels of the dietary cardamom oil (essential oil) on the performance and carcass dressing percentage of broiler chicks for 6 weeks:

Items	(Groups) Mean					
	A	B	C	D	SE±	LSD
Initial weight g / bird	174.8[a]	170.0 [a]	174.0 [a]	174.0 [a]	5.92	.361[NS]
Final weight g / bird	2242[c]	2395[b]	2431[ab]	2478 [a]	34.58	0.00[**]
Weight gain g / bird	2067.2[c]	2225 [b]	2257 [ab]	2304[a]	31.91	0.00[**]
Feed intake g / bird	3978.6[a]	4009 [a]	3954 [a]	3738.40[b]	83.88	0.021[*]
Feed conversion ratio	1.92[c]	1.80 [b]	1.75[b]	1.62 [a]	0.02	0.00[**]
Mortality	0.00	0.00	0.00	0.00	0.00	0.00[**]

[a,b,c] Superscripts in a column differ significantly (P<0.05)

NS: Not Significant (P≥0.05).

**: High Significant (P≤ 0.01).

*: Significant (P≤ 0.05).

LSD = least significant difference.

SE + = standard error

A = Basal diet (controlled)

B = Basal diet + 50 ml of cardamom oil

C = Basal diet + 100 ml of cardamom oil

D = Basal diet + 150 ml of cardamom oil

Table (4) The effect of dietary cardamom oil on giblets (heart, gizzard and liver) of broiler chicks for 6 weeks.

Items	(Groups) Mean					
	A	B	C	D	LSD	SE±
Heart %	0.51[a]	0.52 [a]	0.52 [a]	0.56 [a]	0.246[NS]	0.023
Liver %	2.31[a]	2.30 [a]	2.34 [a]	2.34 [a]	0.430[NS]	0.143
Gizzard %	2.53[a]	2.55[a]	2.57[a]	2.60 [a]	0.081[NS]	0.036
Dressing %	68.80[a]	69.46[a]	69.26[a]	70.00[a]	0.388[NS]	0.66

[a,b,c] Superscripts in a column differ significantly (P<0.05)

NS: Not Significant (P≥0.05).

LSD = least significant difference.

SE + = standard error

A = Basal diet (controlled)

B = Basal diet + 50 ml of cardamom oil

C = Basal diet + 100 ml of cardamom oil

D = Basal diet + 150 ml of cardamom oil

Table (5) The effect of dietary of cardamom oil on the commercial cuts (breast, drum stick and thigh) percentage values of broiler chicks for 6 weeks.

Items	(Groups) Mean					
	A	B	C	D	LSD	SE±
Breast %	23.14[a]	24.95[a]	25.31[a]	27.00[a]	0.141[NS]	1.436
Thigh %	19.11[a]	19.27[a]	19.33[a]	19.42[a]	0.992[NS]	1.061
Drumstick %	16.06[a]	16.33[a]	16.36[a]	16.45[a]	0.967[NS]	0.806

[a,b,c] Superscripts in a column differ significantly (P<0.05)

NS: Not Significant (P≥0.05).

LSD = least significant difference.

SE + = standard error

A = Basal diet (controlled)

B = Basal diet + 50 ml of cardamom oil

C = Basal diet + 100 ml of cardamom oil

D = Basal diet + 150 ml of cardamom oil

Table (6) The effect of dietary of cardamom oil on the percentage of meat expressed from total weight of commercial cuts of broiler chicks for 6 weeks.

Items	Group (mean)					
	A	B	C	D	LSD	SE±
Breast %	80.40[a]	81.49 [a]	80.71 [a]	82.20 [a]	0.703[NS]	2.16
Thigh %	80.42[a]	82.14 [a]	82.31 [a]	83.23 [a]	0.125[NS]	0.71
Drumstick %	68.56[a]	69.03[a]	69.72 [a]	69.73 [a]	0.137[NS]	0.38

[a,b,c] Superscripts in a column differ significantly (P<0.05)

NS: Not Significant (P≥0.05).

LSD = least significant difference.

SE + = standard error

A = Basal diet (controlled)

B = Basal diet + 50 ml of cardamom oil

C = Basal diet + 100 ml of cardamom oil

D = Basal diet + 150 ml of cardamom oil

Table (7): The effect of different dietary levels of cardamom oil on percentage of subjective values of broiler chicks for 5 weeks:

Items	Group (Mean)					
	A	B	C	D	SE±	LSD
Tenderness	5.90^{b}	6.50^{ab}	6.90^{a}	7.20^{a}	0.33	0.003^{**}
Flavor	5.60^{b}	6.30^{ab}	6.70^{a}	7.10^{a}	0.43	0.010^{**}
Color	6.20^{a}	6.40^{a}	6.80^{a}	7.00^{a}	0.33	0.079^{NS}
Juiciness	5.90^{c}	6.30^{bc}	6.90^{ab}	7.10^{a}	0.35	0.007^{**}

^{a,b,c} Superscripts in a column differ significantly (P<0.05)

NS: Not Significant (P≥0.05).

**: High Significant (P≤ 0.01).

LSD = least significant difference.

SE + = standard error

A = Basal diet (controlled)

B = Basal diet + 50 ml of cardamom oil

C = Basal diet + 100 ml of cardamom oil

D = Basal diet + 150 ml of cardamom oil

Table (8): The level of cholesterol in blood between the treatments:

	Group (mean)					
Items	**A**	**B**	**C**	**D**	**LSD**	**SE±**
Cholesterol	2.90^{d}	2.78^{c}	2.61^{b}	2.41^{a}	0.000^{**}	0.03240

^{a,b,c} Superscripts in a column differ significantly (P<0.05)

**: High Significant (P≤ 0.01).

LSD = least significant difference.

SE + = standard error

A = Basal diet (controlled)

B = Basal diet + 50 ml of cardamom oil

C = Basal diet + 100 ml of cardamom oil

D = Basal diet + 150 ml of cardamom oil

Table (9): The total cost, revenue and net profit of broiler chicks fed on different levels of cardamom oil:

Items	Group			
	A	B	C	D
Cost				
Chick purchase	700	700	700	700
Total fed cost	2785	2806	2767	2616
Management	1000	1000	1000	1000
Total cost of production	4485	4506	4467	4316
Revenue				
Dressing percentage	68.80	69.46	69.26	70.00
Average weight	1417	1545	1563	1612
Price / kg of bird	3500	3500	3500	3500
Total revenue	4959.5	5407.5	5470.5	5642
Profit				
Total revenue	4959	5407.5	5470.5	5642
Total cost of production	4485	4507	4467	4316
Total profit	474	900.5	1003.5	1326
Profitability ratio	1	1.90	2.12	2.80

*Total cost calculation to November 2017

*A current (2017) price of meat 3500 (IQD)

*(IQD) = Iraqi Dinar

*1220 IQD = 1 $

CHAPTER FIVE

DISCUSSION

This experiment was conducted to evaluate response of broiler chicks fed graded levels of cardamom essential oils as natural growth promoter. The cardamom oil was added to basal diets at level (50 ml, 100 ml, and 150 ml / ton). In this study the apparent health of experimental stock was good throughout experimental period. The general behavior of the stock also was good. The ambient temperature during the experimental period fell within the thermo neutral zone has extracted no heat on the experimental period. No mortalities were recorded among the different treatment groups throughout the experimental period. This might be due to the hygienic situation of the experimental. The result for birds fed dietary cardamom oil, total feed intake were statistically ($p<0.05$) tended to decreased with increasing levels of cardamom oil as compared with the control group. This result was in contrast with that obtained by **(Kamel, 2000; Giannenas *et al*., 2003**) who found that for birds fed dietary cardamom oil, the total fed intake were statistically increased compared with the control group, this may be related to the appetizing effect of the active ingredients compound such as Cineole present in cardamom and its stimulant properties. In addition to these results were disagreed with the finding of **Elamin *et al*., (2011)** who reported that the cardamom had significant differences on feed intake on broiler chick. **Sonali *et al*., (2017)** found significant differences of dietary cardamom essential oil on the feed intake of broiler chicks.

The highest final weight and body weight gain were significantly ($p<0.05$) produced by the birds fed on dietary cardamom oil as compared with control group. The improvement in body weight and body weight gain for birds fed on cardamom oil groups may be due to stimulant, essential oil content and anti microbial activities of cardamom, this in agreement with findings of (**Krittika *et al*., 2007; Shervin and Imad , 2009)**. . This result

was similar with the finding of (**Elamin *et al*., 2011).** Who stated that the weight gain of broiler chick was significant differences by the addition cardamom in the diet similar results were obtained by **Sonali *et al*., (2017)** who found significant differences in weight gain of chick fed cardamom.

The feed conversion ratio in the present study was significantly ($p<0.05$) improved by increasing the level of cardamom oil. This result coincided with the finding of **Omidi *et al*., (2014)** who reported that the cardamom essential oil had significant differences on feed conversion ratio. Similar results found by **Elamin *et al*., (2011)** who reported that chicks fed with cardamom essential oil diet had significant differences in feed conversion ratio compared with control group , **Ertas *et al*., (2005**) report that the addition of sub –therapeutic levels of antibiotic to broiler feed causes an increase in feed conversion by destroying the pathogenic microorganism in the digestive system. The efficiency of probiotics in improving utilization of digestive products and enhancing liver functions . Addition (**Pelicano *et al*., 2004),** stated that, Improvement in the intestinal environment, increase the efficiency of digestion and nutrient absorption processes which may explain the improvement in feed conversion ratio. Moreover, **(Jamal *et al*., 2005)** stated that Dietary cardamom improved the overall performance of broiler chicks, this may be attributed to the digestion influence on wall mucus and gastric acid.

Treatment effect in this study was not significant on carcass dressing percentage .This result agreed with the finding of **Elamin *et al*., (2011)** who reported that dietary cardamom essential oil showed insignificant effect for carcass dressing percentage.

The effect of cardamom essential oil at all inclusion levels on liver, gizzard and heart resulted no significant differences ($p>0.05$) among all treatment groups. Similar results were obtained by **Amal,(2012)** who reported no significant differences in giblet (liver, heart and gizzard) percentages among treatment group of broiler fed different essential oils .Treatment effects in this study was not significant on commercial cuts (breast, thigh and drumstick) percentages and their separable tissue. Similar results were obtained by **Amal,(2102); Osman and Muna (2002); Avic, (2004)** who

report that essential oils as biological feed additives did not effect significant the carcass yield.

The percentage of cholesterol in blood significantly ($p<0.05$) decreased as the level of cardamom oil increased. This result similar with finding of **Omidi *et al*., (2014)** who reported decreased low density lipoprotein cholesterol when supplementation of cardamom essential oil (CEO) 50 or 100 mg/kg in the broiler diet as compared to control, Moreover, cardamom essential oil had a positive effect on the blood cholesterol profile by decreasing the plasma cholesterol . Serum total lipids decreased by increasing levels of cardamom and this might be due to antioxidant activity of cardamom that decreases lipids per oxidation. **Abdulaziz *et al*.,(2006); Nooman, *et al*., (2007)** reported that copper and manganese which are present in cardamom extracts stimulate superoxide dismutase is an antioxidant enzyme leading to decreased lipid per oxidation in rats pre-fed with them.

The results subjective meat quality attributes indicated that (tenderness, flavor and juiciness) were improved significantly as the level of cardamom essential oil increase the diet. In contrast **Omidi *et al*., (2014**) who found sensory evaluation of meat samples indicated no differences among treatments for appearance, flavor, texture and overall acceptability.

The economical evaluation of the experimental diets indicated that, the diet with 150 ml /ton level of cardamom essential oils showed the highest profitability ratio (2.80) as compared to other experimental groups. This might be due to the highest return of the weight gain recorded by this group. **Sonali *et al*., (2017**) found the use of cardamom powder at 1.0 per cent level was most economical in terms of production. These findings corroborated with the earlier findings of **Rajput *et al*., (2009)**. Increase in profit margin of the birds fed rations supplemented with a mixture of cardamom powder may be attributed to the better efficiency of feed utilization which resulted in more

growth and better feed gain ratio, ultimately leading to higher profit margin in broilers.

Conclusion and Recommendations

Conclusion:

1. The results of present study indicated that the use of cardamom essential oil at various inclusion levels in the diet had significant differences on body weight gain, feed intake, feed conversion ratio of broiler chicks.
2. Adding of cardamom oil essential oils at all inclusion levels in the diet made no change in carcass dressing percentage.
3. Adding the cardamom essential oil at different levels in the diet made change in subjective meat quality attributes of broiler chicks.
4. Using the cardamom essential oil at different levels in broiler diet economically feasible.
5. Adding of cardamom essential oil in broiler diet decrease the cholesterol in the blood serum.

Recommendation:

*** Practical implication:**

1. Application of cardamom essential oil in the diet had significant effect on the performance of broiler chicks reared under well disinfected condition in this study.
2. More effective influences of dietary cardamom essential oil could probably be seen in broilers rearing in less hygienic situation.
3. All levels of cardamom essential oils added to the broiler diets in this study were recommended economic-wise, but the level of dietary cardamom oil 150 ml / ton was more profitable.

***Suggestion for future research:**

1. More trails are needed to clarify the effects of cardamom oil and its extract on productive performance, carcass characteristics, digestive system development, immune system, intestinal micro flora and blood constituents of broilers with regard to varied management conditions, including different stress factors, types and sources of cardamom oil extraction methods, optimal dietary inclusion levels, dietary ingredients and nutrients contents.
2. The future research also should be focused on the use of other herbs and spices and their organic extracts, enzymes, probiotics, prebiotics, synbiotics and organic acids as natural growth promoters in broilers production.

References:

Abdulaziz, M., Al-Othman, Fasih Ahmed, Saada Al-Orf, Khalid S. Al – Murshed and Zarina Arif, (2006). Effect of dietary Supplementation of *Ellataria cardamom* and *Nigella sativa* on the toxicity of rancid corn oil in rats. Intl. J. Pharmacol., 2(1): 60-65, 2006.

Agaoglu, S. Dostbil, N. and Alemdar, S., (2005). Antimicrobial Effect of Seed Extract of Cardamom (*Elettarıa cardamom*), YYU Veterinary Fakültesi Dergisi 16(2), 99–101.

Al – Zuhair H, Sayeh BEL ,Ameen HA,Al – Shoora H ., (1996) . Pharmacological studies of cardamom oil in animal, Pharmacological Research 34, 79 – 82.

Alharthi, M .A., (2006). Impact of supplemental feed enzymes, condiments mixture or their combination on broiler performance, nutrients digestibility and plasma constituents. Inter. J. Poult. Sci, 5 (8):764-771.

Amal .O.A. (2012). Use of Essential oils in Broiler Nutrition as Growth Promoter .Ph.D. Thesis: College of Agricultural studies. Sudan University of Science and Technology.

Aneja KR, Radhika J.,(2009). Antimicrobial Activity of Amomum subulatum and Elettaria cardamomum Against Dental Caries Causing Microorganisms. Ethnobotanical Lealf ;13:840–9.

Archana, S., Samit, G and Shamee B ., (2005). Dietary cardamom inhibits the formation of oxymethane induced Aberrant Crypt Foin Mice and Reduces COX-2 and INOS expression in the colon, Asian Pacific J. Cancer Prev., 6,118-122.

Avic .s. (2004). The effects on fattening performance of the usage of plant extract in broiler diets. M.Sc. Thesis, University of Cukurova Institute of Natural and Applied. Department of Animal Science.

Badei, A. Z. M.; El-Akel, A. T. M.; Faheid, S. M. M.; and Mahmoud, B. S. M., (2002). Application of some spices in flavoring and preservation of cookies: 1-Antioxidant properties of cardamom, cinnamon, and clove. Dtsch. Lebensm.-Rundsch., 98, 176−183.

Bager, F., (1998): Consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals. Food and human in Denmark, Dansk, Copenhagen, Zoonocenter, Denmark.

Batres, Alexis, (2012). "Looking for new markets". El Periodico (in Spanish). Guatemala.

Betts, T.J., (2001). Chemical characterisation of the different types of volatile oil constituents by various solute retention ratios with the use of conventional and novel commercial gas chromatographic stationary phases. J. Chromatogr. A 936, 33–46.

Bhide and Monica., (2010). "Queen of Spices", Saveur,. Retrieved on 4 December 2014.

Board, R.G., Gould, G.W., (1991). Future prospects. In: Gould, N.J.R.a.G.W. (Ed.), Food Preservatives. Blackie, Glasgow, pp. 267 – 284.

Bowles, E.J., (2003). Chemistry of Aromatherapeutic Oils. Allen & Unwin, ISBN 174114051X.

Burt, S., (2004). Essential oils: their antibacterial properties and potential applications in foods—a review. Int. J. Food Microbiol. 94(3), 223-253.

Çabuk , M., Bozkurt , M., Alçiçek , A., Akba, Y., Küçükyýlmaz , K., (2006). Effect of a herbal essential oil mixture on growth and internal organ weight of broilers from young and old breeder flocks. South African Journal of Animal Science, 36: 135–141.

Charlwood, B.V. and Charlwood, K.A.,(1991). Methods in plant biochemistry . In Monoterpenoids ed.

Cowan, M. M., (1999). Plant products as antimicrobial agents. Clin. Microbiol. Rev. 12, 564–582.

Craig WJ., (2001). Herbal remedies that promote health and prevent disease. In: Watson RR (Ed.), Vegetable, fruits and herbs in health promotion .CRC press, Boca Raton, Florida USA 179 – 204.

Croteau, R., Kutchan, T.M., Lewis, N.G., (2000). Natural products (secondary metabolites). In: Buchanan, B., Gruissem, W., Jones, R. (Eds.), Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists.

Dhulap, S., Anita, M. and Hirwani, R.R., (2008). Phyto-pharmacology of Elettaria cardamom, Phcog. Rev. 2(4): 27-35.

Dieumon,F.E.;Tequia,A.;Kuiate,J.R.;Tamokou,J.D.;Fonge,N.B.;Donogmo, M.C., (2009). Effect of ginger (zingiber officinal) and garlic (Allium sativum) essential oils on growth performance and gut microbial population of broiler chicks. Live stock Research for rural Development. 21(8):21 – 33.

Donoghue, D.J., (2003): Antibiotic residues in poultry tissues and eggs human health concerns. Poultry Science, 82 (4): 618-621.

Dwy AC., (1994). In topics in Indian medicinal plants used ayurvedic preparations, Bishen Sing Mahendra Pal, Dehradun.

Elamin RF, Abdel Atti KA, Dousa BM., (2011). Response of broiler chicks to dietary Cardamom (*Elettaria cardamomum*) as a feed additive. U of K. J. Vet. Med. & Anim. prod. 2011; 2(2):33-48.

Ellis, N. (1981). The nutrients composition of Sudanese animal feeds. Bulletin (1): Northern and Central Sudan. Central Animal Nutrition Research Laboratory. Kuku Research Centre, Khartoum-North, Sudan.

Ertas, O.N., Guler T., Ciftci M., Dalkilic B., and Simsek, U.G., (2005). The effect of an essential oil mix derived from oregano, clove and anise on broiler performance. *Inter. J. Poult. Sci.*, 2005, 4, 879–884.

Ferket, P. R., (2004). Alternatives to antibiotics in poultry production: Responses, practical experience and recommendations. Pages 57–67 in Nutritional Biotechnology in the Feed and Food Industries. T. P. Lyons and K. A. Jacques, ed. Nottingham Univ. Press, Nottingham, UK.

Fernandez, M.; Garcia, M.; and Saenz, M., (1996). Antibacterial activity of the phenolic acid fraction of Scrophularia frutescens and Scrophularia sambucifolia. J. Ethnopharmacol. 53, 11–14.

Frost , A.J., (1991) Antibiotics and animal production. In: Woolcock JB (ed) World animal science microbiology of animals and animal products. Elsevier, New York, pp 181–194, 6.

Giannenas, I., Florou-Paneri, P., Papazahariadou, M., Cheristaki, E.Botsoglou, N.A. and Spais, A.B., (2003). Effect of dietary supplementation with oregano essential oil on performance of broilers after experimental infection with Eimeria tenel. J. British Poult. Sci. 57: 99-106.

Govil JN., (1998). In : Tropics in Glimpses in plant research, Medicinal plants part I, Today and Tomorrow ' XIL s printers, Vol XII.

Greathead H., (2003). Plants and plants extracts for improving animal productivity. Proceedings of the Nutrition Society, 62: 279–290.

Griggs, J.P. and J.P. Jacob, (2005). Alternatives to antibiotics for organic poultry production. J. Applied Poult. Res., 14: 750-756.

Guenther, E., (1948). The Essential Oils. D. Van Nostrand, New York. Gustafson, J.E., Liew, Y.C., Chew, S., Markham, J.L., Bell, H.C., Wyllie, S.G., Warmington, J.R., 1998. Effects of tea tree oil on Escherichia coli. Letters in Applied Microbiology 26, 194 – 198.

Gurdip, S., Shashi, K., Palanisamy, M., Valery, I and Ver, V., (2007). Anti oxidant and antimicrobial activities of essential oil and various oleresins of *Elettaria cardamom* (seeds and pods). Gorakhpur University, Gorakhpur 273 009, India.

Gutierrez, J., Barry-Ryan, C., Bourke, P., (2008). The anti-microbial efficacy of plant essential oil combinations and interactions with food ingredients. Int. J. Food Microbiol. 124(1), 91-97.

Hammer, K. A., Carson, C. F. and Riley, T.V., (1999). Antimicrobial activity of essential oils and other plant extracts. J. Appl. Microbiol. 86, 985-990.

Hay, R. Waterman, P.G., (1993) .Volatile oil crops: Their biology, biochemistry and production. Longman Scientific and technical, New York, USA.

Hoult, J. and Paya, M., (1996). Pharmacological and biochemical actions of simple coumarins: natural products with therapeutic potential. Gen. Pharmacol. 27, 713–722.

Hyldgaard,M.,Mygird,T.,Meyer,R.L.,(2012). Essential oil in food preservation: mode of action , synergies ,and interactions with food matrix components . Front, Microbial . 3,12.

Hawrysh, Z.J.; Steedman-Doglas, C.D.; Robble, A.R.;Harding, R.T. and Sam, R.M. (1980). Influence of low glucosinolate (C.V.Tower) rapseed meal on the eating quality of broiler chickens. Poult. Sci. 59:550-557.

Jamal, A., Kalimjaved, M. and Aslam, M.A., (2005). Gastro protective effect of cardamom–Elettaria cardamom. Jafrci Journal of Ethno-pharmacology, 103: 149-153.

Javed, M.; Durrani, F.R.; Hafeez, A.; Khan, R.U. and Ahmed, I., (2009). Effect of aqueous extract of plant mixture on carcass quality of broiler chicks. Arpan Journal of Agriculture and biological Science. 4(1):37-40.

Kamel, C., (2000). A Novel Look at A Classic Approach of Plant Extracts. Feed Mix, Special-2000, pp: 19-21.

Katzer, Gernot., (2017). Spice Pages: Cardamom Seeds (Elettaria cardamomum)". gernot-katzers-spice-pages.com. Retrieved 2017-04-04.

Korikanthimath VS., Ravindra Mulge and John Zachariah T., (1997). Variation in yield and quality characters of cardamom clones. *J. Med. Arom. Plant Sci.* 19:1024-1027.

Korikontimath VS, Mulge R, Zachariah JT., (1999). Variations in essential oil constituents in highyielding selections of cardamom. J. Plantation Craps: 27,p 230-232.

Korikontimath VS., Mulge R., Zachariah JT., (1999): Variations in essential oil constituents in high yielding selections of cardamom. J. Plantation Craps, 27:230-232.

Krittika, N., Natta, L. and Orapin, K., (2007). Antibacterial Effect of Five Zingiberaceae Essential Oils School of Bio-resources and Technology, Thailand, 12: 2047-2060.

Kubo I, Himejima M, Muroi H., (1991). Antimicrobial activity of flavor components of cardamom Elettaria cardamomum (Zingiberaceae) seed. J Agric Food Chem. 1991;39:1984–6.

Lambert RJ., Skandamis , PN ., Coot , PJ ., Nychas, GJ., (2001). A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrd . J Appl Microbial 91:453 – 462.

Langhout, P., (2000). New additives for broiler chickens. World Poultry 16(3), 22-27.

Lawrence BM., (1979). Major tropical spices cardamom (*Eletteria cardamomum).* In: Esential oils, Allured Publ., Wheaton, p. 104.

Lee, K.W.,H.Evertsand ,A.C.Beynen , (2004). Essential oil in broiler nutrition, international journal of poultry science 3(12):738 – 752 , 2004.

Lewis YS., Nambudiri ES. and Philip T., (1966).Composition of cardamom oils. *Perfum. Essent. Oil Rec* 57:623.

Lippens, M., Huyghebaert , G., Cerchiari , E., (2005). Effect of the use of coated plant extracts and organic acids as alternatives for antimicrobial growth promoters on the performance of broiler chickens. European Poultry Science, 6: 48–56.

Mande S., Kumar A., Kishore VVN., (1999). A study of large-cardamom curing chambers in Sikkim, Biomass and Bioenergy ;16:463–73.

Miles R.D., G. D. Butcher, P. R. Henry, and R. C. Littell., (2006). Effect of Antibiotic Growth Promoters on Broiler Performance, Intestinal Growth Parameters, and Quantitative Morphology.Poultry Science 85:476–485 .Department of Animal Sciences, Department of Large Animal Clinical Science, and Department of Statistics, University of Florida, Gainesville 32611.

Miriam P., Christopher R., (1992). The natural pharmacy, an DISCUSION encyclopedic illustrated guide to medicines from nature. Dorling Kindersley, 1992: 100.

Mobacken H., and Fregert S.,(1975). Allergic contact dermatitis from cardamom. Increases gastric acid secretion, Contact Dermatitis; 1(3): 175-176.

M .Snoussi.,E. Noumi,A. Dehmani,G. Flamini,M. Aouni,M. Al-sieni and A. Al-sieni, (2015). Chemical Composition and Antimicrobial Activities of *Elettaria Cardamomum* L. (Manton) Essential Oil: A High Activity against a Wide Range of Food Borne and Medically Important Bacteria and Fungi, Journal of Chemical, Biological and Physical Sciences, Vol. 6 , PP 251 – 252 .

Nasir Z., Grashorn M.A., (2006). Use of Black cumin (Nigella sativa) as alternative to antibiotics in poultry diets. In: M. Rodehutscord (Editor). Proceedings of 9th Tagung Schweine-und Geflugelernahrung. Halle, Saale (Germany), pp. 210-213.

Nooman A., Khalaf, Ashok, K., Shakrya, Atif, A.O., Zha, E. Husin, F., (2007). Antioxidant Activity of Some Common Plants, Faculty of Pharmacy and Medical Sciences, Al-Ahliyya Amman University, Turk J. Biol., 51-55.

NRC. National research council (1994). Nutrient requirements of poultry (9^{th} rev, Ed.) national Academy press. Washington, D.C., USA.

Oliveira, I.; Sousa, A.; Valentao, P.; Andrade, P.; Ferreira, I. C. F. R.; Ferreres, F.; Bento, A.; Seabra, R.; Estevinho, L. and Pereira, J. A., (2007). Hazel (Corylus avellana L.) leaves as source of antimicrobial and antioxidative compounds. Food Chem. 105, 1018-1025.

Omidi M, Taherpour K, Cheraghi J, Ghasemi HA., (2014). Influence of cardamom essential oils and seeds on growth performance, blood characteristics and immunity of broilers. Animal production Science. 2014.

Osman, A. and Muna, H.(2002). Beneficial effects of black seed oil inclusion in broiler dietnon performance and carcass characteristic. Egypt Poult. Sci. J., 22:839-853.

Oyen, L.P,A., Dung , N.X., (1999).Essential – oil plant .In Resources of south – East Asia , Backhuys publishers , kerkwerve , The Netherlands 131 – 135.

Panghal M., Kaushal V., Yadav JP.,(2011) . In vitro antimicrobial activity of ten medicinal plants against clinical isolates of oral cancer cases . Ann clin Microbial Antimicrob 10:21.

Pelicano, E.R.L, Souza, P.A, Souza, H.B.A, Leonelm F.R, Zeola, N.M.B.L, Boiago, M.M., (2004). Productive traits of broiler chickens fed diets containing different growth promoters. Brazilian Journal of Poultry Science; 6:177-182

Pichersky, E., Noel, J.P., Dudareva, N., (2006). Biosynthesis of plant volatiles: nature's diversity and ingenuity. Science 311, 808–811.

Pruthi JR., (1980). Spices and condiments, chemistry, microbiology, technology . In: Chang HM, Yeung HW, Tso WW, Koo A, eds. Advances in Chinese medicinal materials research. New York: Academic Press, 51 – 73.

Pulido, R.; Bravo, L. and Saura-Calixto, F., (2000). Antioxidant activity of dietary polyphenols as determined by a modified ferric reducing/antioxidant power assay. J. Agric. Food Chem. 2000 (48), 3396–3402.

Rajput AB, Kolete BR, Shisodia JM, Chandankhede JM., (2009). Effect of vitamin A, vitamin C, vitamin E and Levamisol on the performance of broilers. Veterinary World, 2:225-227.

Rajput BR AB, Kolete, Shisodia JM, Chandankhede JM., (2009). Effect of vitamin A, vitamin C, vitamin E and Levamisol on the performance of broilers. Veterinary World; 2:225-227.

Ratika Sharma, (2012). Cardamom comfort, Dental Research J. (Isfahan), 9 (2). 237.

Ray, F. and Fox, S., (1979). Practical Poultry feeding. First edition. British Library Cataloguing in Publication Data-London.

Roozbeh, S.;Mehran,N.;Faramjn,j.;Ali,A.;and Hamed ,K.,(2012). The effect of probiotics on growth performance of broiler . (Scholars Research Library, Annals of biological Research) 3(12):5450 – 5452.

Sahin, K., N. Sahin and M. Onderci., (2002). Vitamin E supplementation can alleviate negative effects of heat stress on egg production, egg quality, and digestibility of nutrients and egg yolk mineral cobcentrations of Japanese quails. Res. Vet. Sci. 73:307-312.

Salah, H. F.,(2007). Effect of Some Medicinal Plant Extracts on Antibiotic Resistance by Plasmid of Escherichia coli Isolated from Different Sources. M.Sc. Thesis, College of Science Education. University of Salahaddin. Erbil-Iraq (2007)

Salzer UJ., (**1975)**. Analytical evaluation of seasoning extracts (oleoresins) and essential oils from seasonings. Int**.** Flav. Food Addit. 6:151.

Shelef, L. A., (1983). Antimicrobial effects of spices. Journal of Food Safety 6, 29 – 44.

Shervin, A and Imad, M., (2009). .Antibacterial Activity of The Spice *Elettaria cardamom*, Biology Department, Skyline College, San Bruno CA ,http//:www.smccd.edu.

Silva, B.M.; Andrade, P.B.; Valentaoo, P.; Ferreres, F.; Seabra, R. M. and Ferreira, M. A., (2004). Quince (Cydonia oblonga Miller) fruit (pulp, peel, and seed) and jam: antioxidant activity. J. Agric. Food Chem. 52, 4705–4712.

Smaranika, P., Dipti, K., Padhan, G., Kumar, J., (2010). Evaluation of cinnamon oil, peppermint oil, cardamom oil & orange oil as antimicrobial agents Journal of Pharmacy Research, 3(2) 414-416.

Smid, E.J., Gorris, L.G.M., (1999). Natural antimicrobials for food preservation. In: Rahman, M.S. (Ed.), Handbook of Food Preservation. Marcel Dekker, New York, pp. 285 – 308.

Smink, W., (2000). Oregano-olie alternatief voor antibiotica. De Molenaar 5, 26-27.

Smith-Palmer, A., Stewart, J., Fyfe. L., (1998). Antimicrobial properties of plant essential oils and essences against five important food-borne pathogens. Lett. Appl. Microbiol. 26, 118-122.

Snoussi, M.,E. Noumi, A. Dehmani, G. Flamini, M. Aouni, M. Al-sieni and A. Al-sieni , (2015). Chemical Composition and Antimicrobial Activities of *Elettaria Cardamomum* L. (Manton) Essential Oil: A High Activity against a Wide Range of Food Borne and Medically Important Bacteria and Fungi, Journal of Chemical, Biological and Physical Sciences, Vol. 6 , PP 251 – 252 .

Sonali Shinde, RG Burte, Shalu Kumar, BG Desai, JS Dhekele and DJ Bhagat., (2017). Effect of cardamom (*Elettaria cardamomum)* and Ginger (*Zingiber officinale)* powder supplementation on growth

performance and economic analysis in broiler. International Journal of Chemical Studies; 5(3): 858-861.

Sonali Shinde, RG Burte, Shalu Kumar1, BG Desai, NN Prasade, JS Dhekale and DJ Bhagat, (2016). Effect of ginger (*Zingiber of_icinale*) and cardamom (*Elettaria cardamomum*) on physiological and heamto-biochemical parameters of broiler. Journal of livestock biodiversity Vo.6,No2,pp:59 – 63 .

Steel, R.G.D. and J.H. Torrie, (1986). Principles and Procedures of Statistics: A Biometrical Approach (2nd Ed.). McGraw Hill Co. Inc., NY, USA.

Tekeli, A. Çelik L. H. R. Kutlu, Plant Extracts, (2007). New Rumen Moderator in Ruminant Diets Tekirdağ Ziraat Fakültesi Dergisi, 4 Journal of Tekirdag Agricultural Faculty.

Tseng, T. H.; Kao, E. S.; Chu, C. Y.; Chou, F. P.; Lin Wu, H. W. and Wang, C. J., (1997). Protective effects of dried flower extracts of Hibiscus sabdariffa L. against oxidative stress in rat primary hepatocytes. Food Chem. Toxicol. 35, 1159–1164.

Van de Braak, S.A.A.J., Leijten, G.C.J.J., (1999). Essential Oils and Oleoresins: A Survey in the Netherlands and other Major Markets in the European Union. CBI, Centre for the Promotion of Imports from Developing Countries, Rotterdam, p. 116.

Vasudevan K., Vembar S. , Veeraraghavan K. , Haranath PS .,(2000). Influence of intragastric perfusion of aqueous spice extracts on acid secretion in anesthetized albino rats, Indian J Gastroenterol; 19(2): 53-56.

Verma, S.k., Vartika, J and Katewa, S.S., (2009). Blood pressure lowering, fibrinolysis enhancing and antioxidant activities of cardamom (*Elettaria cardamom*), Indian J. Biochem. Biophys. 46:503-506.

VISEK, W. J., (1978). The mode of growth promotion by antibiotics. J. Anim. Sci. 46:1447- 1469.

Visek, W. J., (1978). The mode of growth promotion by antibiotics. J. Anim. Sci. 46:1447- 1469.

Vogt, H., S. Harnish, H.-W. Rauch and G. Heil, (1989). Der Einsatz von Naturstoffen (Heil- und Gewürzpflanzen) im Geflügelmastfutter. Archiv für Geflügelkunde 53(4), 144-150.

Weiss E.A., (2002). Family wise description of spice crops belonging to Cruciferae, Lauraceae, Leguminosae, Myristicaceae, Myrtaceae, Umbelliferae and Zingiberaceae. All aspects of cultivation processing and industrial applications are discussed. Spice Crops. CABI International, Wallingford, UK. Pp .299

Wijesekera, R.O.B. and Jayawardena AL.,(1973). Recent developments in the production of spices and their essential oils in Ceylon. In abstracts of Proc. Conf. Spices, Tropical Products Institute, London, p159.

Wikipedia, the free encyclopedia, (2017).htt://en. Wikipedia. org/ wiki/ cardamom.

Windisch, W., Schedle, K., Plitzner, C., Kroismayer , A., (2008). Use of phytogenetic products as feed additives for swine and poultry. Journal of Animal Science, 86: E140–E148.

Ziarlarimi, A.; Irani, M.; Gharahverysi , S.and Rahmani , Z.,(2011) . Investigation of antibacterial effect of garlic (Allium sativum) , mint (Menthe spp.) and onion (Allium eepa) herbal extracts on Escherichia coli isolated from broiler chickens . African Journal of biotechnology Vol. 10 (50), pp. 10320 – 10322.

المراجع العربية

عبد الحسين , ناجي (1992) , إنتاج الدواجن ومشاريع فروج اللاحم , جامعة بغداد , الطبعة الأولى , بغداد للنشر , بغداد , العراق .

APPENDICES

Appendix 1:Chemical composition of E. cardamomum essential oil tested

Components	l.r.i.a	l.r.i.b	*E. cardamomum* essential
α-pinene	941	939	1.1
sabinene	978	976	1.3
β-pinene	982	980	0.8
myrcene	993	992	0.8
octanal	1003	1001	0.2
δ-3-carene	1013	1011	0.4
p-cymene	1028	1026	0.7
limonene	1032	1031	2.9
1,8-cineole	1035	1033	26.0
cis-sabinene hydrate	1070	1068	0.6
trans-linalooloxide	1090	1088	0.1
linalool	1101	1098	5.2
δ-terpineol	1168	–	0.2
4-terpineol	1179	1177	1.4
α-terpineol	1191	1189	2.9
cis-sabinene hydrate acetate	1220	1219	0.2
neral	1241	1240	0.2
linalylacetate	1259	1257	5.6
geranial	1270	1270	0.4
α-terpinylacetate	1353	1350	45.6
geranylacetate	1382	1383	0.3
β-caryophyllene	1419	1418	0.2
β-selinene	1487	1485	0.2
γ-cadinene	1513	1513	0.2
(E)-nerolidol	1566	1564	0.7
Monoterpene hydrocarbons		8.2	
Oxygenated monoterpenes		88.7	
Sesquiterpene hydrocarbons		0.6	
Oxygenated sesquiterpenes		0.7	
Total identified		98.2	

Snoussi *et al.*, (2015).

Appendix 2:

***Elettaria cardamom* Capsules**

***Elettaria cardamom* Plant**

Appendix 3:

Experimental chicks

Appendix 4

Cages of experimental chicks

Appendix 5

Cages of experimental chicks

Appendix 6

Process of mixing the cardamom oil with the diet

Appendix 7

Process of spraying the cardamom oil on the diet

Appendix 8

The weight of one of the chicks at the end of experiment

Appendix 9:Sensory Evaluation Card

Evaluate this sample for color, flavor, juiciness and tenderness. For each sample, use the appropriate scale to show your attribute by checking at the point that desk describes your feling about the sample. If you have any question please ask. Thanks for your cooperation.

Name_____Date_____.

Tenderness	Flavor	Color	Juiciness
8-Extremely tender	8-Extremely intense	8-Extremely desirable	8-Extremely Juicy
7-Very tender	7-Very intense	7-Very desirable	7-Very Juicy
6-Moderately tender	6-Moderately intense	6-Moderatel desirable	6-Moderately Juicy
5-Slightly tender	5-Slightly intense	5-Slightly desirable	5-Slightly Juicy
4-Slightly tough	4-Slightly bland	4-Slightly desirable	4-Slightly Juicy
3- Moderately tough	3- Moderately bland	3- Moderately undesirable	3- Moderately dry
2- Very tough	2- Very bland	2- Very undesirable	2- Very dry
1- Extremely tough	1- Extremely bland	1-Extremely undesirable	1- Extremely dry

Serial	Sample Code	Tenderness	Flavor	Color	Juiciness	Comment