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Response of broiler chicks to different mixtures of dietary (Fennel ، Spearmint and Halfa bar) Essential oils as natural feed additives

إستجابة الدجاج اللاحم لمخاليط مختلفه من بعض الزيوت الأساسيه إضافاتاً علفية طبيعية

A Thesis Submitted in fulfillment of the Requirements for the Ph.D. Degree in Animal Production philosophy

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الاية

بسم الله الرحمن الرحيم

قال تعالى: {وَمَا مِنْ دَابَّةٍ فِي الأَرْضِ وَلا طَائِرٍ يَطِيرُ بِجَنَاحَيْهِ إِلَّا أُمَمٌ أَمْثَالُكُمْ مَا فَرَّطْنَا فِي الْكِتَابِ مِنْ شَيْءٍ ثُمَّ إِلَى رَبِّهِمْ يُحْشَرُونَ}

صدق الله العظيم

سورة الأنعام (٣٨)

DEDICATION

I would like to dedicate this work to the souls of my parents who have always loved me unconditionally and taught to work hard.

This work is also dedicated to my husband Awad Abd Allah who has been a constant source of support and encouragement, and to my sons (Abd Alla and Ahmed) who have been affected by my hard work.

Also I would like to dedicate my work to my big family (my dear brother and sisters) and my dear friends who have never left my side and supported me throughout the process.

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I am indebted to (Allah) who granted me everything including the mind, health and patience to accomplish this work.

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Abstract

The studies involves four experiments to evaluate the effect of different levels of mixed of essential oils extracted from different medicinal plants on broiler diets including: Fennel and Spearmint mixed essential oils (FSMEOs), Fennel and Halfa bar mixed essential oils (FHMEOs), Spearmint and Halfa bar mixed essential oils **(**SHMEOs**)** and different levels of Fennel and Spearmint and Halfa bar mixed essential oils (FSHMEOs) (1:1:1) as natural feed additives.

The experimental parameters covered growth performances, carcass and non-carcass values, serum metabolites, and enzyme activities, mineral and economical appraisal. The experimental design used was complete randomize design, a total number of 384 one day old unsexed commercial broilers of Cobb strain were used. Chicks were distributed randomly into four experimental groups of 96 chicks in each experiment, with three replicates each content 8 chicks (4x3x8). Each experiment divided into four experimental groups of diets (A, B, C and D), group A fed on control diet only, other groups B, C and D were fed on control diet supplemented with one of mixing essential oils (FSMEOs), (FHMEOs), (SHMEOs) and (FSHMEOs) at graded levels (200, 400 and 600mg/kg) respectively. The control diet was formulated to meet the nutrient requirements of broilers according to NRC (1994), experimental rations were fed for 5 weeks.

The results showed that, the addition of mixing essential oils, showed no significant ($p \geq 0.05$) differences between all tested groups in feed intake, body weight, body weight gain and feed conversion ratio, but caused improvement in performance, no mortalities were recorded throughout the experimental period. The results indicate that, the dressing and giblets showed no significant ($p \geq 0.05$) difference between all tested groups for all mixing levels of essential oils expect abdominal fat for (FSMEOs) and heart for (FSHMEOs) recorded significant ($p \leq 0.05$) difference, the results of non-carcass components showed

that there were no significant differences among all treatment groups for all mixing levels of essential oils expect head for (FSMEOs), intestine length for (SHMEOs) and back for (FSHMEOs) recorded significant ($p \leq 0.05$) difference, the results recorded that there was no significant difference among all treatment groups in commercial cuts and their meat ,expect breast meat and bone for (FSMEOs) and drumstick meat and bone for (FSHMEOs) recorded significant ($p \leq 0.05$) difference, furthermore the results for subjective quality attributes showed that there were no significant differences among all treatment groups for all mixing levels of essential oils, however there were significant effects on meat chemical composition among all treatment groups expect for ash and crude protein for (FHMEOs), ash, dry matter and moisture for (FSHMEOs) recorded no significant effects, the result of serum enzymes and minerals values showed significant effect among all treatment groups for all mixing levels of essential oils, the results of serum metabolites showed that, inclusion of different EOs mixing at different levels showed significant effect for all treatments except creatinine recorded no significant in experiments (1, 2 and 3). Supplementation of (FSMEOs) at different levels documented significantly decreased in cholesterol value with increased supplementation of mixing Eos in diet, moreover serum metabolite for (FHMEOs) showed no significant effect in cholesterol. The results of interaction between all experiments showed that, experiment two (Fennel and Halfa bar) mixed essential oils recorded, the best performance, also, the results of interaction between levels revealed that, level 400mg/kg recorded the best level.

The economic evaluation of experimental diets, showed that the addition of (Fennel and Spearmint; Fennel and Halfa bar; Spearmint and Halfa bar and Fennel and Spearmint and Halfa bar) mixing EOs at graded levels to the rations of broilers caused more net profit compared to control.

ملخص الأطروحة

شملت الدراسات أربعة تجارب لتقييم أثرخليط مستويات مختلفه من الزيوت الأساسية المستخلصه من نباتات طبيه في علائق الدواجن شملت خليط من زيوت الشمار والنعناع، الشمار والمحريب، النعناع والمحريب والشمار والنعناع والمحريب بنسبه ١:١:١ كإضافات طبيعية.

غطت القياسات التجريبيه الأداء الإنتاجي، قيم الذبيح، تحليل الدم، نشاط الإنزيمات، المعادن والدراسه الإقتصادية. أستخدم تصميم النظام الكامل العشوائية لإجراء التجارب.

أستخدم عدد٣٨٤كتكوت لاحم غير مجنس عمر يوم من سلاله كوب، وزعت الكتاكيت عشوائيا إلي ٤ مجموعات تجريبيه كل تجربة تحتوي علي ٩٦ كتكوت بثلاثة مكررات كل مكرر يحتوي علي ثمانيه كتاكيت(٨x٣x٤).

كل تجربه قسمت إلى أربعة مجموعات تغذويه (أ، ب، ج، د) المجموعه (أ) غذيت علي العليقه الأساسيه بمفردها أما المجموعات الأخري (ب، ج، د) فقد تمت تغذيتها علي العليقة الاساسية بالإضافه إلى واحد من خليط زيوت (الشمار والنعناع، الشمار والمحريب، النعناع والمحريب والشمار والنعناع والمحريب) بمستويات (٢٠٠، ٤٠٠، ٦٠٠) ملجرام/كجم علي التوالي.

العليقة الأساسية كونت لتقابل الإحتياجات الغذائية للدجاج اللاحم طبقا لمجلس بحوث الأغذية (١٩٩٤) وأعطيت علائق التجارب لمده ٥أسابيع.

أظهرت النتائج أن إضافة خليط الزيوت الأساسيه لم يظهر أي فروقات معنويه لجميع المعاملات وبالنسب المختلفه علي العليقة المستهلكة، الوزن الحي، الوزن المكتسب ومعدل التحويل الغذائي، لكنه أظهر تحسن في الأداء الإنتاجي، كما لوحظ عدم تسجيل نفوق خلال فتره التجارب.

أيضا أشارت النتائج الي عدم وجود فروقات معنويه في نسبة التصافي والأجزاء الداخليه لكل المعاملات وبالمستويات المختلفه ماعدا دهن البطن بالنسبه لخليط زيت الشمار والنعناع والقلب بالنسبه لخليط زيت الشمار والنعناع والمحريب فقد أظهرت فرق معنوي، أظهرت نتائج ملحقات الذبيحه عدم وجود فروقات معنويه لكل المعاملات وبالمستويات المختلفه ماعدا الرأس بالنسبه لخليط زيت الشمار والنعناع، طول الأمعاء بالنسبه لخليط زيت النعناع والمحريب والظهر بالنسبه لخليط زيت الشمار والنعناع والمحريب فقد أظهرت فروقات معنويه، أيضا أظهرت النتائج عدم وجود فروقات معنويه في كل المعاملات وبالمستويات المختلفه للقطع التجاريه واللحم المشفي ماعدا لحم وعظم الصدر بالنسبه لخليط زيت الشمار والنعناع ولحم وعظم الساق بالنسبه لخليط زيت الشمار والنعناع والمحريب فقد أظهرت فرق

معنوي، بالنسبه للصفات الإنطباعية والنوعية للحم لم تظهر أي فروقات معنويه في كل المعاملات وبالمستويات المختلفة بين التجارب في الاداء الإنتاجي.

أظهرت النتائج إلى وجود فروقات معنوية في الإنزيمات والمعادن لكل المعاملات وبالمستويات المحتلفه أما نتائج تحليل الدم فقد أظهر أن إضافة خليط الزيوت الأساسيه بمستويات مختلفه لكل المعلملات فروقات معنوية ماعدا الكيرياتينين فقد أظهر عدم وجود فرق معنوي في التجارب (١,٢والثالثة)، كما أظهرت النتائج أن إضافة خليط النعناع والشمار بمستويات محتلفة أدي إلي نقصان معنوي في الكلسترول عند زياده أضافه الزيوت الأساسيه في العلف. وأخيرا لايوجد اي تاثير معنوي في الكلسترول في التجربه الثانيه. وأيضآ عند مقارنة مستويات الإضافه كان مستوي الإضافة ٤٠٠ ملجم/كجم هو الأفضل.

أظهرت الدراسه الإقتصادية أن إضافه خليط الزيوت الأساسيه (الشمار والنعناع، الشمار والمحريب، النعناع والمحريب والشمار والنعناع والمحريب) وبالمستويات المختلفه أدي الي تحسين الربحيه النسبيه بالمقارنه مع الكنترول.

Table of contents

List of Tables

List of figuers

CHAPTER ONE
INTRODUCTION

The poultry sector is developing and well-successful business in the world. Khan and Iqbal, (2016) reported, the poultry industry's present status is the result of improvement in genetics through selection and improvements in poultry nutrition, especially through feed formulation. Feed additives are an essential part of feed formulation to increase performance, growth and production.

Poultry meat is healthy because its high protein content, low of fat has aconsider good sensory qualities, low price and fast production which mean a short reproductive time. Antibiotic at sub-therapeutic levels it been utilized at a very large extent in broiler industry to improve growth performance as well as to decrease morbidity and mortality. Antibiotics are banned by European Union due to residues in poultry products and cross resistance against pathogens, to enhance the growth performance without any resistance of antibiotic in poultry and residues in meat. Therefore, necessity of replacement of antibiotic with other products like prebiotics, probiotics, organic acid botanicals, and herbal essential oils.

Herbs have different combinations, these compounds include essential oils and plant extracts and their active compounds, essential oils (EOs), are important aromatic components of herbs and spices, and are used as natural alternatives for antibiotic growth promoters in poultry feed, for improving growth performance and the characteristic properties of meat products (Simitzis and Deligeorgis 2011). In addition EOs are aromatic oily liquids these are mixture of various compounds extracted by distillation from various plant parts (Başer and Demirci, 2007).

Màthé , (2009) noted essential oils which are concentrated hydrophobic liquids containing volatile aromatic compounds, the EOs having different

effects include antibacterial, antiviral, antifungal, antioxidant, or immune stimulatory properties (Alali *et al.*, 2013; Krishan and Narang, 2014).

Fennel *(Foeniculum vulgare* L.) is aromatic plants which is containing a high percentage of the fatty acids linoleic and stearic, in addition, fennel essential oil has 16.81% trans - anethole pulse 47.20% estragole with total sweeting components of 64.01%, Eldeek *et al*,. (2003) showed that fennel consumption increases weight and improves the nutritional efficiency of broiler chickens, in addation Indisch *et al.*, (2008) reported that plant additives could increase performance and reproduction in animals.

Spearmint is a member of the Labiate family and one of the world's oldest medicinal herbs (Bahmani *et al*., 2015). The chemical components of spearmint are menthol, menthone, 1, 8-cineole, methylacetate, methofuran, isomenthone, limonene, b-pinene, a-pinene, germacrene-d, trans-sabinene hydrate, and pulegone. Menthol is the main phenolic component in oil of peppermint, which has antibacterial activities (Cabuk *et al*., 2006). Spearmint is widespread through out the world and use in food, flavor, cosmetic, and pharmaceutical industries (Farhadi *et al*., 2016).

Halfa bar **:** *Cymbopogon* (Poaceae) represents an important genus of about 140 species that grow in tropical and subtropical regions around the world to produce essential oils are *C.proximus* Stapf, (Halfa bar) and *C. nervatus* (Hochst) Chiov (Anand, 2010).

The objectives of this study:

1. To evaluate the effect of different combinations and levels of EOs (fennel and spearmint and halfa bar) as natural growth promoters on growth performance, carcass parameters.
2. Study the effect of these EOs combinations on the blood serum constituents.
3. To determine the best level and combinations of these EOs.

CHAPTER TWO

LITERATURE REVIEW

2.1 Feed Additive:

Characteristics of phytogenic feed additive:

The phytogenic feed additives (PFA) derived from herbs, spices or aromatic plants (Windisch *et al.,* 2008). These plants derived products are residue-free unlike synthetic antibiotics and are also generally considered safe to be used as the ingredients in the food industry as well as in animal diet as an ideal growth promoter (Li *et al*., 2016). The efficacy of the phytogenic effeced by many factors include the plant parts and their physical properties, the genetic variation of the plant, age of the plant, different dosage used, extraction method, harvest time, and compatibility with other ingredients (Yang *et al*., 2009).

Feed additives are described as ingredient or mixtures of ingredient added to feed in a small amount to satisfy specific need to improve feed conversion ratio and lower mortality rate and to increasing growth performance, live weight gain or egg output (Steiner, 2009; Abde -Aal and Attia, 1993).

Khan *et al*., (2007) reported that, feed additives now used in poultry feeding practices extensively, the feed additive not only used to stimulate the growth and feed efficiency but to improve the health and performance of birds.

Several antibiotic growth promoters (AGP) had been used in poultry feed in past aiming to prevent disease, to improve growth performance, and to increase some useful microorganism in intestinal microflora. However, because of emergence of bio resistance, researchers are now focusing for alternatives in place of antibiotics. Antibiotics have been banned in the European Union due to growing levels of antimicrobial resistance (Darabighane *et al*., 2017). EOs as an alternative to antibiotic growth promoters, because the essential oils are generally considered natural, less toxic, and free from residues when compared with antibiotics (Gong *et al*., 2014). Also, in the latest years, some feed additives such as enzymes Bedford and Cowieson, (2012), probiotics Musa *et*

al., (2009), prebiotics Gibson *et al*., (2004), phytogenic Gong *et al*., 2014; Dhama *et al*., (2015) and organic acids Upadhaya *et al*., (2014) and Upadhaya *et al*., (2016a) are used as a replacement for AGP.

The positive effects of feed additives in poultry may arise from the useful effect on feed intake, digestive secretions, immune stimulation, antibacterial, Coccidiostatical, antiviral or anti-inflammatory activity. In plant tissues, pH values are dependent on the presence of poly-carboxylic acids, phosphate salts, fiber and proteins (Al-Dabbas *et al*., 2010).

2.2 Essential Oils (EOs):

EOs was proposed by Paracelsus in his theory of 'quinta essentia', and described that this quintessence could be an effective element for medical use (Oyen and Dung, 1999). EOs could be obtained through various methods like extraction or expression, fermentation and for commercial purpose used steam distillation consider the common method. The EOs possess characteristic odor, and are soluble in organic solvents. Most of the oils are lighter than water with a specific gravity between 0.8-1.17. These oils are sensitive to heat and light, therefore should be stored in dark bottles and cool places.

Essential oils are oily, volatile or aromatic liquids obtained from flowers, seeds, herbs, leaves, fruits, roots and bark from the plant (Brenes and Roura 2010). Oyen and Dung (1999) noted the essential oils are named according to the aromatic characteristics of the plant origin.

2.2.1 Composition of Essential Oils:

Essential oils are a sum of constituent volatiles, and thus the effects of EOs should be a totality of effects of all components and their interactions. Two or three components could account for up to 85% of the total mixture compared with the minors (Miguel, 2010).

Most EOs consist of mixtures of hydrocarbons, oxygenated compounds, and a small percentage of non-volatile residues (paraffin, wax, etc.). Chemically, EOs

are basically comprised of two classes of compounds, these are terpenes and phenylpropenes, terpenes are sub–divided based on the 5–carbon isoprene unit (building block) into mono (C10H6), sesqui (C15H24) and diterpenes (C20H32), while the phenylpropenes consist of 6-carbon aromatic ring having a 3-carbon side chain (C6-C3 compounds) (Clegg *et al*., 1980; Cooke *et al*., 1998).

In addation Essential oils are complex mixtures of volatile compounds produced by living organisms and isolated by physical means only from a whole plant or plant part of known taxonomic origin (Franz and Novak, 2009).

The chemical composition of an EOs defines its mode of action as well as its attributes differences between, or with in, EOs depend significantly on several variables, such as plant species, physical and chemical soil conditions, harvest time, degree of plant maturity, technology of drying, duration of storage and extraction process (Burt, 2004; Bakkali *et al*., 2008).

Senatore, (1996) reported the composition of Essential oils is primarily determined by the homogeneousness of the starting materials, whose characteristics could be influenced by a plethora of factors , relatively constant over different harvesting times, but the phenol content increasing at the beginning of the flowering and reaches its highest value during the full flowering period of the plant.

2.2.3 Essential oils properties:

Essential oils have long been famous to possess antioxidant, anti-inflammatory, and antimicrobial properties (Krishan and Narang, 2014; Placha *et al*., 2014). EOs were attributed to their antioxidant Placha *et al*., (2010), Silva *et al*., (2012), antimicrobial Du *et al*., (2016) and immunological functions (Hosseini *et al*., 2016).

2.2.3.1 Antimicrobial activity of Essential oils:

Essential Oils mist improves hygiene standards on broiler farms due to its antimicrobial properties, (Bakutis *et al.*, 2011; Witkowska *et al.*, 2016). A

reduction in microbial contamination levels at the source of the infection can indirectly improve performance and blood parameters in broilers (Witkowska *et al.*, 2007; Witkowska and Sowińska 2017). The antimicrobial activity of Fcould also be exploited as a green preserving to prevent food from contamination of pathogens.

2.2.3.2 Anti- Inflammatory Activity:

The main essential oils ingredients with anti –inflammatory abilities are the terpenoids and flavonoids, which were reported to have significant anti inflammatory and analgesic effect (Shahid *et al*., 1998). Evaluating the anti-inflammatory and immunostimulatory effects of essential oils and their components administered per os to mice and rats, Lutomski and Kędzia (2000) reported the highest levels of anti-inflammatory activity in thyme, sage, peppermint, 1,8-cineol, juniper, and eucalyptus EOs. Thyme oil exhibited higher levels of anti-inflammatory activity than a referenced anti-inflammatory drug. Thyme oil was also one of the most potent immune stimulants in the cited study.

2.2.3.3 ImmunomodulatoryActivity:

The essential oils reduce levels of pathogenic bacteria counts and relieve animal from immune defense stress (Windisch *et al*., 2008; Zeng *et al*., 2015).

2.2.3.4 Antioxidant activity:

Karadas *et al*., (2014) found that dietary combination of essential oils including carvacrol, cinnamaldehyde and capsicum oleoresin showed antioxidant potential by improving the hepatic concentration of carotenoids and coenzyme Q10 when fed to broiler chicken. Fernandez-Panchon *et al*., (2008) noted the antioxidant mechanisms of essential oils are depend on both their ability to donate a hydrogen or an electron to free radicals, and their ability to delocalize the unpaired electron with in the aromatic structure.

2.2.4 Essential oils impact on nutrient digestibility:

Essential oils enhance production of digestive secretions, improve the intestinal availability of essential nutrients for absorption, stimulate blood circulation, mitigate the levels of fermentation products and enhance precaecal nutrient digestion, Windisch *et al*., (2008); Zeng *et al*., (2015), also, essential oils stimulate the activity of the digestive enzymes and improve the natural conditions of the gut (Cross *et al*. 2007; Jang *et al*., 2007). The improvement in nutrient absorption explained by increased secretions of saliva, bile and enhanced enzyme activity.

Liu *et al*., (2017) reported organic acids mixed with Essential oils improved feed coversion ratio also, intestinal morphology and digestive enzymes activity in broilers. Microencapsulated organic acid and Essential Oils, alone or mixed, as feed additive in broiler chickens improved gut microflora Gauthier *et al.,* (2007), lowered the pH in stomach Desai *et al*., (2007), reduced intestinal and fecal pathogenic microbial counts Mitsch *et al*., (2004), also, improved the activity of digestive enzymes, pancreatic secretion and changed the gut morphology in terms of villus height and crypt depth in small intestine (Yang *et al*., 2019).

Many researchers noted the positive effects of essential oils on digestive enzyme secretion from pancreas and intestinal mucosal (Jamroz *et al*., 2006; Jang *et al*., 2007). These effects were confirmed by the increased digestibility of nutrients, (Amad *et al*., 2011; Garcia *et al*., 2007). Furthermore, essential oils stimulate the activity of the digestive enzymes and improve the ecological conditions of the gut (Cross *et al*., 2007; Jang *et al*., 2007). Williams and Losa (2001) noted that, essential oils have stimulating effect on animal digestive systems. They postulated that, these effects could be due to the increased production of digestive enzymes and the improved utilization of digestive products through enhanced liver functions.

2.2.5 Effects of Essential Oils in poultry:

The essential oils alone or mixture to be used as a growth promoter in broiler production. Many broiler studies have shown positive effects of dietary essential oils on body weight gain, supplementing the dietary essential oils would improve the growth performance (Cross *et al*., 2002; Bampidis *et al*., 2005).

Cabuk *et al*., (2006) noted asignificantly reduced feed intake of broilers from young breeder's by graded inclusion of a combination of essential oils (oregano oil, laurel leaf oil, sage leaf oil, myrtle leaf oil, fennel seed oil, and citrus peel oil).

In the literature some researcher reported, essential oils increase body weight gain Falaki *et al*., (2016); Yang *et al*., (2018), feed intake Mukhtar *et al*., (2013); Valiollahi *et al*., (2014), feed conversion ratio Yang *et al*., (2018), nutrient digestibility and absorption Boyen *et al.,* (2008), dressing percentage Alcicek *et al*., (2004); Mahmoodi *et al*., (2014) and reduced serum cholesterol Mukhtar *et al*., (2013) and abdominal fat (Rafiee *et al.,* 2013; Valiollahi *et al*., 2014). While, cross *et al*., (2007); Hernandez *et al*., (2004) reported improved growth performance were observed at different ages of birds fed certain EO-supplemented diets. Also, addition of 3% garlic as feed additive could significantly enhance growth and performance of broiler (Elagib *et al*., 2013).

In a study conducted on laying quails, Cabuk *et al*., (2014) reported that, mixtures of essential oils had beneficial effects on egg production and feed conversion ratio when it was used as a dietary supplement(in astudy conducted on laying quails). Essential oil mixture and organic acid supplementation in commercial layer diets under heat stress is beneficial to egg weight and immune function (Ozek *et al.,* 2011). The beneficial effects of essential oils and herbal, including thyme and peppermint oil, on the performance of broiler chickens reported by many researchers (Ocak *et al.*, 2008; Bento *et al.*, 2013; Hashemipour *et al.,* 2013; Wade *et al.,* 2018).

Toghyani *et al.*, (2010b), reported the supplementation of broilers diets with thyme improved broiler performance to a similar extent as antibiotic growth promoters, but without exerting effects on immune responses or blood parameters.

The herbal essential oil may be considered a potential growth promoter. Several studies have been conducted on the effect of dietary essential oils or combinations on the performance of poultry but with varying and often differing results. In addition Simitzis and Deligeorgis (2011) noted Essential oils have been examined as alternatives in animal production for improving growing performance parameters and the quality characteristics of the derived products (meat, milk and eggs).

2.2.6 Uses of Essential Oils:

Botsoglou *et al.*, (2012) noted Essential oils used widely in medicine and in the food and cosmetic industries, essential oils are also known as ethereal oils. Inhalation therapy is recommended for lung diseases such as asthma, cystic fibrosis and chronic obstructive pulmonary disease because it targets specific organs it can be administered at lower doses than oral or intramuscular treatments, and it has less severe adverse effects (Rau, 2005; Ibrahim *et al.*, 2015).

In human medicine, EOs administered orally or as vapour inhalation contribute to the treatment of respiratory problems such as bronchitis, asthma and chronic obstructive pulmonary disease (Mitsch *et al.*, 2004; Sadlon and Lamson, 2010).

2.3 Fennel Essential Oil (FEO):

Specifications for fennel oil:

Colourless or pale yellow, Optical rotation+11 to +24 ,Specific gravity0.965 to 0.977, Refractive index- 1.528 to 1.539, Congealing point, not below 5° and as high as 10° in good oils,Anethol content 50-80% (Singhal *et al.*, 1997).

, Foeniculum vulgare Mill (commonly known as fennel) is a small genus of annual, biennial or perennial herbs, which are used as a cooking spice fennel is distributed in Mediterranean region and central Europe, It is widely cultivated throughout the temperate and tropical regions of the world for its aromatic fruits (Díaz-Maroto *et al*., 2006; Rather, *et al*., 2012). There is high morphological and photochemical variation among and within wild and cultivated fennel (Shahat *et al*., 2012). Fennel is a well-known aromatic plant species named "rezene"in Turkish (Baytop, 1994).

El wahab, (2006) reported *Foeniculum vulgare* has two commercially important fennel types: bitter fennel, *Foeniculum vulgare* Mill.sub sp. *vulgare* var. *vulgare*, and sweet fennel *Foeniculum vulgare*Mill. Sub sp. *vulgare* var. *dulce* (Mill.) Batt.

Capillaceum, one of the two subspecies (the other is piperitum) of this herb, has three varieties (dulce, vulgare, and azoricum).The dulce variety is sweet, the vulgare variety is bitter, and both of them grow wild (Díaz-Maroto *et al*., 2005).

Ozcan *et al*., (2006); Radulescu *et al*., (2009) who reported, Fennel is a plant belonging to Umbelliferae (Apiaceae) family, it is an aromatic glabrous erect perennial reaching aheight of 1 m with finely dissected leaves and yallow flowers in large umbles. Different fennel population have different fruit size, taste, Oder, quality and yield potential. The shamar commonly known as fennel of many synonyms (wild fennel, sweet fennel, large fennel, finocchio carosella and Florence). Essential oils, yield and their components are highly effected by genetic, environmental and climetic conditions, season of collection, age of the plant, the stage of ripening of the fruits. Fennel used by humans since later times. It is also cultivated in the Mediterranean region because of its flavor, and it is used in traditional medicine and as a spice. Interests in natural products rather than synthetic agents have focused attention on plants as a source of flavoring compounds (Yaylayan, 1991). Fennel is palatable plant whose fruit is

used for savory formulations, sauces, liqueurs, confectionery, etc. (Guilled and Manzanons, 1996).

Damjanovic *et al.* (2004) noted Fennel essential oil is extracted from grounded seeds, either by hydro or steam distillation. In recent times, supercritical CO2 is also used. The optimum condition for SC-CO2 was found to be pressure (100 bars), temperature (40°C), and extraction time (120 min.), which gave high content of *trans*-anethole with reduced methylchavicol content.

Fennel Essential Oil Properties:

Fennel seeds have apoptotic, antipyretic properties, anti-inflammatory Antithrombotic, antiviral, antispasmodic, and antimutagenic (Guimarães *et al*., 2011; El-Deek *et al*., 2003). These active ingredients are also known to have digestive, anti-flatulent, and carminative properties (Badgujar *et al*., 2014). These medicinal plant is a potential source of natural phytochemicals, especially antioxidants (Rather *et al*., 2016). Some studies also have reported antimicrobial activities of fennel essential oils (Diao *et al*., 2014). Essential oils and Herbal drugs of fennel have hepatoprotective effect, Ozbek *et al*., (2003), they are also known for their diuretic and analgesic (Choi and Hwang, 2004).

Singh, (2008) also, noted Fennel has hepatoprotective, chemopreventive, cytoprotective, antitumor and oestrogenic activities. Comprehensive investigations on fennel leaves and fruits showed that its essential oil has very strong antioxidant, antimicrobial, and hepatoprotective activity (Ruberto *et al*., 2000; Ozbek *et al*., 2003).

2.3.1.1Antimicrobial:

Antibacterial effect of Fennel essential oils reported by (Ruberto *et al*., 2000; Singh *et al*., 2002). The bacterostatic effects of the crude extract derived from fennel has been proved against *Helicobacter pylori*, the most prevalent gastric pathogen causing gastric dysfunction, ulceration and even cancer (Sadeghian *et al*., 2005). Fennel essential oil

has an antibacterial effect against *Acinetobacterbaumannii*, a gram-negative bacteria (Jazani *et al*., 2009).

2.3.1.2 Antiflatulent and antispasmodic:

Vasudevan *et al*., (2000) reported Fennel is an excellent stomach and intestinal remedy for treating flatulence and colic conditions, also, fennel stimulating healthy appetite and digestion. Fennel seeds act as an antispasmodic in high doses and increase gastrointestinal motility, Fennel extracts decrease maximum possible contractility and produce a reduction in acetylcholine-induced contraction.

2.3.1.3 Stimulant, carminative and expectorant:

The carminative effect of essential oils may be related to their action on intestinal foam, Fennel and other essential oils have been shown to be highly effective in disrupting gastro intestinal foam as a consequence, perhaps, of the stimulation of gastric and intestinal secretion (Harries *et al*., 1978). Fennel can help expel wind from the alimentary canal, freeing the respiratory system, rendering a calming effect on coughs and bronchitis, anethole and fenchone have been shown to have a secretolytic effect on the respiratory tract (Brender *et al*., 1997).

2.3.1.4 Anticarcinogenic properties

The chemopreventive potential of fennel against carcinogenesis has been shown by (Singh and Kale 2008). Estragole, a constituent of fennel, is a procarcinogen but has minimal carcinogenic risk. To reach full toxicity, estragole must be activated by liver enzymes. Other liver enzymes in activate it, limiting liver damage (Iten and Saller, 2004; Iyer *et al*., 2003).

2.3.1.5 Antioxidant activity

The fennel leaf and bulb stalk, mostly consumed raw, have high antioxidant potency and are considered important in disease processes like inflammatory disease, coronary vascular disease, carcinogenesis and aging. The anti-

inflammatory, analgesic and antioxidant activities of fennel fruit have been reported by (Choi and Hwang 2004). The essential oil, water and ethanol extracts from fennel fruits have aconsider astrong antioxidant effect (Oktay *et al*., 2003). Parejo *et al*. (2004b) identified 42 phenolic substances, 27 of which had not previously been reported in fennel, including hydroxycinnamic acid derivatives, flavonoid glycosides and flavonoid aglycons.

2.3.1.6 Muscle relaxant:

Taylor *et al*., (1985) revealed that, Essential oils, such as fennel oil and spearmint have been to exerta significant smooth muscle relaxant effect which is believed to relate to the inhibition of calcium channels. In another animal study, fennel oil inhibited acetylcholine-induced contractions of ileal and bladder smooth muscles, constituents in the fennel oil cases an inhibition of calcium release from intra cellular stores and the binding to calcium-binding proteins (Saleh *et al*., 2005).

2.3.1.7 Nausea and stress relaxer:

Gilligan, (2005) noted a variety of aroma therapy treatments were used on patients suffering from the symptom of nausea in a hospice and palliative care programme, using a synergistic blend of aniseed, sweet fennel, Anthemis nobilis and peppermint. The majority of patients who used the aroma therapy treatments reported relief, using measure ments taken on the Bieri scale. On other treatments for their symptoms of patiens, it was impossible to establish a clear scientific link between the aromatherapy treatments and nausea relief, but the study suggested that the oils used in this aroma therapy treatment were successful complements to the relief of this symptom.

2.3.1.8 Hepatoprotective:

Özbek *et al*., (2003) demonstreded that, hepato toxicity produced by acute carbon tetrachloride-induced liver injury was found to be inhibited by essential

oil from fennel, as evidenced by decreased levels of serum aspartate amino transferase, alkaline phosphatase, alanine amino transferase and bilirubin.

Various spices containing fennel an increase in biliary solids and a pronounced higher rate of secretion of bile acids, probably contributing to the digestive stimulant action of the test spices (Patel and Srinivasan, 2000). Fennel fruit also, has liver protection properties (Özbek *et al*., 2003).

2.3.1.9 Antidysmenorrheal:

Ostad *et al*., (2001) used fennel essential oil in an attempt to find agents with less adverse effect. Administration of different doses of fennel essential oil reduced the intensity of oxytocin- and PGE2-induced contractions significantly. Fennl also reduced the frequency of contractions induced by PGE2 but not with oxytocin. The estimated LD50 was 1326 mg/kg. No obvious damage was observed in the vital organs of the rat.

2.3.1.10 Antihirsutism:

Javidnia *et al*. (2003) evaluated the clinical response of idiopathic hirsutism to topical application of creams containing 1 % and 2 % fennel extract, which had been used as an oestro genic agent, by measuring hair diameter and rate of growth. The efficacy of the cream containing 2 % fennel extract was better than the cream containing 1 % and these two were more potent than the placebo used.

2.3.1.11Antiparasitic:

Powdered fennel seeds are used to keep fleas and other parasites away. The acaricidal activity of components derived from fennel seed oils against *Tyrophagusputrescentiae* adults using direct contact application, and compared with compounds such as benzyl benzoate, dibutyl phthalate and *N*,*N*-diethyl-*m*-toluamide (Lee *et al*., 2006). The bioactive constituent of the fennel seeds was characterized as (+)-carvone by spectroscopic analyses. The most toxic compound to *T.putrescentiae* was naphthalene, followed by dihydrocarvone,

(+)-carvone, (−)-carvone, eugenol, benzyl benzoate, thymol, dibutyl phthalate, *N, N*-diethyl-m-toluamide, methyl eugenol, myrcene and acetyleugenol, on the basis of LD50 values, and reviewed by (Shamina, 2008).

2.3.2 Composition of fennel Oil:

Many studies have been conducted to investigate the chemical composition of the essential oil of fennel from different origins. They state that the major components of fennel are phenyl propanoid derivates: trans-anethole and methyl chavicol. Other major components of fennel include αphellandrene, fenchone, and α-pinene (Diaz-Maroto *et al*., 2006; Ozcan *et al*., 2006).

Composition of Essential oil depends on internal and external factors affecting the plant such as ecological conditions Fuente *et al*., (2003), and genetic structures Telci *et al*., (2006a) and agricultural practices also have serious effects on yield and oil composition in the essential oil crops. In some plants maturation stages consider an important factor influencing essential oil composition (Msaada *et al*., 2007). Fennel seeds contain 0.79 % essential oil, 5.82 % fixed oil and total phenolic compounds 1.17 mg/g dry weight. According to their analysis, the major constituents of essential oil are anethone (86.11 %), 1, 8-cineole (5.09%), fenchone (4.13 %), α-pinene (0.37 %), δ-limonene (0.07 %), and estragole (methyl chavicol) (0.05 %) (El-Awadi and Hassan 2010).

2.3.3 Uses of fennel essential oil:

Mature fruit of fennel and Essential oil are used as a constituent of pharmaceutical products and cosmetic also used as flavoring agents in food products such as (pickles, pastries, liqueurs, bread, , and cheese) (Rather *et al*., 2012; Telci, , *et al*.,2009).

Fennel seeds have anise like aroma and are mainly used as flavourings in food, meat and fish dishes, ice cream, alcoholic beverages and herb mixtures. Also, it is an extremely aromatic and flavor ful herb with cookery and medicative uses (Diaaz-Maroto *et al*., 2005).

Austria and its neighbours traditionally use *Foeniculum vulgare* to avoid gastro intestinal problems such as colic and flatulence (Franz *et al*., 2010). A study on the antibacterial effect of crude protein extract of fennel reported that the extract had an inhibition effect on *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa*, and *Proteus vulgari* (Akeel *et al*., 2014).

Özbek *et al*., (2004) stated that dietary fennel essential oil acts as a hepatoprotective for liver fibrosis in rat, some others reported that fennel fruit methanolic extract Choi and Hwang (2004) and fennel fruit essential oil Salami *et al*., (2016) may reduce the risk of Inflammation-related diseases and have antimicrobial effect related with the content of trans-anathole. Fennel seed essential oil can also be an alternative to commercial insecticides (Zoubiri *et al*., 2014).

Pavela *et al*., (2016) declared that Czech fennel provides high yield and is effective in the development of botanical insecticides. Oral administration of *F. vulgare* fruit methanolic extract exhibited inhibitory effects against acute and subacute inflammatory diseases and type IV allergic reactions and showed a central analgesic effect (Choi and Hwang 2004). An effect of Fennel oil on hemostasis has been evidenced, with a significant correlation with its phenylpropanoid content (Stashenko *et al*., 2002).

Arslan *et al*., (1989) noted Fennel increases elasticity of connective tissues and act as anti-aging agent, also fennel and its preparations are used to cure various disorders, and also act as a carminative, digestive and diuretic agent.

2.3.4 Uses of fennel essential oils in poultry

Saleh *et al*., (2018) showed that supplementation of Foeniculum vulgare seeds powder 750 gm+50 kg in diet caused significant increase in body weigh in poultry. Also addition of fennel at both 1, 2 and 3 g/kg to the diets resulted in a significant ($p \leq 0.05$) improvement in the chicks body weight and feed efficiency while no significant differences were observed in feed intake (Abdullah and Rabia, 2009).

Khajeali *et al*., (2012) noted use of 2% black cumin in the diet for study on broiler reduced the level of triglyceride and total cholesterol also, adding 0.5 and 2**%** cumin powder to the Japanese quail diet reduced total cholesterol and triglyceride.

Lee *et al* ., (2003) found that, the addition of thymol and carvacrol to broiler chickens diet reduced serum cholesterol concentrations, which is attributed to the inhibition of 8-hydroxy-8- methylglutaryl-quanzime reductase enzyme in the synthesis of cholesterol.

Essam,(2018) recorded chick fed on diet supplemented with 200 mg/kg fennel oil showed significantly($p \leq 0.05$) the highest body weghit during the 3 week, although chicks fed on 400mg/kg recorded significantly($p \leq 0.05$) the highest body weghit during the last two weeks of the experiment on the same trend chicks fed 200mg/kg.chick fed on diet with 600mg/kg fennel oil showed significanty($p \leq 0.05$) the lowest value for feed intake.chick fed on diets with different level of FEO recorded significantly($p \leq 0.05$) the highest body weight gain through out the experimental period compared to control group. Sahar and Mukhtar, (2015) reported that, response of broiler chicks fed on diet containing different levels of shamar seed as anatural growth promoter. Result recorded no significant differences among all treated groups in values of perfprmance, dressing percentage and subjective and objective meat quality attributes.

Eldeek *et al*., (2003) noted that fennel consumption increases weight and improves the nutritional efficiency of broiler chickens,

Indisch *et al*., (2008) reported that plant additives could increase performance and reproduction in animals research, the addition of aromatic plants to the feeds and water improved feed intakes, feed conversion ratio and carcass yield.

Çabuk *et al*., (2014) reported that using amixture of essential oils, including fennel essential oil, for laying quails and laying hens at the hot summer seasons improved feed efficiency, also, Nasiroleslami and Torki, (2010) noted the effect

of adding essential oils of fennel and ginger to control diet on laying hen performance, egg quality traits, blood biochemical paramerters and differential count of white blood cells. Results recorded that, adding EOs of fennel or ginger to laying hen diet can be benifical in improving egg characteristics especially in term of egg shel quality traits.

Acimovic *et al*., (2016) reported chicks feed fennel significantly higher in hemoglobin, number of red blood cells and packed cell volume attracts.

2.4 Spearmint Essential Oil

Spearmit ahardy branched perennial herb with bright green, lance shaped, sharply serrated leaves, quickly spreading under ground runners and pink or lilac- coloured flowers in slender cylindercical spikes. Spearmint is amint plant also known by its Scientific name *Mentha Spicata*, it has rich green leaves, grows 2-3 feet in height there are several forms of garden mint, the true variety being of bold, up right growth, with fairly large and broad leaves, pointed and sharply serrated at the edges and of arich bright green colour (Colby *et al*., 1993).

Guenther, (1994) noted the name spearmint is applied to several species and varites of genus menthe for example *Menthe Spicatal L*, *Menthe Vividis* and *Menthe Gentiles* possessing adistinct odour due to hgiht carvone content. In addation Hadjlaoui *et al*., (2009) reported that, the genus Mentha includes 25-30 species that grow in the temperate regions of Eurasia, Australia and South Africa. The mint species have agreat importance, both medicinal and commercially. Spearmint is known by the name Elnana Elbaladi in Northern African, countries and in Sudan (Bashir, 2000). The leaf, fresh or dried, is the culinary source of spearimint, fresh spearmint is usually preferred over dried spearmint (Chopra *et al*., 1992).

Peppermint or mint is a member of the Labiatae family and one of the world's oldest medicinal herbs, and is used in both Eastern and Western traditions. It is widely used in herbal medicine and believed to be mainly

beneficial in building of the immune system and fighting secondary infections (Nanekarani *et al*., 2012). The peppermint plant is an aromatic perennial herb cultivated in Egypt and, in most parts of the world, has traditionally been used in medicine (Abdel-Wareth and Lohakare, 2014; Beigi *et al*., 2018). Peppermint is ability to enhance appetite, mainly due to its active components also widely used for its antimicrobial and strong antioxidant properties (Dorman *et al*., 2003).

The Labiate family, rich in essential oil, these herbs widely use in food, flavor, cosmetic, and pharmaceutical industries, herbs are wide spread through out the world (Farhadi *et al*., 2016).

2.4.1 Spearmint Essential Oil properties:

Peppermint essential oil has an antimicrobial effect Trombetta *et al*., (2005); Pramila *et al*., (2012), due to its antioxidant content and free radical scavenger properties it is a hepato-protective effect Khalil *et al*., (2015), also, peppermint oil has antitumor, antiviral, immunomodulating and chemo preventive potential (Mekay and Blumberg, 2006).

2.4.2 Composition of Spearmint oil:

The chemical components of Spearmint are methofuran, menthol, menthone, 1, 8-cineole, methylacetate, isomenthone, limonene, b-pinene, a-pinene, germacrene-d, trans-sabinene hydrate, and pulegone. Menthol is the main phenolic component in oil of peppermint, which has antibacterial activities (Cabuk *et al*., 2006). In addition Mkaddem *et al*., (2009); Pudpila *et al*., (2011) noted the oil of Spearmint contains limonene, 1, 8-cineole, dihydrocavone, phytol, linalool, thymol, carveol, piperitenone, and eugenol as the primary components

Chemical composition of Spearmint leaves may vary with plant maturity, geographical region and processing conditions (Beigi *et al*., 2018). Peppermint leaves contain about 0.5 to 4% essential oils that are composed of 25 to 78% menthol, 14 to 36% menthone, 1.5 to 10% isomenthone, 3.5 to 14% cineol, 2.8

to 10% menthyl acetate (Aziz *et al*., 2011; Beigi *et al*., 2018). Menthol is known as an appetizer substance (Akbari *et al*., 2016). And has antimicrobial activity (Schuhmacher *et al*., 2003). Also spearmint contains Vitamin A, riboflavin and vitamin C, and it is rich in mineral it also contain about 300mg/100, ca 7.7 mg/100 on wet weight basis. In the leaf essential oil of *Mentha spicata*, as separated by GCMS, 44 Compounds were revealed. The major component was carvone (59.40%) (Habiba, 2011). The specific essential oils constituent of spearmint were also demonstrated by Amal, (2012).

2.4.3 Uses of spearmint oils

Menthe Spicata is an important raw material that has been used as carminative, antispasmodic, diuretic and flavorings agents for confectionary, drinks, antiseptic mouth rinses, chewing gum, toothpaste, desserts and candies (Colby *et al*., 1993). Spirling and Daneils, (2001) reported that**,** Menthe essential oil stimulates secrtion of hormones, discharge of Enzymes, gastric juices and bile and stimulate nerves, brain and blood circulation. This keep the metabolism activated and functioning property and also boosts immune system. Furthermore, it is very useful to deal with digestive problems including flatulence, constipation, diarrhea and nausea, as it relaxes the stomach muscles. Also Spirling and Daneils, (2001) reported that, mint is usually taken after ameal for it is ability to reduce indigestion and colonic speams by reducing the gastrocholic reflex. The main medicinal action of the leaves and flowers of the mint depend on the abundant menthol which is the main phenolic component which has antibacterial activities (Schuhmacher *et al.*, 2003). Also, Dorman *et al*., (2003) reported, peppermint contains polyphenolic compounds, and hence could possess strong antioxidant properties. Al-Ankari *et al.*, (2004) observed the beneficial influence of wild mint on broilers productive performance. Peppermint oil is used to digestive complaints, neuralgia, myalgia, headaches, migraines and chicken pox (Blumenthal, 1998). In addition, the using of Peppermint oil mainly under heat stress conditions improved some blood

biochemical criteria of chicks (Akbari and Torki, 2014). Emami *et al*., (2012) concluded that mint oil at a dose of 200 or 400 mg/kg dry matter diet for chicks could be an effective alternative to an antibiotic. Arab-Ameri *et al.* (2016) revealed that, the addition of peppermint powder to feed improved immunity and minimized oxidative stress in heat-stressed broilers as potent antioxidant.

2.4.4 Effect of spearmint oil addition in poultry diets

Addation of peppermint ingredients in poultry nutrition, especially on broilers, and the results show that peppermint leaves have a growth promoting efficacy at an early stage of the broilers' lives (Ocak *et al*., 2008; Toghyani *et al*., 2010). And improve egg quality (Abdel-Wareth and Lohakare, 2014).

Bushra, (2011) noted that, addition of spearmint in 1, 1.5 and 2% in broiler diet showed no significant differences in feed consumption, feed conversion ratio, and body weight gain although bird fed with level 1.5 have the best performance in the term of total body weight gain, total feed intake. Although dressing percentage for the three treatments received addition of spearmint at 1, 1.5 and 2% were found to be 74.17%, 73.08% and 73.47 respectively. The dressing percentage was not significantly differences ($p \geq 0.05$).

Mukhtar *et al*., (2013) showed that, chicks fed on diets supplemented with spearmint oil (SPO) consumed significantly more feed compared to control group, Also, Khempaka *et al*., (2013) reported that, peppermint leaves have beneficial effects on abdominal fat deposition ,antioxidant activity and ammonia production in broilers. However, it is difficult to directly compare different researches using different phytogenic applications because the effectiveness of these applications will additionally depend on factors such as species, composition, administration dose, method and frequency of application, environmental stress factors and bird age (Hippenstiel *et al.*, 2011). Ahmed *et al*., (2020) reported the body weight was increased with the increase in dietary peppermint leaves (linear, $P < 0.001$) and menthol concentrations (linear, quadratic, ($P < 0.01$) at 21 and 35 Day of age supplementations of peppermint

leaves or menthol in different concentrations to broiler diet significantly increased body weight and daily-body weight gain compared to control groups, proving that peppermint has an imperative effect on the conversion of digested feed into body gain.

Nematollah *et al*., (2017) reported that, in the grower period, a significant growth promoting effect was detected from 4.5 g/kg peppermint powder than the control group. Significant differences were seen among 3 g/kg, 4.5 g/kg, and 6 g/kg peppermint powders when compared with the control treatment in the finisher period improvement in feed conversion ratio of birds kept on a diet containing 4.5 g/kg peppermint powder the results showed that peppermint powder had an effect on the weight of heart, liver, gizzard, and abdominal fat in broilers. Data showed that there was significant difference ($p \leq 0.05$) on liver weight between birds fed 3 g/kg, 4.5g/kg, and 6 g/kg peppermint powder compared to the control group. Habek mint was used by Al-Ankari *et al*., (2004), noted the effect of it is incorporation in basel diet of broiler on over all performance and immunity of the bird. The results of the study showed that, including 150g habek/kg broiler diet make asignificant improvement in the meant body weight, dialy average gain, feed intake and feed conversion. In studied the performance of broiler fed diets supplemented with dry peppermint (*Menthe Piperita* L.) By Galib, (2010), the results appeared improvement in performance traits for all treated groups compare with the control group.

2.5 Halfa Essential oil

Halfa-bar, One species is C. proximus (common names: Halfa bar or Maharaib), strongly aromatic common grass (El Askary *et al*., 2003). The plant is acommon weed with astrong aromatic odour grows in southern Egypt and northern Sudan (Boulos, 1999). It grows in sandy soil and dry rejon. It planted by seed or seedling. *Cymbopogon proximus*, a member from the lemon-grass genus, also known as gavatichaha in the Marathi language (gavat = grass; chaha = tea) (Soenarko, 1977). *Cymbopogon* are plants with many species known for

their high essential oil Content are widely distributed throughout the tropical and subtropical regions of Africa Asia, ,and America (Avoseh *et al* ., 2015). Dutta, (1982); Ganjewala *et al*., (2008) reported that, *Cymbopogon* (Poaceae) represents an important genus of about 140 species.

Anand, (2010) reported between the several aromatic species belonging to the genus *Cymbopogon* the most important in terms of essential oil production are *C. flexuosus* (East Indian lemongrass), *C. citratus* (West Indian lemongrass), and *C.winterianus* (citronella). Also, known to produce essential oils are *C.proximus* Stapf, (Halfa bar) and *C. nervatus* (Hochst) Chiov.

Selim, (2011) demonstrated *C proximus* stapf is spread in Central and Northern Sudan and in Egyptian desert and the sandy coast of the Red Sea on the southern boundaries of Egypt. Halfabar (familyGrammineae) is a perennial plant, grow up word in a form of collected branches, red flowers and small capsules carrying seeds, with along and thin leaves, common weed (Batanouny *et al*., 1999).

2.5.1 Halfa Bar Essential oil properties:

Halfa bar possesses many biological properties, including hypoglycemic, antipyretic, bronchodilation, antibacterial, anticonvulsant, and antiemetic activities (El-Nezhawy *et al*., 2014). The extracts of halfa bar have been shown to have anti-inflammatory, antioxidant and antiapoptotic properties (Warrag *et al*., 2014).

Additionally beneficial pharmacological efects of Cymbopogon spp in vivo and in vitro studies including anticancer, anti-inflammatory, cardioprotective, antioxidant, antidiabetic, anticholinesterase, antibacterial and antifungal properties (Ganjewala, 2009; khan *et al* ., 2018). Also, the volatile oil of halfa bar showed larvicidal, ovicidal, and antioxidant activities (Minute *et al*., 2000).

Abdel-moneim et al., (1969); Ahmed *et al*., (2014) noted Halfa bar extracts possess produces relaxation of the smooth muscle fibers and valuable antihypertensive activity. Radwan, (1975); Al-Taweel *et al*., (2013) reported

Bioactivity-assisted Fractionation of the *C. proximus* extracts led to the isolation of an active sesquiterpene, proximadiol which was found to have antidiabetic activity.

Halfa bar essential oil also was found to possess abronchodilator activity mediated via antagonizing both serotonin receptors and histamine Altaweel *et al*., (2013), furthermore, halfa bar essential oils a mild anti-inflammatory activity and significant ganglionic blocking action.

2.5.2 Composition of halfa bar oils

Phytochemical compositions of halfa bar are Terpenes, carbohydrate, tannins, flavonoids, saponins, alkaloids, and phenolic glycosides which are found in the aqueous extract C. Proximus (Ibrahim and El-Khateeb 2013).. Leaves (dried leaves) are an important part of plant contain volatile oil from 0.4-o.7% (Batanouny *et al*., 1999*)*.A high percentage of the oil found before flowering and low percentage of the oil found at maturity of seed. Selim, (2011) also, noted the chemical composition of *C. proximus* from Egypt was investigated using GC/MS (Gas chromatography-mass spectrometry) system. A total of 19 constituents representing 95.47% of the oil were identified. Piperitone (72.44%), elemol (9.43%), α - eudesmol (4.34%), limonene (2.45%) and β-eudesmol (1.26%) were the main components comprising 88.92% of the oil. Terpenes, tannins, saponins, alkaloids, flavonoids, carbohydrate or glycosides, and phenolic glycosides are the phytochemical compositions which are found in the aqueous extract of *C. proximus* (Ibrahim and El-Khateeb, 2013). In addition GC/MS analysis of the oil samples obtained from Borkino Faso and Sudan showed significant differences. Piperitone was identified as amajor component in samples from Borkino Faso while those of Sudan were free from that compound (Minut *et al*., 2000), the volatile oil showed ovicidal, larvicidal and antioxidant activities (Minut *et al*., 2000). The literature lacks data about the pharmacological effect of the oil on different organs.

2.5.3 Uses of halfa bar oils:

Cymbopogon proximus (Family Poaceae) is a traditional medicinal Sudanese plant commonly known as “Mahareb”, which is used in folk medicine (Eltahir and Ereish, 2010). The plant widely used as an effective renal antispasmodic and diuretic (Batanouny *et al*., 1999).

Cymbopogon proximus usually used in the expulsion of renal and ureteric calculi (Evans *et al*., 1982). Halfa bar used for the treatment of nervous and gastrointestinal disturbances, anxiety andagitation. The petroleum ether extract of*Cymbopogon proximus* proved to have unique antispasmodic characteristics (Radwan, 1975). Halfa-bar acted through relaxation of the smooth muscle fibers without abolishing the propulsive movement of the tissue, thus, it is usually used in the expulsion of renal and ureteric calculi (Evans *et al*., 1982).

The use of *Cymbopogon* species in traditional medicine and uses in pharmaceutical, cosmetics, food and flavor, and agriculture industries is reported.

Several illnesses, such as coughs, fever, infections, cancer, and digestive disorders have reportedly been treated using various species of Cymbopogon world wide (Dutta *et al*., 2016). This herb is recommended for medical purposes as an effective diuretic, renal or abdominal antispasmodic agent.

2.5.4 Effect of halfa oil in poultry diet:

Amal *et al.*, (2013) reported addition of extracted from halfa bar oil (HBO) in the broiler diets improved the feed intake. HBO when added as growth promoter in broiler diets has a similar effect as that with antibiotic without any adverse effects. Supplementation of HBO extracted in the diets of broiler increased body weight gain and resulted in economical benefits (Amal *et al.*, 2013). Broiler diets containing extract of HBO improved Feed conversion ratio and resulted in economical benefits.

CHAPTER THREE

MATERIALS AND METHODS

The studies comprises four experiments to evaluate the effect of different levels of mixed essential oils extracted from different sources on broiler diets: Fennel and Spearmint mixed Essential Oils (1:1), Fennel and Halfa bar mixed Essential Oils (1:1), Spearmint and Halfa bar mixed Essential Oils (1:1) and Fennel and Spearmint and Halfa bar mixed Essential Oils (1:1:1), the experiments were carried out at experimental farm of Department of Animal Production, College of Agricultural Studies, Sudan University of Science and Technology, Shambat Khartoum North, during 19 /1 to 23 /2/ 2019. The ambient temperature ranged between 20 – 26c (**appendix 1**).

3.1 Experiment (1):

Response of broiler chicks to different levels of Fennel and Spearmint mixed Essential Oils:

3.1.1 Experiment chicks:

A total number of (96) one day old unsexed commercial broilers of Cobb strain were brought from Mico (Dajin Breeder Company) and transported to student poultry premises, Sudan University of Science and Technology, college of Agricultural Studies, Department of Animal Production. At the end of period of adaptation (five days), all chicks of experiment were weighed the average of initial weight is185 gram/chick. After that chicks were distributed randomly into four experimental groups A, B, C and D in a complete randomized design with three replicates each group content 8 chicks.

Chicks in hatchery were vaccinated against Newcastle disease (ND) and against Infechious Bronchitis disease (IBD) by (ND+IB) spray day one, inactivated ND injection and Gumbobest injection day one. On farm chicks also vaccinated against Gumboro disease by Bur 706- France at (11) days of age, and against Newcastle disease by Avinew –France at (18) days of age. The

vaccine also gave at (22) and (28) days of age for Gumboro disease by Bur (706 –France) and for ND by Avinew – France. Soluble multivitamin compounds AD3 (pantominovite – pantexHoland and B.V. 5525 ZG DuizelHoland) given to chicks three days before and after vaccination to prevent from stress.

3.1.2 Housing:

The experimental house was semi closed alongside of east –west direction. Dimensions of house were 25 m. length, 8.8 m. width and 3.05 m height. The roof was Designed of trapezoid corrugated aluminum sheet and was isolated of 100mm glass wool with thermal conductivity of 0.04 w/m^2, the sides of wall (northern and southern) of the house were building from red blocks upload high to the level of 0.69 m. the house was equipped with adjustable side wall curtains to control the flow of air into the house. The top and bottom of the curtain opening was equipped with a curtain rod to minimized draft when fully closed. The floor was tightly concreted.

Mechanical airing system was used in the house to generate on one direction air flow to provide the require ment levels of uniformity of air distribution over wide range of climatic condition. two exhaust fan, (fan diameter 1.29 with air 44500 m^2/h) put on middle of the western side, wall were to maintain negative pressure inside the house as a result of negative pressure outside air flows into the house through inlet opening with cellulose pad besides maintaining the desired temperature and ventilations inside also an outlet on the roof was required to exit surplus heat, gases, moisture and supply fresh air

Cooling system was evaporative cooling panel comportment , the cooling pad banks dimensions were (4 m. long ×1.4 m. length ×0.15 width) and that of air inlet valve was 0.45 m. the cooling pad was situated of the at two sides , north and south direction at the rear of the poultry house.

Cooling pad was made of specially impregnated cellulose paper of wait ability, arranged in self-supporting structure that guaranteed long life without sagging or deterioration.

The other integral components provided with each pad cooling bank were pump, polyester, water tank capacity (1000 liters). For storage of water which was continuously supplied from main tap water under control of flouter which was put in the tank also there was one horse power electrical motor for pumping water from the tank to the top of pad cooling banks.

There was piping system for supply and return of water, the cooling and humidification of outside air is obtain by evaporation of very fine water particles. Due to negative pressure maintained by the exhaust fans air flow through the pad and then through special air inlet to the house.Special geometry of the pads enables the air to pass through small opening or flutes in turbulent state .thus creating ideal condition for maximum evaporation and consequently maximum cooling to take place as a result of the layer contact area between water and air (excess water is returned to the bank where it is pumped to the top edge of the pad for r-circulation. The temperature inside the house was maintained at 27-30c throughout the experimental period.

Experiments 20 pens (1.5 ×1 m.) were prepared using wire mesh portioned and then were cleaned washed and disinfected by formalin and white phenol solution.

Before start the experiment allayer of wood shairy (5cm) thick was laid on the floor as littler material. Each pen was provided by (5 kg) rounded feeder and (2.5 lit) baby drinker which were adjusted to the progressive growth of chicks.

The light program was 24 hours light from 1-3 days and 23 hours day for the rest period.

3.1.3 Experimental diets:

Fennel(dried seed) used in this experiment was purchased from Elwhda market Khartoum state, Spearmint was purchased from farm in halfia in Khartoum North then prepared to oil extraction at Industrial Research Center, Khartoum North by the method of hydro distribution. Four Experimental ration were formulated (A,B,C and D) group A (control experimental diet) fed on

control diet only, chicks on other group B, C and D were fed on control diet supplemented with mixed of Fennel and Spearmint essential oils (200, 400, 600mg/kg) respectively.

Feed remaining in feeders was weighed and removed at the end of each week, this feed was not taken in account for intake calculation. Feed intake (g) and weight gain (g) were recorded weekly.

Feed conversion ratio (FCR) = total feed intake / total body weight gain.

Control experimental ration will be formulated to meet the nutrient requirements of broiler chicks according to NRC (1994).

The ingredients percent composition and the calculated chemical composition of the experimental control diet were presented in table (1) and (2). Experiment diets were fed for 5 weeks.

Table 1 Formulation of control diet ingredients

Ingredients	%
Dura	64.289
Ground nut cake	12
Sesame cake	17
Broiler concentrate	5
Dicalcium phosphate	0.618
Oyster shell	0.487
Lysine	0.243
Methionine	0.113
Salt	0.25
Total	100

*Broiler concentrate: ME 2122 kcal/kg, crude protein 40%, crud fiber 1.5, calcium 6.8%, phosphorus av. 4.6%, phosphorus tot. 3%, lysine 1.5%, methionine 5.6%, methionine + systin 6.25%, Sodium 2.60%, vitamin A: 200.000I.U/Kg, vit. E: 500mg/Kg, vit. B1: 40mg/Kg, vit. B2: 100 mg/Kg, vit. B6: 50mg/Kg, vit. B12: 300mg/Kg, vit. C 400mg/kg, Biotin: 1000mg/kg, Nicotinicacid: 600mg/kg, Folicacid: 30mg/kg, vit. K30mg/kg, pantothenic acid: 150mg/kg; choline chloride: 30000mg/kg, copper 200mg/kg, iodine 15mg/kg, Cobalt: 12mg/kg, selenium: 5mg/kg, manganese: 1200mg, zinc: 800mg/kg, iron1000mg/kg, B.H.T.:900mg/kg, Salinomycin-Na: 1.200, phytase: 16 and 1500 FYT antioxidant added.

Table 2 Calculated of experimental control diet

Ingredients	Values
ME/Kcal	3111.o26
NFE	58.86
Crude protein	22.802
Crude fiber	4.o99
Lysine	1.393
Methionine	0.597
Calcium	1.176
Phosphor	0.766

Calculated according to (Ellis, 1981; Kuku Bulletin)

Table 3 Chemical composition of control diets

Components	%
Dry Matter %	94.00
Moisture %	6.00
Ash %	4.60
Crude Protein %	23.19
Crude Fiber %	4.35
Ether Extract %	3.00

(Kuku Research Center Laboratory)

3.1.4 Data collected

3.1.4.1 Performance data

All group of chicks were weekly weighted (feed consumption /gram average body weight gain/gram, and feed conversion ratio) throughout experimental Period. Health of the experimental stock was carefully noticed.

3.1.4.2 Slaughter procedure and data:

At the end of the experimental period the rations were removed and the chicks were fasted over night with only water allowed. Three birds of identical live body weight were choosed randomly from each treatment group then put markers in one feet of each chick after that weighed individually before slaughter by severing the right and left carotid and jugular vessels, trachea and esophagus. After bleeding they were scalded in hot water, feather removed, Head was removed closed to skull, feet and shanks were removed at the hock joint.

3.1.4.3 Carcass data:

The visceral organs (heart, liver, gizzard, abdominal fat and intestine) were removed and weighed individually and were expressed as a percentage of live weight. Also head and neck were removed and weighted of each chicken, hot carcasses were weighed after cleaned by water to calculate the dressing percentage and put in bags in deep freezer.

Carcasses were prepared for analysis by dividing in to wright and left sides by mid sawing along the vertebral column and each side was weighed. The left side was divided in to three commercial cuts, breast, thigh, and drumstick, each cut was weighed separately, and deboned, after that the meat and bone for each separately cut were weighed .finally the meat samples were frozen and stored for meat analysis.

3.1.4.4 Blood serum profile:

Blood samples taken from jugular veins. Serum prepared from the blood analyzed for concentration of metabolites total protein, albumin, cholesterol, cholesterol HDL, cholesterol LDL, triglycerides, glucose, urea, uric acid, creatinine, enzyme activities ALP, AST and minerals (Ca, P).

3.2 Experiment (2):

Response of broiler chicks to different levels of fennel and halfa bar mixed Essential Oils:

3.2.1 Experiment chicks

The same number and programs used in first experiment.

3.2.2 Housing:

The house was similar to depicted in the experiment one.

3.2.3 Experimental diets:

Halfa bar was purchased from Elwhda market then prapation to oil exteraction at Industrial Research Centre/Khartoum North by the method of hydro- distribution. Fennel oil used in this experiment the same user in the previous experiment one, then four Experimental ration were formulaed (A, B, C and D) group A or control experimental diet fed on basal diet only, chicks on group B, C and D were fed on control diet supplemented with mixing of Fennel and Halfa bar essential oils (200,400,600mg/kg) respectively.

3.2.4 Collected Data

Performance, slaughter and carcass data, blood serum, enzyme activities, metabolic indicator and minerals conforming to experiment one.

3.3 Experiment (3):

Response of broiler chicks to different levels of mint and halfa bar mixed Essential Oils:

3.3.1 Experiment chicks

The same number and programs used in first experiment.

3.3.2 Housing:

The house was similar to depicted in the experiment one and two.

3.3.3 Experimental diets:

Spearmint oil and halfa oil used in this experiment were same user in the previous experiments one and two, then four Experimental ration were formulated (A, B, C and D) group A or control experimental diet fed on basal diet only, chicks on group B, C and D were fed on control diet supplemented with mixing of Spearmint and halfa bar essential oils (200, 400, 600 mg/kg) respectively.

3.3.4 Collected Data:

Performance, slaughter and carcass data, blood serum, enzyme activities, metabolic indicator and minerals conforming to experiment one

3.4 Experiment (4):

Response of broiler chicks to different levels of Fennel, Spearmint and Halfa bar mixed Essential Oils:

3.4.1 Experiment Chicks:

The same number and programs used in first experiment.

3.4.2 Housing:

The house of experiment was similar to depicted in the experiment one.

3.4.3 Experimental diets:

Fennel, Speaemint and Halfa Bar oils used in this experiment were same user in the previous experiments one and two, four Experimental ration were formulaed (A, B, C and D) group A or control experimental diet fed on basal diet only, chicks on group B, C and D were fed on control diet supplemented

with mixing of Fennel, Spearmint and Halfa Bar essential oils (200,400,600mg/kg) respectively.

3.4.4 Collected Data:

Performance, slaughter and carcass data, blood serum, enzyme activities, metabolic indicator and minerals conforming to experiment one

3.5 Methods of Analysis:

3.5.1 Method used for meat quality assessment:

3.5.1.1 Subjective Meat Quality Attributes:

3.5.1.1.1 The taste panle:

Frozen deboned breast drumstick and thigh cuts of the right side were thawed at 5-7℃ before cooking for sensory evaluation. The meat was trapped in aluminum foil, placed in roast pan and cooked at 180.7℃ in the conventional preheated electrical oven to about 80 ℃ internal muscle temperature. The cooked meat was allowed to cool to room temperature in about 10 minutes. The samples were kept warm until served. Semi trained panelists were instructed to eat crackers drink water between samples evaluated. The sensory panel evaluated the chops for tenderness, flavor, color, and juiciness using an eight-point scale, (Hawrysh *et al*., 1980) **appendix 2**

3.5.2 Chemical methods:

3. 5.2.1 Serum determination;

Venous unheparition blood samples took from chicks then were centrifuged at 3000 r. p. m. for 5 minutes and were stored at -20C. After that the serum analyzed in the National Public Health Laboratory Chemical Pathology (STAK), by Biosystem a 25, made in Germany. Quality system certified according to EN ISO 13485 and EN ISO 9001 standards.

Procedure of system:

-Full automated biochemical analyzer.

-Well prepared sample and reagent.

-Well calibrated and controlled analyzer.

-Insert patient sample and code number.

-Select tests and click on the position in the bottom.

-Better to use test tube rather than cubs.

-Click on accept and then click start.

-Analyze by batch not by individual sample.

-For result click on current state (result) then print.

Reagents preparation:

Reagents are prepared to use for measurements of serum samples, kits provided by Bio Systems S.A. Costa Brava, 30.08030 Barcelona (Spain).

3.5.2.1.1 Total protein:

Protein in the sample reacts with copper (II) ion in alkaline medium forming a coloured complex that can be measured by spectrophotometry.

Composition:

A. Reagent, Copper (II) acetate 6 mmol/L, potassium iodide 12 mmol/L, sodium hydroxide 1.15 mol/L, detergent.

Corrosive (C): R34: Causes burns. S26-45: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. In case of accident or if you feel unwell, seek medical advice immediately.

S. Protein Standard. Bovine albumin. Concentration is given on the label. Concentration value is traceable to the Standard Reference Material 927 (National Institute of Standards and Technology. USA).

Storage:

Reagent (A): Store at 15-30C.

Protein standard (S): Store at 2-8C, once opened.

Reagent and Standard are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagent: Presence of particulate material, turbidity, absorbance of the blank over 0.150 at 545 nm.

-Standard: Presence of particulate material, turbidity.

3.5.2.1.2 Aspartate Amino Transferase (Glutamyl Oxaloacetic Transaminase) (AST/GOT):

Principle of the method:

Aspartate amino transferase (AST or GOT) catalyzes the transfer of the amino group from aspartate to 2-oxglutarate, forming oxalacetate and glutamate. The catalytic concentration is determined from the rate of decrease of NADH, measured at 340 nm, by means of the malate dehydrogenase (MDH), coupled reaction

$$\text{Aspartate} + \text{2-Oxoglutarate} \xrightarrow{\text{AST}} \text{Oxalacetate} + \text{Glutamate}$$

$$\text{Oxalacetate} + \text{NADH} + H^{+} \xrightarrow{\text{MDH}} \text{Malate} + NAD^{+}$$

Composition:

A. Reagent: 5 x 40 mL. Tris 121 mmol/L, L-aspartate 362 mmol/L, malate dehydrogenase > 460 U/L, lactate dehydrogenase > 660 U/L, pH 7.8.

   WARNING: H315: Causes skin irritation. H319: Causes serious eye irritation. P280: Wear protective gloves/protective clothing/eye protection/face protection. P305+P351+338: IF IN

   EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. P332+P313: If skin irritation occurs: Get medical advice/attention.

B. Reagent: 5 x 10 ml. NADH 1.9 mmol/L, 2-oxoglutarate 75 mmol/L, sodium hydroxide 148 mmol/L, sodium azide 9.5 g/L.

Warning: H302: Harmful if swallowed. EUH031: Contact with acids liberates toxic gas. P301+P312: IF Swallowed: Call a Poison Center or doctor/physician if you feel unwell. P330: Rinse mouth.

Storage:

-Store at 2-8C.

-Reagents are stable until the expiry date show on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, and absorbance of the blank lower the limit indicated in "Assay parameters".

3.5.2.1.3 Alkaline phosphatase (ALP) – AMP 2-Amino-2-Methyl-1-Propanol Buffer:

Principle of the method:

Alkaline phosphatase (ALP) catalyzes in alkaline medium the transfer of the phosphate group from 4-nitrophenylphosphate to 2-amino-2-methyl-1-propanol (AMP), liberating 4-nitrophenol. The catalytic concentration is determined from the rate of 4-nitrophenol formation, measured at 405 nm[1].

4-Nitrophenylphosphate +AMP $\xrightarrow{\text{ALP}}$ AMP– phosphate+ 4-Nitrophenol

Composition:

A. Reagent: 2-Amino-2-methyl-1-propanol 0.4 mol/L, zinc sulfate 1.2 mmol/L, N-hydroxy-ethyl-ethyl-enediaminetriacetic acid 2.5 mmol/L, magnesium acetate 2.5 mmol/L, pH 10.4.

B. Reagent 4-Nitrphenylphosphate 60 mmol/L.

Storage:

Store at 2-8C.

Reagents are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over 1.200 at 405 nm (1 cm cuvette).

3.5.2.1.4 Cholesterol – Cholesterol Oxidase/Peroxidase:

Principle of the method:

Free and esterified cholesterol in the sample originates, by means of the coupled reactions described below, a coloured complex that can be measured by spectrophotometry.

Cholesterol ester $+H_2O \xrightarrow{\text{Chol.esterase}}$ Cholestero1+ fatty acid

Cholesterol + $^1/_2O_2 + H_2O \xrightarrow{\text{Chol.oxidase}}$ Cholestenone $+H_2O_2$

$2H_2O_2$ + 4-Amino antipyrine + phenol $\xrightarrow{\text{Peroxidase}}$ Quinoneimine + 4 H_2O

Composition:

A. Reagent. 10 x 50 ml. Pipes 35 mmol/L, sodium cholate 0.1 U/ml, peroxidase > 0.8U/ml, 4-aminoantipyrine 0.5 mmol/L, pH 7.0.

Storage:

Store at 2-8C. Reagent is stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagent: Presence of particulate material, turbidity, absorbance of the blank over the limit indicated in "Assay parameters".

3.5.2.1.5 Cholesterol HDL:

Principle of the method:

The cholesterol from low density lipoproteins (LDL), very low- density lipoproteins (VLDL) and chylomicrons, is broken down by the cholesterol oxidase in an enzymatic accelerated non-color forming reaction. The detergent present in the reagent B, solubilizes cholesterol from high density lipoproteins (HDL) in the sample. The HDL cholesterol is then spectrophotometrically measured by means of the coupled reactions described below[1].

Cholesterol ester $+H_2O \xrightarrow{\text{Chol.esterase}}$ Cholestero1+ fatty acid

Cholesterol + $^1/_2O_2 + H_2O \xrightarrow{\text{Chol.oxidase}}$ Cholestenone $+H_2O_2$

$2H_2O_2$ + 4-Aminoantipyrine + DSBmTP $\xrightarrow{\text{peroxidase}}$ Quinoneimine + 4 H_2O

Contents and Composition:

A. Reagent. 3 x 20 mL. Goods buffer, cholesterol oxidase < 1 U/mL, peroxidase < 1 U/mL, N, N-bis (4-sulfobutyl)-m-toluidine (DSBmT) 1 mmol/L, accelerator 1 mmol/L.
B. Reagent. 1 x 20 mL. Goods buffer, cholesterol esterase < 1.5 U/mL, 4-aminoantipyrine 1mmol/L, ascorbate oxidase < 3.0 KU/L, detergent.

Storage:

Store at 2-8C.

Reagents are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration: Presence of particulate material, turbidity.

3.5.2.1.6 Cholesterol LDL:

Principle of the method:

A specific detergent solubilizes the cholesterol from high density lipoproteins (HDL), very low- density lipoprotein (VLDL) and chylomicrons. The cholesterol esters are broken down by cholesterol esterase and cholesterol oxidase in a non-color forming reaction. The second detergent, present in the reagent B, solubilizes cholesterol from low density lipoproteins (LDL) in the sample. The LDL cholesterol is then spectrophotometrically measured by means of the coupled reactions described below.

Cholesterol ester $+H_2O \xrightarrow{\text{Chol.esterase}}$ Cholestero1+ fatty acid

Cholesterol $+ {}^{1}/_{2}O_2 + H_2O \xrightarrow{\text{Chol.oxidase}}$ Cholestenone $+H_2O_2$

$2H_2O_2$ + 4-Aminoantipyrine + DSBmT $\xrightarrow{\text{Peroxidase}}$ Quinoneimine + 4 H_2O

Contents and Composition:

A. Reagent. 3 x 20 mL. MES buffer > 30 mmol/L, cholesterol esterase < 1.5 U/mL, cholesterol oxidase < 1.5 U/mL, 4-aminoantipyrine 0.5 mmol/L, ascorbate oxidase < 3.0 U/L, peroxidase > 1 U/mL, detergent, pH 6.3.
B. Reagent. 1 x 20 mL. MES buffer > 30 mmol/L, 1mmol/L, detergent, pH 6.3.

Storage:

Store at 2-8C.

Reagents are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration: Presence of particulate material, turbidity

3.5.2.1.7 Urea /Bun-UV (Urease/Glutamate Dehydrogenase):

Principle of the method:

Urea in the sample consumes, by means of the coupled reactions described below, NADH that can be measured by spectrophotometry.

$$\text{Urea} + H_2O \xrightarrow{\text{urease}} 2NH_4^+ + CO_2$$

$$NH_4^+ + \text{NADH} + H^+ + \text{2-oxoglutarate} \xrightarrow[\text{Glutamate}]{\text{dehydrogenase}} \text{Glutamate} + NAD^+$$

Composition:

A. Reagent: 5 x 40 mL Tris 100 mmol/L, 2-oxoglutarate 5.6 mmol/L, urease > 140 U/mL, glutamate dehydrogenase > 140 U/mL, ethyl-eneglicol 220 g/L, sodium azide 0.95, pH 8.0.

   Warning: H302: Harmful if swallowed. P301 + P312: IF Swallowed: Call a Poison Center or doctor/physician if you feel unwell. P330: Rinse mouth.

B. Reagent: 5 x 10 mL, NADH 1.5 mmol/L, sodium azide 9.5 g/L.

   Warning: H302: Harmful if swallowed. EUH031: Contact with acids liberates toxic gas. P301 + P312: IF Swallowed: Call a Poison Center or doctor/physician f you feel unwell. P330: Rinse mouth.

Storage:

Store at 2-8C.

Reagents are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, and absorbance of the blank lower the limit indicated in “Assay parameters”.

3.5.2.1.8 Glucose (Glucose Oxidase/Peroxidase):

Principle of the method:

Glucose in the sample originates, by means of the coupled reactions described below, a coloured complex that can be measured by spectrophotometry[1].

$$\text{Glucose} + {}^{1}/_{2}\ O_2 + H_2O \xrightarrow{\text{glucose oxidase}} \text{Gluconate} + H_2O_2$$

$$2H_2O_2 + \text{phenol} + \text{4-Amino-antipyrine} \xrightarrow{\text{peroxidase}} \text{Quinoneimine} + 4H_2O$$

Composition:

A. Reagent 10 x 50 mL. Phosphate 100 mmol/L, phenol 5 mmol/L, glucose oxidase > 10 U/mL, peroxidase > 1 U/mL, 4-aminoantipyrine o.4 mmol/L, pH 7.5.

Storage:

Store at 2-8C.

Reagent is stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over the limit indicated in “Assay parameters”.

3.5.2.1.9 Calcium – Arsenazo (Arsenazo III):

Principle of the method:

Calcium in the sample reacts with arsenazo III forming a coloured complex that can be measured by spectrophotometry[1].

Composition:

A. Reagent 10 x 50 ml. Arsenazo III 0.2 mmol/L, imidazole 75 mmol/L.

Storage:

Store at 2-8C.

Reagent is stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity.

3.5.2.1.10 Phosphorus (Phosphomolybdate/UV):

Principle of the method:

Inorganic phosphorus in the sample reacts with molybdate in acid medium forming phosphomolybdate complex that can be measured by spectrophotometry.

Contents and composition:

A. Reagent: 4 x 60 mL. Sulfuric acid 0.36 mol/L, sodium chloride 154 mmol/L.

   DANGER: H314: Causes severe skin burns andprotective gloves/protective clothing/eye protection/face protection. P303 +361+P353: IF ON SKIN (O hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.

B. Reagent: 2 x 50 mL. Sulfuric acid 0.36 mol/L, sodium chloride 154 mmol/L.

DANGER: H314: Causes severe skin burns and eye damage. P280: Wear protective gloves/protective clothing/eye protection/face protection. P303 +361+P353: IF ON SKIN (O hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.

Storage:

Store at 15-30C.

Reagent are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over 0.500 a 340 nm.

3.5.2.1.11 Uric Acid (Uricase/Peroxidase):

Principle of the method:

Uric acid in the sample originates, by means of the coupled reactions described below, a coloured complex that can be measured by spectrophotometry[1, 2].

Uric acid + O_2 + H_2O $\xrightarrow{\text{uricase}}$ Allantoin + CO_2 + H_2O_2

$2H_2O_2$ + 4-Aminoantipyrine + DCFS $\xrightarrow{\text{peroxidase}}$ Quinoneimine + $4H_2O$

Composition:

A. Reagent. 10 x 50 mL. Phosphate 100 mmol/L, detergent 1. g/L, dichloro-Phenol-sulfonate 4 mmol/L, uricase > 0.12 U/ml, ascorbate oxidase > 5 U/mL,

Peroxidase > 1 U/mL, 4-aminoantipyrine 0.5 mmol/L, pH 7.8.

Storage:

Store at 2-8C.

Reagents are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over the limit indicated in “Assay parameters”.

3.5.2.1.12 Albumin (Bromocresol Green):

Principle of the method:

Albumin in the sample reacts with bromocresol green in acid medium forming a coloured complex that can be measued by spectrophotometry[1].

Composition:

A. Reagent. 5 x 50 mL. Acetate buffer 100 mmol/L, bromocresol green 0.27 mmol/L, detergent, pH 4.1.

Storage:

Reagent (A): Store at 2-8C.

Reagent is stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over the limit indicated in “Assay parameters”.

3.5.2.1.13 Creatinine (Alkaline Picrate):

Principle of the method:

Creatinine in the sample reacts with picrate in alkaline medium forming a coloured complex. The complex formation rate is measured in a short period to avoid interferences.

Composition:

A. Reagent. 5 x 50 mL. Sodium hydroxide 0.2 mol/L, detergent.
   Irritant (Xi): R36/38: Irritating to eyes and skin. S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S37/39: Wear suitable gloves and eye/face protection.
B. Reagent. 5 x 50 mL. Picric acid 25 mmol/L.

Storage:

Store at 2-8C.

Reagent is stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over 0.350 at 500 nm (1 cm cuvette).

3.5.2.1.14 Triglycerides (Glycerol Phosphate oxidase/peroxidase):

Principle of the method:

Triglycerides in the sample originates, by means of the coupled reactions described below, a coloured complex that can be measured by spectrophotometry.

$$\text{Triglycerides} + H_2O \xrightarrow{\text{lipase}} \text{Glycerol} + \text{Fatty acids}$$

$$\text{Glycerol} + \text{ATP} \xrightarrow{\text{glycerol kinase}} \text{Glycerol -3- P} + \text{ADP}$$

$$\text{Glycerol} - 3\text{- P} + O_2 \xrightarrow{\text{G-3-P-oxidase}} \text{Dihydroxyacetone-p} + H_2O_2$$

$2H_2O_2$ + 4-Aminoantipyrine+ 4- Chlorophenol $\xrightarrow{\text{peroxidase}}$ Quinoneimine + $4H_2O$

Composition:

A. Reagent: 10 x 50 mL. Pipes 45 mmol/L, magnesium chloride 5 mmol/L, 4-chlorophenol 6 mmol/L, lipase > 100 U/mL, glycerol kinase > 1.5 U/mL, glycerol-3-phosphate oxidase > 4 U/mL, peroxidase > 0.8 U/mL, 4-aminoantipyrine 0.75 mmol/L, ATP 0.9 mmol/L, pH 7.0

Storage:

Store at 2-8C.

Reagent is stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:

-Reagents: Presence of particulate material, turbidity, absorbance of the blank over

The limit indicated in "Assay parameters".

3.5.2.2 Meat Chemical Analysis:

The Approximate chemical analysis of meat samples was carried out at Animal Production Research, Animal nutrition Laboratory Kuku according to (AOAC 1995).

3.5.2.2.1 Determination of Moisture and Dry Matter:

Principle

Moisture as removed from the samples by heating at 105℃ in a force – draught Oven for 3 hour or overnight.

Calculation**:**

$$\% \text{ moisture} = \frac{(\text{WT of original sample + dish}) - (\text{dried sample + dish})}{(\text{WT of original sample "5 gm"})} \times 100$$

Or

% moisture= 100 - % dry matter

$$\% \text{ dry matter} = \frac{(\text{WT of dried sample + dish}) - (\text{WT of dish})}{(\text{WT of original sample "5 gm"})} \times 100$$

3.5.2.2.2 Determination of total nitrogen (Crude Protein):

Principle:

Total nitrogen is determined using the kjeldhal method. Organic nitrogen is converted in to ammonium ions by digestion with concentrated sulphuric acid in the presence of a catalyst such as a mixture of copper sulphate with selenium.

As the digestion proceeds, some of sulphuric acid is reduced to sulphur dioxide which in turn reduces the nitrogenous material to ammonia. The ammonia combines with sulphuric acid to form ammonium sulphate. Amonia is liberated by boiling with sodium hydroxide, steam distilled in to boric acid plus indicator and determined by titration

Reagent:

Concentrate Sulphuric acid.

Catalyst (Copper sulphat+selenium).

Sodium hydroxide solution 50%.

Standard solutionof ammonium sulphate.

Standard acid 0.01 N -HCL.

Boric acid+ bromocresol green/methyl red indicator solution.

Calculation:

$$\text{Titrate} - \frac{\text{Blank}}{\text{Stander-Blank}} \quad \frac{75\ \text{ml}}{3\text{ml}} \quad \frac{1}{0.5\text{g}} \quad \times \quad \frac{1}{1000}$$

3.5.2.2.3 .Determination of Ash and Organic Matter:

Principle:

The sample is ignited at 500-550 ℃ to burn off all organic material. The inorganic material which does not volatilize at that temperature is called ash. The difference between sample and ash gives the organic matter.

Calculation:

$$\%\ \text{Ash} = \frac{(\text{WT. of Ash + dish}) - (\text{WT. of dish})}{(\text{WT. of original sample})} \times 100$$

% organic matter = 100 - % Ash.

Nitrogen free Extraction (N.F.E).

%N.F. E= (100- (Moist + Ash + Crude fat + crud protein + Crude fiber).

3.5.2.2.2 The determination of Crude Fat (soxhlet)

3.5.2.2.4 The Determination of Crude Fat (Soxhlet):

Principle:

The sample is extracted with petroleum spirit, the solvent is distilled off and the extract dried and weighed.

Reagent:

Petroleum spirit, boiling point (60-80 ℃).

Calculation:

$$\%\text{Crude fat} = \frac{\text{WT. of flask +oil - WT. of flask}}{\text{WT. of original sample (2.5)}} \times 100$$

*The approximate chemical analysis of ration samples was carried out at Animal Production Research, Animal nutrition Laboratory Kuku according to (AOAC 1995), the method simlirly the approximate chemical analysis of meat sample.

3.6 Essential oils preparation method:

The essential oils (Fennel, Spearmint and Halfa bar) were extracted at Industrial Research Centre Khartoum North. Prepared using the water and steam distillation method, in which the plant material and water are both found in the retort, but a perforated grid is used to separate the two.

A suitable amount of the plant material was placed in the retort on the perforated grid, and the water was placed below the perforated grid. Then the retort was heated using a gas burner .the steam evolved from the boiling water released the essential oil and which travelled with the steam up and into a condensation tube where the steam condensed to form a liquid phase that poured into the separate chamber, where the aqueous and essential oil phases were separate according to their density. The less dense than water were skimmed off the top and vice versa for the heavier oil.

*Essential oil should be stored in air- tight aluminum containers and stored in cool, dark place.

*All the mixing oils were analyzed to determine chemical component of oils in Forensic Evidence lab using GC/MS (Gas chromatography-mass spectrometry) system.

3.7 Method of analysis of essential oils by GC/MS (Gas chromatography-mass spectrometry) system:

Essential oils are also known as volatile oils. GCMS testing makes use of this property (the volatility of essential oils) in order to separate and identify the different constituents with in a sample. The technique of GC (Gas chromatography) first separates the essential oils mixture into individual molecules. The technique of Mass Spectrometry (MS) then detects what each of these molecules are, along with their relative proportions. The resulting spectrum in a report is essentially (fingerprint) of the chemical makeup of the essential oil.

The GC element of the analysis, consists of a stationary phase and mobile phase. The stationary phase is simply along, coiled tube that is coated with a highly stable liquid that does not move. Running through this tube is also an inert carrier gas. As the gas is moving, it is known as the mobile phase. When an essential oil sample is injected, it first gets vaporized. The various molecules then start moving though the tube. The combination of the mobile and stationary phases together therefore effectively separates the different constituents based on their volatility.

The GC records how long it takes for each constituents to reach its detector. Once a detection is made, a peak can be seen on the resulting gas chromatogram (graph).

The separated compound then enter the mass spectrometer, where they are hit by a beam of electrons. The electrons break up the essential oil compounds further into positively charged fragment. The fragment (ions) are accelerated in

an electric field and deflected using magnetic field to produce a mass spectrum. By comparing the mass spectrum with a database containing the patterns of known samples, the identity of each original molecule can be inferred.

3.8 Statistical Analysis:

The experimental design was completely randomized design (CRD). All collected data were analyzed by using the statistix 10 trial according to (Statistix 2013), the analysis of variance (One-way ANOVA), was used to compare between the groups. Performance data of four experiments were analyzed by using factorial two way- ANOVA for determine the interaction between treatments and their levels.

CHAPTER FOUR

RESULTS

4.1 Response of broiler chicks to graded levels of fennel and Spearmint mixed Essential Oils (FSMEOs):

The chemical constituent of (FSMEOs) presented in table (4).

Results showed 8compounds: Aromandendrene, 2-cyclohexen-1-one,3-methyl-6-(1-methyleth and Bicyclo(3,1,1)hept-3-en-one,4,6,6-trimethyl represented the main compounds.

Table 4 Chemical Analysis of Fennel and Spearmint mixed essential oils

No	Name	RTime	Area%	Heigh%
1	Aromandendrene	5.513	24.04	16.90
2	2-cyclohexen-1-one,3-methyl-6-(1-methyleth	5.596	0.85	1.41
3	Bicyclo(3,1,1)hept-3-en-one,4,6,6-trimethyl	5.973	28.45	16.68
4	Phenol,2-methoxy-4-(2-propenyl)-,aceteate	6.544	11.51	9.99
5	2-cyclohexen-1-01,2-methyl-5-(1-methylether	6.568	1.72	3.45
6	D-Limonene	3.325	0.40	0.71
7	Eucalyptol	3.366	0.54	0.91
8	1,4-cyclohexadiene-1-methanol,4-(methyle	6.305	0.84	1.67

*Forensic Evidence lab using GC/MS (Gas chromatography-mass spectrometry) system.

4.1.1 Growth Performance of Experimental Chicks:

The effect of feeding broiler chicks on graded levels of fennel and spearmint mixed essential oils on the performance was tabulated in table (5). There was no significant ($p \geq 0.05$) difference between all tested groups in feed intake, body weight body, weight gain and feed conversion ratio.

For feed consumption there was no significant ($p \geq 0.05$) difference between all tested groups, however, numerically lowest consumption was noticed by chicks fed on 200mg/kg oils (3305) gm, but chicks fed on control diet consumed numerically the highest feed (3428) gm amount compared to chicks fed on 400 and 600 (3366 and 3409gm) respectively.

For body weight group fed on 400mg/kg mixed essential oils recorded numerically the heaviest body weight (2177) gm and the group fed on 200mg/kg mixed essential oils showed numerically the lowest body weight (1926) gm compared to chicks fed on control diet and 600 mg/kg mixed essential oils which recorded (1943 and 2052gm) respectively.

Results for body weight gains also showed no significant ($p \geq 0.05$) difference between all tested groups, Although chicks 400mg/kg mixed essential oils recorded numerically the highest body weight gain (1989) gm and chicks fed on 200mg/kg mixed essential oils showed numerically the lowest body weight (1744) gm compared to chicks fed on control diet and 600 mg/kg mixed essential oils (1757 and 1864gm) respectively.

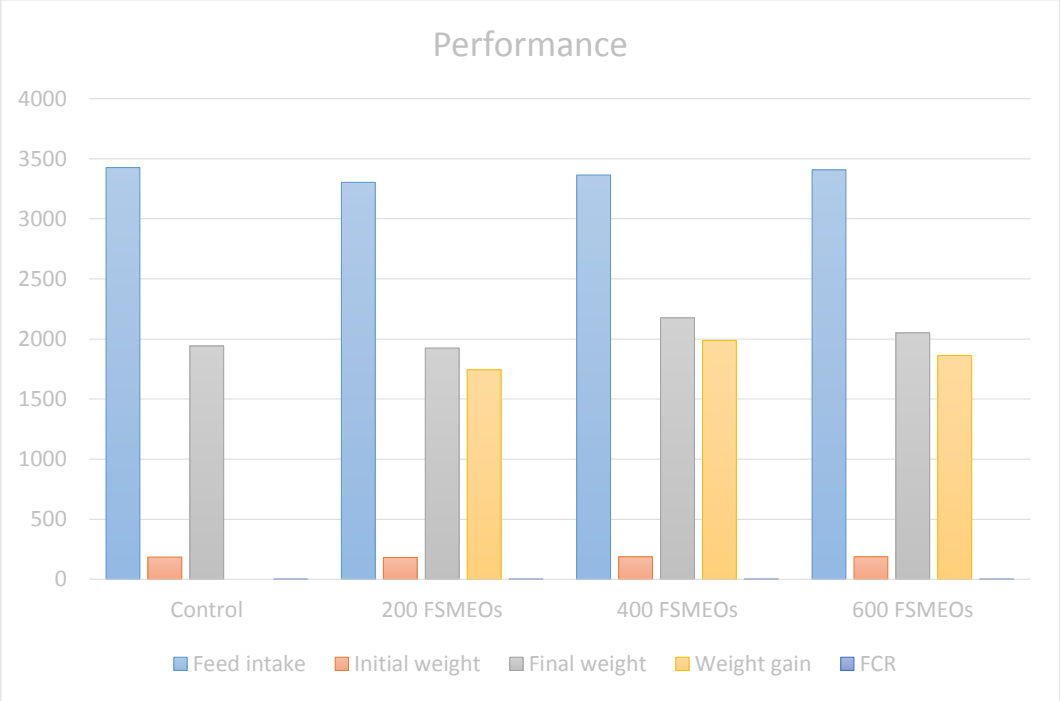
. Lastly for feed conversion ratio (FRC) there was no significant ($p \geq 0.05$) difference between all tested groups, however, group fed on 400mg/kg mixed essential oils showed numerically the best value (1.69) between all tested groups.

Table 5. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on the performance of experimtal broiler chicks

Items mg/kg	Feed intake(gm)	Initial Weight(gm)	Final weight(gm)	weight gain(gm)	FCR
Control	3428	186	1943	I757	1.95
200 FSMEOs	3305	182	1926	1744	1.90
400 FSMEOs	3366	188	2177	1989	1.69
600 FSMEOs	3409	188	2052	1864	1.87
SE±	133.57		126.90	126.90	0.1781
C.V	427.57		406.22	406.22	0.5701
L.sd 0.05	N.S	N.S	N.S	N.S	N.S

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Figure 1. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on performance of broiler chicks



4.1.2 Dressing and Giblets:

For (Dressing, intestine weight, liver, gizzard and heart) percentages, results showed no significant ($p \geq 0.05$) differences between all tested groups except for abdominal fat which recorded significant ($p \leq 0.05$) difference as shown in table(6).

For abdominal fat there was significant ($p \geq 0.05$) difference between chicks fed on control, 400 and 600 mg/kg mixed essential oils (1.067,1.233 and 1.33) respectively , whereas chicks fed 200 mg/kg mixed essential oils recorded lwoest significant($p \geq 0.05$) difference compared to other tested groups (1.067) .

4.1.3 Non Carcass Components:

As shown in table (7), results revealed no significant ($p \geq 0.05$) difference in parameters (kidney, lung, legs, neck, intestine length, back, and wing) between all tested groups except head which recorded significant effect.

Table 6. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on Dressing and Giblets of broiler chicks (%)

Item mg/kg	Dressing%	Intestine wt%	Liver%	Gizzard%	Heart%	Abdominal fat %
Control	70.31	3.80	2.05	1.55	0.51	1.07^{ab}
200 FSMEOs	70.41	3.94	1.88	1.46	0.55	0.83^{b}
400 FSMEOs	70.90	3.45	1.99	1.40	0.51	1.23^{ab}
600 FSMEOs	70.45	4.26	1.97	1.70	0.62	1.33^{a}
SE±	0.7698	0.4137	0.2147	0.1809	0.0738	0.1371
C.V	2.4642	1.3243	0.6872	0.5792	0.2362	0.4389
L.SD0.05	N.S	N.S	N.S	N.S	N.S	S

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

Table 7. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on non carcass component of broiler chicks

Item mg/kg	Kidney %	Lung%	Legs%	Neck%	Head%	Gut/cm	Back %	wing %
Control	0.37	0.73	3.62	5.19	2.55[a]	178.33	19.69	10.47
200 FSMEOs	0.41	0.55	3.64	5.16	2.17[ab]	180.00	17.48	10.23
400 FSMEOs	0.49	0.46	3.69	4.60	2.11[b]	172.67	18.96	10.35
600 FSMEOs	0.41	0.74	3.98	4.82	2.38[ab]	182.67	18.97	9.92
SE±	0.0844	0.1307	0.3417	0.4700	0.1358	3.9370	1.5366	0.9225
CV	0.2701	0.4183	1.0939	1.5045	0.4346	12.603	4.9190	2.9530
L.SD0.05	NS	NS	NS	NS	S	NS	NS	NS

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.1.4 Commercial Cuts:

The effect of graded levels of fennel and spearmint mixed essential oils on percentages of commercial cuts tabulated in table (8), results showed no significant ($p \geq 0.05$) difference between all tested groups in breast, thigh and drumstick values, however, chicks fed on 200mg /kg oils showed numerically the highest percentage value for breast (39.99) and thigh (16.09), while chicks fed on 600 mg/kg showed numerically the lowest percentage value of breast (37.21) and thigh (13.72), as compared to other tested groups.

For drumstick, chicks fed on 600mg/kg oils noted numerically the highest percentage value of weight (13.65), while chicks fed on 400mg/kg oils recorded the lowest percentage value (11.20) compare all tested groups.

Table 8. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on Commercial Cuts of broiler chick

Items mg/kg	Breast%	Thigh%	Drumstick%
Control	39.22	15.07	11.73
200 FSMEOs	39.99	16.09	12.00
400 FSMEOs	39.97	14.05	11.20
600 FSMEOs	37.21	13.72	13.65
SE±	2.7956	1.3507	0.8422
C.V	8.9492	4.3240	2.6960
L.SD 0.05	N.S	N.S	N.S

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.1.5 Meat of Commercial Cuts:

The effect of feeding of graded level of fennel and Spearmint mixed essential oils on meat percentages of commercial cuts showed in table (9).

The Result for breast meat showed that, chicks fed on 200 and 600mg/kg obtained significantly ($p \leq 0.05$) highest percentage values (88.34 and 88.51) respectively, compared to control (85.15), whereas no significant ($p \geq 0.05$) difference observed between chicks fed on 200, 400 and 600 mg/kg oils (88.34, 87.14 and 88.51) respectively, also no significant ($p \geq 0.05$) difference between chicks fed on control diet and 400 mg/kg oils (85.15and 87.14) respectively. For breast bone chicks fed on control and 600 had significantly ($p \leq 0.05$) differ (14.08 and 9.37) respectively, whereas no significant ($p \geq 0.05$) difference between chicks fed on 200, 400 and 600 mg/kg oils (10.84, 11.86 and 9.37) respectively.

Finally no significant ($p \geq 0.05$) difference showed between all tested groups in meat and bone percentages of thigh and drumstick.

Table 9. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on Meat and Bone of Commercial Cuts of broiler chicks

Item mg/kg	Breast meat%	Breast bone%	Thigh meat%	Thigh bone%	Drumstick meat%	Drumstick bone%
Control	85.15[b]	14.08[a]	84.78	14.88	72.53	26.69
200 FSMEOs	88.34[a]	10.84[ab]	82.09	14.96	71.94	27.44
400 FSMEOs	87.14[ab]	11.86[ab]	82.15	15.08	71.33	26.46
600 FSMEOs	88.51[a]	9.37[b]	83.41	15.98	72.30	25.08
SE±	0.9189	1.4520	2.4629	2.0081	2.0178	1.3252
C.V	2.9414	4.6481	7.8844	6.4283	6.4594	4.2421
L.SD0.05	S	S	NS	NS	NS	NS

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.1.6 Subjective Quality Attributes:

The Effect of fennel and spearmint mixed essential oils on Subjective Quality Attributes showed in table (10). Results revealed no significant difference ($p \geq 0.05$) between all tested groups in the scores given for using (tenderness, flavor, color and juiciness), an eight point scale, and scores given for all attributes were above the moderate acceptance.

4.1.7 Meat Chemical compositions of experimental chicks:

The effect of fennel and spearmint mixed essential oils on meat chemical compositions were illustrated in table (11). Results showed that the moisture value was significantly ($p \leq 0.05$) difference between tested groups ,the result showed that, chicks fed on diets supplemented with 600mg/kg FSMEOs recorded significantly ($p \leq 0.05$) the highest value(75.90) as compared with control and 200 mg/kg FSMEOs (73.23 and 73.80 respectively), on the contrast, chicks fed on diets supplemented with 600mg/kg FSMEOs recorded significantly ($p \geq 0.05$) the lowest value (24.10) for dry matter as compared with control, 200 and 400 mg/kg o FSMEOs (26.77, 26.20 and 25.40) respectively. Results concerning ash showed that, chicks fed on 200mg/kg FSMEOs recorded significant ($p \leq 0.05$) high concentration (1.30) as compared to all tested groups, which showed no significant difference ($p \geq 0.05$) between them. The analysis of data for crude protein showed, that chicks fed on control diet recorded significant($p \leq 0.05$) the highest value (22.58) as compared to other tested groups, followed by chicks fed on 400 (21.02) whereas, 600 (19.92) 200 (19.70) mg/kg FSMEOs obtained the lowest value of crude protein. Data collected for ether extract observed that chicks fed on control diet recorded significantly ($p \leq 0.05$) the highest value (1.38),while chicks fed on 200 and 400mg/kg FSMEOs noted significantly ($p \geq 0.05$) the lowest values (0.45 and 0.60) respectively.

Table 10. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on Subjective Quality Attributes

Items mg/kg	Tenderness	Flavor	Color	Juiciness
Control	6.10	6.10	6.32	5.85
200 FSMEOs	6.50	5.85	5.91	5.83
400 FSMEOs	6.22	5.75	6.25	6.26
600 FSMEOs	5.75	6.67	6.72	6.29
SE±	0.3070	0.0884	0.1390	0.1054
C.V	0.9827	0.2830	0.4450	4.527
L.SD0.05	NS	NS	NS	NS

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Table 11. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on Meat Chemical Composition of Experimental Broiler chicks

Items	Moisture	Dry matter	ASH	Crude protein	Ether Extract
Control	73.23^{b}	26.77^{a}	1.20^{ab}	22.58^{a}	1.38^{a}
200 FSMEOs	73.80^{b}	26.20^{a}	1.30^{a}	19.70^{c}	0.45^{c}
400 FSMEOs	74.60^{ab}	25.40^{ab}	1.05^{b}	21.02^{b}	0.60^{bc}
600 FSMEOs	75.90^{a}	24.10^{b}	1.15^{ab}	19.92^{c}	0.80^{b}
SE±	0.4534	0.4534	0.0677	0.1550	0.1066
C.V	1.4514	1.4514	0.2167	0.4962	0.3411
L.SD 0.05	S	S	S	S	S

Any two means values having same superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.1.8 Serum Enzyme and Minerals

The result showed significantly ($p \leq 0.05$) difference among all tested groups for serum enzymes and minerals table (12).

For AST chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (38.95 iu/L) followed by group of chicks fed on 400mg/kg FSMEOs (38.30 iu/L), then chicks fed on 200mg/kg FSMEOs (27.65 iu/L), while group of chicks fed on 600mg/kg FSMEOs recorded significantly($p \geq 0.05$) the lowest value (24.85
iu/L).

Result for ALP enzyme FSMEOs showed significant effect ($p \leq 0.05$). Chicks fed on control diet and 200mg/kg recorded the highest values (247.50 iu/L and 246.0 iu/L) respectively, while, chicks fed on 400 mg/kg FSMEOs noted significantly ($p \geq 0.05$) the lowest value (230.35 iu/L).

Then again, results obtained for Ca showed that chicks fed on 600mg/kg FSMEOs recorded significantly($p \leq 0.05$) the highest value (9.90 mg/dl) compared to all tested groups, while chicks fed on 200mg/kg FSMEOs showed significant ($p \geq 0.05$) the lowest value(6.70 mg/dl)

Finally experiential chicks fed on control diet obtained significantly ($p \leq 0.05$) the highest value (8.75 mg/dl) for phosphorus concentration in the serum, and the chicks fed on 400mg/kg FSMEOs recorded significantly ($p \geq 0.05$) the lowest value (5.80 mg/dl).

Table 12. Effect of Graded levels of Fennel and Spearmint mixed Essential Oils on Serum Enzymes and Minerals of Broiler chicks

Item	AST iu/L	ALP iu/L	Ca mg/dl	P mg/dl
Control	38.95[a]	247.50[a]	8.15[b]	8.75[a]
200 FSMEOs	27.65[c]	246.00[a]	6.70[d]	7.25[c]
400 FSMEOs	38.30[b]	230.35[c]	7.40[c]	5.80[d]
600 FSMEOs	24.85[d]	237.00[b]	9.90[a]	8.50[b]
SE±	0.0791	0.6288	0.1021	0.0645
C.V	0.2531	2.0130	0.3267	0.2066
L.SD0.05	S	S	S	S

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.1.9 Serum Metabolite

The effect of fennel and spearmint mixed oils showed significant difference between all treatments for serum metabolites, except createin, shown in table (13).

Total protein results showed that chicks fed on control diet recorded significantly ($p \leq 0.05$) the highest value (3.95g/dl) compared to other tested groups, followed by chicks fed on diet supplemented with 600 mg/kg FSMEOs (3.50g/dl), while chicks fed on 400 and 200 mg/kg FSMEOs recorded significantly ($p \geq 0.05$) the lowest values (2.90 and 2.65g/dl) respectively.

On the other hand the analysis of data for albumin showed that, chicks fed on 400mg/kg FSMEOs recorded significantly ($p \leq 0.05$) the highest value (2.30g/dl) compared to other tested group and chicks fed on 200 and 600 mg/kg FSMEOs which noted significantly ($p \leq 0.05$) the lowest values (1.70 and 1.85g/dl) respectively .

For uric acid, there was no significant difference($p \geq 0.05$) between chicks fed on control diet and chicks fed on 200mg FSMEOs (3.45 and 3.15 mg/dl) respectively, also, between chicks fed on 400and 600mg/kg FSMEOs (2.15 and 2.25 mg/dl) respectively.

Data obtained For urea, experimental chicks fed on control diet presented significantly ($p \leq 0.05$) the highest value (7.10 mg/dl), compared to other tested groups, While chicks fed on 400mg/kg FSMEOs showed significantly ($p \leq 0.05$) the lowest value (5.15 mg/dl), whereas, no significant ($p \geq 0.05$) different between chicks fed on 200 and 600mg/kg FSMEOs (6.10and 6.00 mg/dl) respectively.

Supplementation of fennel and spearmint mixed oils at differents levels documented significantly decreased in cholesterol value with increased of FSMEOs Supplementation in diet.

On the other hand for HDL, chicks fed on control diet showed significantly

(P ≤0.05) the highest value (130.50 mg/dl) between all tested groups while chicks fed on 600mg/kg FSMEOs recorded significantly (p ≤0.05) the lowest value (74.50 mg/dl). For LDL result revealed that chicks fed on 200mg/kg FSMEOs noted significantly (p ≤0.05) the highest value (27.05 mg/dl), compared to other tested groups, while the chicks fed on 400 mg/kg FSMEOs showed significantly (p ≤0.05) the lowest value (17.45 mg/dl), but there was no significant difference (p ≤0.05) between chicks fed on control diet and chicks fed on 600 mg/kg FSMEOs (22.50 and 23.00 mg/dl) respectively.

For serum triglyceride, groups of chicks fed on control diet and 600mg/kg FSMEOs showed significantly (p ≤0.05) the highest values (43.50 and 42.50 mg/dl) respectively, compared to other tested groups, whereas no significant difference (p ≥0.05) between chicks fed on 200mg/kg and 400 mg/kg FSMEOs (39.50and 41.00 mg/dl) respectively also chicks fed on 400mg/kg and 600 mg/kg FSMEOs (41.00 and 42.50 mg/dl respectively).

The analysis of data for serum glucose showed that chicks fed on control diet and 200mg/kg FSMEOs recorded significantly (p ≤0.05) the highest values (220.50 and 221.00 mg/dl) respectively compared to other tested groups, while chicks fed on 600 mg/kg FSMEOs recorded significantly (p ≤0.05) the lowest value (188.50 mg/dl).

On the other hand data for creatinine showed no significant difference (p ≥0.05) between all tested groups.

Table 13. Effect of different levels of Fennel and Spearmint mixed Essential Oils on Serum Metabolite of Broiler chick

Item mg/kg	Tp g/dl	Alb g/dl	Uric mg/dl	Ureamg/dl	Chol mg/dl	HDL mg/dl	LDL mg/dl	Trigl mg/dl	Glu mg/dl	Creatine mg/dl
Control	3.95^{a}	2.05^{b}	3.45^{a}	7.10^{a}	124.50^{a}	130.50^{a}	22.50^{b}	43.50^{a}	220.50^{a}	0.100
200FSMEOs	2.65^{c}	1.70^{c}	3.15^{a}	6.10^{b}	122.00^{ab}	85.00^{c}	27.05^{a}	39.50^{c}	221.00^{a}	0.100
400FSMEOs	2.90^{c}	2.30^{a}	2.15^{b}	5.15^{c}	121.50^{b}	116.50^{b}	17.45^{c}	41.00^{bc}	198.50^{b}	0.150
600FSMEOs	3.50^{b}	1.85^{c}	2.25^{b}	6.00^{b}	120.00^{b}	74.50^{d}	23.00^{b}	42.50^{ab}	188.50^{c}	0.100
SE±	0.112	0.0500	0.1354	0.084	0.8660	0.5401	0.4958	0.5401	0.5401	0.0204
C.V	0.358	0.1601	0.4334	0.269	2.7723	1.7288	1.5872	1.7288	1.7288	0.0653
L.SD0.05	S	S	S	S	S	S	S	S	S	NS

Any two means values having same superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Chol: Cholesterol, Trigl: Triglyceride, Alb: Albumin, T P: Total Protein, Glu: Glucos.

4.1.10 Economic appraisal:

The total costs, return and profitability ratio per head of broiler chicks fed different amount of fennel and spearmint mixed essential oils were shown in table(14).

Chicks purchase, feed, electricity, management and labor values were the major inputs considered. The total selling values of meat is the total revenues obtained. Profitability ratio (1.35) for group fed on 400mg/kg was the best of the tested groups followed by group fed on diet supplemented with 200 mg/kg (1.32) and finally group fed on diet supplemented with 600 mg/kg (0.99) compared to control group .

Table 14. Economical present of fennel and spearmint mixed essential oils:

Parameters	control	200mg/kg FHMEOs	400mg/kg FHMEOs	600mg/kg FHMEOs
Chick purchase	19.00	19.00	19.00	19.00
Total feed cost	37.71	38.86	42.03	45
Labor	7.00	7.00	7.00	7.00
Total cost	63.71	64.86	68.03	71
Average wt. of carcass	1.38	1.627	1.680	1.442
Price	100	100	100	100
Revenues	138	162.7	168	144.2
Total cost	63.71	64.86	68.03	71
Profit	74.29	97.84	99.97	73.2
Profitability ratio	1	1.32	1.35	0.99

The total cost was calculated according to January 2019.

Price/kg meat was 100SDG according to February 2019.

4.2 Response of broiler chicks to Graded levels of fennel and halfa bar mixed Essential Oils (FHMEOs):

The Specific chemical component of oils determined by testifying oils distasted From fennel and halfa bar mixed oils illustrated in table (15). Results showed eight main chemical compounds; Longifolene, 4, 7-Methano-5H-inden-5-one, octahydro-, and gamma-Elemene were the main compounds.

4.2.1Performance of experimental broiler chicks:

The effect of feeding broiler chicks on graded levels of fennel and halfa bar mixed essential oil on the performance was tabulated in table (16). There was no significant ($p \geq 0.05$) difference between all tested groups in feed intake, body weight, body weight gain and feed conversion ratio. For feed consumption numerically lowest value (3411) gm was noticed in chicks fed on 200mg/kg oils, while the chicks fed on 400mg/kg mixed essential oils noted numerically the highest value (3538) gm between all tested groups.

Group fed on 600 mg/kg mixed essential oils recorded numerically the heaviest body weight (2177) gm, while the group fed on control diet showed numerically the lowest body weight (1943) gm as compared to all tested groups.

Chicks fed on 600mg/kg mixed essential oils showed numerically the highest body weight gain (1995) gm between all tested groups, even though chicks fed on control diet logged numerically the lowest value (1757) gm.

Finally for feed conversion ratio group fed on diet treated with 200mg/kg mixed essential oils showed numerically the best value (1.71) between all tested groups.

Table 15. Chemical properites of fennel and halfa bar mixed essential oils

No	**Name**	RTime	Area%	Heigh%
1	Longifolene	8.373	9.88	14.98
2	4,7-Methano-5H-inden-5-one,octahydro-	6.002	14.57	6.31
3	gamma-Elemene	3.057	5.68	6.62
4	2-Naphthalenemethanol,1,2,3,4,4a,5,6,7-octal	9.357	5.55	6.09
5	1H-3a,7-Methanoazulene,octahydro-1,4,9,9-te	5.002	6.77	6.46
6	Phenol,2-methoxy-4-(2-propenyl)-acetate	6.543	4.81	6.28
7	Cyclohexene,1-methyl-4-(1-methylethylidene	3.604	5.03	3.51
8	Cyclohexene,3-methyl-6-(1-methylethenyl)	3.325	3.30	5.58

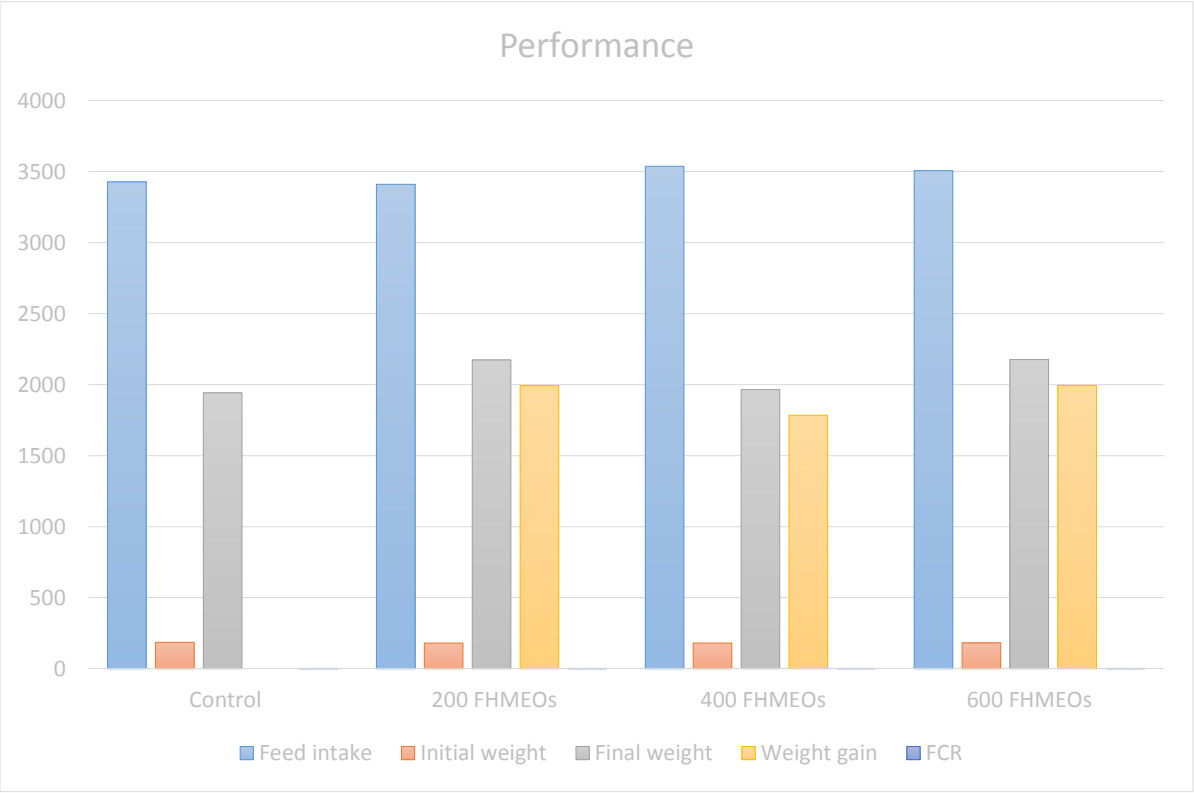
*Forensic Evidence lab using GC/MS (Gas chromatography-mass spectrometry) system.

Table 16. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on the performance of broiler chicks

Items mg/kg	Feed intake/gm	Initial weight/gm	Final weight/gm	Weight gain/gm	FCR
Control	3428	186	1943	I757	1.95
200 mg/kg FHMEOs	3411	181	2174	1993	1.71
400 mg/kg FHMEOs	3538	181	1966	1785	2.00
600 mg/kg FHMEOs	3507	182	2177	1995	1.75
SE±	137.49		125.16	125.16	0.1084
C.V	440.13		400.67	400.67	0.3469
L.sd 0.05	N.S	N.S	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Figure 2. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on the performance of broiler chicks



4.2.2 Dressing and Giblets:

Dressing and Giblets were tabulated in table (17). The results showed that, no significant ($p \geq 0.05$) differences between all tested groups in percentages of (dressing, intestine, liver, gizzard, heart and abdominal fat). For dressing percentage chicks fed on 200 mg/kg mixed oils recorded numerically the highest value (71.23) between all tested groups, while the chicks fed on 400mg/kg mixed oil presented numerically the lowest value (69.25).

4.2.3 Non Carcass Components:

As shown in table (18), the results recorded that, no significant difference ($p \geq 0.05$) between all tested groups in Percentages of (kidney, lung, legs, neck, head, intestine length, back and wing).

Table 17. Effect of Graded levels of Fennel and hafa bar mixed Essential Oilson Dressing and Giblets of broiler chicks

Item mg/kg	Dressing%	Intestine%	Liver%	Gizzard%	Heart%	Abdominal fat%
Control	70.31	3.80	2.05	1.55	0.51	1.07
200 FHMEOs	71.23	3.78	1.85	1.54	0.58	0.77
400 FHMEOs	69.25	4.14	1.82	1.52	0.68	0.90
600 FHMEOs	70.37	4.04	1.89	1.40	0.56	1.07
SE±	1.1676	0.2484	0.2579	0.1237	0.0614	0.3522
C.V	3.7378	0.7958	0.8257	0.3960	01966	1.1276
L.SD0.05	N.S	N.S	N.S	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Table 18. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on non-carcass component of broiler chicks

Items mg/kg	Kidney %	Lung%	Legs%	Neck %	Head %	Intestin lengthcm	Back %	Wing %
Control	0.37	0.73	3.62	5.19	2.55	178.33	19.69	10.47
200FHMEOs	0.42	0.60	4.10	5.29	2.26	198.00	20.13	10.70
400FHMEOs	0.48	0.64	4.28	4.72	2.40	187.33	20.90	10.06
600FHMEOs	0.43	0.64	3.41	4.97	2.27	198.00	20.26	11.44
SE±	0.0748	0.1526	0.3322	0.4478	0.1755	7.1841	2.3227	0.9167
C.V	0.2396	0.4884	1.0633	1.4335	0.5619	22.998	7.4355	2.9345
L.SD0.05	NS	NS	NS	NS	NS	NS	NS	NS

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.2.4 Commercial Cuts:

The graded levels of fennel and halfa bar mixed oil on persentages of commercial cuts presented in table (19), the commercial cuts (breast, thigh and drum stick) documented no significant ($p \geq 0.05$) difference among all tested groups, however chicks fed on 600mg/kg FHMEOs noted numerically the highest value for breast (39.80) between all tested groups and chicks fed on 200mg /kg FHMEOs showed numerically the lowest value for breast (37.85). For thigh chicks fed on 200mg/kg mixed oils noted numerically the highest value for thigh (15.21), while chicks fed on 400mg/kg FHMEOs recorded numerically the lowest value (12.86) as compare to all tested groups.

On the other hand chicks fed 400mg/kg FHMEOs revealed numerically the heaviest value for drumstick (12.41), conversely chicks fed on 600mg/kg FHMEOs showed numerically the lowest value (11.43).

Table 19. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on Commercial Cuts of broiler chick

Items mg/kg	Breast%	Thigh%	Drumstick%
Control	39.22	15.07	11.73
200 FHMEOs	37.85	15.21	11.87
400 FHMEOs	39.10	12.86	12.41
600 FHMEOs	39.80	13.89	11.43
SE±	1.9954	0.9107	0.7076
C.V	6.3877	2.9153	2.2651
L.SD 0.05	N.S	N.S	N.S

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.2.5 Meat of commercial cuts:

The effect of fennel and halfa mixed essential oils on meat percentages of commercial cuts of broiler chicks was tabulated in table (20). Results revealed that, no significant ($p \geq 0.05$) difference between all tested groups in meat of commercial cuts, however, chicks fed on 600mg/kg FHMEOs recorded numerically the highest value for breast meat (88.41) as compared to chicks fed on control diets which showed numerically the lowest value (85.15).

Breast bone showed that group of chicks fed on 600mg/kg mixed oil recorded numerically the lowest value (10.46), while those chicks fed on control diet noted numerically the highest value (14.08) between all tested groups.

Data collected concerning thigh meat showed that chicks fed on dietary control recorded numerically the highest value (84.78) between all tested groups, although chicks fed on 400mg/kg FHMEOs noted numerically the lowest value (82.47).

On the other hand, for thigh bone chicks fed on 400mg/kg FHMEOs showed numerically the highest value (17.17) between all tested groups, while, chicks fed on 200mg/kg FHMEOs recorded numerically the lowest value (14.12).

Finally for drumstick meat chicks fed on 600mg/kg FHMEOs recorded numerically the heighest values (77.91), for drumstick bone chicks fed on control diet recorded numerically the heighest values (26.69).

Table 20. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on Meat of Commercial Cuts of broiler chicks

Item mg/kg	Breast meat%	Breast bone%	Thigh meat%	Thigh bone%	Drumstick meat%	Drumstick bone%
Control	85.15	14.08	84.78	14.88	72.53	26.69
200 mg/kg FHMEOs	87.43	11.58	84.55	14.12	77.26	22.06
400 mg/kg FHMEOs	85.44	14.00	82.47	17.17	75.42	23.85
600 mg/kg FHMEOs	88.41	10.46	82.58	15.40	77.91	20.15
SE±	1.3955	1.1710	1.2111	1.2007	2.6417	2.2692
C.V	4.4671	3.7485	3.8769	3.8438	8.4567	7.2643
L.SD0.05	NS	NS	NS	NS	NS	NS

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.2.6 Subjective meat attributes:

The effect of fennel and halfa mixed essential oils on subjective meat attribute for experimental broiler chicks was tabulated in table (21). Resulst revealed no significant difference ($p \geq 0.05$) between tested groups on the scores given for (tenderness, flavor, color and juiciness) using an eight point scale, and scores given for all attributes were above the moderate acceptance.

Table 21. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on Subjective Quality Attribute

Items	Tendernes	Flavor	Color	Juiciness
Control	6.10	6.10	6.32	5.85
200 mg/kg FHMEOs	5.93	6.01	5.91	5.45
400 mg/kg FHMEOs	6.69	6.13	6.50	6.33
600 mg/kg FHMEOs	6.36	6.30	5.84	6.32
SE±	0.3580	0.2190	0.3058	0.4562
C.V	1.461	0.7009	0.9788	1.4603
L.SD 0.05	NS	NS	NS	NS

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error.

4.2.7 Meat Chemical Compositions:

Effect of feeding broiler chicks on graded levels of fennel and halfa bar mixed essential oils on meat chemical composition was tabulated in table (22). Results recorded significantly ($p \leq 0.05$) differences in moisture value between groups, chicks fed on diets supplemented with 200mg/kg FHMEOs obtained significantly highest moisture value (74.95) compared to control group (73.23), whereas, no significant differences ($p \geq 0.05$) between chicks fed on 200, 400 and 600 mg/kg FHMEOs (74.95, 74.40 and 74.75 respectively), also, between chicks fed on control and 400 and 600 mg/kg FHMEOs (73.23, 74.40 and 74.75) respectively. Although chicks fed on control diets and 200mg/kg FHMEOs showed significant ($p \leq 0.05$) differences in dry matter value (26.77 and 25.05) respectively, however, there is no significant difference ($p \geq 0.05$) between chicks fed on control diet, 400 and 600 mg/kg FHMEOs (26.77, 25.60 and 25.25 respectively), also, between chicks fed on 200 and 400 and 600 mg/kg FHMEOs (25.05, 25.60 and 25.25) respectively. Results concerning ash content showed that, no significant difference ($p \geq 0.05$) between all tested groups.

The analysis of data for crude protein showed, no significant difference ($p \geq 0.05$) between all tested groups, although, chicks fed on 200mg/kg FHMEOs recorded numerically the highest value (23.11) and chicks fed on 400 mg/kg FHMEOs noted numerically the lowest value (15.89) as compared to chicks fed on control and chicks fed on 600 mg/kg FHMEOs.

Data obtained for ether extract observed that chicks fed on control diet and 200 mg/kg FHMEOs recorded significantly ($p \leq 0.05$) differences in ether extract value (1.38 and 0.80) respectively, whereas, no significant difference ($p \geq 0.05$) between chicks fed on 200, 400 and 600 mg/kg FHMEOs (0.80, 0.95 and 1.15) respectively, also, between chicks fed on control and 400 and 600 mg/kg FHMEOs (1.38, 0.95 and 1.15) respectively.

Table 22. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on Meat Chemical Composition of Broiler chicks

Items mg/kg	Moisture	Dry matter	ASH	Crude protein	Ether Extract
Control	73.23^{b}	26.77^{a}	1.20	22.58	1.38^{a}
200 FHMEOs	74.95^{a}	25.05^{b}	1.30	23.11	0.80^{b}
400 FHMEOs	74.40^{ab}	25.60^{ab}	1.15	15.89	0.95^{ab}
600 FHMEOs	74.75^{ab}	25.25^{ab}	1.35	21.35	1.15^{ab}
SE±	0.4740	0.4740	0.0677	4.7540	0.1584
C.V	1.5175	1.5175	0.2167	15.219	0.5072
L.SD 0.05	S	S	NS	NS	S

Any two means values having same superscript with in Columns are not significantly different ($p \leq 0.05$). SE±: Stander error.

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4.2.8 Serum enzyme and minerals:

The results showed significantly ($p \leq 0.05$) difference among all tested groups for serum enzyme and minerals table (23). For AST chicks fed on 600mg/kg FHMEOs showed significantly the highest value (50.25iu/L) and chicks fed on control diet recorded significantly the lowest value (38.95iu/L), while no significant ($p \geq 0.05$) differences between chicks fed on 200 and 400mg/kg FHMEOs (46.70 and 46.40 iu/L) respectively.

Result for ALP enzyme showed significant ($p \leq 0.05$) difference between all tested groups, for the time being ALP level in serum decreased by increasing supplementation levels of FHMEOs in diet, control group recorded the highest value while group fed on 600mg/kg FHMEOs recorded the lowest value (247.50 and 130.00 iu/L) respectively.

On the other hand, result obtained for Ca showed that, chicks fed on 600mg/kg FHMEOs revealed significantly($p \leq 0.05$) the lowest value (6.20mg/dl) compared to all tested groups, while no significant($p \geq 0.05$) difference between chicks fed on control, 200 and 400mg/kg FHMEOs (8.15, 8.05 and 8.05 mg/dl) respectively .

Finally experiential chicks fed on control diet obtained significantly the highest value (8.75 mg/dl) of p concentration in the serum, also, chicks fed on 600mg/kg FHMEOs recorded significantly the lowest value (6.50 mg/dl) compared to all treatments.

Table 23. Effect of Graded levels of Fennel and halfa bar mixed Essential Oils on Serum Enzymes and Minerals of Broiler chicks

Item mg/kg	AST iu/L	ALP iu/L	Camg/dl	P mg/dl
Control	38.95[c]	247.50[a]	8.15[a]	8.75[a]
200 FHMEOs	46.70[b]	149.05[b]	8.05[a]	7.45[c]
400 FHMEOs	46.40[b]	132.10[c]	8.05[a]	8.25[b]
600 FHMEOs	50.25[a]	130.00[d]	6.20[b]	6.50[d]
SE±	0.1979	0.2092	0.0890	0.0979
C.V	0.6335	0.6696	0.2848	0.3134
L.SD0.05	S	S	S	S

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

4.2.9 Serum Metabolite:

The serum metabolite values of broiler chicks fed different levels of fennel and halfa bar mixed essential oils for five week is shown in table (24). The results showed significant ($p \leq 0.05$) difference among all tested groups of serum metabolite (total protein, albumin, uric acid, urea, HDL, LDL, tri glyceride and glucose) expect for cholesterol and creatinine showed that, no significant difference ($p \geq 0.05$). Values of total protein was significantly high ($p \leq 0.05$) in group of chicks fed on control diet (3.95g/dl), where is no significant ($p \geq 0.05$) differences were detected between chicks fed on 200,400 and 600 mg/kg FHMEOs (3.45, 3.20 and 3.40 mg/dl) respectively

Result for albumin revealed that chicks fed on 200 mg/kg FHMEOs showed significantly ($p \leq 0.05$) the highest value (2.25 g/dl), while chicks fed on 400 mg/kg FHMEOs noted significantly ($p \leq 0.05$) the lowest value (1.40 g/dl), where no significant ($p \geq 0.05$) difference between chicks fed on control group and chicks fed on 600 mg/kg FHMEOs (2.05and 2.05 g/dl) respectively.

For uric acid chicks fed on 400mg/kg FHMEOs reported significantly ($p \leq 0.05$) the highest value (4.35 mg/dl), and chicks fed on control diet recorded significantly ($p \leq 0.05$) the lowest value (3.45 mg/dl), although, there was significant difference between 200 and 600 mg/kg FHMEOs (3.95and 4.20 mg/dl) respectively .

Data collected for urea revealed significant difference, but no significant difference ($p \geq 0.05$) between chicks fed on control diet and chicks fed on 400mglkg FHMEOs (7.10 and 7.00 mg/dl) respectively, also, between chicks fed on 200 mg/kg oils and chicks fed on 600mg/kg oils (6.15 and 6.00 mg/dl) respectively.

0n the other hand, there were no significant differences ($p \geq 0.05$) between all treatments for cholesterol, however, chicks fed on control diet obtained numerically the highest value (124.50 mg/dl) compared to other tested groups.

For cholesterol HDL chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (130.50 mg/dl), compared to other tested groups, whereas, no significant difference ($p \geq 0.05$) between chicks fed on 200 and 600 mg/kg FHMEOs **(**41.50 and 41.00mg/dl) respectively, while, chicks fed on 400 mg/kg FHM**EOs** recorded significant ($p \leq 0.05$) different from all tested groups.

For cholesterol LDL there was significant difference ($p \leq 0.05$) between chicks fed on control and chicks fed on 200 mg/kg mixed oils (22.50 and 18.50 mg/dl) respectively, also, between control and chicks fed on 600 mg/kg mixed oils (22.50 and 19.00 mg/dl) respectively, while there were no significant difference ($p \geq 0.05$) between group fed on 400 and 600 mg/kg (21.00 and 19.00 mg/dl) respectively.

For triglyceride result showed that chicks fed on diet supplemented with 600 mg/kg FHMEOs recorded the significantly ($p \leq 0.05$) the highest value (49.50 mg/dl) compared to other tested groups, whereas, no significant difference ($p \geq 0.05$) between chicks fed on 200 and 400mg/kg FHMEOs (36.50 and 39.50 mg/dl) respectively.

On the other hand the analysis of data for glucose presented that chicks fed on control diet detailed significantly ($p \leq 0.05$) the highest value (220.50 mg/dl), while chicks fed on 600mg/kg mixed oils recorded significantly ($p \leq 0.05$) the lowest value (160.50 mg/dl) compared to chicks fed on 200 mg/kg FHMEOs (169.50 mg/dl) and chicks fed on 400mg/kg FHMEOs (178.00 mg/dl).

For creatinine result showed no significant difference ($p \geq 0.05$) between all tested groups.

Table 24. Effect of different levels of Fennel and Halfa bar mixed Essential Oils on Serum Metabolite of Broiler chicks

Item mg/kg	Tp g/dl	Alb g/dl	Uric mg/dl	Urea mg/dl	Chol mg/dl	HDL mg/dl	LDL mg/dl	Trigl mg/dl	Glue mg/dl	Crea mg/dl
Control	3.95^{a}	2.05^{b}	3.45^{d}	7.10^{a}	124.50	130.50^{a}	22.50^{a}	43.50^{b}	220.50^{a}	0.100
200 FHMEOs	3.45^{b}	2.25^{a}	3.95^{c}	6.15^{b}	121.50	41.50^{c}	18.50^{c}	36.50^{c}	169.50^{c}	0.100
400 FHMEOs	3.20^{b}	1.40^{c}	4.35^{a}	7.00^{a}	123.00	76.00^{b}	21.00^{ab}	39.50^{c}	178.00^{b}	0.150
600 FHMEOs	3.40^{b}	2.05^{b}	4.20^{b}	6.00^{b}	122.00	41.00^{c}	19.00^{bc}	49.50^{a}	160.50^{d}	0.100
SE±	0.0957	0.0354	0.0354	0.0736	0.9574	0.8660	0.6455	1.0801	0.7906	0.0204
C.V	0.3065	0.1132	0.1132	0.2356	3.0649	2.7723	2.0664	3.4577	2.5308	0.0653
L.SD0.05	S	S	S	S	NS	S	S	S	S	NS

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$).SE±: Stander error. C.V: Critical value

Chol: Cholesterol, Trigl: Triglyceride, Alb: Albumin, T P: Total Protein, Glu: Glucose, crea: Creatine

4.2.10 Economic appraisal:

The total costs, return and profitability ratio per head of broiler chicks fed different amount of fennel and halfa bar mixed essential oils were shown in table (25).

Chicks purchase, feed, electricity, management and labor values were the major inputs considered. The total selling values of meat is the total revenues obtained. Profitability ratio (1.37) for group fed on 200mg/kg was the best of the tested groups followed by group fed on diet supplemented with 600 mg/kg (1.20)and finally group fed on diet supplemented with 400 mg/kg (1.04) compared to control group .

Table 25. Economical present of fennel and halfa bar mixed essential oils:

Parameters	control	200mg/kg FHMEOs	400mg/kg FHMEOs	600mg/kg FHMEOs
Chick purchase	19.00	19.00	19.00	19.00
Total feed cost	37.71	39.25	42.42	43.83
Labor	7.00	7.00	7.00	7.00
Total cost	63.71	65.25	68.42	69.83
Average wt of carcass	1.38	1.668	1.457	1.592
Price	100	100	100	100
Revenues	138	166.8	145.7	159.2
Total cost	63.71	65.25	68.42	69.83
Profit	74.29	101.55	77.28	89.37
Profitability ratio	1	1.37	1.04	1.20

The total cost was calculated according to January 2019.

Price/kg meat was 100SDG according to February 2019.

4.3 Response of broiler chicks fed on Graded levels of spearmint and halfa bar Mixed Essential Oils (SHMEOs)

The Specific chemical component of oils determined by testifying oils distasted From spearmint and halfa bar mixed oils illustrated in table (26). Results showed 11 chemical compound: IH-cycloprop(e)azulene,decahydro-1,1,4,7-te, I-Cyclohexene-1-carboxaldehyde,2,6,6-trimei and Naphthalene,decahydro-4a-methyl-1-methyler were the main compounds.

4.3.1Performance

The effect of feeding different levels of spearmint and halfa bar mixed essential oils on the performance of broiler chicks is shown in table (27). There was no significant ($p \geq 0.05$) difference observed between all tested groups in feed intake, final body weight, body weight gain and feed convection ratio for experimental broiler chicks, however chicks in group 400mg/kg SHMEOs were consumed numerically the lowest value (3328) gm while chicks fed on 200mg/kg SHMEOs noted numerically the highest value (3440) gm compared to all tested groups.

The result indicated that the chicks of group fed on 600mg/kg SHMEOs obtained numerically the highest body weight (2083) gm, while the group fed on control diet recorded numerically the lowest body weight (1943) gm.

Group fed on 600mg/kg SHMEOs showed numerically the best body weight gain (1897) gm, and chicks fed on control diet registered numerically the lowest value (1757) gm.

On the other hand, group fed on diet treated with 600mg/kg SHMEOs showed numerically the best value (1.78) in feed convection ratio between all tested groups, while group fed on control diet recorded the worse value (1.95).

Table26. Chemical properites of Spearmint and halfa bar mixed essential oils

No	**Name**	RTime	Area%	Heigh%
1	IH-cycloprop(e)azulene,decahydro-1,1,4,7-te	5.513	15.78	9.46
2	I-Cyclohexene-1-carboxaldehyde,2,6,6-trimei	5.648	19.54	9.21
3	Naphthalene,decahydro-4a-methyl-1-methyler	8.373	8.84	9.33
4	Phenol,2-methoxy-4-(2-propenyl)-,acetate	6.544	8.08	7.40
5	Cyclohexene,1-methyl-4-(1-methylethylidene)	3.043	8.12	9.39
6	2-Naphthalenemethanol,1,2,3,4,4a,5,6,8a-octa	9.354	7.45	7.78
7	2-Cyclohexen-1-o1,2-methyl-5-(1-methylether)	6.570	2.45	3.92
8	Cyclohexanol,2-methyl-5-(1-methylethenyl)	5.018	5.11	7.20
9	Alpha-Terpineol	4.988	2.38	3.70
10	D-limonene	3.325	3.24	4.91
11	Eucalyptol	3.369	1.03	1.62

*Forensic Evidence lab using GC/MS (Gas chromatography-mass spectrometry) system

Table 27. Effect of Graded levels of spearmint and halfa bar mixed Essential Oils on performance of broiler chicks

Items mg/kg	Feed intake	Initial weight	Final weight	Weight gain	FCR
Control	3428	186	1943	I757	1.95
200 mg/kg SHMEOs	3440	182	2071	1889	1.83
400 mg/kg SHMEOs	3328	188	1956	1768	1.90
600 mg/kg SHMEOs	3372	186	2083	1897	1.78
SE±	123.28		98.628	98.628	0.1167
C.V	394.63		315.71	315.71	0.3737
L.sd 0.05	N.S	N.S	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

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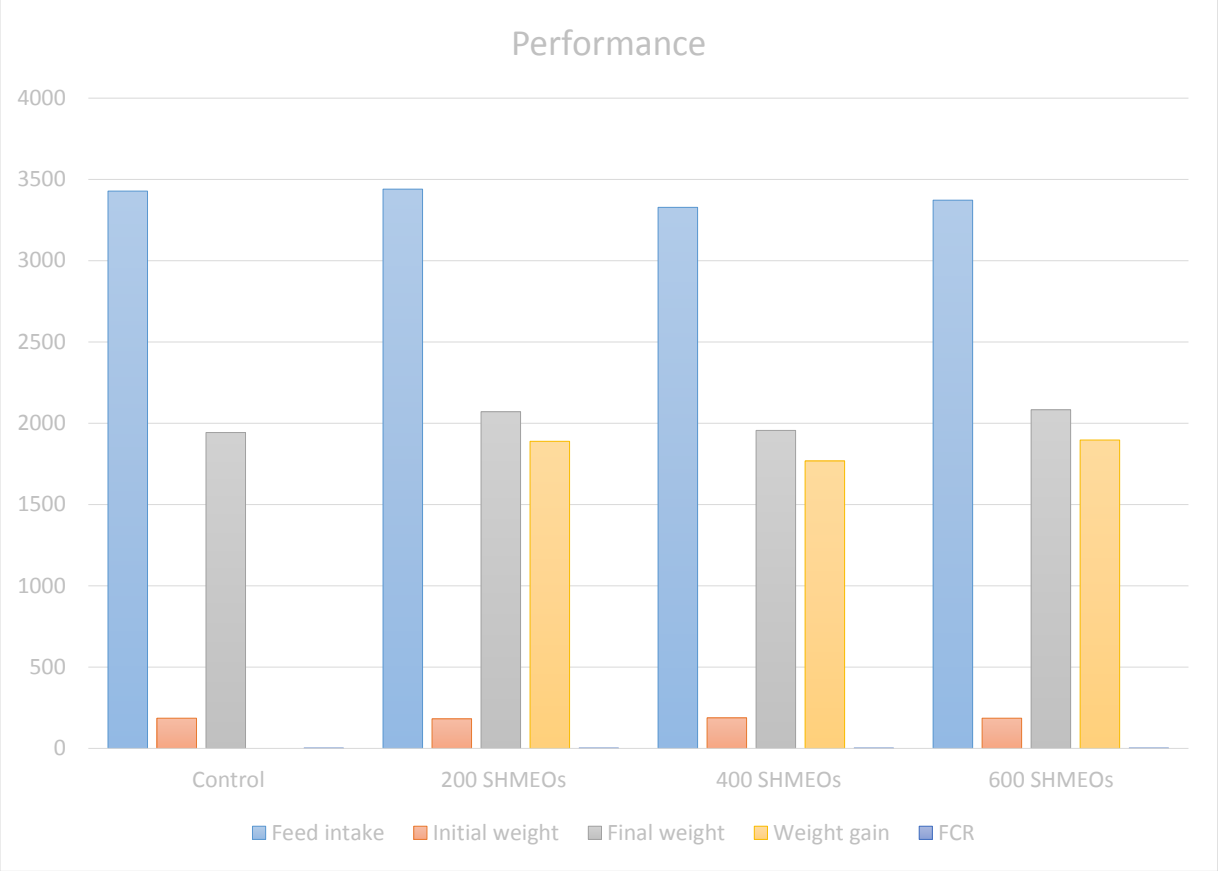
Figure 3. Effect of Graded levels of spearmint and halfa bar mixed Essential Oils on performance of broiler chicks



4.3.2 Dressing and Giblets of experimental chicks:

As showed in table (28), the result indicated no significant ($p \geq 0.05$) difference between all treated groups in dressing, Intestine, liver, gizzard, heart and abdominal fat percentages, although for dressing, chicks fed on 600mg/kg SHMEOs recorded numerically the highest value (72.15) compared to all tested groups, while chicks fed on control diet showed numerically the lowest value (70.31) .

4.3.3 Non Carcass Components:

As showed in table (29), the results obtained indicated no significant ($p \geq 0.05$) difference between all treated groups in non-carcass components (kidney, lung, legs, neck, head, back and wings) percentages, except the intestine length recorded significant ($p \leq 0.05$) difference between chicks fed on 200 and 400mg/kg SHMEOs (166.00 and 183.33cm) respectively, whereas, no significant ($p \geq 0.05$) difference showed between chicks fed on control diet and those fed on 400 and 600 mg/kg SHMEOs (178.33, 183.33 and 170.00cm) respectively, also, between chicks fed on control and chicks fed on 200 and 600mg/kg **S**HMEOs (178.33, 166.00 and 170.00cm) respectively.

Table 28. Effect of Graded levels of Spearmint and Halfa bar mixed Essential Oils on Dressing and Giblet of broiler chicks

Item mg/kg	Dressing%	Intestine wt%	Liver%	Gizzard%	Heart%	Abdominal fat %
Control	70.31	3.80	2.05	1.55	0.51	1.07
200 **S**HMEOs	70.50	4.30	2.22	1.69	0.61	1.43
400 **S**HMEOs	71.38	3.99	2.06	1.35	0.49	1.17
600 **S**HMEOs	72.15	3.56	1.87	1.58	0.51	0.77
SE±	1.5179	0.4110	0.4185	0.1318	0.0713	0.2349
C.V	4.8592	1.3157	1.3396	0.4219	0.2281	0.7518
L.SD0.05	N.S	N.S	N.S	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Table 29. Effect of Graded levels of spearmint and halfa bar mixed Essential Oils On non carcass component of broiler chicks:

Item mg/kg	Kidney %	Lung %	Legs %	Neck %	Head %	Gut/cm	Back %	Wing %
Control	0.37	0.73	3.62	5.19	2.55	178.33^{ab}	19.69	10.47
200**S**HMOs	0.41	0.68	3.79	5.26	2.25	166.00^{b}	20.66	10.51
400**S**HMOs	0.33	0.63	4.32	4.54	2.53	183.33^{a}	19.10	10.49
600**S**HMOs	0.35	0.74	3.86	4.27	2.07	170.00^{ab}	19.92	13.81
SE±	0.0559	0.0966	0.3811	0.6180	0.2232	4.9441	458.91	2.8512
CV	0.1789	0.3093	1.2200	1.9783	0.7144	15.827	1469.1	9.1273
L.SD0.05	NS	NS	NS	NS	NS	S	NS	NS

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$) SE±: Stander error C.V: Critical value

4.3.4 Commercial cuts values of experimental chicks:

The effect of feeding graded levels of spearmint and halfa bar mixed essential oils on percentages values of commercial cuts, shown in table (30), treatments did not affected significantly ($p \geq 0.05$) on commercial cuts (breast, thigh and drumstick%), however, chicks fed on 600mg /kg SHMEOs revealed numerically the highest value (41.16) of breast compared to all other tested groups, also chicks fed on 200mg/kg SHMEOs recorded numerically the lowest value (36.23).

On the other hand chicks fed on control diet showed numerically the highest value of thigh (15.07), on the contrary chicks fed on 400mg/kg SHMEOs noted numerically the lowest value (13.38), also chicks fed on 600mg/kg SHMEOs noted numerically the highest value of drumstick (13.15), while chicks fed on control diet documented the lowest value (11.73) between all tested groups.

Table 30. Effect of Graded levels of spearmint and halfa bar mixed Essential Oils on Commercial Cuts of broiler chick

Items	Breast%	Thigh%	Drumstick%
Control	39.22	15.07	11.73
200 SHMEOs	36.23	14.53	12.28
400 SHMEOs	37.62	13.38	12.96
600 SHMEOs	41.16	14.16	13.15
SE±	2.0018	1.3348	0.8086
C.V	6.4082	4.2730	2.5885
L.SD 0.05	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.3.5 Meat of Commercial Cuts:

The percentages meat values of commercial cuts of broiler chicks fed graded levels of spearmint and halfa bar mixed essential oils shown in table (31).

Treatments did not affect significant ($p \geq 0.05$) on values of commercial cuts meat percentages, however chicks fed on 400mg/kg SHMEOs recorded numerically the highest breast meat value (86.63), while chicks fed on control diets displayed numerically the lowest value (85.15) compared to all tested groups.

For breast bone, group of chicks fed on control diet documented numerically the highest value (14.08), while the chicks fed on 600mg/kg SHMEOs noted numerically the lowest value (12.08) compared to other tested groups.

Data collected concerning thigh meat showed that, chicks fed on dietary control recorded numerically the highest value (84.78) compared to other tested groups, while chicks fed on 600mg/kg SHMEOs noted numerically the lowest value (82.50). For thigh bone group fed on 600mg/kg SHMEOs recorded numerically the highest value (15.95), although chicks fed on 200mg/kg **S**HMEOs numerically the lowest value (13.51) compared to other tested groups.

For meat of drum stick, group fed on 600mg/kg SHMEOs recorded numerically the highest value (75.57) between other tested groups, while group fed on control diet recorded numerically the lowest value (72.53), lastly for drum stick bone, chicks fed on dietary control diet recorded numerically the highest value (26.69), while chicks fed on 600 mg/kg SHMEOs noted numerically the lowest value (23.20).

Table 31. Effect of Graded levels of spearmint and halfa bar mixed Essential Oils on Meat of Commercial Cuts of broiler chicks

Item mg/kg	Breast meat%	Breast bone%	Thigh meat%	Thigh bone%	Drumstick meat%	Drumstick bone%
Control	85.15	14.08	84.78	14.88	72.53	26.69
200 SHMEOs	85.49	12.50	84.35	13.51	73.01	24.86
400 SHMEOs	86.63	12.26	83.09	14.51	74.33	24.36
600 SHMEOs	86.45	12.08	82.50	15.95	75.57	23.20
SE±	1.9559	1.5705	1.6353	1.5380	2.0554	2.4682
C.V	6.2614	5.0274	5.2350	4.9235	6.5799	7.9011
L.SD0.05	NS	NS	NS	NS	NS	NS

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.3.6 Subjective meat Attribute:

Treatment effects on subjective meat attributes showed no significant ($p \geq 0.05$) difference between all tested groups, mean values of all sensory attributes are closely similar, and scores given for all attributes were above the moderate acceptance, as shown in table(32), the scores were given for (tenderness, flavor, color and juiciness) using an eight points scale.

Table 32. Effect of Graded levels of spearmint and halfa bar mixed Essential Oils on Subjective Quality Attribute

Items mg/kg	Tenderness	Flavor	Color	Juiciness
Control	6.10	6.10	6.32	5.85
200 **S**HMEOs	6.13	6.22	6.41	5.81
400 **S**HMEOs	6.22	5.92	6.02	5.88
600 **S**HMEOs	6.41	6.41	5.95	6.01
SE±	0.1940	0.2308	0.4099	0.2635
C.V	0.6209	0.7389	1.3121	0.8437
L.SD0.05	NS	NS	NS	NS

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error C.V: Critical value

4.3.7 Meat Chemical Compositions:

Meat chemical composition aspects were shown in table (33), treatments affect on moisture, dry matter, ash, crude protein and ether extract ,were significant ($p \leq 0.05$), chicks fed on 600mg/kg SHMEOs recorded significantly ($p \leq 0.05$) higher in moisture value(75.20) compared to chicks fed on control diet (73.23), whereas, no significant differences noted between chicks fed on control diet and those chicks fed on 200 and 400 mg/kg SHMEOs (73.23,73.87and 74.37) respectively, also between chicks fed on 200, 400 and 600 mg/kg SHMEOs (73.87,74.37 and 75.20) respectively.

For dry matter, chicks fed 600mg/kg SHMEOs recorded significantly ($p \leq 0.05$) lower dry matter value (24.83) compared to chicks fed on control diet (26.77), whereas no significant differences between chicks fed on control diet and chicks fed on 200 and 400 mg/kg SHMEOs (26.77, 26.13and 25.63) respectively, also between chicks fed on 200, 400 and 600 mg/kg SHMEOs (26.13, 25.63 and 24.83) respectively.

For ash content, results found that, chicks fed on 200 and 600mg/kg SHMEOs noted the highest values (1.50 and 1.40 respectively), compared to chicks fed on control diet and chicks fed on 400 mg/kg **S**HMEOs (1.20 and 1.20) respectively.

For crude protein, chicks fed on 200 and 600mg/kg **S**HMEOs showed significantly ($p \leq 0.05$) the highest values (23.65and 23.44) respectively compared to chicks fed on control diet (22.58) and chicks fed on 400 mg/kg **S**HMEOs (22.14).

The analysis of data for Ether Extract, showed that chicks fed on control and 400 mg/kg **S**HMEOs obtained significantly ($p \leq 0.05$) higher valueS (1.38 and 1.00) respectively, compared to chicks fed on 200 and 600mg/kg **S**HMEOs (0.30 and 0.65) respectively, whereas no significant ($p \geq 0.05$) difference between chicks fed on 400 and chicks fed on 600mg/kg SHMEOs (1.00 and 0.65) respectively.

Table 33. Effect of Graded levels of Spearmint and Halfa bar mixed Essential Oils on Meat Chemical Composition of Broiler chicks

Itemsmg/kg	Moisture	Dry matter	ASH	Crude protein	Ether Extract
Control	73.23^{b}	26.77^{a}	1.20^{b}	22.58^{b}	1.38^{a}
200 SHMEOs	73.87^{ab}	26.13^{ab}	1.50^{a}	23.65^{a}	0.30^{c}
400 SHMEOs	74.37^{ab}	25.63^{ab}	1.20^{b}	22.14^{c}	1.00^{ab}
600 SHMEOs	75.20^{a}	24.83^{b}	1.40^{a}	23.44^{a}	0.65^{bc}
SE±	0.5477	0.5588	0.0456	0.1327	0.1461
C.V	1.7534	1.7887	0.1461	0.4248	0.4678
L.SD 0.05	S	S	S	S	S

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

4.3.8 Serum Enzyme and Minerals:

The treatment effects on serum enzyme and minerals were shown in table (34), the results showed significantly ($p \leq 0.05$) difference among all tested groups for AST, ALP, Ca and P.

For AST, chicks fed on 200 and 400mg/kg SHMEOs showed significantly ($p \leq 0.05$) the highest values (51.10 and 51.10 iu/L) respectively, nevertheless chicks fed on 600mg/kg SHMEOs documented significantly ($p \leq 0.05$) the lowest value (29.90) compared to all tested groups while, chicks fed on control diet noted significant ($p \leq 0.05$) different value (38.95 iu/L) compared to all tested groups.

For ALP levels in serum there were significant ($p \leq 0.05$) differences between all tested groups, however, chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (247.50 iu/L), while chicks fed on 400mg/kg SHMEOs recorded significantly the lowest value (138.65 iu/L) compared to other tested groups.

On the other hand, for Calcium content chicks fed on 200mg/kg SHMEOs presented significantly the highest value (9.25 mg/dl), whereas, chicks fed on 400 and 600mg/kg SHMEOs recognized significantly the lowest values (6.85 and 7.10 mg/dl) respectively compared to other tested groups, while chicks fed on control diet differ significantly (8.15 mg/dl) from all tested groups.

Finally for Phosphorus, the results indicated that the group of chicks fed on 200mg/kg SHMEOs and chicks fed on control diet significantly ($p \leq 0.05$) obtained the highest values (9.00, 8.75 mg/dl) respectively, while chicks fed on 400mg/kg SHMEOs recorded significantly the lowest value (6.60 mg/dl) compared to other tested groups, also, chicks fed on 600mg/kg SHMEOs recorded significantly (7.00 mg/dl) difference compared to all tested groups.

Table 34. Effect of Graded levels of Spearmint and Hafa bar mixed Essential Oils on Serum Enzymes and Minerals of Broiler chicks

Items	AST iu/L	ALP iu/L	Ca mg/dl	P mg/dl
Control	38.95[b]	247.50[a]	8.15[b]	8.75[a]
200 SHMEOs	51.10[a]	152.55[b]	9.25[a]	9.00[a]
400 SHMEOs	51.10[a]	138.65[d]	6.85[c]	6.60[c]
600 SHMEOs	29.90[c]	144.90[c]	7.10[c]	7.00[b]
SE±	0.0736	0.3841	0.1137	0.0842
C.V	0.2356	1.2294	0.3638	0.2694
L.SD0.05	S	S	S	S

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

4.3.9 Serum Metabolite:

The serum metabolite collected values of broiler chicks fed on different levels of spearmint and hafa bar mixed essential oils for five weeks is shown in table (35). The effect of spearmint and halfa bar mixed oils showed significant difference between all treatments for serum metabolites, expect createin.

For total protein, there were significant ($p \leq 0.05$) differences between chicks fed on control diet, chicks fed on 400 and 600 mg/kg SHMEOs (3.95, 3.30 and 2.40g/dl) respectively, whereas, no significant ($p \geq 0.05$) differences were noticed between chicks fed on 200 and 400 mg/kg SHMEOs (3.55 and 3.30 gdl) respectively, also, between chicks fed on control and chicks fed on 200mg/kg SHMEOs (3.95 and 3.55 g/dl) respectively.

For albumin, results recorded that, chicks fed on 200 mg/kg SHMEOs indicated significantly ($p \leq 0.05$) the highest value (2.40 g/dl), and chicks fed on 600 mg/kg SHMEOs noted significantly ($p \leq 0.05$) the lowest value (1.40 g/dl), whereas no significant ($p \geq 0.05$) difference between chicks fed on control diet and chicks fed on 400 mg/kg SHMEOs (2.05and 2.00 g/dl) respectively.

For uric acid, there were significant ($p \leq 0.05$) difference between all tested groups, chicks fed on 200mg/kg SHMEOs noted significantly ($p \leq 0.05$) the highest value (4.75 mg/dl), while chicks fed on control diet recorded significantly ($p \leq 0.05$) the lowest value (3.45 mg/dl), as compared to chicks fed on 400 and 600 mg/kg SHMEOs (4.60 and 4.45 mg/dl) respectively.

Data for urea, revealed significant difference between control groups and all other tested groups (200, 400 and 600) mg/kg SHMEOs, whereas, no significant difference ($p \geq 0.05$) between chicks fed on 200, 400 and 600mglkg SHMEOs (6.00, 5.60 and 5.50 mg/dl) respectively.

0n the other hand, there were significant difference ($p \leq 0.05$) recorded between all treatments for cholesterol, chicks fed on 400mg/kg SHMEOs obtained

significantly the highest value (133.00 mg/dl) compared to other tested groups, while no significant difference ($p \geq 0.05$) between chicks fed on control and chicks fed 200mg/kg SHMEOs (124.50 and 123.00 mg/dl) respectively, also, between chicks fed on control and chicks fed on 600 mg/kg SHMEOs (124.50 and 127.50 mg/dl) respectively,

For cholesterol HDL, chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (130.50 mg/dl), compared to other tested groups, whereas, no significant differences ($p \geq 0.05$) between chicks fed on 400 and 600 mg/kg SHMEOs (34.50 and 37.00 mg/dl) respectively, while, chicks fed on 200 mg/kg SHMEOs (59.00 mg/dl) significantly ($p \leq 0.05$) different from all tested groups.

For cholesterol LDL, chicks fed on 600 mg/kg SHMEOs obtained significantly ($p \leq 0.05$) the highest value (61.00 mg/dl), compared to other tested groups, there were no significant difference ($p \geq 0.05$) between chicks fed on control diet and chicks fed on 200 mg/kg SHMEOs (22.50 and 23.00 mg/dl) respectively, also chicks fed on 400 mg/kg SHMEOs showed significant value (51.00 mg/dl) difference ($p \leq 0.05$) compared to all tested groups.

For triglyceride, result showed that chicks fed on 400 mg/kg SHMEOs diet recorded significantly ($p \leq 0.05$) the highest value (71.50 mg/dl), and chicks fed on control showed significantly ($p \leq 0.05$) the lowest value (43.50 mg/dl), compared to chicks fed on 200 and 600 mg/kg SHMEOs (52.00 and 62.00 mg/dl) respectively. The analysis of data for glucose, recorded that chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (220.50 mg/dl), while chicks fed on 400mg/kg SHMEOs recorded significantly ($p \leq 0.05$) the lowest value (196.50 mg/dl), whereas no significant ($p \geq 0.05$) differences between chicks fed on 200 and 600 mg /kg SHMEOs (213.50 and212.50 mg/dl) respectively.

For creatinine, results showed no significant differences ($p \geq 0.05$) between all tested groups.

Table 35. Effect of different levels of Spearmint and halfa bar

Mixed Essential Oils on Serum Metabolite of Broiler chicks

Items mg/kg	TP g/dl	Alb g/dl	Uric mg/dl	Urea mg/dl	Chol mg/dl	HDL mg/dl	LDL mg/dl	Trigl mg/dl	Glu mg/dl	Creatien mg/dl
Control	3.95^{a}	2.05^{b}	3.45^{d}	7.10^{a}	124.50^{bc}	130.50^{a}	22.50^{C}	43.50^{d}	220.50^{a}	0.100
200 SHMEOs	3.55^{ab}	2.40^{a}	4.75^{a}	6.00^{b}	123.00^{c}	59.00^{b}	23.00^{C}	52.00^{c}	213.50^{b}	0.100
400 SHMEOs	3.30^{b}	2.00^{b}	4.60^{b}	5.60^{b}	133.00^{a}	34.50^{c}	51.00^{b}	71.50^{a}	196.50^{c}	0.100
600 SHMEOs	2.40^{c}	1.40^{c}	4.45^{c}	5.50^{b}	127.50^{b}	37.00^{C}	61.00^{a}	62.00^{b}	212.50^{b}	0.150
SE±	0.1708	0.0612	0.0354	0.2082	1.3229	0.8660	0.7360	0.8660	0.7071	0.0204
C.V	0.5467	0.1960	0.1132	0.6664	4.2348	2.7723	2.3560	2.7723	2.2636	0.0653
L.SD0.05	S	S	S	S	S	S	S	S	S	NS

Any two means values having same superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

Chol: Cholesterol, Trigl: Triglyceride, Alb: Albumin, T P: Total Protein, Glu: Glucose,

4.3.10 Economic appraisal:

The total costs, return and profitability ratio per head of broiler chicks fed different amount of spearmint and halfa bar mixed essential oils for five weeks were shown in table (36). Chicks purchase, feed, electricity, management and labor values were the major inputs considered. The total selling values of meat is the total revenues obtained. Profitability ratio (1.35) for group fed on 600mg/kg SHMEOs was the best of the tested groups followed by group fed on diet supplemented with 400 mg/kg SHMEOs (1.31) and finally group fed on diet supplemented with 200 mg/kg SHMEOs (1.10) compared to control group .

Table 36. Economical present of Spearmint and halfa bar mixed essential oils:

Parameters	control	200 mg/kg SHMEOs	400 mg/kg SHMEOs	600 mg/kg SHMEOs
Chick purchase	19.00	19.00	19.00	19.00
Total feed cost	37.71	39.93	40.79	43.36
Labor	7.00	7.00	7.00	7.00
Total cost	63.71	65.93	66.79	69.36
Average wt of carcass	1.38	1.48	1.64	1.70
Price	100	100	100	100
Revenues	138	148	164	170
Total cost	63.71	65.93	66.79	69.36
Profit	74.29	82.07	97.21	100.64
Profitability ratio	1	1.10	1.31	1.35

The total cost was calculated according to January 2019.

Price/kg meat was 100SDG according to February 2019.

4.4 Response of broiler chicks to Graded levels of fennel and spearmint and halfa bar mixed Essential Oils (FSHMEOs):

The chemical constituent of FSHMEOs presented in table (37).

Result showed eleven compounds: Aromandendrene, 1-Cyclohexene-1-carboxaldehyde,2,6,6-triment and 1,3-Benzenedimethanol,2-hydroxy-5-methyl- were the main compounds.

4.4.1Performance

The effect of feeding different levels of fennel, spearmintand halfa bar mixed essential oils on the performance of broiler chicks is shown in table (38).

The results indicated that, no significant ($p \geq 0.05$) differences were observed between all tested groups in feed intake, final body weight, body weight gain and feed conversion ratio throughout the experimental period.

For feed consumption chicks fed on 600mg/kg FSHMEOs consumed numerically the lowest quantity of feed (3262) gm, while chicks fed on 400mg/kg FSHMEOs recorded numerically the highest quantity of feed intake (3430) gm compared to all other tested groups.

For final body weight the result indicated that, the group of chicks fed on 400mg/kg FSHMEOs showed numerically the heaviest body weight (2105) gm, whereas, the chicks fed on 600 mg/kg FSHMEOs recorded numerically the lowest body weight value (1862) gm compared to other tested groups.

For body weight gain chicks fed on 400mg/kg FSHMEOs presented numerically the highest body weight gain value (1919) gm, while chicks fed on 600 mg/kg FSHMEOs recorded numerically the lowest value (1675) gm compared to all tested groups. Then again for feed conversion ratio group of chicks fed on 400mg/kg FSHMEOs showed numerically the best value (1.79) compared to all tested groups.

Table 37. Chemical Analysis of Fennel and Spearmint and halfa bar mixed essential oils

No	Name	RTime	Area%	Heigh%
1	Aromandendrene	5.537	13.65	7.06
2	1-Cyclohexene-1-carboxaldehyde,2,6,triment	5.648	10.92	6.92
3	1,3-Benzenedimethanol,2-hydroxy-5methyl-	5.928	14.02	7.03
4	Phenol,2-methoxy-4-(2-propenyl)-,acetate	6.552	8.97	7.10
5	Naphthalene,decahydro-4a-methyl-1-methyler	8.373	5.19	7.02
6	Cyclohexanol,2-methyl-5-(1-methylethenyl)	5.018	9.48	7.15
7	Cyclohexene,1-methyl-4-(1-methylethylidene)	3.599	4.78	5.70
8	D-Limonene	3.323	2.30	4.22
9	Benzoic acid ,2,3-dimethoxy-,methyl ester	6.650	3.01	3.88
10	Benzaldehyde dimethyl acetal	6.989	1.26	2.45
11	Octanenitrile	6.107	1.08	1.72

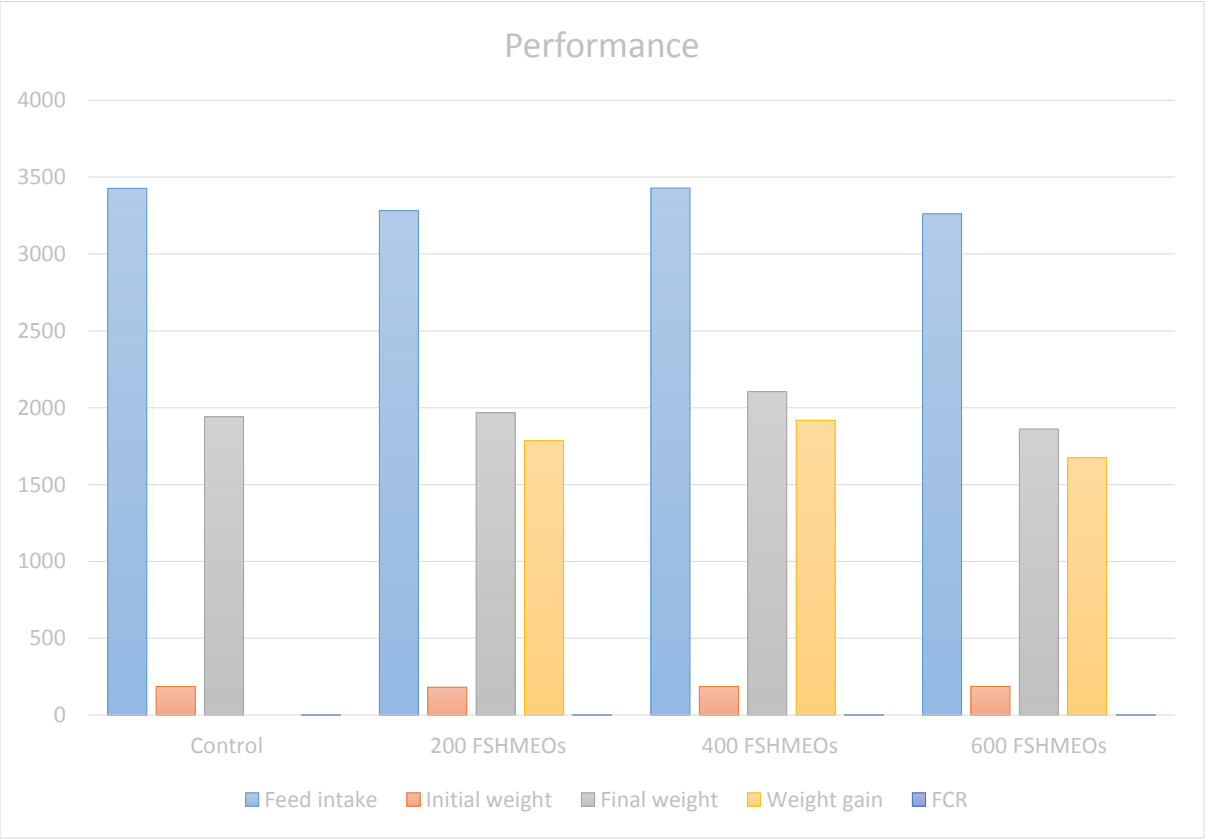
*Forensic Evidence lab using GC/MS (Gas chromatography-mass spectrometry) system

Table 38. Effect of Graded levels of Fennel and Spearmint and halfa mixed Essential Oils on performance of broiler chicks

Items mg/kg	Feed intake	Initial weight	Final weight	Weight gain	FCR
Control	3428	186	1943	I757	1.95
200mg/kg FSHMEOs	3283	182	1968	1786	1.86
400 mg/kg FSHMEOs	3430	186	2105	1919	1.79
600 mg/kg FSHMEOs	3262	187	1862	1675	1.96
SE±	124.87		122.01	122.01	0.1408
C.V	399.73		390.58	390.58	0.4507
L.sd 0.05	N.S	N.S	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Figure 4. Effect of Graded levels of Fennel and Spearmint and halfa mixed Essential Oils on performance of broiler chicks



4.4.2 Dressing and Giblets:

As shown in table (39) the result indicated no significant difference between all treatment groups in dressing, Intestine, liver, gizzard, and abdominal fat percentages except for heart recorded significant difference.

For dressing chicks fed on 600mg/kg FSHMEOs recorded numerically the highest value (71.24) compared to all tested groups, while chicks fed on 400 mg/kg **FSHMEOs** showed numerically the lowest value (69.88).

4.4.3 Non- Carcass Components:

The effect of supplementation of fennel, spearmint and halfa bar mixed essential oils on percentages of non-carcass components for broiler chicks shown in table (40), the result indicated no significant ($p \geq 0.05$) difference between all treated groups except the back documented significant ($p \leq 0.05$) difference .

For back were as no significant ($p \geq 0.05$) difference between chicks fed on control, chicks fed on 400 and 600 mg/kg FSHMEOs (19.69,17.51and 17.87) respectively, also, chicks fed on 200, 400and 600 mg/kg FSHMEOs (15.68,17.51 and 17.87) respectively.

Table 39. Effect of Graded levels of Fennel and Spearmint and halfa bar mixed Essential Oils on Dressing and Giblet of broiler chicks:

Item mg/kg	Dressing%	Intestine wt%	Liver%	Gizzard%	Heart %	Abdominal fat%
Control	70.31	3.80	2.05	1.55	0.51^{ab}	1.07
200 FSHMEOs	70.40	4.06	2.09	1.61	0.63^{ab}	0.81
400 FSHMEOs	71.20	3.85	2.13	1.39	0.48^{b}	1.2
600 FSHMEOs	71.24	3.70	2.32	1.57	0.66^{a}	0.49
SE±	2.2779	0.3181	0.3719	0.0993	0.0495	0.4113
C.V	7.2921	1.0183	1.1905	0.3179	0.1585	1.3167
L.SD0.05	N.S	N.S	N.S	N.S	S	N.S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Table 40. Effect of Graded levels of Fennel and Spearmint and halfa bar mixed Essential Oils on non carcass component of broiler chicks

Item mg/kg	Kidney%	Lung%	Legs%	Neck%	Head%	Gut/cm	Back%	Wing%
Control	0.37	0.73	3.62	5.19	2.55	178.33	19.69[a]	10.47
200FSHMEOs	0.41	0.69	4.19	4.98	2.60	173.67	15.68[b]	10.32
400FSHMEOs	0.43	0.71	3.96	4.45	2.18	169.67	17.51[ab]	10.15
600FSHMEOs	0.51	0.68	4.05	4.58	2.32	177.67	17.87[ab]	11.46
SE±	0.0682	0.1068	0.4259	0.6099	0.1370	5.9907	0.8269	1.1689
CV	0.2182	0.3419	1.3634	1.9525	0.4385	19.178	2.6471	3.7419
L.SD0.05	NS	NS	NS	NS	NS	NS	S	NS

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.4.4 Commercial cuts:

The results of commercial cuts percentages of broiler chicks fed graded levels of fennel, spearmint and halfa bar mixed essential oils shown in table (41).

Treatments effect is not significant ($p \geq 0.05$) in all commercial cuts (drumstick , breast and thigh), However, for breast chicks fed on 200mg /kg FSHMEOs noted numerically the highest value (39.77), while chicks fed on 600mg/kg FSHMEOs recorded numerically the lowest value(38.06) compared to all other tested groups.

Also for thigh, chicks fed on 200 mg/kg FSHMEOs diet displayed numerically the highest value (15.13), while chicks fed on 400mg/kg FSHMEOs showed numerically the lowest value (14.16) compared to all tested group.

As a final point for drumstick, chicks fed on 200mg/kg FSHMEOs showed numerically the highest value (13.70), while chicks fed on control diet documented the lowest value (11.73) compared to all tested groups.

Table 41. Effect of Graded levels of Fennel and spearmint and halfa bar mixed Essential Oils on Commercial Cuts of broiler chick

Items mg/kg	Breast%	Thigh%	Drumstick%
Control	39.22	15.07	11.73
200 FSHMEOs	39.77	15.13	13.70
400 FSHMEOs	38.53	14.16	12.06
600 FSHMEOs	38.06	15.01	12.88
SE±	2.1803	0.8773	0.9942
C.V	6.9796	2.8084	3.1826
L.SD 0.05	N.S	N.S	N.S

Any two means values having no superscript with in columns are not significantly bdifferent ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.4.5 Meat of Commercial Cuts:

Effect of feeding broiler chicks of different levels of fennel, spearmint and halfa bar mixed essential oils on percentages of breast meat, thigh meat, drumstick meat and their bones was tabulated in table (42).

Result showed no significant ($p \geq 0.05$) difference between meat and bone of commercial cuts except for drumstick which documented significant difference.

For drumstick meat there was no significant difference between chicks fed on control, 200 and 600mg/kg FSHMEOs (72.53, 73.53 and76.37) respectively, also between chicks fed on 200, 400 and 600mg/kg FSHMEOs (73.53, 77.22 and 76.37) respectively.

On the other hand for drumstick bone there was no significant difference between chicks fed on control diet and chicks fed on 200mg/kg FSHMEOs (26.69 and 24.97) respectively and chicks fed on 400 and 600 mg/kg FSHMEOs (21.42 and 22.53) respectively, also, between chicks fed on 200 and 600 mg/kg FSHMEOs (24.97 and 22.53) respectively.

Table 42. Effect of Graded levels of Fennel and Spearmint and halfa bar mixed Essential Oils on Meat of Commercial Cuts of broiler chicks

Item mg/kg	Breast meat%	Breast bone%	Thigh meat%	Thigh bone%	Drumstick meat%	Drumstick bone%
Control	85.15	14.08	84.78	14.88	72.53^{b}	26.69^{a}
200 FSHMEOs	86.39	13.36	84.22	13.57	73.53^{ab}	24.97^{ab}
400 FSHMEOs	85.89	13.15	86.36	12.49	77.22^{a}	21.42^{c}
600 FSHMEOs	85.15	13.75	84.67	13.69	76.37^{ab}	22.53^{bc}
SE±	2.7850	2.7851	1.3766	2.0165	1.2251	0.9837
C.V	8.9153	8.9156	4.4068	6.4554	3.9219	3.1491
L.SD0.05	NS	NS	NS	NS	S	S

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

4.4.6 Subjective Quality Attributes:

Treatments effect on subjective meat attributes showed no significant ($p \geq 0.05$) difference between all tested groups, mean values of all sensory attributes are closely similar, and score given for all attributes were above the moderate acceptance, as shown in table(43), the score given for (tenderness, flavor, color and juiciness) using an eight points scale.

4.4.7 Meat Chemical Composition:

Meat chemical composition aspects were shown in table (44). The results indicated that there were no significant ($p \geq 0.05$) differences between the experimental groups in moisture, dry matter and ash in the tested meat, but crude protein and ether extract showed significant ($p \leq 0.05$) effect. Broiler chicks fed on control diets and 200mg/kg FSHMEOs recorded significantly ($p \leq 0.05$) the highest crude protein values (22.58and 22.57) respectively as compared to chicks fed on 400 and 600 mg/kg FSHMEOs (22.09 and 21.81) respectively.

For ether extract the results noted no significant difference between chicks fed on control, 400 and 600 mg/kg FSHMEOs values (1.38, o.95 and 1.15) respectively, also, chicks fed on 200 and 400 mg/kg FSHMEOs values (0.45 and 0.95) respectively.

Table 43. Effect of Graded levels of fennel and speamint and halfa bar mixed essential Oils on Subjective Quality Attribute

Items mg/kg	Tenderness	Flavor	Color	Juiciness
Control	6.10	6.10	6.32	5.85
200 FSHMEOs	5.48	6.09	6.38	5.75
400 FSHMEOs	6.19	6.08	5.82	6.23
600 FSHMEOs	6.43	6.05	5.99	6.27
SE±	0.3390	0.2812	0.1563	0.4195
C.V	1.0853	0.9001	0.5002	1.3428
L.SD0.05	NS	NS	NS	NS

Any two means values having no superscript with in columns are not significantly different ($p \leq 0.05$).SE±: Stander error. C.V: Critical value

Table 44. Effect of Graded levels of Fennel and Spearmint and Halfa mixed Essential Oils on Meat Chemical Composition of Broiler chicks

Items mg/kg	Moisture	Dry matter	Ash	Crude protein	Ether Extract
Control	73.23	26.77	1.20	22.58[a]	1.38[a]
200 FSHMEOs	73.90	26.10	1.15	22.57[a]	0.45[b]
400 FSHMEOs	74.47	25.53	1.30	22..09[b]	0.95[ab]
600 FSHMEOs	73.63	26.37	1.25	21.81[b]	1.15[a]
SE±	0.7083	0.7083	0.0540	0.1254	1.699
C.V	2.2674	2.2674	0.1729	0.4015	0.5438
L.SD 0.05	NS	NS	NS	S	S

Any two means values having no superscript within columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

4.4.8 Serum enzymes and minerals:

The serum enzymes and minerals values of broiler chicks fed different levels of fennel, spearmint and halfa bar mixed essential oils are shown in table (45).

The result showed significantly ($p \leq 0.05$) differences among all tested groups for serum enzymes and minerals (AST, ALP, Ca and P).

For AST chicks fed on 600 mg/kg FSHMEOs revealed significantly ($p \leq 0.05$) the highest value (51.65 iu/L) between all other groups, whereas chicks fed on 200mg/kg FSHMEOs noted significantly ($p \leq 0.05$) the lowest value (36.50 iu/L)

On the other hand for ALP level in serum chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (247.50 iu/L), even though chicks fed on 600mg/kg documented significantly ($p \leq 0.05$) the lowest value (182.15 iu/L) compared to 200 and 400 mg/kg FSHMEOs (213.00 and 209.00iu/L) respectively.

For Ca chicks fed on 600mg/kg FSHMEOs recorded significantly ($p \leq 0.05$) the highest value (10.05 mg/dl) compared to other tested groups.

For Serum phosphorus chicks fed on control diet showed significantly($p \leq 0.05$) the highest value (8.75 mg/dl) between all other tested groups, although, chicks fed on 400 mg/kg FSHMEOs noted significantly ($p \geq 0.05$) the lowest value (5.45 mg/dl).

Table 45. Effect of Graded levels of fennel and spearmint and hafa bar mixed Essential Oils on Serum Enzymes and Minerals of Broiler chicks

Item	AST iu/L	ALP iu/L	Ca mg/dl	P mg/dl
Control	38.95^{c}	247.50^{a}	8.15^{b}	8.75^{a}
200 FSHMEOs	36.50^{d}	213.00^{b}	7.90^{b}	6.90^{c}
400 FSHMEOs	47.10^{b}	209.00^{b}	7.10^{b}	5.45^{d}
600FSHMEOS	51.65^{a}	182.15^{c}	10.05^{a}	7.55^{b}
SE±	0.1323	4.2086	0.3708	0.0791
C.V	0.4235	13.473	1.1870	0.2531
L.SD0.05	S	S	S	S

Any two means values having same superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value

4.4.9 Serum Metabolites:

Serum Metabolite values of broiler chicks fed of different levels of fennel , spearmint and halfa bar mixed oils are shown in table (46), results showed significant ($p \leq 0.05$) differences (observed between all treatments for serum metabolite).

For total protein chicks fed on control diet noted significantly ($p \leq 0.05$) the highest value (3.95g/dl) compared to other tested groups, while chicks fed on 200 and 400mg/kg FSHMEOs presented significantly ($p \geq 0.05$) the lowest values (2.70 and 2.70 g/dl).

The analysis of data for albumin broiler chicks fed on diets supplemented with control and 200mg/kg FSHMEOs showed significantly ($p \leq 0.05$) the highest values (2.05 and 2.10 g/dl) respectively, compared to all other tested groups, for albumin chicks fed on 400 mg/kg FSHMEOs recorded significantly ($p \geq 0.05$) the lowest value (1.65 g/dl).

Results obtained showed significant ($p \leq 0.05$) uric acid. For the analysis of serum urea, broiler chicks fed on control diet recorded significantly ($p \leq 0.05$) the highest values (7.10 mg/dl) compared to other tested groups.

For cholesterol concentration, chicks fed on 600 mg/kg FSHMEOs noted significantly ($p \leq 0.05$) the highest value (129.50 mg/dl), while chicks fed on 200 and 400 mg/kg FSHMEOs recorded significantly ($p \geq 0.05$) the lowest values (114.50 and 112.00 mg/dl) respectively.

For HDL chicks fed on control diet noted significantly ($p \leq 0.05$) the highest value (130.50 mg/dl) between all tested groups, whereas chicks fed on 200 and 400 mg/kg FSHMEOs documented significantly ($p \geq 0.05$) the lowest values (21.50 and 19.50 mg/dl) respectively.

For LDL chicks fed on 200 mg/kg FSHMEOs noted significantly ($p \leq 0.05$) the highest values (29.00 mg/dl), while chicks fed on 400 mg/kg FSHMEOs noted

significantly ($P \leq 0.05$) the lowest values (17.00 mg/dl) compared to chicks fed on control diet and chicks fed on 600 mg/kg FSHMEOs (22.50 and 24.00 mg/dl) respectively. For triglyceride chicks fed on 200mg/kg FSHMEOs detailed significantly ($p \leq 0.05$)the highest value (49.00 mg/dl) between all tested groups, while chicks fed on 400mg/kg FSHMEOs showed significantly ($p \leq 0.05$)the lowest value (29.50 mg/dl) as compared to chicks fed on control and 600 mg/kg FSHMEOs values (43.50 and 42.00 mg/dl) respectively.

For glucose results showed that chicks fed on 200 and 400 mg/kg FSHMEOs noted significantly ($p \leq 0.05$) the highest values (229.00 and 228.50 mg/dl) respectively, although, chicks fed on control diet recorded significantly ($p \leq 0.05$) the lowest value (220.50 mg/dl).

For creatine experimental chicks fed on 600mg/kg FSHMEOs recorded significantly ($p \leq 0.05$) the highest values (0.20 mg/dl) as compared to other tested groups, where as no significant ($p \geq 0.05$) difference between chicks fed on control diet and chicks fed on 200 and 400 mg/kg FSHMEOs (0.10, 0.04 and 0.05 mg/dl) respectively.

Table 46. Effect of different levels of Fennel and Spearmint and halfa bar mixed Essential Oils on Serum Metabolite of Broiler chick

Item mg/kg	T.P g/dl	Albu g/dl	Uric mg/dl	Urea mg/dl	Chol mg/dl	HDL mg/dl	LDL mg/dl	Trigl mg/dl	Glu mg/dl	Cre mg/dl
Control	3.95[a]	2.05[a]	3.45[d]	7.10[a]	124.50[b]	130.50[a]	22.50[b]	43.50[b]	220.50[c]	0.10[b]
200 FSHMEOs	2.70[c]	2.10[a]	3.80[c]	5.00[b]	114.50[c]	21.50[c]	29.00[a]	49.00[a]	229.00[a]	0.04[b]
400 FSHMEOs	2.70[c]	1.65[c]	7.00[b]	5.50[b]	112.00c	19.50[c]	17.00[c]	29.50[c]	228.50[a]	0.05[b]
600 FSHMEOs	2.95[b]	1.85[b]	7.60[a]	5.50[b]	129.50[a]	49.50[b]	24.00[b]	42.00[b]	226.00[b]	0.20[a]
SE±	0.0764	0.0540	0.0736	0.2915	0.9789	0.9129	1.1726	1.1902	0.6455	0.0205
C.V	0.2445	0.1729	0.2356	0.9333	3.1338	2.9223	3.7537	3.8102	2.0664	0.0657
L.SD0.05	S	S	S	S	S	S	S	S	S	S

Any two means values having s

Ame superscript with in columns are not significantly different ($p \leq 0.05$). SE±: Stander error. C.V: Critical value.

Chol: Cholesterol, Trigl: Triglyceride, Alb: Albumin, T P: Total Protein, Glu: Glucose, Cre: Creatinine.

4.4.10 Economic appraisal:

The total costs, return and profitability ratio per head of broiler chicks fed different amount of fennel, spearmint and halfa bar mixed essential oils were shown in table(47).

Chicks purchase, feed, electricity, management and labor values were the major inputs considered. The total selling values of meat is the total revenues obtained. Profitability ratio (1.21) for group fed on 400mg/kg FSHMEOs was the highest of the tested groups followed by group fed on diet supplemented with 200 mg/kg FSHMEOs (1.03)and finally group fed on diet supplemented with 600 mg/kg FSHMEOs (1.01) compared to control group.

Table. 47 Economical present of Fennel and Spearmint and Halfa bar mixed Essential Oils

Parameters	Control	200 mg/kg	400 mg/kg	600 mg/kg
Chick purchase	19	19	19	19
Total feed cost	37.71	38.23	41.97	42.24
Labor	7	7	7	7
Total cost	63.71	64.23	67.97	68.24
Average wt of carcass	1.38	1.408	1.577	1.432
Price	100	100	100	100
Revenues	138	140.8	157.7	143.2
Total cost	63.71	64.23	67.97	68.24
Profit	74.29	76.57	89.73	74.96
Profitability	1	1.03	1.21	1.01

The total cost was calculated according to January 2019.

Price/kg meat was 100SDG according to February 2019.

4.5 Effect of dietary (FSMEOs), (FHMEOs), (SHMEOs) and (FSHMEOs) and their levels on performance and their interaction

The results of interaction between all experiments (Fennel and Spermint, Fennel and Halfa bar, Spermintand Halfa bar and Fennel and Spermint and Halfa bar) mixed essential oils were shown in table (48), the results indicated that, no significant effect on feed intake, body weight, body weight gain and feed conversion ratio (FCR) between all experiments but the experiment two (Fennel and Halfa bar) mixed oils recorded numerically the heaviest body weight and body weight gain (2,109.78 and 1,924.78) respectively, and obtained the best FCR (1.82) as compared to other experiments. About levels, the results of interaction between levels recorded that, no significant effect on feed intake, body weight, body weight gain and feed conversion ratio between all levels, but the level 400mg/kg recorded numerically the heaviest body weight and body weight gain (2,050.67 and 1,865.67) respectively, and obtained the best FCR compared to other levels.

Table. (48) Effect of four experiments (FSMEOs, FHMEOs, SHMEOs and FSHMEOs) and their levels on performance and their interaction

Treatments		BW	BWG	FI	FCR
CONTROL		1,942.00	1,757.00	3,428.67	1.95
EXPERIMENT EFFECT					
1	Fennel+Spermint	2,050.89	1,865.89	3,360.33	1.82
2	Fennel + Halfa bar	2,109.78	1,924.78	3,485.56	1.82
3	Spermint+Halfa bar	2,036.56	1,851.56	3,380.44	1.83
4	Fennel+Spermint+Halfa	1,97878	1,793.78	3,325.33	1.87
	SEM	52.66	52.66	47.13	0.06
	p –value	0.39	0.39	0.12	0.94
	Sig	N.S	N.S	N.S	N.S
LEVEL EFFECT					
1	200 mg/Kg	2,038.42	1,853.42	3,360.08	1.82
2	400 mg/K	2,050.67	1,865.67	3,415.92	1.85
3	600 mg/Kg	2,042.92	1,857.60	3,387.75	1.84
	SEM	45.60	45.60	40.81	0.05
	p –value	0.98	0.98	0.63	0.95
	Sig	N.S	N.S	N.S	N.S
EXP X LEVEL INTERACTION					
	SEM	91.21	91.21	81.62	0.11
	p –value	0.11	0.11	0.59	0.29
	Sig	N.S	N.S	N.S	N.S

a-b: Means in a column and main effect with no common superscript differ significantly (P≤0.05).*: Significant with (P≤0.05). N.S: Not sign.

Figure (5). Effect of four experiments (FSMEOs, FHMEOs, SHMEOs and FSHMEOs) and their levels on body weight and their interaction

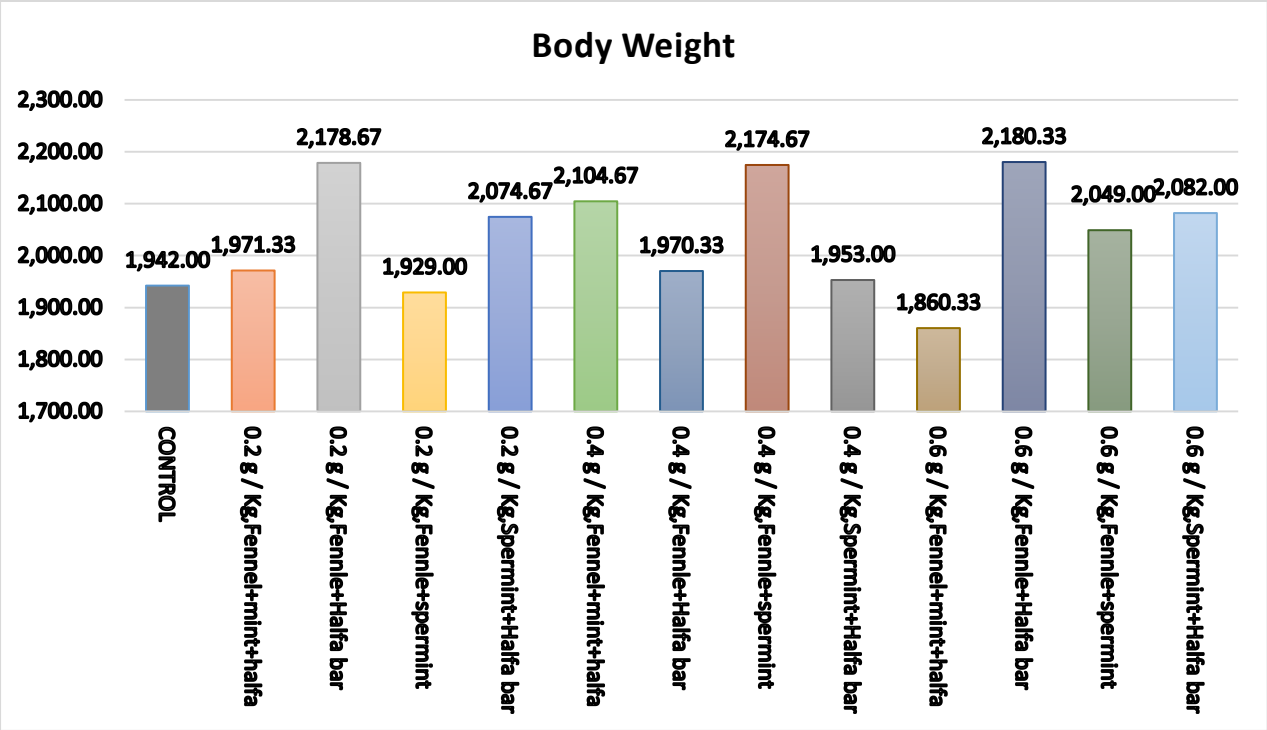


Figure (6). Effect of four experiments (FSMEOs, FHMEOs, SHMEOs and FSHMEOs) and their levels on body weight gain and their interaction

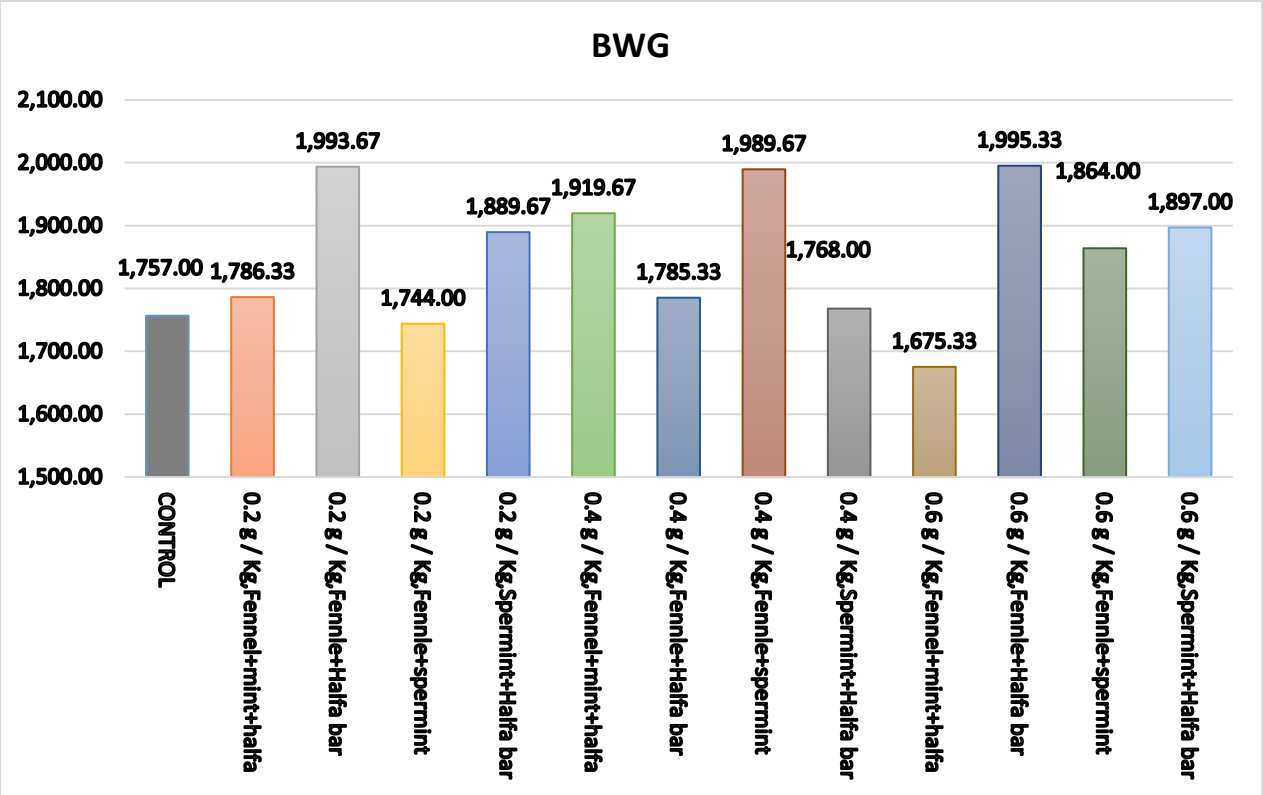


Figure (7). Effect of four experiments (FSMEOs, FHMEOs, SHMEOs and FSHMEOs) and their levels on feed intake and their interaction

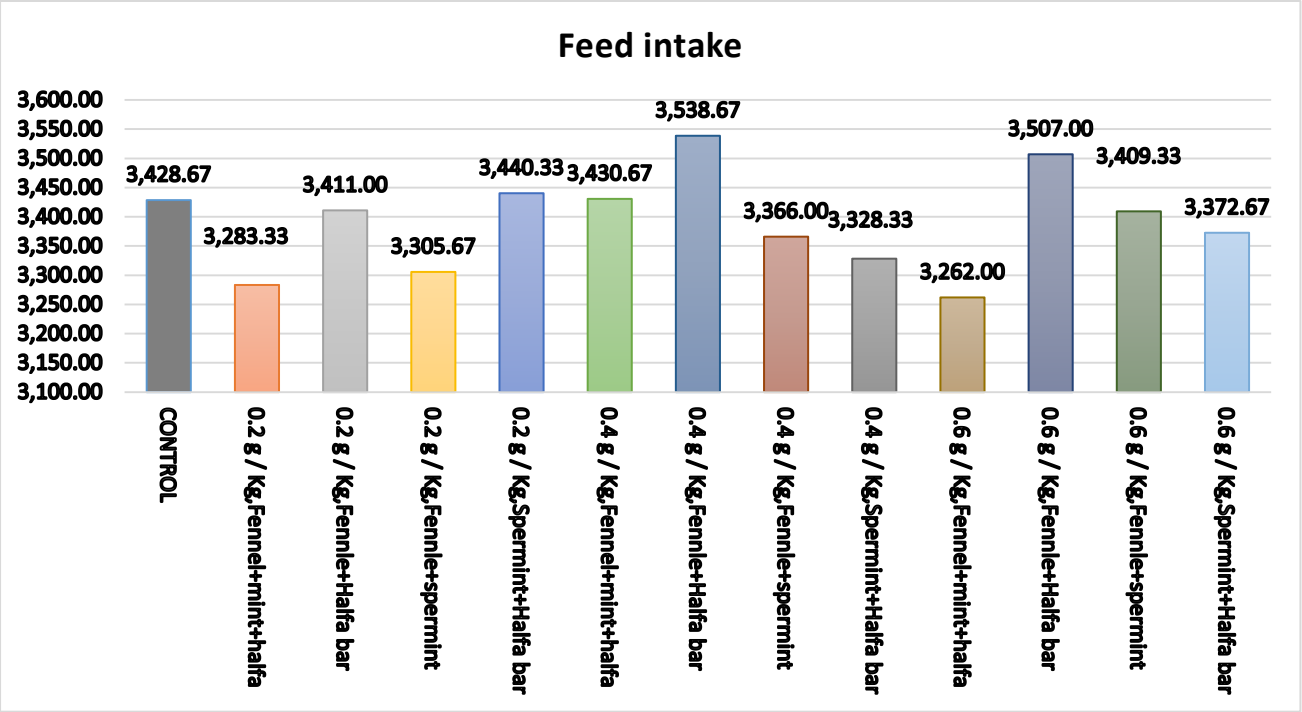
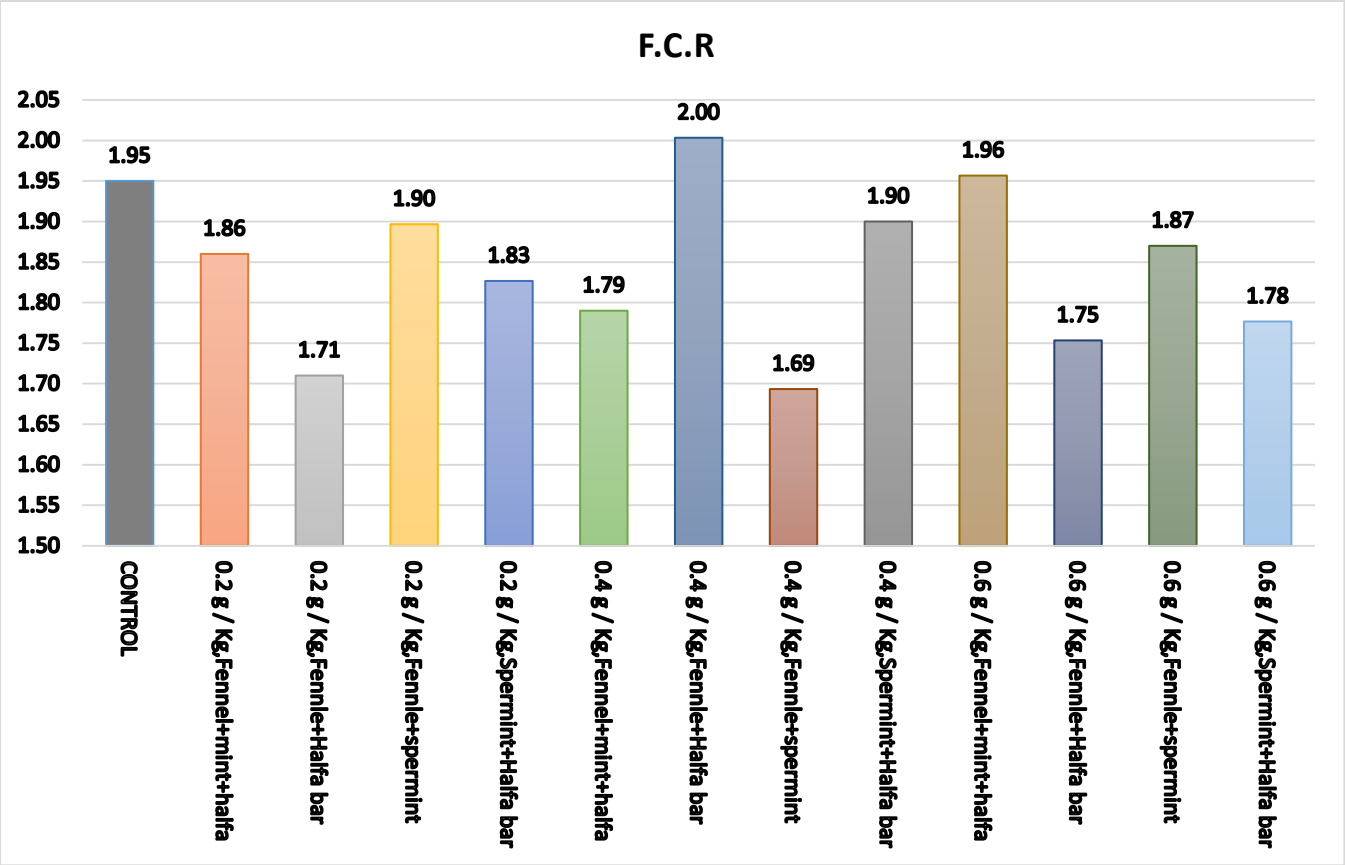


Figure (8). Effect of four experiments (FSMEOs, FHMEOs, SHMEOs and FSHMEOs) and their levels on feed conversion ratio and their interaction



4.6 Comparative between economic appraisals of all experiments:

As shown in table (49), the results of economic evaluation revealed that, Chicks fed on all mixed essential oils with all levels (200, 400 and 600 mg/kg) obtained more net profit/bird as compared to chicks fed on control diet, except the level 600mg/kg of experiment one (fennel and spearmint) mixed oils recorded less profit than control (0.99), although, the chicks fed on 200mg/kg of experiment (2) (fennel and spearmint) mixed oils was recorded the highest of the all tested groups (1.37), follow by chicks fed on 600mg/kg of experiment (3) (spearmint and halfa bar) mixed oils (1.35), then chicks fed on 200mg/kg of experiment one (fennel and spearmint) mixed oils obtained (1.32).

Table. (49) Comparative between economic appraisals of all experiments

mixed essential oils	Items	Control	200mg/kg	400mg/kg	600mg/kg
Fennel and Spearmint	Total cost	63.71	64.86	68.03	71
	Revenue	138	162.7	168	144.2
	Net profits	74.29	97.84	99.97	73.2
	Profitability ratio/bird	1	1.32	1.35	0.99
Fennel and Halfa bar	Total cost	63.71	65.25	68.42	69.83
	Revenue	138	166.8	145.7	159.2
	Net profits	74.29	101.55	77.28	89.37
	Profitability ratio/bird	1	1.37	1.04	1.20
Spearmint and Halfa bar	Total cost	63.71	65.93	66.79	6936
	Revenue	138	148	164	170
	Net profits	74.29	82.07	97.21	100.64
	Profitability ratio/bird	1	1.10	1.31	1.35
Fennel and Spearmint and Halfa bar	Total cost	63.71	64.23	67.97	68.24
	Revenue	138	140.8	157.7	143.2
	Net profits	74.29	76.57	89.73	74.96
	Profitability ratio/bird	1	1.03	1.21	1.01

CHAPTER FIVE

DISCUSSION

Results obtained for broiler chicks supplemented with graded levels of different combinations for (Fennel, Spearmint and Halfa bar essential oils), showed no mortality through out the experimental period due to treatments, this might be due to the good hygiene conditions, and it could be that essential oils (EOs) enhance production of digestive secretions, stimulate blood circulation, mitigate the levels of fermentation products and enhance precaecal nutrient digestion, improve the intestinal availability of essential nutrients for absorption (Windisch *et al*., 2008; Zeng *et al*., 2015), also, EOs improve the ecological conditions of the gut and stimulate the activity of the digestive enzymes (Cross *et al*., 2007; Jang *et al*., 2007). This result was in line with the finding of (Osman ***et al***., 2005; Mukhtar *et al*., 2010; Mukhtar, 2011), also, similarly with result of (Nematollah *et al*., 2017) who reported that, enjoying Spearmint especially at the starting period could decrease broiler mortality. It seems that the antiseptic properties of the plant prevent harmful bacterial growth in the intestinal tract and finally decreased broiler mortality. In addition, it has been shown that the improvement in the broiler health might be due to the role of Spearmint as an immune stimulating factor. Studies have shown that Spearmint extract prevent bacterial growth and many of organisms (Pattnaik *et al*., 1997).

5.1 Response of broiler chicks to graded levels of Fennel and Spearmint mixed Essential Oils (FSMEOs):

The chemical analysis of (FSMEOs) showed eighet compounds: Aromandendrene, 2-cyclohexen-1-one,3-methyl-6-(1-methyleth) and Bicyclo (3,1,1) hept-3-en-one,4,6,6-trimethyl represented the main compounds, the composition depends upon mixing of oils, season of collection, age of plant and area of collection.

The results of the present study showed that, no significant ($p \geq 0.05$) difference between all tested groups in feed intake, body weight, body weight gain and feed conversion ratio. for feed consumption there was no significant ($p \geq 0.05$) difference between all tested groups, however, numerically lowest consumption was noticed by chicks fed on 200mg/kg oils (3305gm), chicks fed on control diet consumed numerically the highest feed (3428gm) , the results of the present study was disagreed with Mukhtar *et al* ., (2013) who showed that chicks fed on diets supplemented with SPO consumed significantly more feed compared to control group, the results recorded no significant ($p \geq 0.05$) difference in body weight and body weight gain and feed conversion ratio, however, group fed on 400mg/kg mixed essential oils recorded numerically the highest body weight (2177 gm), body weight gain (1989gm) and best feed conversion ratio (1.69) between all tested groups, This result is similar to the finding of Çabuk M. *et al*., (2006) who studied the Essential oils supplementation of the diet did not affect ($P > 0.05$) body weight of the broilers at 21 and 42 days of age, This result also similarly to the finding of Madrid *et al*., (2003) who showed the effect of a plant extract from, (blend of oregano, cinnamon and pepper essential oils) on broiler performance. However, the result agree with Alçiçek *et al*., (2003) who showed, positive effects of dietary essential oils on body weight were observed, Hernandez *et al*., (2004) found that the addition of two plants extracts to a broiler diet significantly improved broiler body weight at 35 days of age. Furthermore, the inclusion of 150 or 300 mg/kg of a plant extract containing capsaicin, carvacrol and cinnamicaldehyde in a diet improved body weight by 5.4 and 8.1%, respectively. In similar to our result, Lee *et al*., (2003), Botsoglou *et al*. (2004) and Hernandez *et al*. (2004) reported that addition of plant extracts or essential oils to the diet had no positive effect on feed intake or FCR, the result disagree with the finding of Çabuk M.*et al*., (2006) who reported feed intakes and feed conversion ratios were significantly influenced by the addition of EOM (oregano oil , laurel leaf

oil , sage leaf oil , myrtle leaf oil , fennel seed oil and citrus peel oil) to the diet at the 42 days of age stage.

Also the result disagree with those of (Alcicek *et al*., 2004) who used 48 mg/kg of an essential oil mixture in the diet of broiler. Halle *et al*., (2004) noted that the addition of oregano and its essential oil reduced daily feed intake of broilers and significantly improved FCR, the result similar to finding *Daffallaa, (2016) who revealed no significant (P>0.05) difference in FCR among all tested groups, in addition Khattak *et al*., (2014) reported adding of a blend of EO in a ration meeting the nutrient requirements of broilers would improve the body weight gain.

For dressing, intestine weight, liver, gizzard and heart, results showed no significant (p≥ 0.05) difference between all tested groups expect for abdominal fat which recorded significant (p≤ 0.05) difference, for abdominal fat chicks fed 200 mg/kg mixed essential oils recorded least significant (p≥ 0.05) difference compared to other tested groups, also results obtained recorded that, no significant difference (p ≥ 0.05) between all tested groups in kidney, lung, legs, neck, , intestine length, back and wing, except for head which recorded significant (p≤ 0.05) difference, this result agreement with Çabuk et al., (2006) who noted relative weights of the carcass, liver, gizzard and small intestine weight were not affected by dietary treatment. The results are also, in line with the results of Hernandez *et al*., (2004) who found no differences in gizzard and liver weights of broiler chickens fed diet containing an essential oil extract. Related results were observed by Jamroz *et al*., (2005) who used essential oils in broiler diets based on maize and locally grown cereals. In difference result Denli *et al*., (2004) reported that inclusion of thyme and black seed essential oil increased intestinal weight and intestinal length in quail. This results vary with Iqbal *et al*., (2021) who reported exhibited a marked (p<0.05) increase in carcass characteristics, especially inevisceratedweight and giblet weight, group B containing essential oils, revealed the highest eviscerated weight and giblet

weight than others, the results of this study are also preferred by Rehman *et al.*, (2016), who noted insignificant results in dressing percentage. Results obtained showed no significant ($p \geq 0.05$) difference between all tested groups in breast, thigh and drumstick percentages values, for meat of commercial cuts results for breast meat showed that chicks fed on 200 and 600 obtained significantly ($p \leq 0.05$) the highest values (88.34 and 88.51) respectively compared to control (85.15), no significant ($p \geq 0.05$) difference showed between all tested groups in thigh, drumstick and theire meat and bone, our finding supported by Daffallaa, (2016) who showed no significant difference ($p \geq 0.05$) among all treatment groups in the percentages of carcass dressing, giblets, commercial cuts and their separable tissue percentages when they fed broiler chicks on diet supplemented with MEO. The results differ with the finding of Mehdi *et al.*, (2018) who reported increased thigh muscle percentage and less abdominal fat are the meat characteristics that are improved by feeding essential oils to broilers.

Results revealed no significant difference ($p \geq 0.05$) between tested groups on the scores given for (tenderness, flavor, color and juiciness) using an eight point scale, and scores given for all attributes were above the moderate acceptance, these results related with Essam, (2018) who noted inclusion of fennel essential oil at various levels had no significant effects on subjective and objective meat qual. Result for meat chemical compositions showed that the moisture value was significantly ($p \leq 0.05$) difference between tested groups, the result showed that, chicks fed on diets supplemented with 600mg/kg FSMEOs recorded significantly ($p \leq 0.05$) the highest value of moisture (75.90) and the lowest value (24.10) for dry matter . Results concerning ash showed that, chicks fed on 200mg/kg FSMEOs recorded significantly ($p \leq 0.05$) the highest value (1.30) as compared to other tested groups, which showed no significant difference ($p \geq 0.05$) between them. The analysis of data for crude protein and ether extract showed, that chicks fed on control diet recorded significantly ($p \leq 0.05$) the highest values (22.58,1.38) respectively as compared to other tested

groups, the result vary with the finding with Daffallaa, (2016) who revealed no significant difference (P>0.05) among all treatment groups, for meat chemical composition and subjective meat quality parameters when broiler chicks fed on MEOs in diets, also, the result differ with Amal, (2012) who reported no significant difference (P>0.05) between the experimental groups in (crude protein, ether extract, moisture and ash in the tested meat).

The result showed significantly (p≤ 0.05) difference among all tested groups for serum enzymes and minerals (AST, ALP, Ca and P), for AST chicks fed on control diet showed significantly (p≤ 0.05) the highest value (38.95 iu/L), while group of chicks fed on 600mg/kg FSMEOs recorded significantly (p ≥0.05) the lowest value (24.85 iu/L), the study differ with Amal, (2012) who reported the treatment effect was not significant on AST enzyme. Result for ALP enzyme showed that, chicks fed on control diet and 200mg/kg FSMEOs recorded significantly (p≤ 0.05) the highest values (247.50 iu/L and 246.0 iu/L) respectively, while, chicks fed on 400 mg/kg FSMEOs noted significantly (p ≥0.05) the lowest value (230.35 iu/L), these results agreement with Amal, (2012) who noted the use of BC, LG, SP and HB essential oils at different levels in broiler diets resulted in asignificant (p≤ 0.05) reduction in the activity of alkaline phosphatase (ALP) enzyme compared to the antibiotic (PC) and (NC) groups with in the normal range. For Ca and P the result showed significant (p≤ 0.05) difference among all tested groups, these results differ with Amal, (2012), also our study contrast with Essam, (2018) who recorded calcium and phosphorus concentration in blood serum showed no significant.

The results of the study showed significant difference between all treatments for serum metabolites, except createine. The results of total protein, urea and HDL showed that, chicks fed on control diet recorded significantly (p ≤0.05) the highest values (3.95, 7.10and 130.50) respectively compared to other tested groups, these results vary with Witkowska *et al*., (2019) who reported**,** the mean

values of serum total protein did not differ (P <0.05) between groups in all test series.

In this study chicks fed on 400mg/kg FSMEOs recorded significantly (p ≤0.05) the highest value (2.30) of albumin compared to other tested group. For uric acid, there was no significant difference (p ≥0.05) between chicks fed on control diet and chicks fed on 200mg FSMEOs (3.45 and 3.15 respectively) also, between chicks fed on 400and 600mg/kg FSMEOs (2.15 and 2.25 respectively). Supplementation of fennel and spearmint mixed oils at different levels documented significantly reduction in cholesterol value with increasing of FSMEOs in diet, these result in line with (Khajeali *et al*, 2012) who reported, the use of 2% black cumin in the diet of broiler reduced the level of triglyceride and total cholesterol, also, adding 0.5 and 2% cumin powder to the Japanese quail diet reduced total cholesterol and triglyceride. Sedlakova *et al*., (2003) noted reducing the level of cholesterol by using fennel and cumin plants which associated with a decrease in the absorption of fat in the intestines by their active components, the main cause is the presence of thymol, thymocaine, anethole, and carvone in the building of these medicinal plants that reduce cholesterol and its biosynthesis. Also, the results were agree with Mukhtar *et al*., (2013) who added different dietary levels of spearmint oil (SPO) as a natural growth promoter which reduced levels of serum cholesterol, urea and ALP enzyme activity and without any effect on the total protein, calcium, phosphorus and AST enzyme activity. Also, the result vary with Iqbal *et al* ., (2021) who revealed no remarkable change in total cholesterol and high-density lipoprotein levels when birds were offered essential oil and organic acids in the diet, low-density lipoprotein was decreased by feeding essential oils and organic acids, the result differ with Gharehsheikhloul *et al*., (2018) who reported the use of different levels of fennel and savory essential oils and their mixture in broiler chickens diet which did not have a significant effect on total cholesterol /HDL ratio and LDL/HDL ratio compared to control treatment (p≥0.05). For

LDL result revealed that chicks fed on 200mg/kg FSMEOs noted significantly ($p \leq 0.05$) the highest value (27.05mg/dl), compared to other tested groups, concerning the serum triglyceride, group of chicks fed on control diet and 600mg/kg FSMEOs showed significantly ($p \leq 0.05$) the highest values (43.50 and 42.50 mg/dl respectively) compared to other tested groups,

The analysis of data for serum glucose showed that chicks fed on control diet and 200mg/kg FSMEOs recorded significantly ($p \leq 0.05$) the highest values (220.50 and 221.00 mg/dl) respectively, this result similar with Iqbal *et al* ., (2021) who reported essential oil and organic acids raised the blood glucose level significantly compared to the control group. However, some studies are against our study showing no obvious influence on broilers' glucose level (Belenli *et al.,* 2015). On the other hand, data for creatinine showed no significant difference ($p \geq 0.05$) between all tested groups.

The study showed that Profitability ratio (1.32) for group fed on 200mg/kg was the best of the tested groups followed by group fed on diet supplemented with 400 mg/kg (1.26) and finally group fed on diet supplemented with 600 mg/kg (0.99) compared to control group. Profitability ratio (1.32) for group fed on 200mg/kg was the highest of the all tested groups this result agree with that noted by Mukhtar *et al*., (2013) reported the addition of different essential oils at different level broiler diet to give better relative economic efficiency compared to the control diet.

5.2 Response of broiler chicks to graded levels of Fennel and Halfa bar mixed Essential Oils FHMEOs:

The Specific chemical component of FHMEOs showed eight main chemical compounds: Longifolene, 4, 7-Methano-5H-inden-5-one, octahydro- and gamma-Elemene were the main compounds, the composition depends upon mixing of oils, season of collection, age of plant and area of collection.

In the present study the results for feed intake, showed that, chicks fed diets supplemented with FHMEOs, recorded no significant differences between all tested groups, however for feed intake, chicks fed on 400mg/kg mixed essential oils noted numerically the highest value (3538) gm between all tested groups, this due to quicker digestion and passage of nutrients through the digestive tract (Tekeli *et al*., 2011). Moreover**,** El- Deek *et al.,* (2003) postulated that fennel stimulates the flow of digestive juices in the stomach and intestine and increase the efficiency of broken fat into fatty acids. These results were in line with that reported by Ould- Sidi *et al*., (2015) when fed Turkey on diets supplemented with two levels of FEO (0.2g/kg, 0.5g/kg of fennel oil). This result is similar to (Abdullah and Rabia, (2009), found addition of fennel to the diets observed no significant differences in feed consumption, also, this result was in line with finding of Mukhtar *et al*. (2013); Valiollahi *et al*., (2014) who reported that essential oils increase feed intake, moreover this result is related to Taki *et al*.,(2014) who studied different levels of fennel essential oils on feed consumption, which showed no significant effect on daily feed intake during different weeks. This result was in contrast with the findings of Amal *et al*., (2013) who found that chicks fed diets supplemented with halfa bar essential oil (HBO) as a natural feed additive consumed significantly more feed compared to control group.

Our result showed no significant difference in body weight, body weight gain, and feed conversion ratio, however group fed on 600mg/kg FHMEOs recorded numerically the heaviest body weight (2177) gm and body weight gain (1995) gm although group fed on 200mg/kg FHMEOs showed numerically the best value (1.71) of FCR as compared to all tested groups. This might be due to herbal supplements, through their effect on the micro flora of the digestive system and the control of pathogens, have their role in improving growth. As a result, these compounds contribute to the immune system during critical production conditions and increase the availability of some nutrients to absorb

the intestines, they create the right conditions for genetic potential growth (Indisch *et al*., 2008). This improvement may be related to active ingredients found in essential oils such as anethol, carovine, and limonine which have stimulating effects and increases production of digestive products by stimulating secretion of gastric juice, acids and bile in the stomach and soothes the digestive tract acting directly on the intestinal muscles to relive flatulence (Cabuk *et al*., 2003). These results also supported with findings of Mukhtar, (2011); Hernandez *et al*., (2004); Tekeli *et al*., (2011), who reported positive effects of essential oils on body weight gain of broilers. These results disagreed with Lee *et al*., (2003a) who stated that commercial essential oils mixture did not affect BWG of female broiler chicks, the same results were recorded for FCR. The improvement of FCR resulted from the increase in appetite due to the stimulating of salivary and gastric glands by HBO, the decrease in pathogenic bacteria and better digestibility (Osman *et al*., 2005; Tekeli *et al*., 2011). Although, the results were agreed with the findings of Ismail, (2011), who found no significant effects on FCR of broilers chicks when fed on ration supplemented with black cumin oil .These findings were in agreement with those of Amal *et al*., (2013); Mukhtar, (2011) who noted that adding Fennel and Hafa bar or mixed essential oils to the diet resulted in increased body weight, body weight gain, and feed conversion ratio. Çabuk *et al*., (2014) reported that using a mixture of essential oils, including fennel essential oil, for laying quails and laying hens at the hot summer seasons improved feed efficiency.

While some earlier reports showed no significant variations in weight gain of broilers (Nidaullah *et al*., 2010; Nnenna and Okey, 2013), moreover this result similar to Falaki *et al*., (2016)**;** Yang *et al*., (2018) who reported essential oils increase body weight gain. Also this result is differ to Saleh *et al*., (2018) showed that supplementation of Foeniculum vulgare seeds powder in ration caused significant increase in body weight in poultry, moreover on the contrary to our findings, there is also some reports in which birds exhibited poor

performance and lower body weights in all treatment groups (Deore *et al*.,2005). Essam (2018) noted the effect of feeding broiler chicks on diets supplemented with essential oil mixed (EOM) showed positive significant effects on broiler chick's performance.

Result also showed no significant ($p \geq 0.05$) difference in dressing percentage and giblets (dressing, liver, gizzard, heart, intestine and abdominal fat) between all tested groups fed on diets supplemented with FHMEOs, this result similarly with findings of Essam, (2018) who reported no significant in meat value and internal organs (liver, gizzard and heart), when fed broilers on diets supplemented with essential oil mixed (EOM), also these results were agree with the findings of Daffalla and Mukhtar (2016), however result disagree with Ahmed *et al*., (2020) reported heart was significantly smaller in broilers fed the 1.6% fennel diet compared to the un supplemented control. also this result disagree with Hassan *et al*., (2004) reported a significant ($P \leq 0.05$) increase in dressing and liver percentages for broiler chicks fed the supplemented herbal feed additives as compared to those fed the control. The results in the present study disagree with Acimovic *et al*., (2016) noted The weight and length of the small intestine together with the carcass yield in bird's fed with medicinal plants are usually higher than control.

The graded levels of Fennel and Hafa bar mixed oil on percentages of commercial cuts (breast, thigh and drumstick) documented no significant ($p \geq 0.05$) difference among all tested groups, however chicks fed on 600mg /kg mixed oils showed numerically the highest value of breast (39.80) between all other tested groups, this result agreed with that found by Amal *et al* ., (2013) who indicated that, effect of some essential oils include halfa bar had no significant effect on commercial cuts (thigh, breast and drum stick) percentages, more over the results of the present study agree with that found by Essam, (2018) noted the effect of feeding broiler chicks on diets supplemented with essential oils mixed (MEO) showed no significant difference in

commercial cuts. Daffalla and Mukhtar, (2016) recorded no significant effect on commercial cuts, dressing percentage, giblets, subjective and objective values when they fed broiler chicks on diet supplemented with MEO.

The effect of FHMEOs on subjective meat attribute for experimental broilers revealed no significant difference ($p \geq 0.05$) between tested groups on the score given for (tenderness, flavor, color and juiciness) using an eight point scale, and scores given for all attributes were above the moderate acceptance, this study was in line with the finding of Amal *et al*., (2013) who reported addition of halfa bar essential oils at various inclusion levels did not effect on subjective meat attribute, also, Daffalla and Mukhtar (2016) recorded no significant effect on commercial cuts, dressing percentage, giblet, subjective and objective values when they fed broilers on diet supplemented with MEO (anise, clove and caraway).

Effect of feeding broiler chicks on graded levels of Fennel and Halfa bar mixed essential oils on meat chemical composition indicated significantly ($p \leq 0.05$) differences in moisture, dry matter and ether extract values, In contrast, Daffalla and Mukhtar (2016) recorded no significant effect on commercial cuts, dressing percentage, giblets, subjective and objective values when they fed broilers on diet supplemented with MEO (anise, clove and caraway). Amal *et al*., (2013) reported that chemical compositions of broiler meat were not affected significantly by dietary some essential oils include halfa bar at various inclusion levels.

The results showed significant ($p \leq 0.05$) difference among all tested groups on aspartate amino transferase (AST) enzyme this result disagree with (Amal *et al*., 2013) who found use some essential oils include halfa bar at different levels in broiler diet not significant on AST enzyme. Result for ALP enzyme showed significant ($p \leq 0.05$) difference between all tested groups, for ALP level in serum decreased by increasing supplementation levels of FHMEOs in diet,The reduction of ALP enzyme activity related to the dietary essential oil natural

growth promoters, might be due to their protective action on the liver, vital organ lesions, especially the liver were believed to be source of enzyme leakage to the blood, hence normal peripheral enzyme values reflect the interity of most vital organ (kaneko *et al*., 1997), this result is supported by Amal *et al*., (2013) who recorded that including essential oil of halfa bar at different level in broiler diet significantly ($p \leq 0.05$) cause reduction in the activity of alkaline phosphatase (ALP) enzyme.

Result obtained for calcium and phosphorus recorded significantly ($p \leq 0.05$) difference between all tested groups, these results disagree with those recorded by (Talibi, 2006).

The result of the present study showed significant ($p \leq 0.05$) difference among all tested groups of serum metabolites (total protein, albumin, uric acid, urea, HDL, LDL, tri glyceride and glucose) except for cholesterol and creatinine showed that, no significant difference ($p \geq 0.05$) between all tested groups. However, for cholesterol chicks fed on control diet obtained numerically the highest value (124.50mg/dl) compared to other tested groups، for HDL chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (130.50mg/dl), compared to other tested groups, for LDL there was significant difference ($p \leq 0.05$) between chicks fed on control and chicks fed on 200 mg/kg mixed oils, this result was similarity with Gharehsheikhloul *et al* ., (2018) who reported the LDL / HDL ratio also increased with the addition of essential oil, but this difference was not significant. Also, the present study result similar with that obtained by Belenli *et al*., (2015) who reported fennel essential oil containing essential oil mixtures in dietary dosages of 100 and 200 ppm did not affect blood cholesterol levels, however, dietary 100 ppm fennel essential oil decreased blood cholesterol levels, also the result similarly with Oulmouden *et al*., (2014) who reported that dietary fennel extract reduces blood cholesterol levels of mice. Also this result similarly with Essam, (2018) who reported total protein was significantly decreased with the increase of fennel essential oils in

the diet, this improvement in blood parameters may be due to the improvement in immune responsiveness (Daader *et al* ., 2002).

The economical evaluation of the present experiment showed that addition of dietary Fennel and Halfa bar mixed essential oils at different levels resulted in economical benefits, profitability ratio (1.37) of group 200mg/kg mixed oil was the highest of the tested groups, this result agree with that obtained by many researchers: (Amal *et al*., 2013 ; Mukhtar *et al*., 2013; Essam, 2018 ; Daffalla and Mukhtar 2016), who reported the profitability ratio of chicks fed on different essential oils at different levels recorded better relative economic efficiency compared to the control diet.

5.3 Response of broiler chicks fed on graded levels of spearmint and halfa bar mixed Essential Oils:

Constituent of Spearmint and Halfa bar mixed oils showed that, IH-cycloprop(e)azulene,decahydro-1,1,4,7-te; I-Cyclohexene-1-carboxaldehyde,2,6,6-trimet and Naphthalene,decahydro-4a-methyl-1-methyler are the main compounds, the differentiation in the compounds concentration might be due to the varieties, age of leaves, mixing of oils, varieties and season of collection.

Results obtained in this study revealed that, no significant ($p \geq 0.05$) difference between all tested groups performance, however, for feed intake chicks fed on diet 200mg/kg SHMEOs consumed numerically the highest value (3440gm) while chicks fed on 400mg/kg essential oils noted numerically the lowest value (3328gm) compared to other tested groups, this result similarly to reviews published by Bozkurt *et al*., (2014); Franz *et al*., (2010**)**who reported that, feed intake unchanged or slightly reduced by dietary inclusion of essential oil. For the decreased in feed consumption, one possible justification is that essential oils possess an irritating smell, which renders the palatability of diet disagreeable to birds. These results disagree with that reported by Mona *et al*.,

(2015) who observed that the supplementation of 0.50 % and 0.75% CP in broiler diets improve feed intake, also these result disagree with Al-Kassie, (2010) who observed that the addition of mint in poultry ration improve the feed intake in comparison with control, also, Amal *et al*., (2013) recorded that chicks fed diets supplemented with HBO consumed significantly more feed compared to control group. Collected data of present study indicated no significant difference on body weight, feed converction ratio and body weight gain for chicks fed different levels of SHMEOs, however, group of chicks fed on 600mg/kg mixed essential oils obtained numerically the highest body weight, body weight gain and best feed convection ratio (2083, 1897gm and 1.78) respectively, while the group fed on control diet recorded numerically the lowest body weight, body weight gain and lowest value of FCR (1943, 1757 gm and1.95) respectively, these results were agree with Witkowska *et al* .,(2019) showed, that the use of essential oil mist does not adversely affect broiler growth performance. The positive effects of HBO and SPO on body weight and body weight gain related to its biological functions that could act not only as antimicrobial and antioxidant but also as stimulant of digestive enzymes in the intestinal mucosa and pancreas that improve digestion of dietary nutrients and feed efficiency subsequently increasing growth rate, These results also supported with findings of (Mukhtar *et al.*, 2013; Amal *et al*., 2013; Mukhtar 2011; Hernandez *et al*., 2004; Botsoglou *et al*., 2004). In addition the results of this study agree with those reported by Arab-Ameri *et al*., (2016), broilers whose diets were supplemented with peppermint powder had higher BW, also similar to Saleh *et al*., (2018) who found that dietary supplemented with essential oil improves the growth performance of broilers. Falaki *et al*., (2016); Yang *et al*., (2018), were reported EOs increase body weight gain, however disagree with Nematollah *et al* ., (2017) who reported feeding broilers with peppermint led to significant improvements in daily weight gain in the grower and finisher periods, also this result was disagree with the results of (Ocak *et*

al., 2008), in contract Essam (2018) noted the effect of feeding broiler chicks on diets supplemented with essential oil mixed (EOM) showed positive significant effects on broiler chick's performance, also, Toghyani *et al* ., (2010); Ocak *et al* ., (2008) did not observed any positive effect of dry peppermint on broiler performance and carcass traits, This result agree with study reported by Mona *et al*., (2015) who stated that the addition of 0.50 % and 0.75% Cp in broiler diets does not affect FCR. Results of this study obtained no significant ($p \geq 0.05$) differences between all tested groups fed on spearmint and halfa bar mixed essential oils in dressing, liver, gizzard, heart, intestine except abdominal fat, this result similar to the finding of Amal, (2012)who noted no effect for spearmint and halfa bar oils at all inclusion levels on dressing percentage, liver, gizzard and heart among all treatment groups, also result of this study agree with Huda,(2015) who reported the effect of spearmint at all inclusion levels on dressing percentage was not significant, also, similar effect was recorded in spearmint by (Howida, 2009). Also Daffalla and Mukhtar, (2016) recorded no significant effect on commercial cuts, dressing percentage and giblets. The result disagree with Nematollah *et al*., (2017) who showed that, peppermint powder had an effect on the weight of heart, liver, gizzard, and abdominal fat in broilers, also in contrast Alcicek *et al*., (2004) noted that the dressing percentage improved by dietary essential oil. In the precent study the results obtained indicated that, no significant ($p \geq 0.05$) difference between all treated groups in non-carcass components (kidney, lung, legs, neck, head, back and wings) percentages, except the intestine length recorded significant ($p \leq 0.05$) difference between chicks fed on 200 and 400mg/kg mixed essential oils (166.00 and 183.33cm respectively), this result agrees with Amal *et al*., (2013) who observed that, the supplementation of graded levels of essential oil extracted from Halfa Bar Oil (HBO) did not affected on dressing percentage and edible organs. The results of feeding graded levels of SHMEOs showed no significantly effect on commercial cuts (breast, thigh and drumstick), however,

chicks fed on 600mg /kg SHMEOs revealed numerically the highest value (41.16) of breast compared to all other tested groups, also chicks fed on 200mg/kg SHMEOs recorded numerically the lowest value (36.23), these results similarly with finding of (Huda, 2015) who noted treatment effect (spearmint) at all inclusion levels was not significant on commercial cuts percentage and their separable tissues, the subjective meat quality also, similarly to observationof Amal *et al*., (2013) who stated that addition of spearmint essential oil in the diet with levels of 50,100 and 150 ppm/ton had no significant effect on thigh, breast and drumstick of broilers. The addition of different level of SHMEOs to broilers diet, did not affect significant ($p \geq 0.05$) on values of meat percentages of commercial cuts, similar results obtained by Mukhtar *et al*., (2013) added different dietary levels of spearmint oil (SPO) as a natural growth promoter, results showed no significant ($p>0.05$) differences between all treatments groups in weight of carcass cuts, dressing percentage, non carcass components meat chemical composition and subjective meat values. The findings are in agree to results recorded by Jamroz and Kamal (2002), who recorded that, carcass yield was not affected by the dietary essential oil treatments, Daffalla and Mukhtar (2016) recorded no significant effect on commercial cuts, dressing percentage, giblet, subjective and objective values when they fed broiler chicks on diet supplemented with MEO(anise, clove and caraway). In the present study the addition of SHMEOs were significant ($p\leq 0.05$) effect on meat chemical compositions (moisture, dry matter, ash, crude protein and ether extract), these results disagree with finding of Amal, (2012) who noted meat chemical composition, were not affected significantly by dietary spearmint and halfa bar essential oils at various inclusion.

In this study the treatments effects showed significantly ($p\leq 0.05$) effect on serum enzymes and minerals among all tested groups for (AST, ALP, Ca and P). For aspartic amino transferas (AST), chicks fed on 600mg/kg mixed essential oils documented significantly the lowest value (29.90) compared to all

tested groups, this result similarly with finding of (Huda, 2015) who noted addition of spearmint at all inclusion levels in broiler diets causes significant reduction in the activity of aspartic amino transferas (AST) enzyme compared to PC and NC groups with in the normal range, the reduction of AST enzyme activity related to the dietary natural growth promoter, in this study may be due to their protective action in the liver. Vital organs lesion, especially the liver were believed source of enzyme linkage to blood, hence normal peripheral enzyme reflect the integrity of most vital organs (kaneko *et al*., 1997), Mukhtar *et al*., (2013) reported that, reduced levels of serum cholesterol, urea and ALP enzyme activity without any effect on the total protein, calcium, phosphorus and AST enzyme activity with the addition of spearmint oil (SPO)**,** these results disagree with Amal *et al*.,(2013) who found that, use some essential oils include sparmint and halfa bar at different level in broilers diet did not significantly effect on AST enzyme.

For ALP levels in serum, there were significant differences($p \leq 0.05$) between all tested groups, however, chicks fed on control diet showed significantly the highest value (247.50iu/L), compared to other tested groups, while chicks fed on400mg/kg SHMEOs recorded significantly the lowest value (138.65iu/L) compared to other tested groups, these results were supported by the findings of Amal *et al*., (2013) who found, the use of some essential oils include spearmint and halfa bar at different levels in broiler diet causes significant ($p \leq 0.05$) reduction in the activity of alkaline phosphatase (ALP) enzyme. The reduction of ALP enzyme activity related to the dietary essential oil natural growth promoters, might be due to their protective action on the liver, vital organ lesions, especially the liver were believed to be source of enzyme leakage to the blood, hence normal peripheral enzyme values reflect the integrity of most vital organ (kaneko *et al*., 1997), these results disagree with the finding of Huda, (2015) who noted treatment effect (spearmint) at all inclusion levels in broiler diets did not have any significant effect on ALP

activity. for calcium content chicks fed on 200mg/kg SHMEOs presented significantly the highest value (9.25mg/dl) compared to other tested groups, this result differ with the finding of Huda, (2015) who noted treatment effect (spearmint) at all inclusion levels in broiler diets did no significant effect on Ca content, also this result disagree with finding of (Amal *et al*.,2013).

Finally for Phosphorus, the results indicated that the group of chicks fed on 200mg/kg SHMEOs and chicks fed on control diet significantly obtained the highest values (9.00, 8.75mg/dl) respectively, compared to other tested groups, this result differ with the finding of Huda,, (2015) who noted treatment effect (spearmint) at all inclusion levels in broiler diets did no significant effect on P. The effect of SHMEOs showed significant difference between all treatments for serum metabolites, except createnine. For total protein, the results recorded that, there were significant ($p \leq 0.05$) differences between chicks fed on control diet, 400 and 600 mg/kg SHMEOs (3.95, 3.30 and 2.40g/dl) respectively, total protein significant decreased by increasing mixing essential oils in diets, contradict to the result of this study result reported by Huda, (2015) who noted the serum total protein level was not influenced by the dietary treatment. These results also disagree with the results obtained by Amal *et al*., (2013), who found the addition of spearmint and halfa bar essential oils at various levels had no significant effects in total serum protein. For albumin, results recorded that, chicks fed on 200 mg/kg SHMEOs indicated significantly ($p \leq 0.05$) the highest value (2.40g/dl), and chicks fed on 600 mg/kg SHMEOs noted significantly ($p \leq 0.05$) the lowest value (1.40g/dl), for uric acid, there was significant ($p \leq 0.05$) difference between all tested groups.

Data for urea, revealed significant difference between control group and all other tested groups (200, 400 and 600 mg/kg SHMEOs, also showed numerically decrease in urea by increase the level of supplementation mixing essential oil in diets, these results agree with the findings of Amal *et al* ., (2013) showed that, urea values were significantly lower in groups of chicks fed

spearmint and halfa bar essential oils at various inclusion levels compared to either antibiotic PC or NC, the result vary with Huda, (2015), who showed that, dietary effect was not significant on serum urea level, on the other hand, chicks fed on 400mg/kg mixed essential oils obtained significantly the highest value (133.00mg/dl) compared to other tested groups, this study agreement with the findings of Amal *et al* ., (2013) who reported that, cholesterol value was significantly lower in groups fed on spearmint and halfa bar at various inclusion levels. The result of this study showed that essential oils decreased serum cholesterol level, the hypo cholesterolemic effect of essential oils may be due to their active ingredients inhibit heapatic 3-hydroxyl-3- methylglutary co-enzyme A(HMG-CoA) reductase activity which akey regulatory enzyme in cholesterol synthesis (lee, 2004).

For cholesterol HDL, chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (130.50mg/dl), compared to other tested groups. For cholesterol LDL, chicks fed on 600 mg/kg mixed essential oils obtained significantly ($p \leq 0.05$) the highest value (61.00mg/dl), compared to other tested groups. For triglyceride, result showed that chicks fed on 400 mg/kg SHMEOs recorded significantly ($p \leq 0.05$) the highest value (71.50mg/dl), and chicks fed on control showed significantly ($p \leq 0.05$) the lowest value (43.50mg/dl), compared to chicks fed on 200 and 600 mg/kg SHMEOs (52.00 and 62.00mg/dl) respectively.

The analysis of data for glucose, recorded that chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (220.50mg/dl), while chicks fed on 400mg/kg mixed essential oils recorded significantly ($p \leq 0.05$) the lowest value (196.50mg/dl), For creatinine, results showed no significant differences ($p \geq 0.05$) between all tested groups.

The result of economical evaluation of experimental diets showed that, addition of spearmint and halfa bar mixed essential oils improved the performance of broiler chicks, and resulted in economical benefit, profitability

ratio registered (1.0, 1.10, 1.31and 1.35) for (control, 200,400 and600 mg/kg) respectively, profitability ratio (1.35) of group 600mg/kg mixed oils was the highest of the tested groups, this result agree with the results obtained by **(Amal *et al*., 2013).**

5.4 Response of broiler chicks to Graded levels of fennel and spearmint and halfa bar mixed Essential Oils (FSHMEOs):

The chemical analysis of FSHMEOs showed eleven compounds: Aromandendrene, 1-Cyclohexene-1-carboxaldehyde,2,6,6-triment and 1,3-Benzenedimethanol,2-hydroxy-5-methyl- were found to be the main compounds, the composition depends upon mixing of oils, season of collection, age of plant and area of collection.

The results indicated that, no significant ($p \geq 0.05$) differences were observed between all tested groups in feed intake, final body weight, body weight gain and feed conversion ratio through out the experimental period. For feed consumption chicks fed on 400mg/kg FSHMEOs recorded numerically the highest quantity of feed intake (3430) gm compared to all other tested groups. Also group fed on 400 mg/kg mixed essential oils recorded numerically the heaviest body weight (2105 gm) and body weight gain (1919gm), furthermore group fed on 400 mg/kg mixed essential oils showed numerically the best value of FCR (1.79) as compared to all tested groups. the results are in line with those reported in earlier works Alcicek *et al*., (2003); Spernakova *et al*., (2007), which showed that, supplementing broiler diets with volatile oils significantly improves broiler body weight gain, also the results of this study similar with the finding of Khattak *et al.*, (2013) who reported positive effects of EOs on broiler performance as showed with improving BWG, FCR (Pirgozliev V *et al*., 2019). The improvement in body weight may be due to stimulating effect on the digestive system of broilers Hernandez *et al*., (2004), or due to the presence of the fatty acids (Murray *et al*., 1991), This result vary with (Ertas *et al* ., 2005)

who reported the supplementation of essential oils mixture (EOM) at 200 ppm significantly improved FCR by 6% and 12% over the antibiotic group and the control group in broilers feed respectively, also, these results disagree with finding of Cabuk *et al* ., (2006), who showed that broilers fed essential oils include fennel seed oil showed significant improvement in feed conversation ratio, the result similarly with finding of Jamroz *et al* ., (2005) who reported that inclusion of essential oils in diet improves their growth performance, this due to stimulates secretion of digestive enzymes resulting into improved nutrient digestion (Jamroz *et al* ., 2005), support growth performance also, causes due to mixing of EOs in animal actually minimize happening of intestinal diseases caused by undesirable bacteria and thus favor beneficial gut micro biota growth (Bento *et al* ., 2013).

These results indicated no significant difference between all treatment groups in dressing, gut, liver, gizzard and abdominal fat percentages between all tested groups fed on diets supplemented with FSHMEOs except heart documented significant ($p \leq 0.05$) difference, also, the results study showed no significant ($p \geq 0.05$) difference between all treated groups for non- carcass component except the back documented significant ($p \leq 0.05$) difference, these results vary with Alcicek *et al* ., (2004) who observed the effects of 2500 mg/kg organic acid, 1000 mg/kg probiotic and either 36 mg/kg or 48 mg/kg volatile oil on hot and cold carcass yield values after 42 d of feeding, the carcass yield value was reported to be increased in the group receiving a probiotic and volatile oil, these results agreement with the studies of Toghyani *et al*., (2010) who found that the use of black seed and peppermint had no significant effect on carcass characteristics and relative weight of internal organs (liver, heart and gizzard) despite beneficial effects on growth performance. These results also similarly with finding of Essam, (2018) who reported no significant in meat value and internal organs (liver, gizzard and heart), when fed broiler chicks on diets supplemented with essential oil mixed, these results disagree with the

finding of Hassan *et al.*, (2004) who reported a significant (P≤0.05) increase in dressing and liver percentages for broiler chicks fed the supplemented herbal feed additives as compared to those fed on control, the results of these study differ with the finding of Agung *et al*., (2021) who reported administration of EOs (oregano EOs, thyme EOs, mint EOs, rosemary EOs, star anise EOs, cinnamon EOs, basil EOs, caraway EOs, laurel EOs, lemon EOs, sage EOs, tea EOs, turmeric EOs, clove EOs) increased carcass and gizzard and decreased abdominal fat percentage. In addition these results agree with Ahmed *et al*., (2020) who reported heart was significantly smaller in broilers fed the 1.6% fennel diet compared to the un supplemented control, the results agree with Alp et *al*., (2012) who noted dietary supplementation of OEO 300 mg/kg showed non-significant effect on characteristics of carcass. These result vary with Alcicek *et al.*, (2003) who found presence of an essential oil in combination of 48 mg/kg and 72 mg/kg causes improvement in the carcass yield. Also, the results disagreed with the finding of Alcicek *et al*., (2004) who observed improvement in dressing percentage by the dietary essential oil. And Al-Kassie (2010) who reported that the chicks fed with 0.50% peppermint showed significant difference in liver weight between treatments when compared with the control.

Treatments effect is not significant ($p \geq 0.05$) in all commercial cuts (drumstick, breast and thigh) percentage, However, for breast chicks fed on 200mg /kg oils noted numerically the highest value (39.77), these results agreed with other studies that reported no significant effect of phytogenic additives and probiotic on the relative weight of carcass and cut yields of broilers (Toghyani *et al*., 2010; Falaki *et al*., 2010). The results of this study also, agreement with Essam, (2018) who showed no significant difference among treatments in commercial cuts and their meat values in broiler fed on fennel supplemented alone or in combination at all levels. Also, the result differ with Khattak *et al*.

(2013) who found that, increase in (carcass weight, breast weight and breast meat) with the supplementation of a natural combination of essential oils.

Treatments effect on subjective meat attributes showed no significant ($p \geq 0.05$) difference between all tested groups, mean values of all sensory attributes are closely similar, and score given for all attributes were above the moderate the score given for (tenderness, flavor, color and juiciness) using an eight points scale ,this result similar with Essam, (2018) who recorded no significant difference among tested groups for tenderness, flavor, color and juiciness for broilers supplemented with combination of EOs at different levels.

The results indicated that there were no significant ($p \geq 0.05$) differences between the experimental groups in moisture, dry matter and ash in the tested meat, but crude protein and ether extract showed significant ($p \leq 0.05$) effect. These results similar with Amal, (2012) who showed that meat chemical composition of protein, dry matter and ash was not affected significantly by dietary BC, LG, SP and HB essential oils at various inclusion levels, however these results are differ with the finding of Abaza *et al*., (2008) who reported that fat and protein percentages of broiler meat were not significantly affect by BC essential oil supplementation in diets. The result showed significantly ($p \leq 0.05$) differences among all tested groups for serum enzymes and minerals (AST, ALP, Ca and P). For AST chicks fed on 600mg/kg FSHMEOs revealed significantly ($p \leq 0.05$) the highest value (51.65 iu/L) between all other groups. However, this result vary with Amal, (2012), also, disagree with Dieumou *et al*., (2009) who noted the effect of dietary ginger and garlic EOs on the AST enzyme activity in broilers not to differ from that of the control group. On the other hand for ALP level in serum chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (247.50iu/L), For calcium chicks fed on 600mg/kg oil recorded significantly ($p \leq 0.05$) the highest value (10.05mg/dl) compared to other tested groups, this study agree with Amad, *et al* ., (2011) who noted mixtures of essential oil containing (thyme, black cumin,

fennel, anise, and rosemary) have been reported to increase the calcium concentration in the tibia of laying hens. Also, Alagawany *et al* ., (2021) Showed Ileal calcium bio availability has also been improved by the supplementation of EO in broilers, However, Olgun and Yıldız (2014) reported the same EOs mixtures has also been reported to decrease calcium excretion in breeder quails. This tendency for increased plasma calcium level in the in ovo + in-water EO delivery route is possibly induced by increased mobilization of calcium-binding protein in the mucosa, activating the calcium activated tenderization complex (Baratta *et al*., 1998). The result disagree with Essam, (2018) who reported no significant effect in calcium and phosphorus concentration in blood serum in broiler fed on combination of EOs at all levels.

For phosphorus chicks fed on control diet showed significantly ($p \leq 0.05$) the highest value (8.75 mg/dl) between all other tested groups.

Results showed significant ($p \leq 0.05$) differences (observed between all treatments for serum metabolite). Result recorded chicks fed on control diet noted significantly ($p \leq 0.05$) the highest value (3.95g/dl) for total protein compared to other tested groups, while chicks fed on 200 and 400mg/kg oils presented significantly ($p \geq 0.05$) the lowest values (2.70 and 2.70g/dl) respectively. This result similar with Essam, (2018) who reported the blood serum analysis reveald asignificant reduction in total protein, cholesterol concentration compared to group fed on control diet when chicks fed on combination of EOs in diets. This improvement in blood parameter may be due to the improvement in immune responsiveness (Daader *et al* ., 2002), for albumin broiler chicks fed on diets supplemented with control and 200 mg/kg oil showed significantly ($p \leq 0.05$) the highest values (2.05and2.10g/dl) respectively compared to all other tested groups, these results in line with several experiments in which dietary EOs extracted from a variety of plants reduced cholesterol levels (Supuka *et al* ., 2105), and increased blood albumin and protein (Ghazalah and Ali 2008; Amad *et al* .,2013). At the same time

Agung *et al*., (2021) recorded blood protein, glucose, and albumin also increased. These results showed significant ($p \leq 0.05$) effect in uric acid, this result differ with Essam, (2018) who reported a significant reduction in uric acid compared to group fed on control in broiler fed on fennel in combination at all levels. For the analysis of serum urea in our results, broiler chicks fed on control diet prominent significantly ($p \leq 0.05$) the highest values (7.10mg/dl) compared to other tested groups.

results for cholesterol concentration, chicks fed on 600mg/kg oil noted significantly ($p \leq 0.05$) the highest value (129.50mg/dl), this result disagree with finding (Gharehsheikhloul *et al*., 2018) who reported did not have a significant effect on total cholesterol /HDL ratio and LDL/HDL ratio compared to control treatment ($p \geq 0.05$) when used different levels of fennel and savory essential oils and their mixture in broiler chickens diet.

For HDL chicks fed on control diet noted significantly ($p \leq 0.05$) the highest values (130.50mg/dl) between all tested groups. In addition results for LDL and triglyceride showed chicks fed on 200 mg/kg FSHMEOs noted significantly ($p \leq 0.05$) the highest values (29.00, 49.00mg/dl) respectively, these results agree with Agung *et al*., (2021) who noted responses of serum metabolites to dietary Eos (include mint EO) were positive, as the EOs linearly reduced low density lipoprotein (LDL) concentration ($p<0.01$) and concomitantly increased high density lipoprotein (HDL), glucose and protein concentrations at a linear pattern ($p<0.01$). The concentration of triglycerides and cholesterol linearly decreased in response to elevating the dose of EOs ($p<0.01$), also, Agung *et al* ., (2021) noted not only less fat accumulation and more carcass portion, but also a positive correlation to the decreased of cholesterol, triglycerides, and LDL concentrations of serum metabolites were produced in your study. These results showed that chicks fed on 200 and 400 mg/kg oils noted significantly ($p \leq 0.05$) the highest values (229.00 and 228.50mg/dl respectively) for glucose, for creatinine chicks fed on 600mg/kg

oils recorded significantly ($p \leq 0.05$) the highest values (0.20mg/dl) as compared to other tested groups.

These results indicated that profitability ratio (1.21) for group fed on 400 mg /kg FSHMEOs was the highest of the tested groups followed by group fed on diet supplemented with 200 mg/kg FSHMEOs (1.03) and finally group fed on diet supplemented with 600 mg/kg FSHMEOs (1.01) compared to control group, profitability ratio (1.21) of group 400mg/kg mixed oils was the highest of the all tested groups, this result agree with that obtained by many researchers, Amal *et al*., (2013) ; Mukhtar *et al*., (2013), reported the addition of different essential oils at different level in broiler diet to give better relative economic efficiency compared to the control diet.

5.5 Effect of dietary (FSMEOs), (FHMEOs), (SHMEOs) and (FSHMEOs) and their levels on performance and their interaction

In the present studies the results of interaction between all experiments and their levels recorded that, no significant differences between all treatments with all levels in feed intake, body weight, body weight gain and feed conversion ratio, although, experiment two (Fennel + Halfa bar) was recorded numerically the heaviest body weight and body weight gain, and obtained the best feed conversion ratio (FCR) as compared to other experiments. For levels, the results of interaction between levels recorded that, no significant effect on feed intake, body weight, body weight gain and feed conversion ratio between all levels, but the level 400g/kg obtained numerically the heaviest body weight and body weight gain, and obtained the best (FCR) compared to other levels.

5.6 Comparative between economic appraisals of all experiments

In the present studies the results of comparative between economic appraisals of all experiments illustrated that, chicks fed on all mixed essential oils with all levels (200, 400 and 600mg/kg) obtained more net profit/bird as compared to

chicks fed on control diet, except the level 600mg/kg of experiment one (fennel and spearmint) mixed essential oils recorded less profit than control (less than 1), although, the chicks fed on 200mg/kg of experiment (2) (fennel and halfa bar) mixed essential oils was the highest of the tested groups (1.37)

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS:

- Combinations of (fennel and spearmint; fennel and halfa bar, spearmint and halfa bar and fennel and spearmint and halfa bar) mixing EOs at graded levels to the ration as natural feed additives causes improvement on performance of broiler chicks.

- Group fed on 400mg/kg fennel and spearmint mixed EOS showed numerically the best value (1.69) for FCR.

- Group fed on 600mg/kg fennel and halfa bar mixed essential oils recorded numerically the heaviest body weight (2180) gm.

- Group of chicks fed on 400mg/kg fennel and spearmint and halfa bar mixed oils showed numerically the heaviest body weight (2104) gm.

- Dressing and giblets showed no significant ($p \geq 0.05$) difference between all tested groups for all mixing levels of essential oils except abdominal fat for fennel and spearmint mixed essential oils and heart for fennel and spearmint and halfa bar mixed essential oils recorded significant effect.

- Non carcass components showed no significant differences among all treatment groups for all mixing levels of essential oils except head for fennel and spearmint mixed EOs, intestine length for spearmint and halfa and back for fennel, spearmint and halfa bar mixed ESO recorded significant effect.

- Commercial cuts and their meat recorded no significant difference among all treatment groups except breast meat and bone for fennel and spearmint mixed EOs and drumstick meat and bone for fennel and spearmint and halfa bar mixed EOs recorded significant.

- Subjective quality attributes showed that no significant differences among all treatment groups for all mixing level of essential oils.

- Meat chemical composition showed significant effect among all treatment groups expect for Ash and crude protein for fennel and halfa bar mixed EOS, ash, dry matter and Moisture for fennel and spearmint and halfa bar mixed EOs showed no significant effects,

- Serum enzyme and minerals values showed significant effect among all treatment groups for all mixing levels of essential oils compared with control group. -Supplementation of fennel and spearmint mixed oils at different levels documented significantly decreased in cholesterol value with increased Supplementation of mixed oils in diet compared with control group.

- Essential oils could be used as feed additive to improve the growth performance in the poultry diet and it can also help in producing value added products with low cholesterol meat, flavor etc.

- The results of interaction between all experiments showed experiment two (fennel and halfa bar) mixed essential oils recorded, the best one, also the results of interaction between levels revealed that, level 400mg/kg recorded the best level.

- Addition of (fennel and spearmint; fennel and halfa bar; spearmint and halfa bar and fennel, spearmint and halfa bar) EOs in combination at graded levels to the rations of broilers was economically likely.

RECOMMENDATIONS:

Practical implication:

- The Mixing of essential oils can be used effectively when comparing their costs with those of antibiotics and other commercially obtainable products on the market.
- Based on results of these studies the mixing of essential oils (fennel and spearmint; fennel and halfa bar; spearmint and halfa bar and fennel and spearmint and halfa bar) MEOS could be considered as potential natural growth promoters.
- All level of mixing essential oils added to broiler diets in the above studies were recommended economic –wise.
- EOS are suitable to be used as growth promoters and their economic benefit may be promising.

Suggestion for future research:

- More trials are need to depend on the finding of present study to confirm these results in layer testing their effect on egg yield and quality.
- More trials are needed to determine the effect of combinations of essential oils supplementation on the performance, carcass characteristic, and serum of broilers chicks with regard to variable management conditions, containing dietary ingredients and nutrient density, active substances of oils, different stress factors, Essential oils and their optimal dietary inclusion levels.
- Further and more mixing and levels of EOS are needed to complete appraisal required for the effect of mixing of EOS in diets on the performance, carcass yield and meat quality, immune system, intestinal micro flora, blood constituent etc.
- In the near future, it is expected that essential oils will have a wonderful role in the poultry industry development.

- More researchs are is recommended in order to have more stable results and also to determine the exact level of use of these additives in broiler diets.

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APPENDIXES

Appendix -1

Weekly minimum and maximum experimental temperature during the 19th January to 23 February 2019. Temperature (ºC).

Weeks	Minimum	Maximum
1	24	34
2	22	30
3	20	26
4	18	22
5	16	18
Average temperature	20	26

Appendix -2

Card used for judgment of subjective meat quality attributes sensory evaluation. Evaluate these sample for tenderness, flavor, color and juiciness, for each sample, use the appropriate scale to show your attitude by checking at the point that best describes you're feeling 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-Moderately desirable	6-Moderately juicy
5-Slightly tender	5-Slightly intense	5-Slightly desirable	5-Slightly juicy
4-Slightly tough	4-Slightly bland	4-Slightly undesirable	4-Slightly dry
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	Comments
A	1					
B	2					
C	3					
D	4					
E	5					

Appendix -3

Cobb500 Broiler Performance & Nutrition Supplement

Performance objectives - metric

AS HATCHED

Age days	Weight for Age	Daily Gain (g)	Average Daily Gain (g)	Cumulative Feed Conversion	Daily Feed Consumption (g)	Cumulative Feed Consumption (g)
0	42					
1	52	10				
2	66	14				
3	81	15				
4	100	19				
5	122	22				
6	148	26				
7	**177**	**29**	**25.3**	**0.847**		**150**
8	208	31	26.0	0.865	30	180
9	242	34	26.9	0.888	35	215
10	279	37	27.9	0.914	40	255
11	320	41	29.1	0.938	45	300
12	364	44	30.3	0.962	50	350
13	410	46	31.5	0.988	55	405
14	**459**	**49**	**32.8**	**1.013**	**60**	**465**
15	511	52	34.1	1.039	66	531
16	567	56	35.4	1.063	72	603
17	626	59	36.8	1.088	78	681
18	688	62	38.2	1.112	84	765
19	753	65	39.6	1.135	90	855
20	821	68	41.1	1.158	96	951
21	**891**	**70**	**42.4**	**1.182**	**102**	**1053**
22	964	73	43.8	1.205	109	1162
23	1039	75	45.2	1.230	116	1278
24	1115	76	46.5	1.257	123	1401
25	1193	78	47.7	1.283	130	1531
26	1272	79	48.9	1.311	137	1668
27	1353	81	50.1	1.339	144	1812
28	**1436**	**83**	**51.3**	**1.367**	**151**	**1963**
29	1521	85	52.4	1.394	158	2121
30	1608	87	53.6	1.422	165	2286
31	1697	89	54.7	1.448	172	2458
32	1788	91	55.9	1.475	179	2637
33	1880	92	57.0	1.502	186	2823
34	1973	93	58.0	1.529	193	3016
35	**2067**	**94**	**59.1**	**1.556**	**200**	**3216**
36	2162	95	60.1	1.581	202	3418
37	2257	95	61.0	1.604	203	3621
38	2352	95	61.9	1.627	205	3826
39	2447	95	62.7	1.648	206	4032
40	2542	95	63.6	1.668	208	4240
41	2637	95	64.3	1.687	209	4449
42	**2732**	**95**	**65.0**	**1.705**	**210**	**4659**
43	2826	94	65.7	1.724	212	4871
44	2919	93	66.3	1.742	214	5085
45	3011	92	66.9	1.761	216	5301
46	3102	91	67.4	1.779	218	5519
47	3192	90	67.9	1.798	220	5739
48	3281	89	68.4	1.817	222	5961
49	**3369**	**88**	**68.8**	**1.836**	**224**	**6185**
50	3456	87	69.1	1.855	225	6410
51	3542	86	69.5	1.874	226	6636
52	3627	85	69.8	1.892	226	6862
53	3711	84	70.0	1.910	227	7089
54	3794	83	70.3	1.928	227	7316
55	3876	82	70.5	1.946	228	7544
56	**3958**	**82**	**70.7**	**1.964**	**228**	**7772**

Appendix -4

Cobb500 Broiler Performance & Nutrition Supplement

Yield Performance

Predicted carcass yields at given weights

AS HATCHED

Weight g	Weight lb	% Carcass	% Boneless Breast	% Whole Thigh	% Whole Drum Stick	% Wing
1600	3.528	71.9	20.70	13.78	8.77	7.78
1800	3.969	72.5	21.25	13.94	8.79	7.75
2000	4.410	73.1	22.12	14.08	8.81	7.72
2200	4.851	73.8	22.74	14.16	8.83	7.69
2400	5.292	74.4	23.31	14.28	8.85	7.66
2600	5.733	75.1	23.83	14.40	8.87	7.63
2800	6.174	75.9	24.26	14.50	8.89	7.60
3000	6.615	76.4	24.56	14.58	8.91	7.57
3200	7.056	77.0	25.11	14.66	8.93	7.54

FEMALES

Weight g	Weight lb	% Carcass	% Boneless Breast	% Whole Thigh	% Whole Drum Stick	% Wing
1600	3.528	72.0	21.53	14.02	8.52	7.84
1800	3.969	72.6	21.65	14.20	8.54	7.81
2000	4.410	73.2	22.40	14.36	8.56	7.78
2200	4.851	73.7	22.98	14.40	8.58	7.75
2400	5.292	74.5	23.46	14.52	8.60	7.72
2600	5.733	75.6	23.93	14.66	8.62	7.69
2800	6.174	75.8	24.31	14.76	8.64	7.66

MALES

Weight g	Weight lb	% Carcass	% Boneless Breast	% Whole Thigh	% Whole Drum Stick	% Wing
1600	3.528	71.8	20.35	13.54	9.02	7.71
1800	3.969	72.4	20.97	13.67	9.04	7.68
2000	4.410	73.0	21.84	13.79	9.06	7.65
2200	4.851	73.7	22.50	13.91	9.08	7.62
2400	5.292	74.3	23.15	14.04	9.10	7.58
2600	5.733	75.0	23.73	14.14	9.12	7.55
2800	6.174	75.6	24.21	14.24	9.14	7.52
3000	6.615	76.3	24.46	14.36	9.16	7.49
3200	7.056	76.9	24.95	14.48	9.18	7.46
3400	7.497	77.5	25.53	14.59	9.20	7.43
3600	7.938	78.2	26.10	14.71	9.22	7.40

- Eviscerated carcass is calculated with feet and shanks removed from the hock joint.
- % Boneless breast is as a percentage of live weight.

Appendix -5

CHICKS NORMAL PROFILE

METABOLITES:

Total Protein	(g/dl)	2.58 – 7.56
Albumin	(g/dl)	1.11 – 3.5
Globulin	(g/dl)	1.34 – 2.01
Total Bilirubin	(mg/dl)	0.015 – 0.61
Creatinine	(mg/dl)	2.0 – 3.56
Uric acid	(mg/dl)	4.58 – 8.3
Urea	(mg/dl)	4.67 – 12.95
Triglycerides	(mg/dl)	40 – 100.47
Cholesterol	(mg/dl)	102 – 203
Total Lipids	(mg/dl)	5.0 – 7.65
Glucose	(mg/dl)	219 – 247

ENZYMES:

Aspartate Amino Transferase (AST)	(iu/L)	16.72 – 54.0
Alkaline Phosphatase (ALP)	(iu/L)	36.9 – 244 86
Gamma-glutamyl Transferase (GGT)	(i.u.)	13.89 – 41.8
Lactate Dehydrogenase (LDH)	(i.u.)	63.2
Creatine Kinase (CK)	(i.u.)	129.6

MINERALS:

Calcium (Ca)	(mg/dl)	5.78 – 10.6
Phosphorus (P)	(mg/dl)	4.59 – 11.38
Iron (Fe)	(mg/dl)	111.09 – 119.05
Copper (Cu)	(mg/dl)	0.35 – 1.04
Manganese (Mn)	(mg/dl)	1.4 – 2.0

Zinc (Zn)	(mg/dl)	0.35 – 2.0

HEAMATOLOGY:

Red Blood Cell (RBC)	(cell/L)	(2.0 – 2.35)10^{12}
White Blood Cell (WBC)	(cell/L)	(1.14 – 1.17)10^{12}
Packed Cell Volume (PCV)	(%)	5 – 38
Hemoglobin (Hb)	(g/L)	7.5 – 18.3
Mean Corpusular Volume (MCV)	(fl)	27.27 - 138.2
Mean Corpusular Hemoglobin (MCH)	(pg)	32.42 - 37.27
Mean Corpusular Hemoglobin Concentration (MCHC)	(g/dl)	24.79 – 137.5

The Source:

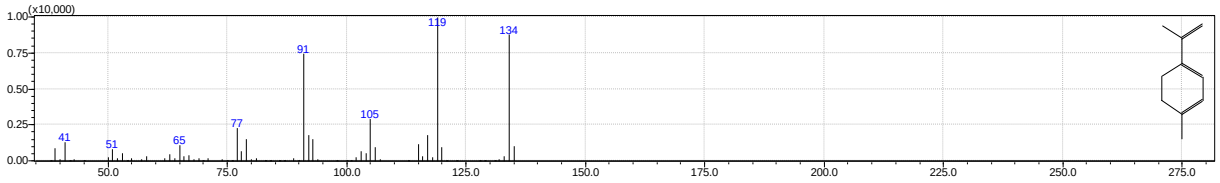
AL- Amin. A. M. (2012), scientific issue.

Faculty of Veterinary Science, University of Khartoum.

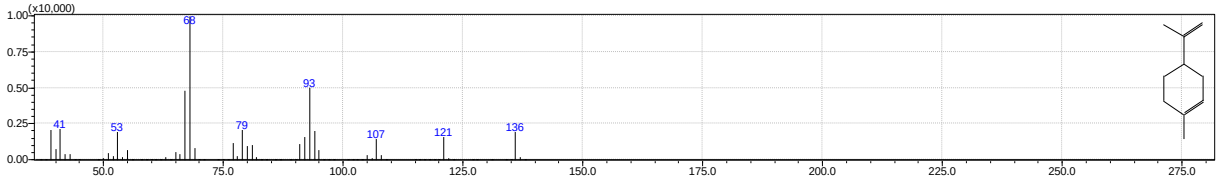
Appendix -6

SAMPLE1 Scan by GC-MS EI

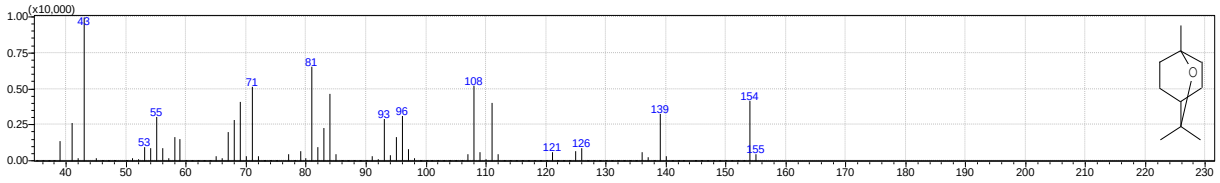
Chemical constituent of FSMEOs:



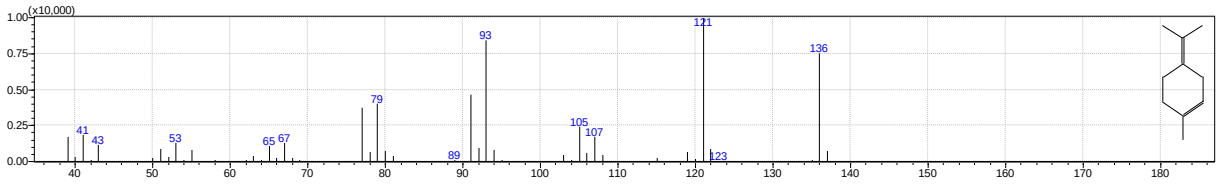
1 : 134 : 1,3,8-p-Menthatriene $$ p-Mentha-1,3,8-triene $$ 1-Isopropenyl-4-methyl-1,3-cyclohexadiene # $$ 1,3,8-para-Menthatriene $$ p-1,3,8-Menthatriene $$ p-Menta-1,3,8-triene $$ 1,3-Cyclohexadiene, 1-methyl-4-(1-methylethenyl)- $$



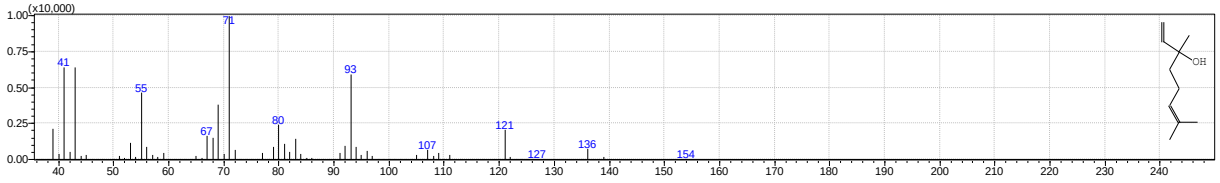
1 : 136 : D-Limonene $$ Cyclohexene, 1-methyl-4-(1-methylethenyl)-, (R)- $$ p-Mentha-1,8-diene, (R)-(+)- $$ (+)-(R)-Limonene $$ (+)-(4R)-Limonene $$ (+)-p-Mentha-1,8-diene $$ (+)-Limonene $$ (R)-(+)-Limonene $$ Carvene $$ D-(+)-Limonene $$ Limonene, (D)- $$ Limonene, (+)- $$ (R)-1-methyl-4-(1-methylethenyl)cyclohexene $$ Dextro-limonene $$ (R)-4-Isopropenyl-1-methyl-1-cyclohexene $$ 4-Isopropenyl-1-methyl-1-cyclohexene-, (R)- $$ (R)-Limonene $$ (+)-Dipentene $$ (4R)-(+)-Limonene $$ (4R)-Limonene $$ (R)-(+)-p-Mentha-



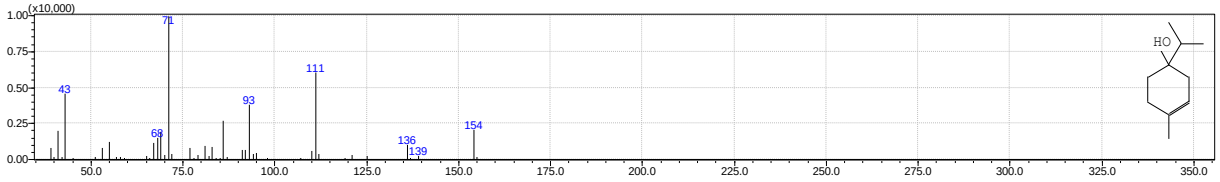
1 : 154 : Eucalyptol $$ Cineole $$ 2-Oxabicyclo[2.2.2]octane, 1,3,3-trimethyl- $$ p-Menthane, 1,8-epoxy- $$ p-Cineole $$ Cajeputol $$ Cucalyptol $$ Eucapur $$ Terpan $$ Zineol $$ 1,3,3-Trimethyl-2-oxabicyclo[2.2.2]octane $$ 1,8-Cineole $$ 1,8-Epoxy-p-menthane $$ 2-Oxa-1,3,3-trimethylbicyclo[2.2.2]octane $$ Cineol $$ Eucalyptole $$ NCI-C56575 $$ 1,8-Cineol $$ 1,8-Oxido-p-menthane $$ Eukalyptol $$ NSC 6171 $$



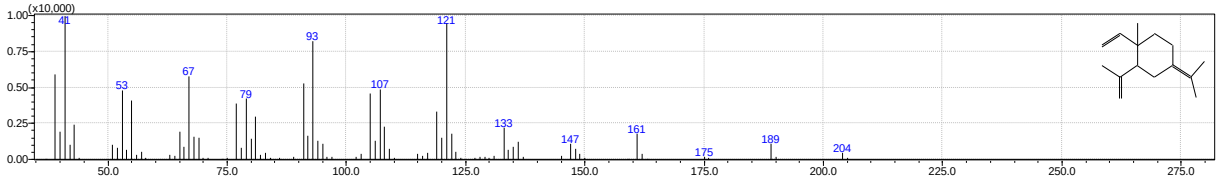
1 : 136 : Cyclohexene, 1-methyl-4-(1-methylethylidene)- $$ p-Mentha-1,4(8)-diene $$ Terpinolene $$ Terpinolen $$ UN 2541 $$ .alpha.- Terpinolen $$ 1-Methyl-4-(1-methylethylidene)-1-cyclohexene # $$ .alpha.-Terpinolene $$ 4-Isopropylidene-1-methyl-cyclohexene $$ p-Menth-1,4(8)-diene $$



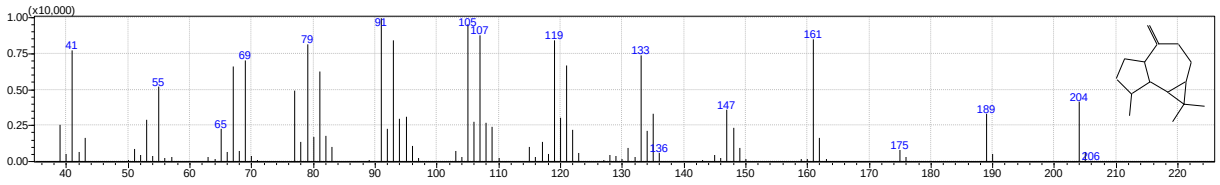
1 : 154 : Linalool $$ 1,6-Octadien-3-ol, 3,7-dimethyl- $$ .beta.-Linalool $$ Linalol $$ Linalyl alcohol $$ 2,6-Dimethyl-2,7-octadien-6-ol $$ allo-Ocimenol $$ 2,6-Dimethyl-2,7-octadiene-6-ol $$ 2,6-Dimethylocta-2,7-dien-6-ol $$ 3,7-Dimethyl-1,6-octadien-3-ol $$ 3,7-Dimethylocta-1,6-dien-3-ol $$ Linolool $$ Linanool $$ 3,7-Dimethyl-octa-1,6-dien-3-ol $$ dl-3,7-Dimethyl-3-hydroxy-1,6-octadiene $$ Linalool ex bois de rose oil $$ Linalool ex ho oil $$ Linalool ex orange oil $$ Phantol $$ Linalool, .beta. $$ (.+/-.)-Linal



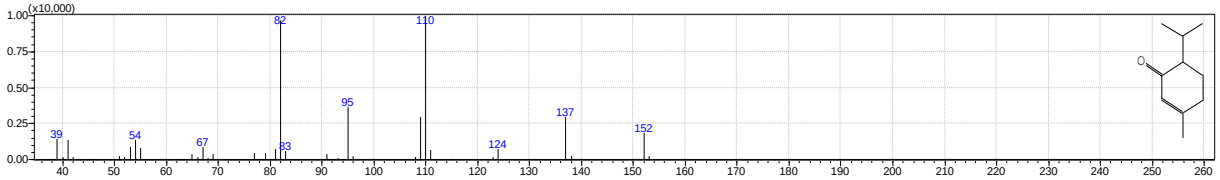
1 : 154 : 3-Cyclohexen-1-ol, 4-methyl-1-(1-methylethyl)-, (R)- $$ p-Menth-1-en-4-ol, (R)-(-)- $$ (-)-Terpinen-4-ol $$ (-)-4-Terpineol $$ L-terpinen-4-ol $$ L-4-terpineneol $$ L-4-terpineol $$ 1-Isopropyl-4-methyl-3-cyclohexen-1-ol, (R)- $$



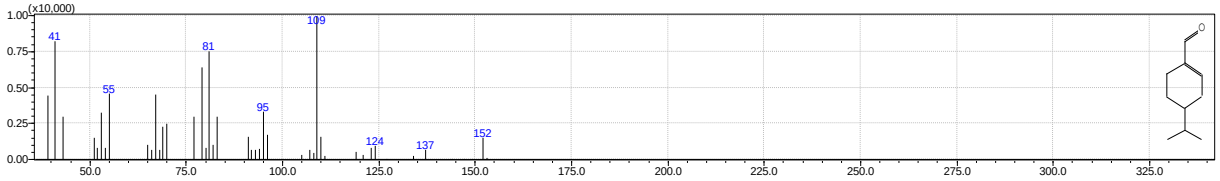
1 : 204 : .gamma.-Elemene $$ 1-Methyl-2-(1-methylethenyl)-4-(1-methylethylidene)-1-vinylcyclohexane), (1R-trans)- $$ (-)-.gamma.-Elemene $$ o-Menth-8-ene, 4-isopropylidene-1-vinyl, (-)- $$



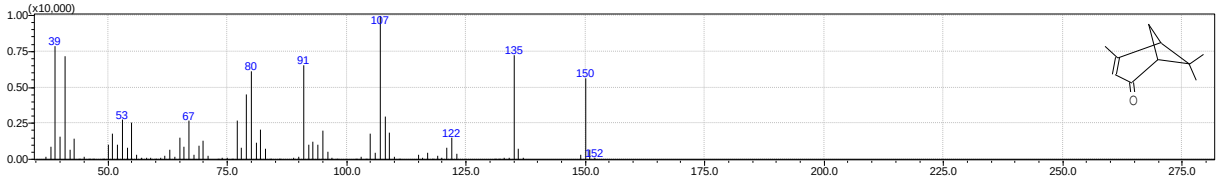
1 : 204 : Aromandendrene $$ 1H-Cycloprop[e]azulene, decahydro-1,1,7-trimethyl-4-methylene-, [1aR-(1a.alpha.,4a.alpha.,7.alpha.,7a.beta.,7b.alpha.)]- $$ 1H-Cycloprop[e]azulene, decahydro-1,1,7-trimethyl-4-methylene-, (1aR,4aR,7R,7aR,7bS)-(+)- $$ (1aR,4aR,7R,7aR,7bS)-1,1,7-Trimethyl-4-methylenedecahydro-1H-cyclopropa[e]azulene $$ Aromadendr-7(15)-ene $$ (+)-Aromadendrene $$ Aromadendrene, (+)- $$ 1,1,7-Trimethyl-4-methylenedecahydro-1H-cyclopropa[e]azulene-, [1aR-(1a.alpha.,4a.alpha.,7.alpha.,7a.beta.,7b.alpha.)]- $$



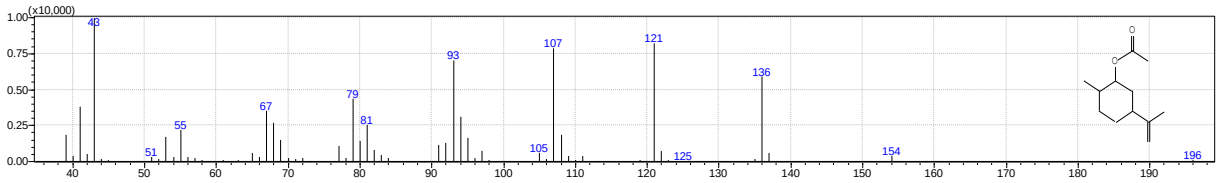
1 : 152 : 2-Cyclohexen-1-one, 3-methyl-6-(1-methylethyl)- $$ p-Menth-1-en-3-one $$ Piperitone $$ 3-Carvomenthenone $$ 1-Methyl-4-isopropyl-1-cyclohexen-3-one $$ 6-Isopropyl-3-methyl-2-cyclohexen-1-one # $$



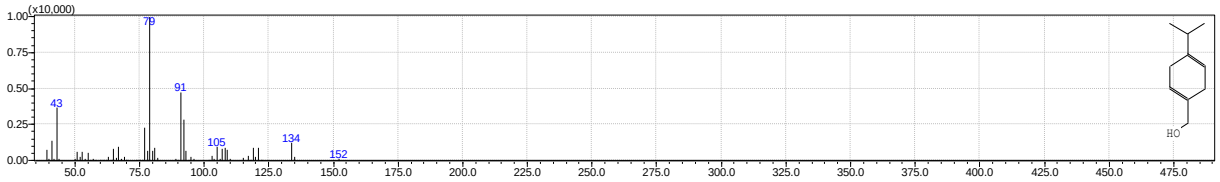
1 : 152 : 1-Cyclohexene-1-carboxaldehyde, 4-(1-methylethyl)- $$ Phellandral $$ 4-Isopropyl-1-cyclohexene-1-carbaldehyde $$ 4-[1-Methylethyl]-1-cyclohexene-1-carboxaldehyde $$ p-Menth-1-en-7-al $$



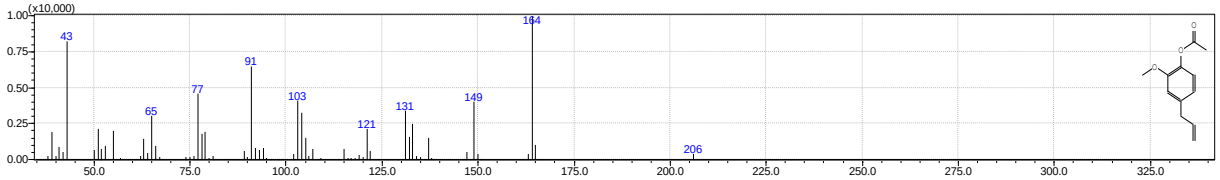
1 : 150 : Bicyclo[3.1.1]hept-3-en-2-one, 4,6,6-trimethyl- $$ 2-Pinen-4-one $$ Berbenone $$ Verbenone $$ 4,6,6-Trimethylbicyclo[3.1.1]hept-3-en-2-one # $$



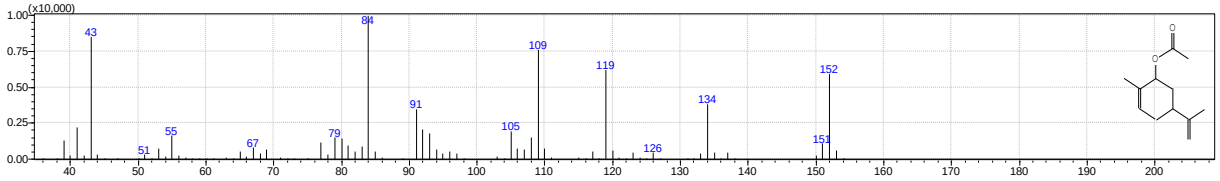
1 : 196 : (-)-8-p-Menthen-2-yl, acetate, trans $$ (-)-Dihydrocarvyl acetate $$ (-)-trans-p-Menth-8-en-2-ol, acetate $$ Cyclohexanol, 2-methyl-5-(1-methylethenyl)-, acetate, [1R-(1.alpha.,2.beta.,5.alpha.)]- $$ (-)-trans-Dihydrocarvyl acetate $$



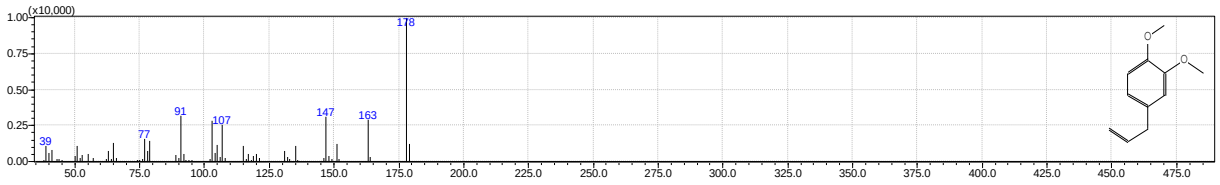
1 : 152 : 1,4-Cyclohexadiene-1-methanol, 4-(1-methylethyl)- $$ p-Mentha-1,4-dien-7-ol $$ 1,4-p-Menthadien-7-ol $$ (4-Isopropyl-1,4-cyclohexadien-1-yl)methanol # $$



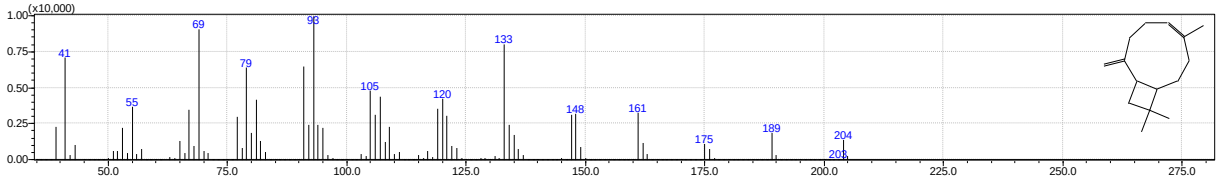
1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$



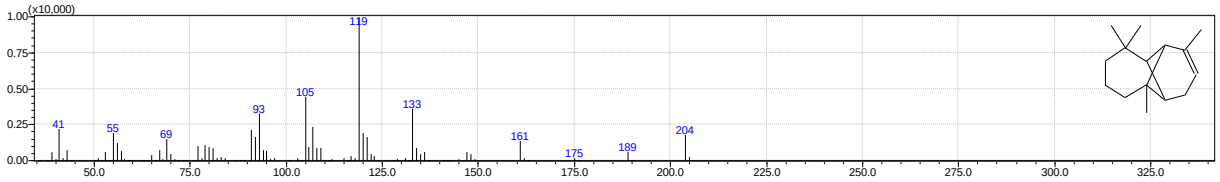
1 : 194 : 2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-, acetate, cis- $$ p-Mentha-6,8-dien-2-ol, acetate, cis- $$ cis-Carvyl acetate $$ 5-Isopropenyl-2-methyl-2-cyclohexen-1-yl acetate, cis- # $$ Carvyl acetate (Z) $$ Z-Carvyl acetate $$ 2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-, 1-acetate, (1R,5R)-rel- $$



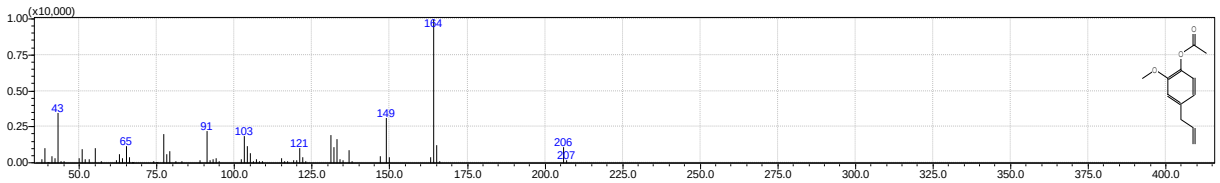
1 : 178 : Methyleugenol $$ Benzene, 1,2-dimethoxy-4-(2-propenyl)- $$ Benzene, 4-allyl-1,2-dimethoxy- $$ Ent 21040 $$ Eugenol methyl ether $$ Eugenyl methyl ether $$ Methyl eugenol ether $$ O-Methyleugenol $$ Veratrole methyl ether $$ 1-(3,4-Dimethoxyphenyl)-2-propene $$ 1-Allyl-3,4-dimethoxybenzene $$ 1,2-Dimethoxy-4-allylbenzene $$ 1,3,4-Eugenol methyl ether $$ 3,4-Dimethoxyallylbenzene $$ 4-Allyl-1,2-dimethoxybenzene $$ 4-Allylveratrole $$ 1,2-Dimethoxy-4-(2-propenyl)benzene $$ Methyl eugenol $$ 4-Allyl-1,2-dimeth



1 : 204 : Caryophyllene $$ Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-, [1R-(1R*,4E,9S*)]- $$ Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-, (E)-(1R,9S)-(-)- $$ .beta.-Caryophyllen $$ .beta.-Caryophyllene $$ trans-Caryophyllene $$ L-Caryophyllene $$ Bicyclo(7.2.0)undec-4-ene, 8-methylene-4,11,11-trimethyl-, (E)-(1R,9S)-(-)- $$ 8-Methylene-4,11,11-(trimethyl)bicyclo(7.2.0)undec-4-ene, (1R,4E,9S)- $$ beta-Caryophyllene $$ .beta.-(E)-Caryophyllene $$ .beta.-trans-Caryophyllene $$ Caryophyllene

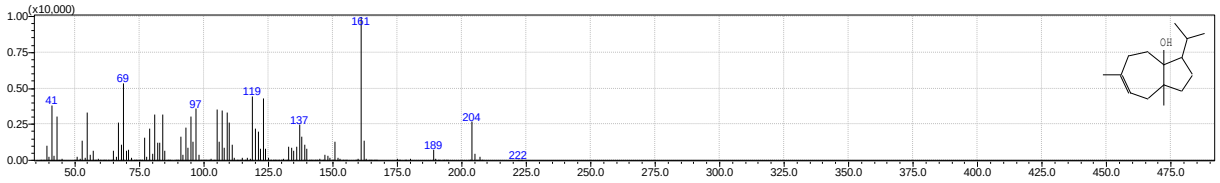


1 : 204 : Tricyclo[5.4.0.0(2,8)]undec-9-ene, 2,6,6,9-tetramethyl-, (1R,2S,7R,8R)- $$ .alpha.-Longipinene $$ (+)-.alpha.-Longipinene $$ Longipinene $$



1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$

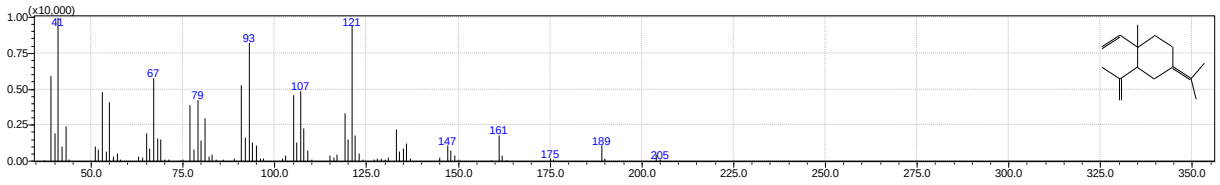
Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$



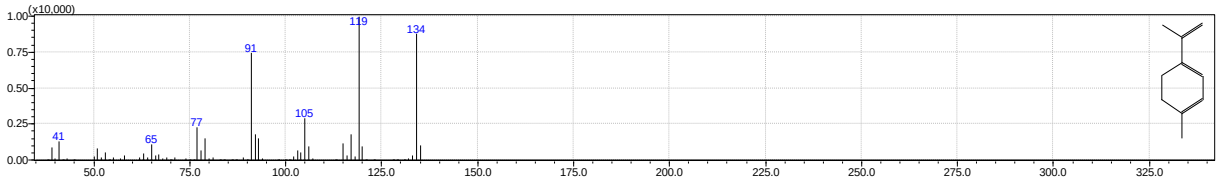
1 : 222 : Carotol $$ 3a(1H)-Azulenol, 2,3,4,5,8,8a-hexahydro-6,8a-dimethyl-3-(1-methylethyl)-, [3R-(3.alpha.,3a.alpha.,8a.alpha.)]- $$ 3a.alpha.(1H)-Azulenol, 2,3,4,5,8,8a-hexahydro-3.alpha.-isopropyl-6,8a.alpha.-dimethyl-, (+)- $$ (+)-Carotol $$ Carotol, (+)- $$ 3-Isopropyl-6,8a-dimethyl-2,3,4,5,8,8a-hexahydro-3a(1H)-azulenol # $$ cis-Dauc-8-en-5.beta.-ol $$

SAMPLE 2

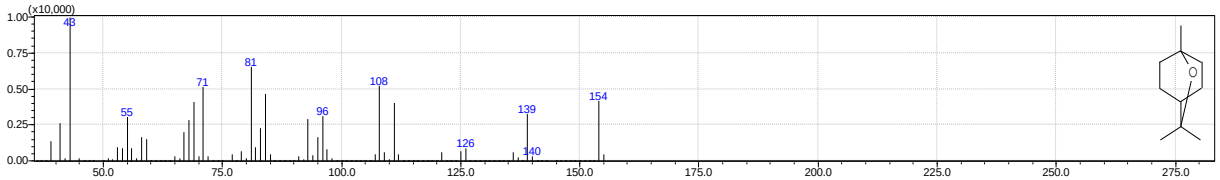
Chemical constituent of FHMEOs:



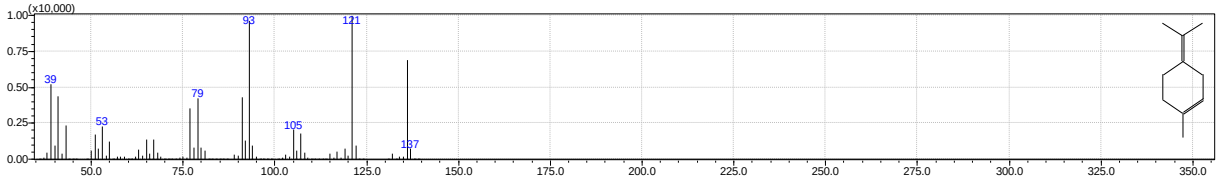
1 : 204 : .gamma.-Elemene $$ 1-Methyl-2-(1-methylethenyl)-4-(1-methylethylidene)-1-vinylcyclohexane), (1R-trans)- $$ (-)-.gamma.-Elemene $$ o-Menth-8-ene, 4-isopropylidene-1-vinyl, (-)- $$



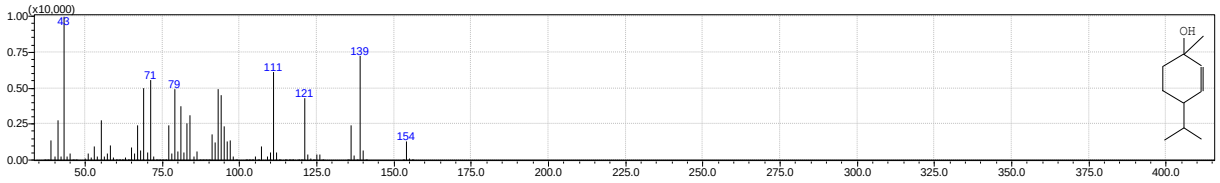
1 : 134 : 1,3,8-p-Menthatriene $$ p-Mentha-1,3,8-triene $$ 1-Isopropenyl-4-methyl-1,3-cyclohexadiene # $$ 1,3,8-para-Menthatriene $$ p-1,3,8-Menthatriene $$ p-Menta-1,3,8-triene $$ 1,3-Cyclohexadiene, 1-methyl-4-(1-methylethenyl)- $$



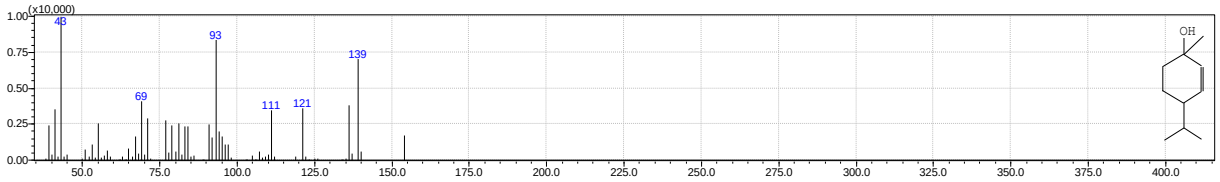
1 : 154 : Eucalyptol $$ Cineole $$ 2-Oxabicyclo[2.2.2]octane, 1,3,3-trimethyl- $$ p-Menthane, 1,8-epoxy- $$ p-Cineole $$ Cajeputol $$ Cucalyptol $$ Eucapur $$ Terpan $$ Zineol $$ 1,3,3-Trimethyl-2-oxabicyclo[2.2.2]octane $$ 1,8-Cineole $$ 1,8-Epoxy-p-menthane $$ 2-Oxa-1,3,3-trimethylbicyclo[2.2.2]octane $$ Cineol $$ Eucalyptole $$ NCI-C56575 $$ 1,8-Cineol $$ 1,8-Oxido-p-menthane $$ Eukalyptol $$ NSC 6171 $$



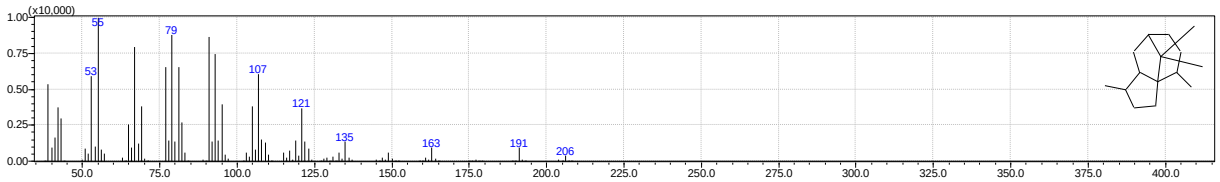
1 : 136 : Cyclohexene, 1-methyl-4-(1-methylethylidene)- $$ p-Mentha-1,4(8)-diene $$ Terpinolene $$ Terpinolen $$ UN 2541 $$ .alpha.- Terpinolen $$ 1-Methyl-4-(1-methylethylidene)-1-cyclohexene # $$ .alpha.-Terpinolene $$ 4-Isopropylidene-1-methyl-cyclohexene $$ p-Menth-1,4(8)-diene $$



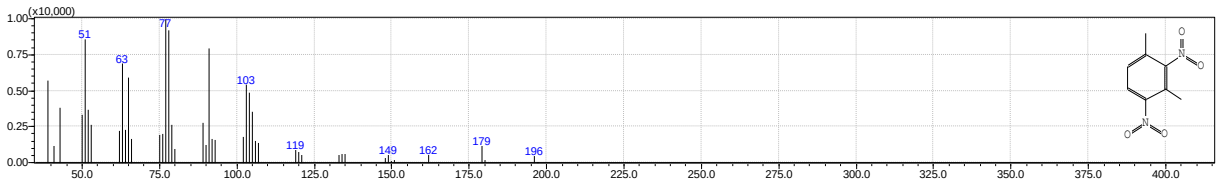
1 : 154 : 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- $$ (1R,4R)-4-Isopropyl-1-methylcyclohex-2-enol $$ 4-Isopropyl-1-methyl-2-cyclohexen-1-ol, cis- $$ cis-2-Cyclohexene-1-ol-1-methyl-4(1-methylethyl) $$ cis-2-p-Menthen-1-ol $$ cis-p-Menth-2-en-1-ol $$ cis-para-Menth-2-en-1-ol $$ cis-para-Menth-2-ene-1-ol $$ cis-p-Menth-2-ene-1-ol $$ cis-p-Mentha-2-en-1-ol $$ Menth-2-en-1-ol (cis-p) $$ Menth-2-en-1-ol, cis-para $$ p-Menth-2-en-1-ol, cis $$ (Z)-p-Menth-2-en-1-ol $$ (Z)-p-Mentha-2-en-1-ol $$ cis-2-Menthenol $



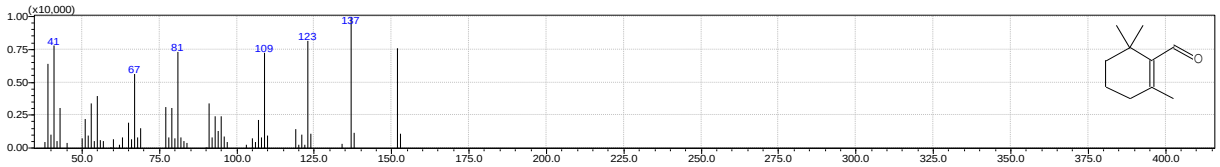
1 : 154 : 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- $$ (1R,4R)-4-Isopropyl-1-methylcyclohex-2-enol $$ 4-Isopropyl-1-methyl-2-cyclohexen-1-ol, cis- $$ cis-2-Cyclohexene-1-ol-1-methyl-4(1-methylethyl) $$ cis-2-p-Menthen-1-ol $$ cis-p-Menth-2-en-1-ol $$ cis-para-Menth-2-en-1-ol $$ cis-para-Menth-2-ene-1-ol $$ cis-p-Menth-2-ene-1-ol $$ cis-p-Mentha-2-en-1-ol $$ Menth-2-en-1-ol (cis-p) $$ Menth-2-en-1-ol, cis-para $$ p-Menth-2-en-1-ol, cis $$ (Z)-p-Menth-2-en-1-ol $$ (Z)-p-Mentha-2-en-1-ol $$ cis-2-Menthenol $



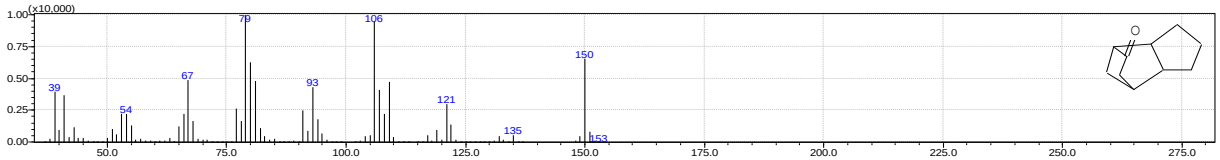
1 : 206 : 1H-3a,7-Methanoazulene, octahydro-1,4,9,9-tetramethyl- $$ Patchoulane $$



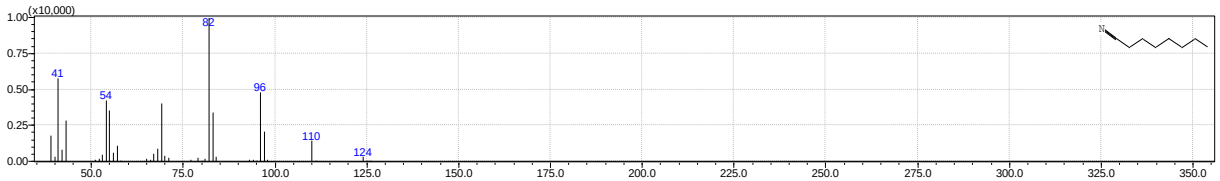
1 : 196 : 2,4-Dinitro-1,3-dimethyl-benzene $$ 2,4-Dinitro-m-xylene $$ Benzene, 1,3-dimethyl-2,4-dinitro- $$ m-Xylene, 2,4-dinitro- $$ 1,3-Dimethyl-2,4-dinitrobenzene # $$



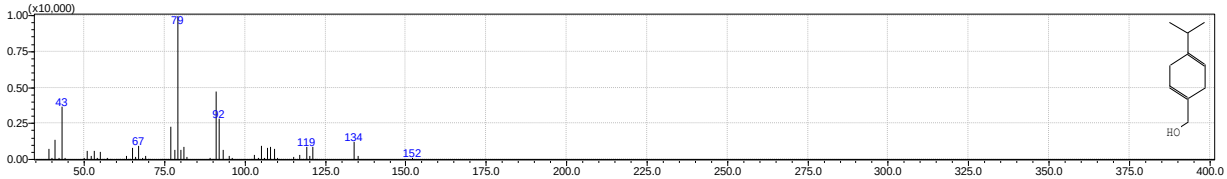
1 : 152 : 1-Cyclohexene-1-carboxaldehyde, 2,6,6-trimethyl- $$ .beta.-Cyclocitral $$ 1-Formyl-2,6,6-trimethyl-1-cyclohexene $$ 2,6,6-Trimethyl-1-cyclohexene-1-carbaldehyde # $$ 2,6,6-trimethyl-cyclohexene-1-carboxaldehyde $$



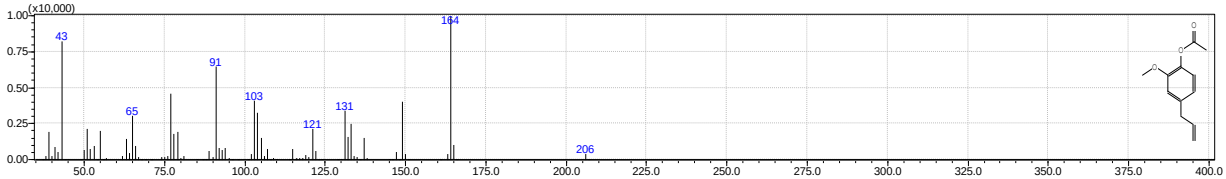
1 : 150 : 4,7-Methano-5H-inden-5-one, octahydro- $$ 4,7-Methanoindan-5(4H)-one, tetrahydro- $$ Tricyclo(5,2,1,0(2,6))decanone-8 $$ Tricyclo[5.2.1.0(2,6)]decan-8-one $$ Corodane $$ 8-Ketotricyclo(5.2.1.0(sup2,6))decane $$ 8-Oxotricyclo(5.2.1.0(2,6))decane $$ Tricyclo[5.2.1.0(2,6)]decanone-8 $$ 8-Oxotricyclo[5.2.1.0(2,6)]decane $$ NSC 77098 $$



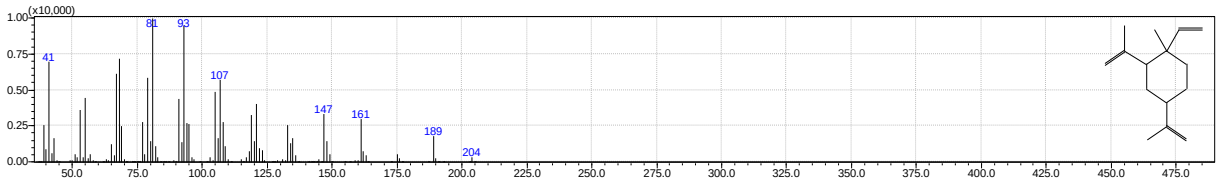
1 : 125 : Octanenitrile $$ Arneel 8 $$ Caprylnitrile $$ Caprylonitrile $$ Octanonitrile $$ Normal-heptyl cyanide $$ n-Heptyl cyanide $$ 1-Cyanoheptane $$



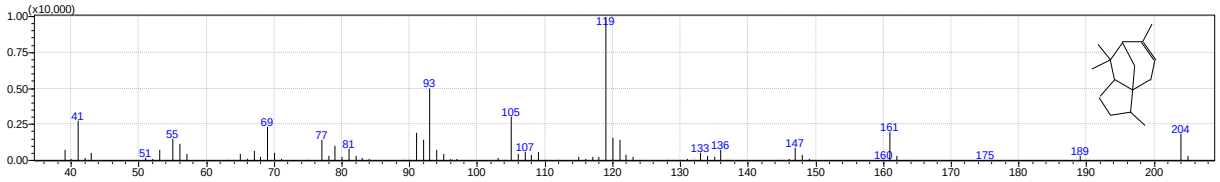
1 : 152 : 1,4-Cyclohexadiene-1-methanol, 4-(1-methylethyl)- $$ p-Mentha-1,4-dien-7-ol $$ 1,4-p-Menthadien-7-ol $$ (4-Isopropyl-1,4-cyclohexadien-1-yl)methanol # $$



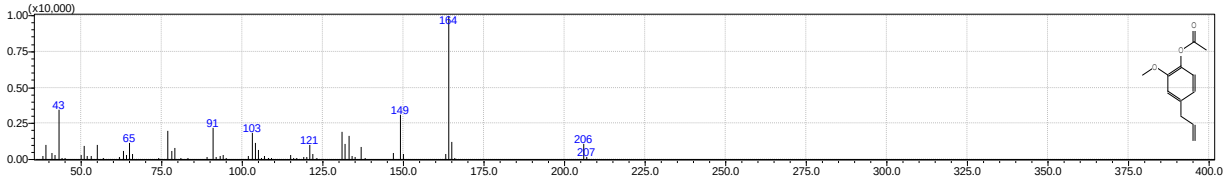
1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$



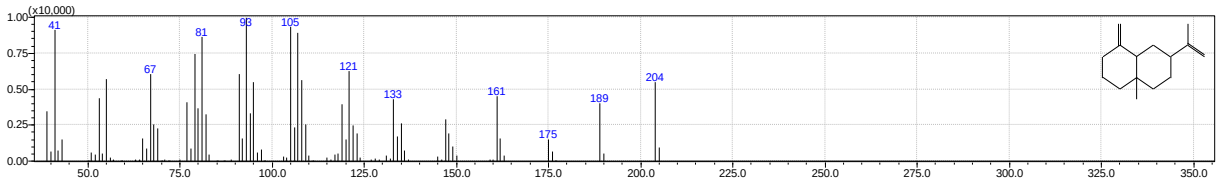
1 : 204 : Cyclohexane, 1-ethenyl-1-methyl-2,4-bis(1-methylethenyl)-, [1S-(1.alpha.,2.beta.,4.beta.)]- $$ Cyclohexane, 2,4-diisopropenyl-1-methyl-1-vinyl-, (1S,2R,4R)- (-)- $$ .beta.-Elemene, (-)- $$ (-)-.beta.-Elemene $$ .beta.-Elemen $$ levo-.beta.-Elemene $$ .beta.-Elemene $$ .beta.-Elemene enantiomer $$ 2,4-Diisopropenyl-1-methyl-1-vinylcyclohexane, [1S-(1.alpha.,2.beta.,4.beta.)]- $$



1 : 204 : 1H-3a,7-Methanoazulene, 2,3,4,7,8,8a-hexahydro-3,6,8,8-tetramethyl-, [3R-(3.alpha.,3a.beta.,7.beta.,8a.alpha.)]- $$ Cedr-8-ene $$ .alpha.-Cedrene $$

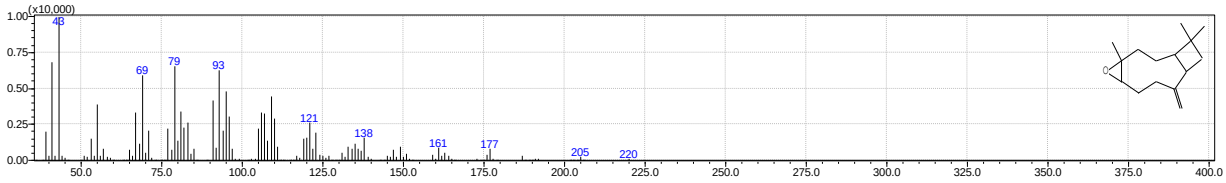


1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$

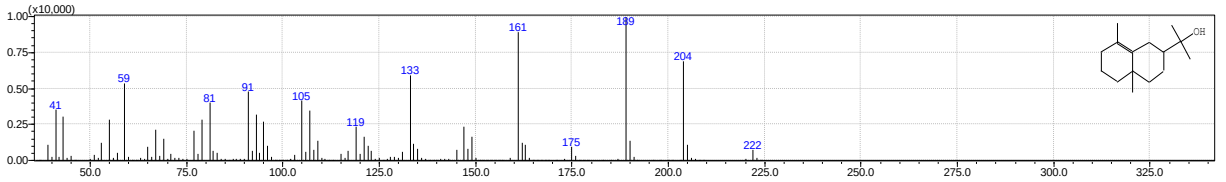


1 : 204 : Naphthalene, decahydro-4a-methyl-1-methylene-7-(1-methylethenyl)-, [4aR-(4a.alpha.,7.alpha.,8a.beta.)]- $$ Eudesma-4(14),11-diene $$ .beta.-Eudesmene $$ .beta.-Selinene

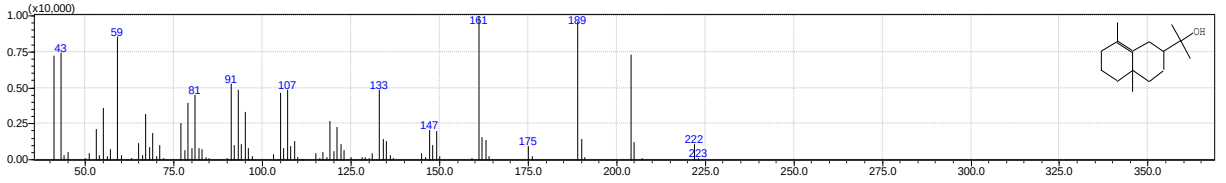
$$ (+)-.beta.-Selinene $$ Selina-4(14),11-diene $$ 7-Isopropenyl-4a-methyl-1-methylenedecahydronaphthalene-, (4aR-(4a.alpha.,7.alpha.,8a.beta.))- $$



1 : 220 : Caryophyllene oxide $$ 5-Oxatricyclo[8.2.0.0(4,6)-]dodecane, 4,12,12-trimethyl-9-methylene-, [1R-(1R*,4R*,6R*,10S*)]- $$ 5-Oxatricyclo(8.2.0.0(4,6))dodecane, 4,12,12-trimethyl-9-methylene-, (1R,4R,6R,10S)- $$ Caryophylene oxide $$ Caryophyllene epoxide $$ (-)-.beta.-Caryophyllene epoxide $$ .beta.-Caryophyllene oxide $$ Epoxycaryophyllene $$ (-)-Epoxydihydrocaryophyllene $$ 4,11,11-Trimethyl-8-methylene-5-oxatricyclo(8.2.0.0(4,6))dodecane, (1R,4R,6R,10S)- $$ (-)-5-Oxatricyclo[8.2.0.0(4,6)]dodecane,4,12,12-



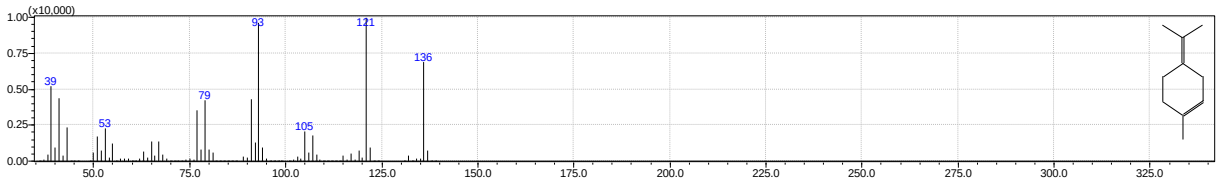
1 : 222 : 2-Naphthalenemethanol, 1,2,3,4,4a,5,6,7-octahydro-.alpha.,.alpha.,4a,8-tetramethyl-, (2R-cis)- $$ .gamma.-Eudesmol $$ .gamma.-Eudesmole $$ [2R-cis]-1,2,3,4,4a,5,6,7-Octahydro-.alpha.,.alpha.,4a,8-tetramethyl-2-naphthalenemethanol $$ 2-((2R,4aR)-4a,8-Dimethyl-1,2,3,4,4a,5,6,7-octahydronaphthalen-2-yl)propan-2-ol $$ Selinenol $$ Machilol $$ Eudesm-4-en-11-ol $$ Uncineol $$



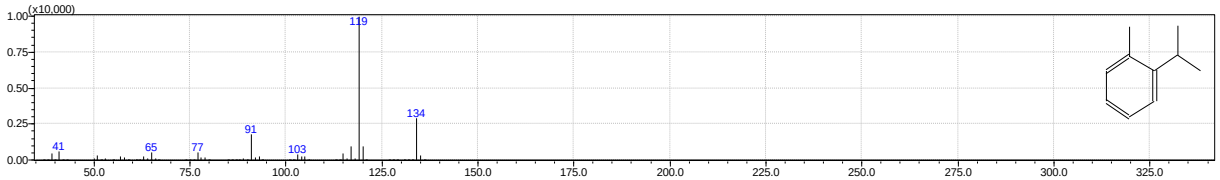
1 : 222 : 2-Naphthalenemethanol, 1,2,3,4,4a,5,6,7-octahydro-.alpha.,.alpha.,4a,8-tetramethyl-, (2R-cis)- $$ .gamma.-Eudesmol $$ .gamma.-Eudesmole $$ [2R-cis]-1,2,3,4,4a,5,6,7-Octahydro-.alpha.,.alpha.,4a,8-tetramethyl-2-naphthalenemethanol $$ 2-((2R,4aR)-4a,8-Dimethyl-1,2,3,4,4a,5,6,7-octahydronaphthalen-2-yl)propan-2-ol $$ Selinenol $$ Machilol $$ Eudesm-4-en-11-ol $$ Uncineol $$

SAMPLE3

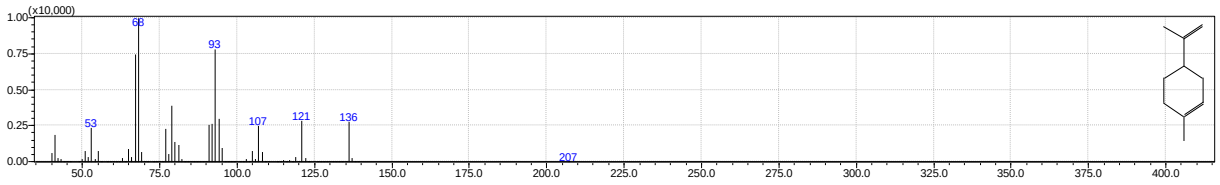
Chemical constituent of SHMEOs:



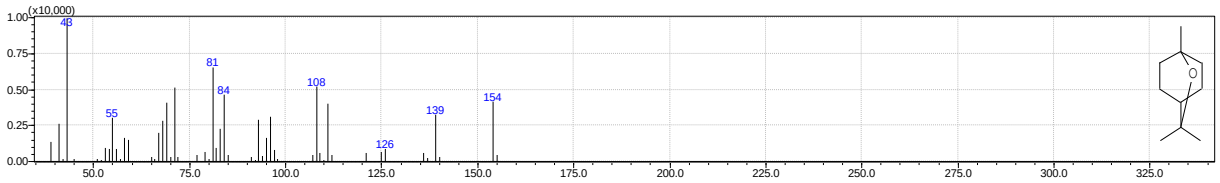
1 : 136 : Cyclohexene, 1-methyl-4-(1-methylethylidene)- $$ p-Mentha-1,4(8)-diene $$ Terpinolene $$ Terpinolen $$ UN 2541 $$ .alpha.- Terpinolen $$ 1-Methyl-4-(1-methylethylidene)-1-cyclohexene # $$ .alpha.-Terpinolene $$ 4-Isopropylidene-1-methyl-cyclohexene $$ p-Menth-1,4(8)-diene $$



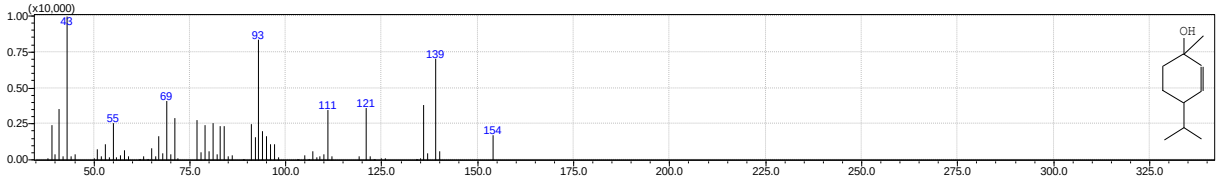
1 : 134 : o-Cymene $$ Benzene, 1-methyl-2-(1-methylethyl)- $$ o-Cymol $$ o-Isopropyltoluene $$ 1-Isopropyl-2-methylbenzene $$ 1-Methyl-2-isopropylbenzene $$ 2-Isopropyltoluene $$ 1-Methyl-2-(1-methylethyl)-benzene $$ Cymene, ortho $$ UN 2046 $$ 1-(1-methylethyl)-2-methylbenzene $$ 1-methyl,2-n-isopropylbenzene $$ ortho-Cymene $$



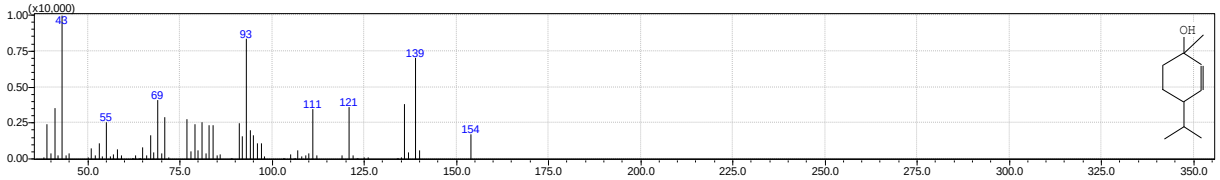
1 : 136 : D-Limonene $$ Cyclohexene, 1-methyl-4-(1-methylethenyl)-, (R)- $$ p-Mentha-1,8-diene, (R)-(+)- $$ (+)-(R)-Limonene $$ (+)-(4R)-Limonene $$ (+)-p-Mentha-1,8-diene $$ (+)-Limonene $$ (R)-(+)-Limonene $$ Carvene $$ D-(+)-Limonene $$ Limonene, (D)- $$ Limonene, (+)- $$ (R)-1-methyl-4-(1-methylethenyl)cyclohexene $$ Dextro-limonene $$ (R)-4-Isopropenyl-1-methyl-1-cyclohexene $$ 4-Isopropenyl-1-methyl-1-cyclohexene-, (R)- $$ (R)-Limonene $$ (+)-Dipentene $$ (4R)-(+)-Limonene $$ (4R)-Limonene $$ (R)-(+)-p-Mentha-



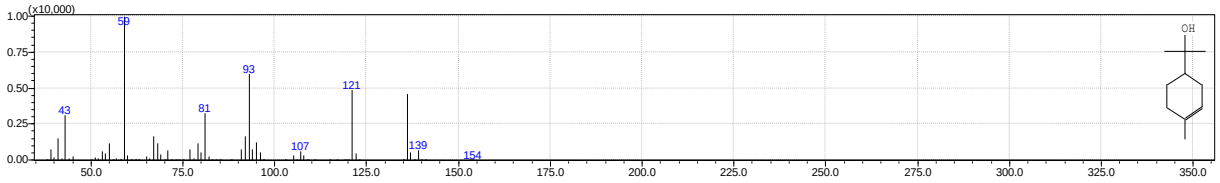
1 : 154 : Eucalyptol $$ Cineole $$ 2-Oxabicyclo[2.2.2]octane, 1,3,3-trimethyl- $$ p-Menthane, 1,8-epoxy- $$ p-Cineole $$ Cajeputol $$ Cucalyptol $$ Eucapur $$ Terpan $$ Zineol $$ 1,3,3-Trimethyl-2-oxabicyclo[2.2.2]octane $$ 1,8-Cineole $$ 1,8-Epoxy-p-menthane $$ 2-Oxa-1,3,3-trimethylbicyclo[2.2.2]octane $$ Cineol $$ Eucalyptole $$ NCI-C56575 $$ 1,8-Cineol $$ 1,8-Oxido-p-menthane $$ Eukalyptol $$ NSC 6171 $$



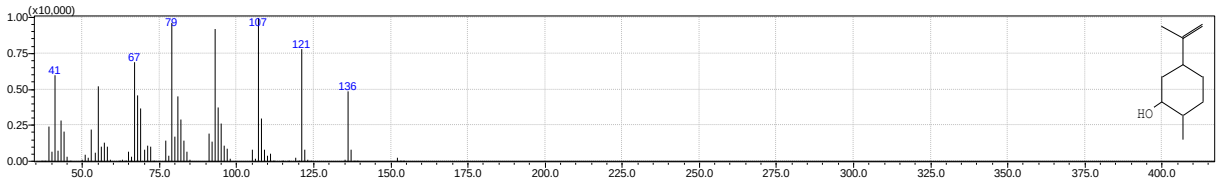
1 : 154 : 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- $$ (1R,4R)-4-Isopropyl-1-methylcyclohex-2-enol $$ 4-Isopropyl-1-methyl-2-cyclohexen-1-ol, cis- $$ cis-2-Cyclohexene-1-ol-1-methyl-4(1-methylethyl) $$ cis-2-p-Menthen-1-ol $$ cis-p-Menth-2-en-1-ol $$ cis-para-Menth-2-en-1-ol $$ cis-para-Menth-2-ene-1-ol $$ cis-p-Menth-2-ene-1-ol $$ cis-p-Mentha-2-en-1-ol $$ Menth-2-en-1-ol (cis-p) $$ Menth-2-en-1-ol, cis-para $$ p-Menth-2-en-1-ol, cis $$ (Z)-p-Menth-2-en-1-ol $$ (Z)-p-Mentha-2-en-1-ol $$ cis-2-Menthenol $



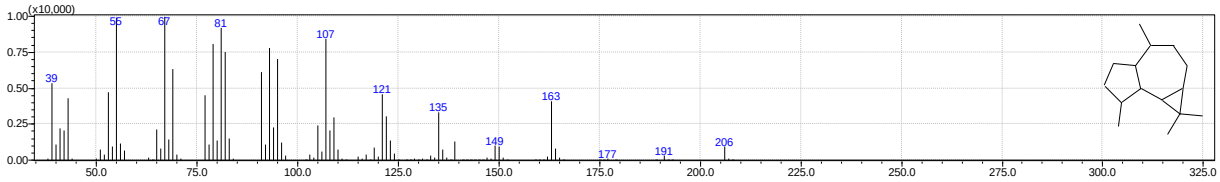
1 : 154 : 2-Cyclohexen-1-ol, 1-methyl-4-(1-methylethyl)-, cis- $$ (1R,4R)-4-Isopropyl-1-methylcyclohex-2-enol $$ 4-Isopropyl-1-methyl-2-cyclohexen-1-ol, cis- $$ cis-2-Cyclohexene-1-ol-1-methyl-4(1-methylethyl) $$ cis-2-p-Menthen-1-ol $$ cis-p-Menth-2-en-1-ol $$ cis-para-Menth-2-en-1-ol $$ cis-para-Menth-2-ene-1-ol $$ cis-p-Menth-2-ene-1-ol $$ cis-p-Mentha-2-en-1-ol $$ Menth-2-en-1-ol (cis-p) $$ Menth-2-en-1-ol, cis-para $$ p-Menth-2-en-1-ol, cis $$ (Z)-p-Menth-2-en-1-ol $$ (Z)-p-Mentha-2-en-1-ol $$ cis-2-Menthenol $



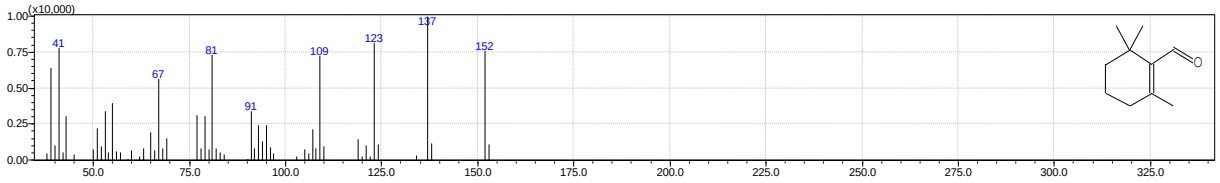
1 : 154 : .alpha.-Terpineol $$ 3-Cyclohexene-1-methanol, .alpha.,.alpha.4-trimethyl- $$ p-Menth-1-en-8-ol $$ Terpineol schlechthin $$ Terpineol, .alpha. $$ .alpha.-Terpinol $$ .alpha.,.alpha.,4-Trimethyl-3-Cyclohexene-1-methanol $$ 2-(4-Methyl-3-cyclohexen-1-yl)-2-propanol # $$ alpha-Terpineol $$ 2-(4-methylcyclohex-3-enyl)propan-2-ol $$ Menth-1-en-8-ol $$ dl-.alpha.-Terpineol $$ 1-p-Menthen-8-ol $$ (.+/-.)-.alpha.-Terpineol $$ 2-(4-Methyl-3-cyclohexenyl)-2-propanol $$ 8-Hydroxy-p-menth-1-ene $$ NSC 21449 $$ PC 593



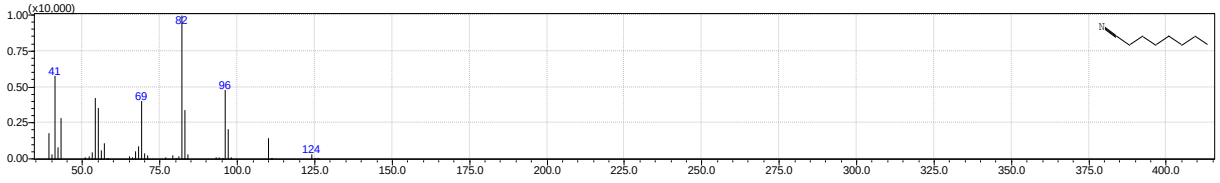
1 : 154 : Cyclohexanol, 2-methyl-5-(1-methylethenyl)- $$ p-Menth-8-en-2-ol $$ 1,6-Dihydrocarveol $$ 6-Methyl-3-isopropenylcyclohexanol $$ 8-p-Menthen-2-ol $$ 5-Isopropenyl-2-methylcyclohexanol # $$ 2-Methyl-5-(1-methylethenyl)cyclohexanol $$



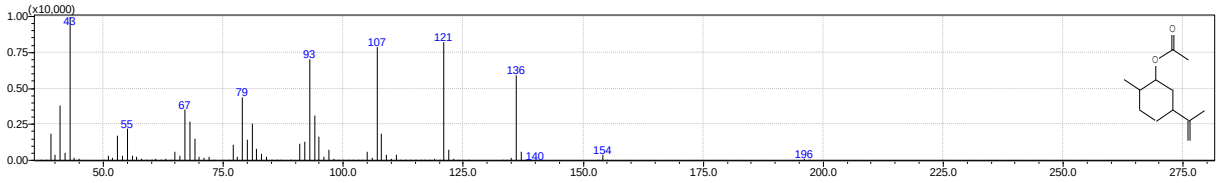
1 : 206 : 1H-Cycloprop[e]azulene, decahydro-1,1,4,7-tetramethyl-, [1aR-(1a.alpha.,4.beta.,4a.beta.,7.beta.,7a.beta.,7b.alpha.)]- $$ Ledane $$ 1,1,4,7-Tetramethyldecahydro-1H-cyclopropa[e]azulene # $$



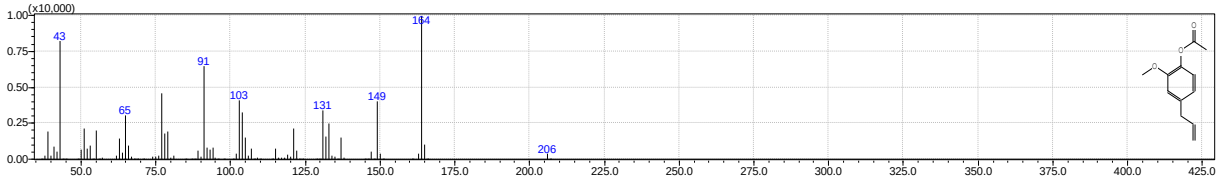
1 : 152 : 1-Cyclohexene-1-carboxaldehyde, 2,6,6-trimethyl- $$ .beta.-Cyclocitral $$ 1-Formyl-2,6,6-trimethyl-1-cyclohexene $$ 2,6,6-Trimethyl-1-cyclohexene-1-carbaldehyde # $$ 2,6,6-trimethyl-cyclohexene-1-carboxaldehyde $$



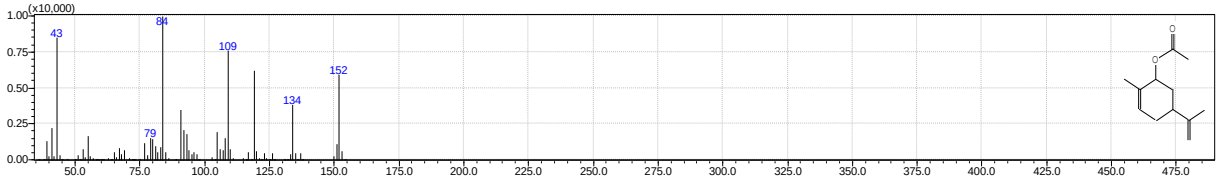
1 : 125 : Octanenitrile $$ Arneel 8 $$ Caprylnitrile $$ Caprylonitrile $$ Octanonitrile $$ Normal-heptyl cyanide $$ n-Heptyl cyanide $$ 1-Cyanoheptane $$



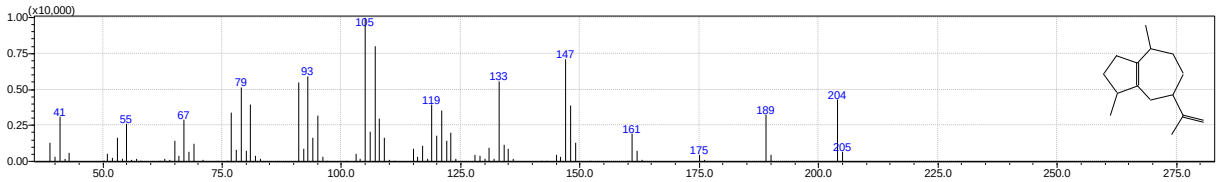
1 : 196 : (-)-8-p-Menthen-2-yl, acetate, trans $$ (-)-Dihydrocarvyl acetate $$ (-)-trans-p-Menth-8-en-2-ol, acetate $$ Cyclohexanol, 2-methyl-5-(1-methylethenyl)-, acetate, [1R-(1.alpha.,2.beta.,5.alpha.)]- $$ (-)-trans-Dihydrocarvyl acetate $$



1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$

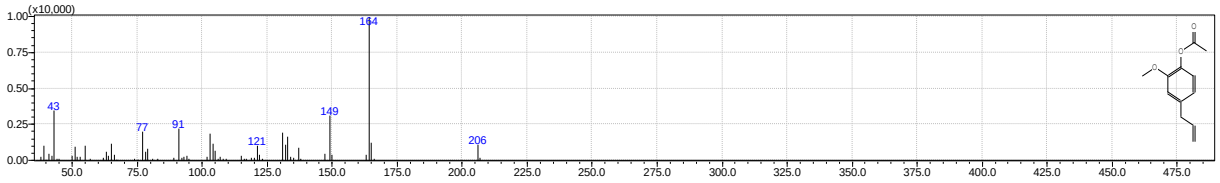


1 : 194 : 2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-, acetate, cis- $$ p-Mentha-6,8-dien-2-ol, acetate, cis- $$ cis-Carvyl acetate $$ 5-Isopropenyl-2-methyl-2-cyclohexen-1-yl acetate, cis- # $$ Carvyl acetate (Z) $$ Z-Carvyl acetate $$ 2-Cyclohexen-1-ol, 2-methyl-5-(1-methylethenyl)-, 1-acetate, (1R,5R)-rel- $$

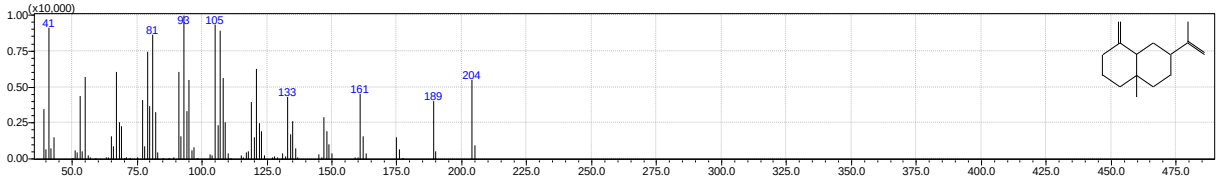


1 : 204 : .alpha.-Guaiene $$ Azulene, 1,2,3,4,5,6,7,8-octahydro-1,4-dimethyl-7-(1-methylethenyl)-, [1S-(1.alpha.,4.alpha.,7.alpha.)]- $$ (1S,4S,7R)-1,4-Dimethyl-7-(prop-1-en-2-yl)-1,2,3,4,5,6,7,8-octahydroazulene $$ Guaia-1(5),11-diene $$ 7-Isopropenyl-1,4-dimethyl-1,2,3,4,5,6,7,8-

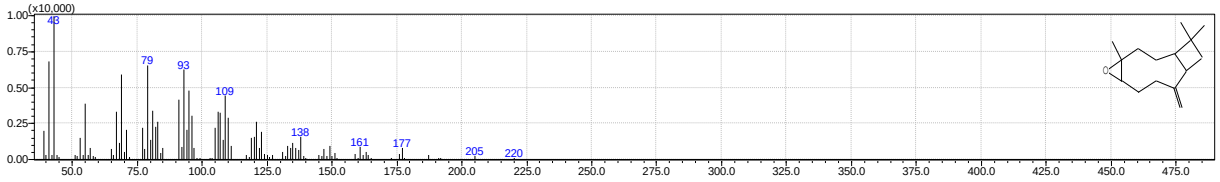
octahydroazulene-, [1S-(1.alpha.,4.alpha.,7.alpha.)]- $$ Azulene, 1,2,3,4,5,6,7,8-octahydro-1,4-dimethyl-7-(1-methylethenyl)-, (1S,4S,7R)- $$



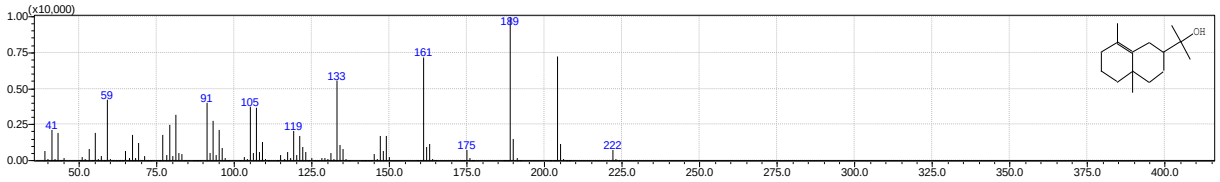
1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$



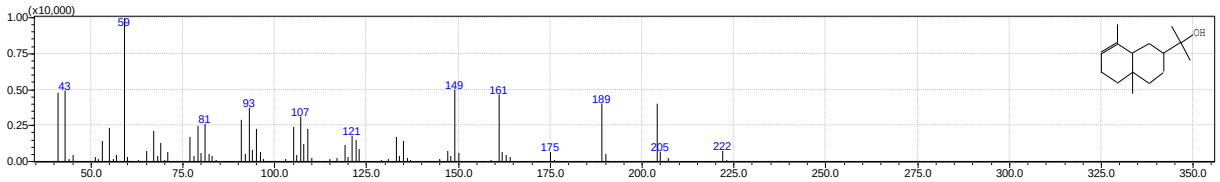
1 : 204 : Naphthalene, decahydro-4a-methyl-1-methylene-7-(1-methylethenyl)-, [4aR-(4a.alpha.,7.alpha.,8a.beta.)]- $$ Eudesma-4(14),11-diene $$ .beta.-Eudesmene $$ .beta.-Selinene $$ (+)-.beta.-Selinene $$ Selina-4(14),11-diene $$ 7-Isopropenyl-4a-methyl-1-methylenedecahydronaphthalene-, (4aR-(4a.alpha.,7.alpha.,8a.beta.))- $$



1 : 220 : Caryophyllene oxide $$ 5-Oxatricyclo[8.2.0.0(4,6)-]dodecane, 4,12,12-trimethyl-9-methylene-, [1R-(1R*,4R*,6R*,10S*)]- $$ 5-Oxatricyclo(8.2.0.0(4,6))dodecane, 4,12,12-trimethyl-9-methylene-, (1R,4R,6R,10S)- $$ Caryophylene oxide $$ Caryophyllene epoxide $$ (-)-.beta.-Caryophyllene epoxide $$ .beta.-Caryophyllene oxide $$ Epoxycaryophyllene $$ (-)-Epoxydihydrocaryophyllene $$ 4,11,11-Trimethyl-8-methylene-5-oxatricyclo(8.2.0.0(4,6))dodecane, (1R,4R,6R,10S)- $$ (-)-5-Oxatricyclo[8.2.0.0(4,6)]dodecane,4,12,12-



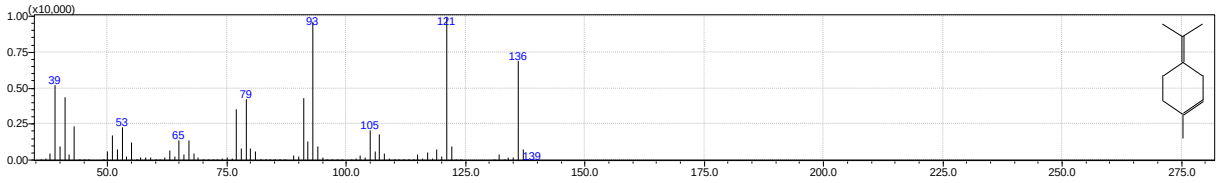
1 : 222 : 2-Naphthalenemethanol, 1,2,3,4,4a,5,6,7-octahydro-.alpha.,.alpha.,4a,8-tetramethyl-, (2R-cis)- $$ .gamma.-Eudesmol $$ .gamma.-Eudesmole $$ [2R-cis]-1,2,3,4,4a,5,6,7-Octahydro-.alpha.,.alpha.,4a,8-tetramethyl-2-naphthalenemethanol $$ 2-((2R,4aR)-4a,8-Dimethyl-1,2,3,4,4a,5,6,7-octahydronaphthalen-2-yl)propan-2-ol $$ Selinenol $$ Machilol $$ Eudesm-4-en-11-ol $$ Uncineol $$



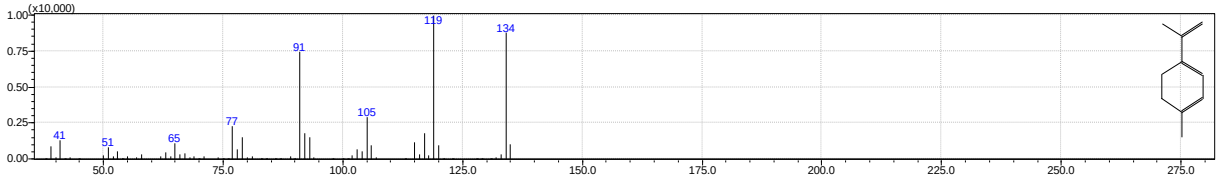
1 : 222 : 2-Naphthalenemethanol, 1,2,3,4,4a,5,6,8a-octahydro-.alpha.,.alpha.,4a,8-tetramethyl-, [2R-(2.alpha.,4a.alpha.,8a.beta.)]- $$ .alpha.-Eudesmol $$ 2-(4a,8-Dimethyl-1,2,3,4,4a,5,6,8a-octahydro-2-naphthalenyl)-2-propanol # $$

SAMPLE 4

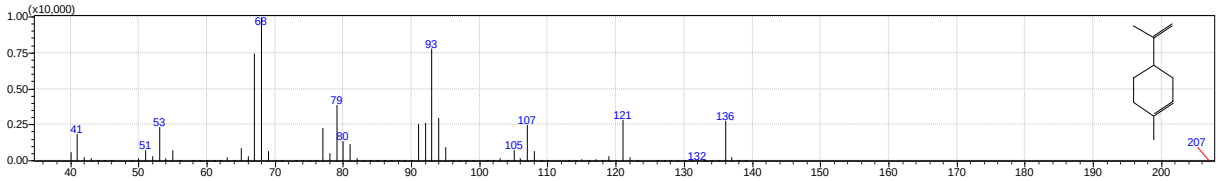
Chemical constituent of FSHMEOs:



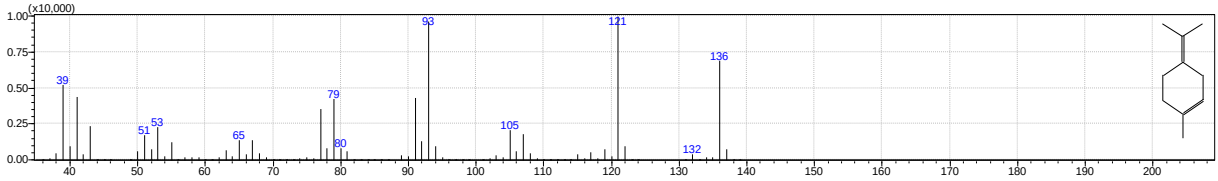
1 : 136 : Cyclohexene, 1-methyl-4-(1-methylethylidene)- $$ p-Mentha-1,4(8)-diene $$ Terpinolene $$ Terpinolen $$ UN 2541 $$ .alpha.- Terpinolen $$ 1-Methyl-4-(1-methylethylidene)-1-cyclohexene # $$ .alpha.-Terpinolene $$ 4-Isopropylidene-1-methyl-cyclohexene $$ p-Menth-1,4(8)-diene $$



1 : 134 : 1,3,8-p-Menthatriene $$ p-Mentha-1,3,8-triene $$ 1-Isopropenyl-4-methyl-1,3-cyclohexadiene # $$ 1,3,8-para-Menthatriene $$ p-1,3,8-Menthatriene $$ p-Menta-1,3,8-triene $$ 1,3-Cyclohexadiene, 1-methyl-4-(1-methylethenyl)- $$

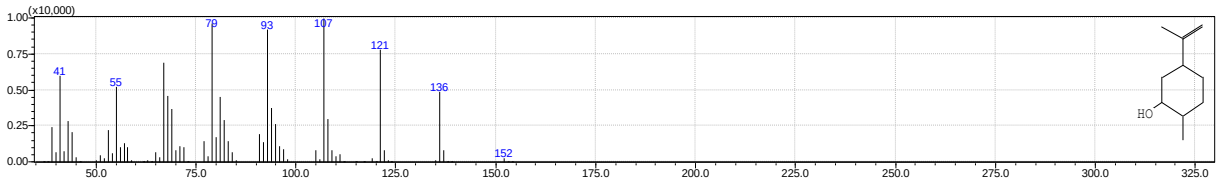


1 : 136 : D-Limonene $$ Cyclohexene, 1-methyl-4-(1-methylethenyl)-, (R)- $$ p-Mentha-1,8-diene, (R)-(+)- $$ (+)-(R)-Limonene $$ (+)-(4R)-Limonene $$ (+)-p-Mentha-1,8-diene $$ (+)-Limonene $$ (R)-(+)-Limonene $$ Carvene $$ D-(+)-Limonene $$ Limonene, (D)- $$ Limonene, (+)- $$ (R)-1-methyl-4-(1-methylethenyl)cyclohexene $$ Dextro-limonene $$ (R)-4-Isopropenyl-1-methyl-1-cyclohexene $$ 4-Isopropenyl-1-methyl-1-cyclohexene-, (R)- $$ (R)-Limonene $$ (+)-Dipentene $$ (4R)-(+)-Limonene $$ (4R)-Limonene $$ (R)-(+)-p-Mentha-

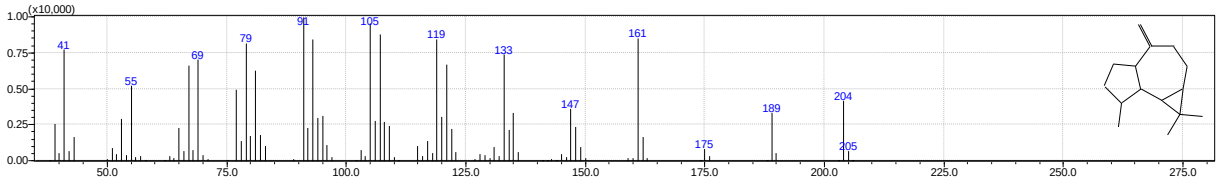


1 : 136 :

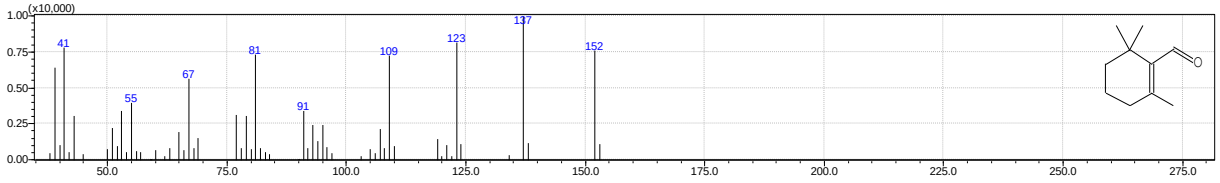
Cyclohexene, 1-methyl-4-(1-methylethylidene)- $$ p-Mentha-1,4(8)-diene $$ Terpinolene $$ Terpinolen $$ UN 2541 $$ .alpha.- Terpinolen $$ 1-Methyl-4-(1-methylethylidene)-1-cyclohexene # $$ .alpha.-Terpinolene $$ 4-Isopropylidene-1-methyl-cyclohexene $$ p-Menth-1,4(8)-diene $$



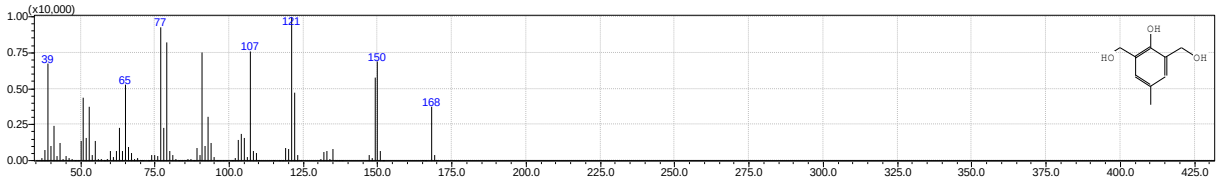
1 : 154 : Cyclohexanol, 2-methyl-5-(1-methylethenyl)- $$ p-Menth-8-en-2-ol $$ 1,6-Dihydrocarveol $$ 6-Methyl-3-isopropenylcyclohexanol $$ 8-p-Menthen-2-ol $$ 5-Isopropenyl-2-methylcyclohexanol # $$ 2-Methyl-5-(1-methylethenyl)cyclohexanol $$



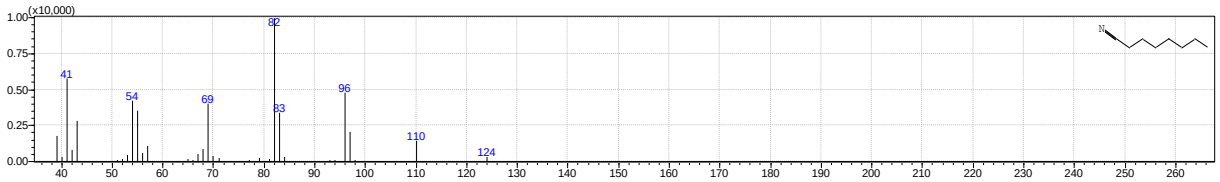
1 : 204 : Aromandendrene $$ 1H-Cycloprop[e]azulene, decahydro-1,1,7-trimethyl-4-methylene-, [1aR-(1a.alpha.,4a.alpha.,7.alpha.,7a.beta.,7b.alpha.)]- $$ 1H-Cycloprop[e]azulene, decahydro-1,1,7-trimethyl-4-methylene-, (1aR,4aR,7R,7aR,7bS)-(+)- $$ (1aR,4aR,7R,7aR,7bS)-1,1,7-Trimethyl-4-methylenedecahydro-1H-cyclopropa[e]azulene $$ Aromadendr-7(15)-ene $$ (+)-Aromadendrene $$ Aromadendrene, (+)- $$ 1,1,7-Trimethyl-4-methylenedecahydro-1H-cyclopropa[e]azulene-, [1aR-(1a.alpha.,4a.alpha.,7.alpha.,7a.beta.,7b.alpha.)]- $$



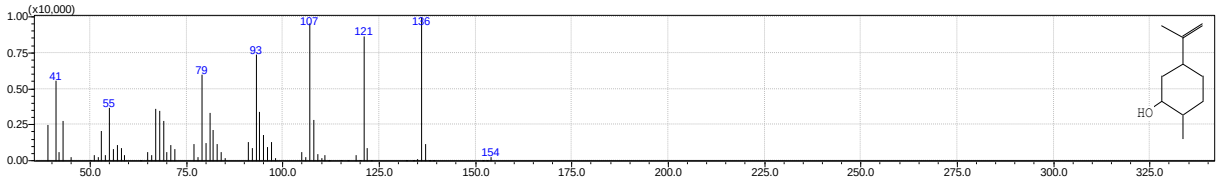
1 : 152 : 1-Cyclohexene-1-carboxaldehyde, 2,6,6-trimethyl- $$ .beta.-Cyclocitral $$ 1-Formyl-2,6,6-trimethyl-1-cyclohexene $$ 2,6,6-Trimethyl-1-cyclohexene-1-carbaldehyde # $$ 2,6,6-trimethyl-cyclohexene-1-carboxaldehyde $$



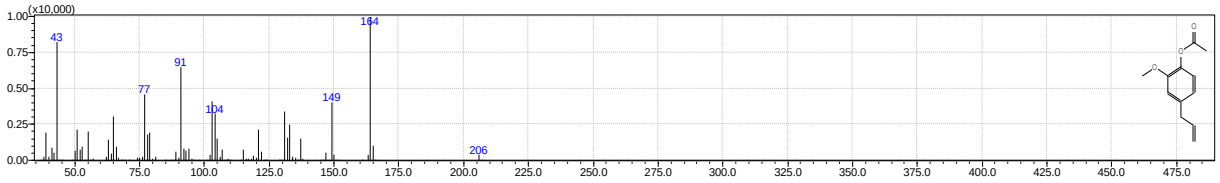
1 : 168 : 1,3-Benzenedimethanol, 2-hydroxy-5-methyl- $$ .alpha.1,.alpha.3-Mesitylenediol, 2-hydroxy- $$ .alpha.1,.alpha.3, 2-Trihydroxymesitylene $$ 2,6-Bis(hydroxymethyl)-p-cresol $$ 2,6-Bis(hydroxymethyl)-4-methylphenol $$ 2,6-Di(hydroxymethyl)-p-cresol $$ 2,6-Dimethylol-p-cresol $$ 2,6-Dimethylol-4-methylphenol $$ 2-Hydroxy-5-methyl-1,3-benzenedimethanol $$ 4-Methyl-2,6-bis(hydroxymethyl)-phenol $$ NSC 15838 $$



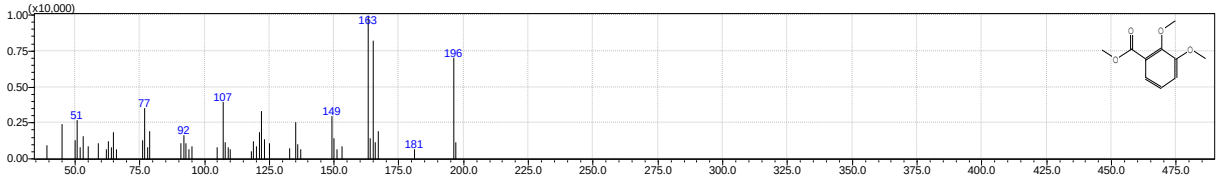
1 : 125 : Octanenitrile $$ Arneel 8 $$ Caprylnitrile $$ Caprylonitrile $$ Octanonitrile $$ Normal-heptyl cyanide $$ n-Heptyl cyanide $$ 1-Cyanoheptane $$



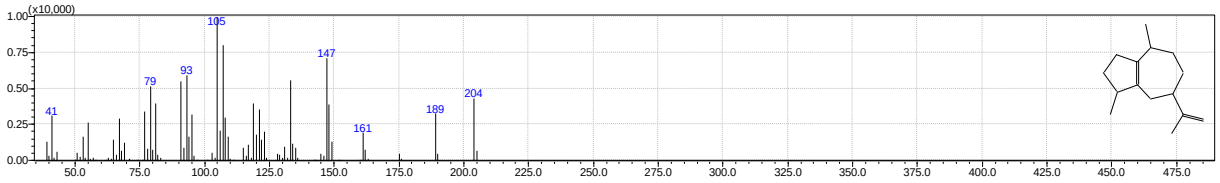
1 : 154 : Cyclohexanol, 2-methyl-5-(1-methylethenyl)-, (1.alpha.,2.alpha.,5.beta.)- $$ p-Menth-8-en-2-ol, cis-1,2,trans-1,4- $$ Neodihydrocarveol $$ 5-Isopropenyl-2-methylcyclohexanol, (1.alpha.,2.alpha.,5.beta.)- $$ Dihydro carveol neo $$ (1R,2S,5S)-neodihydrocarveol $$ Cyclohexanol, 2-methyl-5-(1-methylethenyl)-, (1R,2S,5S)-rel- $$ Neocarveol, dihydro- $$



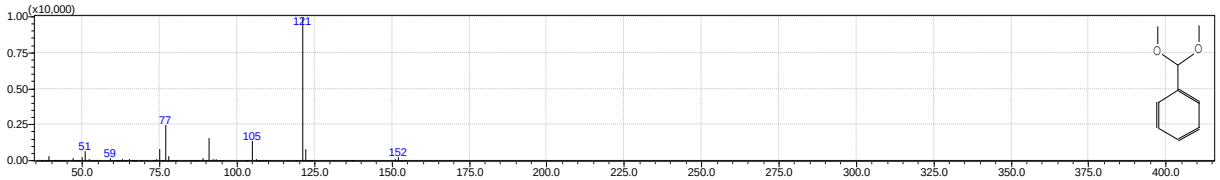
1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$



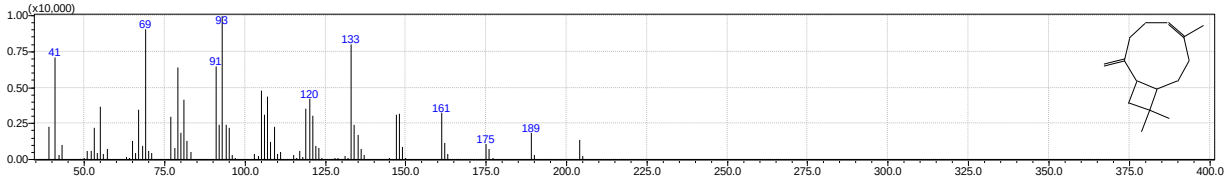
1 : 196 : Benzoic acid, 2,3-dimethoxy-, methyl ester $$ o-Veratric acid, methyl ester $$ Methyl o-veratrate $$ Methyl 2,3-dimethoxybenzoate $$ Methyl methoxy(3-methoxyphenyl)acetate # $$



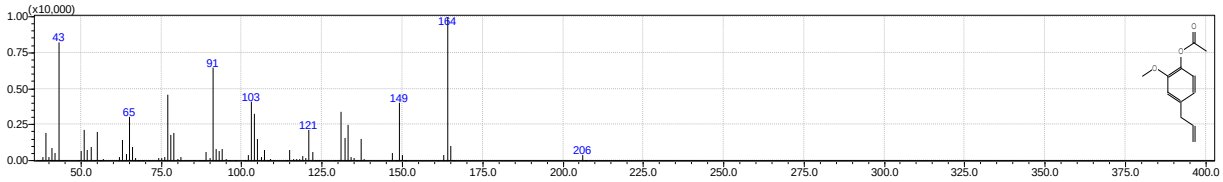
1 : 204 : .alpha.-Guaiene $$ Azulene, 1,2,3,4,5,6,7,8-octahydro-1,4-dimethyl-7-(1-methylethenyl)-, [1S-(1.alpha.,4.alpha.,7.alpha.)]- $$ (1S,4S,7R)-1,4-Dimethyl-7-(prop-1-en-2-yl)-1,2,3,4,5,6,7,8-octahydroazulene $$ Guaia-1(5),11-diene $$ 7-Isopropenyl-1,4-dimethyl-1,2,3,4,5,6,7,8-octahydroazulene-, [1S-(1.alpha.,4.alpha.,7.alpha.)]- $$ Azulene, 1,2,3,4,5,6,7,8-octahydro-1,4-dimethyl-7-(1-methylethenyl)-, (1S,4S,7R)- $$



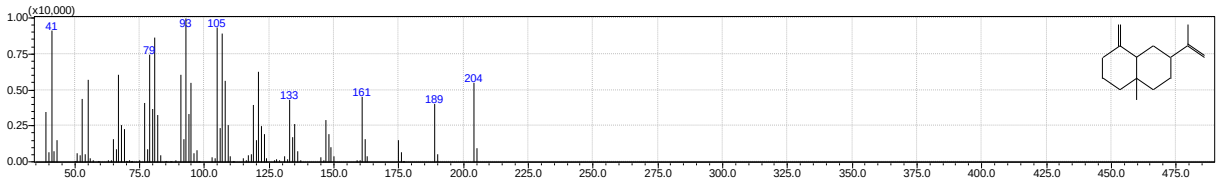
1 : 152 : Benzaldehyde dimethyl acetal $$ Benzene, (dimethoxymethyl)- $$ .alpha.,.alpha.-Dimethoxytoluene $$ Dimethoxymethylbenzene $$ Dimethoxyphenylmethane $$ Toluene, .alpha.,.alpha.-dimethoxy- $$



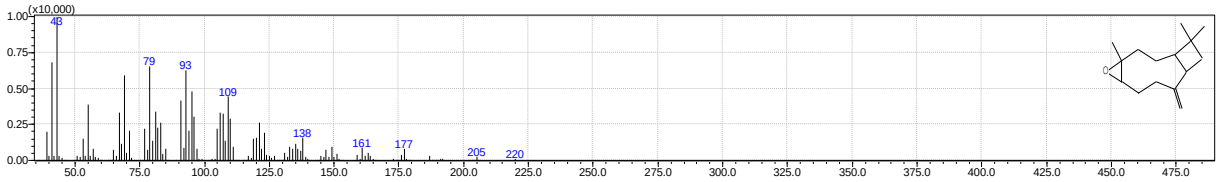
1 : 204 : Caryophyllene $$ Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-, [1R-(1R*,4E,9S*)]- $$ Bicyclo[7.2.0]undec-4-ene, 4,11,11-trimethyl-8-methylene-, (E)-(1R,9S)-(-)- $$ .beta.-Caryophyllen $$ .beta.-Caryophyllene $$ trans-Caryophyllene $$ L-Caryophyllene $$ Bicyclo(7.2.0)undec-4-ene, 8-methylene-4,11,11-trimethyl-, (E)-(1R,9S)-(-)- $$ 8-Methylene-4,11,11-(trimethyl)bicyclo(7.2.0)undec-4-ene, (1R,4E,9S)- $$ beta-Caryophyllene $$ .beta.-(E)-Caryophyllene $$ .beta.-trans-Caryophyllene $$ Caryophyllene



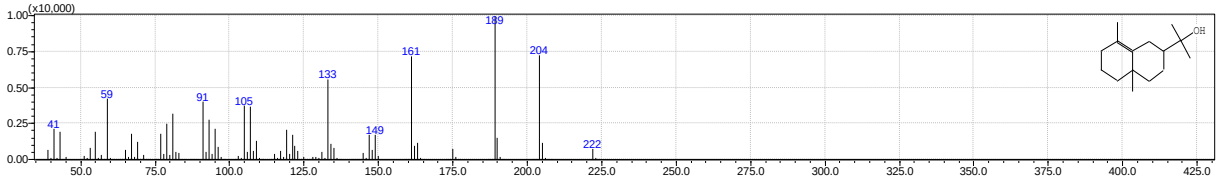
1 : 206 : Phenol, 2-methoxy-4-(2-propenyl)-, acetate $$ Phenol, 4-allyl-2-methoxy-, acetate $$ Aceteugenol $$ Acetyleugenol $$ Eugenol acetate $$ Eugenyl acetate $$ 1,3,4-Eugenol acetate $$ Aceto eugenol $$ 1-Acetoxy-2-methoxy-4-allylbenzene $$ 4-Allyl-2-methoxyphenol acetate $$ 4-Allyl-2-methoxyphenyl acetate $$ NSC 1242 $$ Phenol, 2-methoxy-4-(2-propen-1-yl)-, 1-acetate $$



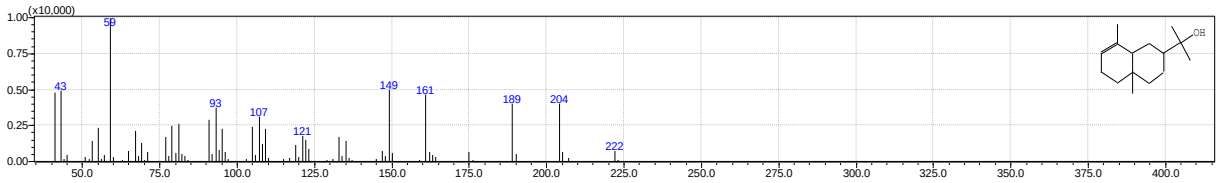
1 : 204 : Naphthalene, decahydro-4a-methyl-1-methylene-7-(1-methylethenyl)-, [4aR-(4a.alpha.,7.alpha.,8a.beta.)]- $$ Eudesma-4(14),11-diene $$ .beta.-Eudesmene $$ .beta.-Selinene $$ (+)-.beta.-Selinene $$ Selina-4(14),11-diene $$ 7-Isopropenyl-4a-methyl-1-methylenedecahydronaphthalene-, (4aR-(4a.alpha.,7.alpha.,8a.beta.))- $$



1 : 220 : Caryophyllene oxide $$ 5-Oxatricyclo[8.2.0.0(4,6)-]dodecane, 4,12,12-trimethyl-9-methylene-, [1R-(1R*,4R*,6R*,10S*)]- $$ 5-Oxatricyclo(8.2.0.0(4,6))dodecane, 4,12,12-trimethyl-9-methylene-, (1R,4R,6R,10S)- $$ Caryophylene oxide $$ Caryophyllene epoxide $$ (-)-.beta.-Caryophyllene epoxide $$ .beta.-Caryophyllene oxide $$ Epoxycaryophyllene $$ (-)-Epoxydihydrocaryophyllene $$ 4,11,11-Trimethyl-8-methylene-5-oxatricyclo(8.2.0.0(4,6))dodecane, (1R,4R,6R,10S)- $$ (-)-5-Oxatricyclo[8.2.0.0(4,6)]dodecane,4,12,12-



1 : 222 : 2-Naphthalenemethanol, 1,2,3,4,4a,5,6,7-octahydro-.alpha.,.alpha.,4a,8-tetramethyl-, (2R-cis)- $$ .gamma.-Eudesmol $$ .gamma.-Eudesmole $$ [2R-cis]-1,2,3,4,4a,5,6,7-Octahydro-.alpha.,.alpha.,4a,8-tetramethyl-2-naphthalenemethanol $$ 2-((2R,4aR)-4a,8-Dimethyl-1,2,3,4,4a,5,6,7-octahydronaphthalen-2-yl)propan-2-ol $$ Selinenol $$ Machilol $$ Eudesm-4-en-11-ol $$ Uncineol $$



1 : 222 : 2-Naphthalenemethanol, 1,2,3,4,4a,5,6,8a-octahydro-.alpha.,.alpha.,4a,8-tetramethyl-, [2R-(2.alpha.,4a.alpha.,8a.beta.)]- $$ .alpha.-Eudesmol $$ 2-(4a,8-Dimethyl-1,2,3,4,4a,5,6,8a-octahydro-2-naphthalenyl)-2-propanol # $$