بسم الله الرحمن الرحيم

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Effect of Some Aromatic Oils (Grow-Nat) on Broilers Performance

تأ ثير بعض الزيوت العطرية (الجرونات) علي الأداء الإنتاجي للدجاج اللاحم

By

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بسم الله الرحمن الرحيم

الاستهلال

قَالَ تَعَالَىٰ:

﴿ فَأَنشَأْنَا لَكُم بِهِۦ جَنَّٰتٍ مِّن نَّخِيلٍ وَأَعْنَٰبٍ لَّكُمْ فِيهَا فَوَٰكِهُ كَثِيرَةٌ وَمِنْهَا تَأْكُلُونَ ﴿١٩﴾ ﴾

المؤمنون: ١٩

Dedication

I dedicate this to:

My Mother, Father

My wife, sons and daughters

My Sisters and Brothers

My relatives

My friends and colleagues

Abdelraheem

Acknowledgement

Praise and unlimited thanks to Allah, who gave me the strength and patience to complete this work.

I wish to express my deep sense of gratitude and sincere thanks to my supervisor Prof. Dr. Mohammed Tag-ELdeen Ibrahim for his guidance, advice, help, criticism, supervision and encouragement throughout the period of the research. I want to acknowledge and express my great thank to Dr. Abubakur Sayed Ali for consistency help, tide work, support and continuous interest in order to see this research the light. May Allah bless his family and our families.

Deepest thank to my wife for her effort, encouragement and participate me in hard time, may Allah reworded for her. Grateful thanks extend to my family for giving me their whole heart support and help.

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Abstract

The current study was conducted to evaluate the effect of aromatic oils Grow-Nat (eucalyptol, oregano, thyme) on growth performance of broilers. The aromatic oils were supplemented in drinking water at three different levels (0, 0.25 and 0.5ml/L) during the period from day 10 to day 44 (i.e. 5 weeks). A total of 120 day old chicks (Hubbard F15) were allocated as complete randomized design in three treatment groups, each group was replicated 4 times each of 10 birds (3×4×10) (treatments X replicates X birds). Two nutritionally adequate diets were formulated according to (NRC, 1994). feed and water were provided adlibtum to meet the nutrient requirements of broiler chicks. Three levels of diets were fed prestarter (0-5 day), starter (6 -21 day) and finisher (22-44 day). The supplementation of aromatic oils revealed no significant differences in feed intake (FI), body weight gain (BW), feed conversion ratio (FCR), protein efficiency ratio, production efficiency factor and energy efficiency ratio among treatments.

مستخلص البحث

اجريت هذه الدراسة لتقييم اثر اضافة الزيوت العطرية الجرونات (المردقوش , كافور والزعتر) على اداء الدجاج اللاحم. اضيفت الجرونات بثلاث مستويات مختلفة في ماء الشرب بمعدل (0.0 , 0.25 و 0.5 مل لكل لتر) خلال الفترة من اليوم العاشر و حتى اليوم الاربعة والاربعون(خمسة اسابيع) . استخدمت 120 كتكوت عمر يوم من سلالة هبرد اف15 . تم توزيع الطيور عشوائيا (باستخدام التصميم كامل العشوائية) الي ثلاثة مجموعات ثم قسمت كل مجموعة الي اربعة مكررات عشرة طائر لكل مكرر(3*4*10)(معاملات, مكررات, طيور). تم تركيب نوعين من العلائق حسب توصية (المجلس العالمي للبحوث 1994) تقدم العلف والماء علي الاستهلاك الحر لمقابلة احتياج الطائر. ثلاثة مستويات من العلف قبل البادئ (0 -5 يوم) و عليقة البادئ (6 – 21 يوم) و النهائي (22 – 44 يوم). اظهرت نتائج اضافة الزيوت العطرية عدم وجود فروقات معنوية علي العلف المستهلك، الزيادة الوزنية، معدل التحول الغذائي، معدل كفاءة البروتين، معامل الكفاءة الانتاجية، ومعدل كفاءة الطاقة .

LIST OF CONTENTS

LIST OF TABLES

Introduction

Feed additives are products used in animal nutrition for many purposes such as enhancing quality of food from animal origin and to improve the animals' performance and health. There are several attempts to reduce antibiotics uses in animal production for many reasons including increase in microbial resistance to antibiotic and their residues in animal products which can be harmful to consumer (Yeo *et al*., 1997). Hence, a product without any drug residue in the poultry meat is highly desirable in broiler production. Feed additives from Plants origin is one of the antibiotic alternatives. It is important to make distinction between antibiotics used as treatment and prevention of diseases in the farm livestock (prescribed therapeutic and prophylactic use), which differs from their use as feed additives to improve growth (Castanon, 2007). Therefore the search for alternatives to antibiotic as growth promoters that can give similar results in improving poultry performance particularly weight gain and feed efficiency or in the prevention or control of infectious diseases are the target of numerous lines of investigation.

Aromatic oils (extracted products) are incorporated in poultry diets to replace synthetic products in order to stimulate or promote the effective use of feed nutrients which may subsequently result in more rapid bodyweight (BW) gain, higher production rates and improved feed efficiency. Moreover, active components of herbs may improve digestion and stimulate the immune function in broilers (Ghazal and Ali, 2008). Addition of natural herbs in poultry diets participate in improving broilers performance, more over it reduce feed cost and help in producing high broilers meat quality. Poultry producers commonly apply natural feeding supplements, mainly herbs. So that the positive effects of herbal supplements on

broiler performance and carcass quality have been demonstrated (Ademola, 2009, and Al-Khdri, 2013).

The poultry industry is now facing a ban for the use of antibiotic feed as growth promoter. Therefore essential oils were used as growth promoter to overcome this problem. Herbs and spices and essential oils, extracts, dried whole plant and powder have been replaced the antibiotic as growth promoters. Essential oils have been widely proposed as alternatives to antibiotics because of their derived benefits and growth promoting effects (Wang *et al*., 2007; Windisch *et al*., 2008 and Yan *et al*., 2011).

The objective of this research is to study the effect of aromatic oils (Grow-Nat) on broilers chicken performance.

Chapter one

Literature review

1.1. Poultry industry:

The poultry industry plays a vital role among agricultural industries in many parts of the world. In Sudan intensive poultry production goes back to 1972 as small scale farms around Khartoum and other big cities. Khartoum state produces almost 70% of Sudan broiler product and the consumption of poultry meat in 2015 was 1kg/capita (Chamber of Poultry, 2012).The quality of good protein in shortest period of time in form of meat and eggs had major participation role in human food. Mohamed (2014) reported that poultry meat production in Sudan approximately 90 million tons/year, where Khartoum State produces 90% of Sudan production. Zhao *et al*., (2001) reported that most developing countries suffering from food borne diseases due to food problems and lack of economics. White meat such as chicken meat is considered superior in health aspects to red meat because of comparably low content of fat and cholesterol and relatively low price (Jaturasitha, 2004).

During processing of poultry carcasses microbial contamination inevitably occur as a consequence of processing procedures employed, at each stage processes opportunity exists for contamination of carcasses by microorganisms from the processing plant by cross contamination from the birds.

The microorganisms in different part of carcass ,carried out on food from origin animal, particularly poultry product, contribute significantly to food- borne disease in humans , during processing, a high proportion of this organisms will be removed and will result in reducing the incidence of illnesses but further contamination may occur at any stage of processing operation (Kabour 2011).

1.2. Breeds of chicken:

Chickens are grown for their egg and meat and they are classified as egg type and meat type chickens. The domestic chicken is descended primarily from the red jungle fowl (*Gallus gallus*) and is classified as a sub-species (*Gallus gallus domesticus*) of that species. So it can freely inter breed with populations of red jungle fowl. (Wong *et al*., 2004). The traditional poultry farming view is stated in Encyclopædia Britannica (2007). Humans first domesticated chickens of Indian origin for the purpose of cock fighting. In Asia, Africa, and Europe. Very little formal attention was given to egg or meat production (Garrigus, 2007). A hybrid variety of chicken was produced from a cross of a male of a naturally double-breasted Cornish strain and a female of a tall, large-boned strain of white Plymouth Rocks (Damerow, 1995).

1.3. Effect of essential oils on broilers performance:

1.3.1. Feed intake:

Feed intake can be influenced by a large number of factors. Therefore selection of food depends on visual appearance, ambient temperature, viscosity, nutritive value of feed, toxicity of feed components, particle size. (AL-kassie *et al*.2011) showed that no difference in feed intake for broilers fed diet with black pepper.

The addition of (0.005ml/L) oregano in drinking water decreases average daily feed intake (Galal *et al*, 2016). (Al-kassie and Jameel, 2009) observed that the Supplementation of thymus vulgaris oils (thyme) and cinnamomuim zeylanicium (cinnamon) on broiler diet has positive effect on feed intake. The addition of essential oil in poultry diet has appetizing and stimulating effect of digestion and enhance feed intake (Cabuk *et al*., 2003). Najafi and Torki (2009) showed that supplementation of high level of essential oils thyme had adverse effect on feed intake in broilers. Feizi *et al* (2014) reported that supplementation of (1ml/L) thyme in drinking water increase feed intake. Cross *et al*. (2007) found that the average feed intake was reduced for birds which were fed 10g/kg of oregano herb, while birds which were fed1g/kg oregano consumed comparable amounts of feed as the control birds. Supplementation of (300mg/kg) oregano to broilers diet decrease feed intake (Kirkpinar, *et al*., 2011).

1.3.2. Body weight and body weight gain:

Herbal formulations as feed additives have shown encouraging results as regards weight gain, feed efficiency, lowered mortality and increased liveability in poultry birds (Deepak *et al*., 2002, Javandel *et al*., 2008, and Onibi *et al*., 2009). However, some researchers reported that some plant extracts additives have no any effects on growth performance or health status of poultry. Supplementation of oregano essential oil through the drinking water (150ml/1000L) increased the broilers body weight by (4%) of birds and reduced the period to slaughter by one day (Basset, 2000). Supplementation of essential oils on broiler diet had positive effects on body weight gain (Tekeli *et al*, 2011). Supplementation of safflower seeds oils to the broiler diet had no effect on weight gain (Malakian *et al.*, 2011). Addition of high levels of herbal combination in broiler diets decreases weight gain of broiler chicks (Thayalini *et al*., 2011). Baretto *et al*. (2008) showed that the addition of oregano

oils 200mg/kg in broiler diet had reveres effect on feed conversion. Khosravinia (2015) showed that the addition of savory (0.4ml/l) in drinking water increases average daily gain. Addition of (700mg/kg) oregano on broiler diet did not affect weight gain (Causlar *et al*. 2009). Betancourt *et al* (2014) examined the effects of different oregano plant extracts compared to chlortetracycline on performance and microflora communities in broilers, the results showed that no differences in body weight parameters were seen for any treatment group compared to the control group at 42 days of age. Simsek *et al* 2007, Ciftci *et al*., (2005) observed an improvement of approximately 15% in body weight gain when added essential oil to the diet compared to the control group.

1. 3. 3. Feed conversion ratio:

Several studies indicated that the use of essential oils improved broiler feed conversion ratio (Hertrampf, 2001; Windisch *et al*., 2008). Addition of black cumin oils on broiler diet did not affects FCR of broiler chicks (Ismail, 2011).The addition of essential oil isolated from oregano by the age of three weeks to the drinking water (300ml/1000L) improved the feed conversion ratio of broiler by 12.9%. (Hertrampt, 2001). Supplementation of herbs to broiler diets with lower level improves weight gain and FCR of broiler (Mohamed *et al.,* 2012). Inclusion of a blend that contained oregano, thyme, cinnamon and eucalyptus oil tended to improve FCR by 5% compared to the control treatment (Ulfah 2006). Alali *et al.,* (2013) showed that supplementation of (0.05ml/l) essential oil blend eucalyptus, thyme, lemon in drinking water decreases FCR. Abdel-Wareth *et al*, (2012) reported that the birds fed on diet containing carvacrol or carvacrol rich in essential oils decreased FCR. Toghyani *et al*. (2010) reported that supplementation of (5g/kg) thyme on broilers diet decreases FCR.. Karimi *et al*. (2010) observed that supplementation of 20mg/kg of oregano on broiler diet didn't affect FCR.

1.3.4. Protein efficiency ratio:

Gopi *et al* (2014) showed that essential oils also help to improve protein digestion by increasing the secretion of hydrochloric acid and pepsin. In addition, the substances contained in essential oils affect the taste and smell of the feed, which stimulates the secretion of saliva and gastric juices.

1.3.5. Energy efficiency ratio:

Addition of essential oils as feed additives stimulates digestive enzymes and may affect lipid metabolism and fat digestibility (Platel and Srinivasan, 2000). Khosravinia *et al*. (2013) reported that supplementation of drinking water with Sekeo (500 to 2500 ml/L) significantly reduced abdominal fat in both male and female birds raised under normal condition.

1.3.6. Production efficiency factor:

Supplementation of herbal plants as feed additives effect on production performance in poultry(Hashemi and Davoodi 2010).Weber *et al*. (2012) suggested that the combination of mixture of essential oil compounds (including thymol, eugenol and piperine) and benzoic acid increased the growth performance of broilers. Alali *et al*. (2013) studied the effects of a mixture of oils (eucalyptus, thyme and lemon) added to drinking water on the production parameters, mortality, water intake, and Salmonella enterica colonization in broiler chickens. A considerable improvement in feed conversion and weight gain was observed after the addition of 0.025 and 0.0125% of oil mixture. In addition, Khosravinia (2015) reported that the addition of savory oil to drinking water improve production performance. Bozkurt *et al*., (2012) reported that addition of herbal extracts mixture from oregano oil,

laurel leaf oil and lavender oil to broiler diet can assist in lighten the production performance of broiler chicks.

1.4. Aromatic oil (Grow-Nat):

1.4.1. Description:

The Grow-Nat is herbal plants product its combination of essential oils (oregano oils. eucalyptus oils. thyme oils) and it is derived from plants extracts and produced by the Animal Wellness Products (A.W.P) Italian Company. Essential oils are commercially available and are used extensively in medicine and in the food. The uses of essential oils which derived mainly from spices and herbs and their purified compounds have been shown to have antimicrobial action invitro (Cowan,1999: |Ultee *et al*, 2002: Faleiro *et al*,2003). Various essential oils have many properties in common, e.g. they can be vaporized with steam, are lipophilic, liquid at 18ºC, optically active, and well soluble in ethanol, propylene glycol, or in lipids (Gopi *et al*., 2014). Compounds and aromas of essential oils can be divided into 2 major groups: terpene hydrocarbons and oxygenated compounds.

1.4.2. Chemical components of essential oils:

Essential oils are aromatic oily liquids obtained from plant material such as flowers, buds, seeds, leaves, twigs, bark, wood, fruits and roots (Burt, 2004). Plant extracts consists mainly of proteins, peptides, oligosaccharides, fatty acids, vitamins, micro minerals. Plant extracts have a wide range of activities and their active secondary plant metabolites typically belong to the classes of isoprene derivatives and flavonoids (Tajodini *et al.*, 2015). Bakkali *et al* (2008) reported that there are more than 3,000 chemical compounds that have

been isolated from essential oils (EO). Mono terpenes, made by coupling of two isoprene units, constitute 90% of the essential oil molecules. The chemical composition of an EO defines its mode of action as well as its attributes. Differences between, or within EO 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). So it is very important to explore active chemical components in EO of some selected herbs which are commonly used as feed additives in broiler diets.

1.4.3. Functions of aromatic oils:

There are several functions of aromatic oils including:

- Stimulating the voluntary feed intake (Lee *et al*., 2003, Kroismayr *et al*., 2008; Yan *et al*., 2011) and the secretion of digestive enzyme (Platel and Srinivasan, 1996; Wenk, 2003);

- Exerting direct antimicrobial effect (especially inhibiting the growth of particularly potentially pathogenic bacteria : gram (−) bacteria, such as, E. coli O157:H7,Staphylococcus aureus) through disruption of the cell membrane by H+ bonding, rendering the membranes and mitochondria more permeable and disintegrating the outer cell membrane (Kamel,ab. 2001; Di Pasqua *et al*., 2007; Ouwehand *et al*., 2006).

- Having anticoccidial, fungicidal or antioxidant properties (Cruickshank, 2001; Wenk, 2003).

-Playing immunomodulatory functions (Vidanarachchi *et al*., 2005; Windisch *et al*., 2008; Wang *et al*., 2011).

1.4.4. Popularity and safety of plants:

Herbs and spices are generally considered safe and proved to be effective against certain ailments. They are also extensively used in many countries and the uses of spices and herbs have been gradually increases due to their beneficial effects. So this form of treatments common in Europe among these Germany holds the largest share (49%) Italy, France and UK hold 10% each. Spain, Netherlands, Belgium 2% each and remaining 15% rest of Europe. About one third of the US adults use herbal remedies (Polasa and Nirmala, 2003). When Compared with synthetic antibiotic or inorganic chemicals, these plant-derived products have proven to be natural, less toxic, residue free, and are thought to be ideal growth promoters in animal diets (Hashemi *etal*., 2008).

Chapter two
Materials and Methods

2.1- Experimental site and duration:

The experiment was conducted at Sudan University of Science and Technology, College of Animal Production Science and Technology, during the period from (31thMarch to 13th May 2017). Minimum and Maximum temperature were 25.3˚C to 45.6˚C respectively and the relative humidity was 20% through the experimental period.

2.2-Experimental house:

The experiment was conducted in an open sided deep litter house building; the long axis of the house was extended from east to west facing the wind direction for good ventilation. The house with concreted floor and constructed of brick wall (0.5 m) height between wall and roof was made of wire net in all sides. The roof was made of corrugated iron sheets supported with iron posts. The house was divided into twelve experimental units (replicates) (1×1 m^2) equal area and it was dry cleaned and washed. The northern and southern sides of the house were covered by nylon bag and then disinfected with formalin diluted in water (37%, 5ml/L) before arrival of birds, every cage was equipped with round feeder and drinker also wheat stem straw with 5cm depth was used as litter. The house was left closed over night.

2.3-Experimental birds:

A total of one hundred and twenty unsexed one day old commercial broiler chicks (*Hubbard F15*) were used in this study purchased from Arab Poultry Breeders Company (Ommat), After incubation period (9 days) the chicks were weighted and

randomly distributed as 3×4×10 (treatments X replicates X birds) by complete randomized design.

2.4-Prevention and vaccination:

During the incubation week the birds were daily supplemented with multi vitamins (A, D_3, E 2ml/L) in drinking water for seven days. The birds were vaccinated in day one against infectious bronchitis and Newcastle diseases (IB+ND) by spray and the second dose of ND was repeated on the 21th day by eye drop. On the 11th and 18th day each chick was vaccinated against infectious bursal disease (IBD) by eye drop and 1ml/L of (A, D_3, E) vitamins were added in drinking water after each vaccination. On the period from 27th to 29thall birds were given Doxycycline (0.3g/L) as preventive dose.

2.5- Feeding and drinking:

During incubation and adaptation period the chicks were fed on prestarter diet (table1). The experimental essential mix oils (Grow-Nat) was purchased from Khirat Elneil Company and were added in drinking water then given as follows 0, 0.25 and 0.5 ml/L then given to experimental birds the recommended dose (0.25ml/L) and recommended plus (0.5ml/L). The two diets were formulated according to (NRC, 1994) others ingredients of diet were purchased from kuku local market. Starter and finisher shown in (table 2) respectively.

Table (1) pre-starter chemical composition	
Item	%
Crude protein	23
Crude fat	6.5
Crude fiber	0.5
Crude ash	3
Lysine	1.4
Calcium	1
Sodium	0.16
Threonine	0.9
Available phosphorus	0.62
Methionine and cystine	0.99

Metabolizable energy	3100 kcal/kg

Table(2): Feed composition as percentage and calculated analysis of the experimental starter and finisher

Ingredients	Starter	Finisher
Sorghum	65	72
Ground nut cake	27.3	19
Concentrate*	5	5
Vegetable oil	1.6	3.2
Dicalcium phosphate	1	0.6
Antitoxin	0.1	0.2
Total	100	100
Calculated analysis		
Metabolizable energy	3073.659	3206.643
Crude protein	22	18.79
Crude fiber	6.3	5.8
Methionine	0.34	0.28
Lysine	1.2	0.96
Available phosphorus	0.43	0.37
Calcium	0.68	0.55

* Concentrate(starter): composition: Crude protein 35%, Crude fat 2.8%, Crude fiber 4.8%, Calcium 6.8% available phosphorus 5%, Lysine 12%, Methionine 3.71% and Metabolizable energy 1897.77 kcal/kg

* Concentrate(finisher): composition: Crude protein 35%, Crude fat 2.7%, Crude fiber 4.6%, Calcium 6.56% available phosphorus 5.14%, Lysine 10%, Methionine 3% and Metabolizable energy 1904.45 kcal/kg

2.6. Broiler performance:

2.6.1. Feed intake:

Feed intake for the birds of each replicate was recorded daily by using electronic balance (offered feed - residual feed from quantity of provided feed as g/bird).

2.6.2. Body weight (BWT) and body weight gain (BWG):-

Body weight for the birds of each replicate was recorded weekly weight gain was calculated by subtracting the body weight at beginning of the week from body weight at the end of the same week.

2.6.3. Feed conversion ratio (FCR):

Feed conversion ratio (FCR) was calculated by dividing the amount of the feed intake (g) by weight gain (g).

2.6.4. Livability (%):

Livability% = number of live birds/ total number of birds*100

2.6.5. Production efficiency factor (PEF):-

PEF= bird final weight (kg) X livability (%) / (age in days X FCR) X100 (Lemme *et al*., 2006).

2.6.6. Protein efficiency ratio (PER):-

PER= weight gain/protein intake (Kamran *et al*., 2008)

2.6.7. Energy efficiency ratio (EER):-

EER = weight gain/energy intake X100 (Kamran *et al*.,2008)

2.7. Dressing percentage:-

At the end of the study period (44days) eight birds from each treatment (2/replicate) were randomly selected, individually weighed slaughtered then carcass weight was recorded and dressing percentage was calculated as follows:

Dressing% = carcass weight/ live body weight X 100

2.8. **Statistical analysis**:-

Complete randomized design was used in the current experiment. The obtained data was subjected to analysis of variance (ANOVA) using statistical package for social science (SPSS) (Version 16) software program. The significant differences among means were determined by least significant differences (LSD).

Chapter three

Results and discussion

3.1. The effect of aromatic oils (Grow-Nat) on broiler performance:

3.1.1. The effect of aromatic oil (Grow-Nat) on feed intake:

The addition of different levels of Grow-Nat in drinking water (Table 3) had no significant effect (P>0.05) on feed intake. Although there were no significant differences but group A showed the highest feed intake value in week one and two while group (C) was the lowest, however the results are typically reversed from week three until the final week (5^{th}). These findings were disagreed with Al-kassie and Jameel (2009) who reported that the supplementation of thyme on diet has positive effect on feed intake perhaps this might be due to differences in additions levels of essential oil . Similar result was observed by Feizi *et al .,* (2014) who recorded that addition of thyme increase feed intake. But in another study Najafi and Torki (2009) found that addition of thyme has reverse effect on feed intake.

Table 3. Effect of different level of Grow-Nat on feed intake of experimental birds

Grow-Nat	Feed intake (g/bird/week)				
(ml/L)	Week 1	Week 2	Week 3	Week 4	Week 5
A	28.61±6.19	50.84±4.25	68.91±5.67	78.30±9.71	99.50±14.23
B	27.19±3.30	49.86±6.85	70.91±10.83	82.27±8.71	104.54±15.85
C	26.47±3.69	46.84±4.04	72.07±7.37	87.05±7.67	107.76±7.79

Significant	NS	NS	NS	NS	NS

N=40 birds/group, NS= No significant differences

3.1.2- The effect of aromatic oil (Grow-Nat) on weight gain:

The effect of different levels of Grow-Nat on broilers weight gain was showed in (Table 4) no significant differences was found among the group (P>0.05) however group B showed the highest in week five while group A showed the lowest in week one. Different results were observed by Alali et al. (2012) who found that a concentration of 0.5% of essential oil blend enhanced weight gain. While Basset (2000) recorded that oregano essential oil through the drinking water (150ml/1000L) increased the body weight. On other hand the results were in agreement with those reported by Thayalini *et al.,(*2011) who found that high levels of herbal combination in broiler diets have a negative effect on weight gain. Also Malakian *et al.,* (2011). indicated that supplementation of safflower seeds oil to broiler diet not affect significantly on weight gain. these variation in results could be due to differences in additive levels or supplementation method.

Table 5. Effect of different level of Grow-Nat on weight gain of experimental birds

Grow-Nat	Weight gain (g/bird/week)				
(ml/L)	Week 1	Week 2	Week 3	Week 4	Week 5
A	26.65±8.34	38.35±7.47	43.88±4.75	50.85±8.04	46.59±18.19
B	28.91±10.84	32.50±6.14	44.88±6.62	40.61±7.96	53.21±8.52
C	32.06±6.49	34.71±3.29	47.63±7.48	41.14±11.69	49.69±15.37
Significant	NS	NS	NS	NS	NS

N=40 birds, NS= No significant difference

3.1.3- The effect of aromatic oil (Grow-Nat) on feed conversion ratio (FCR):

The effect of supplemented drinking water with graded levels of Grow-Nat on FCR is showed in (Table 5). It revealed of FCR. although the result showed in significant effect but group C recorded the lowest value in week one while group A showed the highest in week five. The addition of grow-Nat in broilers drinking water impaired FCR, and this might be attributed to the small dose of addition or pungent taste of the herbs. Similar result was observed by Alali *et al.*, (2013) who showed that supplementation of (0.05 ml/l) essential oil blend eucalyptus, thyme, lemon in drinking water decreases FCR. This result is in agreement with study reported by (Ulfah 2006) who reported that Inclusion of a blend that contained oregano, thyme, cinnamon and eucalyptus EO tended to improve FCR by 5%. also in agreement with Hertramp f(2001) who obtained that The addition of essential oil isolated from oregano by the age of three weeks to the drinking water (300ml/1000l) improved the feed conversion ratio of broiler by 12.9%.the variation in result of this study (Hertampt, 2001) maybe due to difference in doses of inclusion.

Table 6. Effect of different level of Grow-Nat on feed conversion ratio of experimental birds

Grow-Nat	Period (week)				
(ml/L)	Week 1	Week 2	Week 3	Week 4	Week 5
0	1.03±0.46	1.35±0.16	1.58±0.17	1.56±0.22	2.70±1.98
0.25	1.03±0.34	1.55±0.12	1.58±0.11	2.07±0.36	1.97±0.14
0.50	0.84±0.09	1.36±0.16	1.52±0.09	2.27±0.71	2.43±1.12
Significant	NS	NS	NS	NS	NS

N=40 birds, NS= No significant difference

3.1.4. The effect of essential oil (Grow-Nat) in protein efficiency ratio (PER):

The effect of drinking water that contained difference levels of Grow-Nat on PER is presented in (table 6) with the exception of week 4 result revealed no significand differences (P>0.05) among the studied group during the study period. Group A was the highest and differ significantly (P<0.05) than the other groups. This result disagreed with Gopi *et al.,* (2014) who reported that Essential oils helps to improve protein digestion by increasing the secretion of hydrochloric acid and pepsin. This might be due to difference in inclusion level of essential oil.

Table 7. Effect of different level of Grow-Nat on protein efficiency ratio of experimental birds

Grow-Nat	Protein efficiency ratio				
(ml/L)	Week 1	Week 2	Week 3	Week 4	Week 5
A	1.05±0.32	0.48±0.06	0.49±0.06	0.50±0.07[a]	0.37±0.16
B	1.16±0.32	0.41±0.03	0.48±0.03	0.37±0.06[b]	0.39±0.03
C	1.34±0.13	0.47±0.06	0.50±0.03	0.36±0.09[b]	0.35±0.12
Significant	NS	NS	NS	*	NS

N=40 birds

Different superscript within the same column means significant differences at P<0.05

*= significant differences at P<0.05 NS= No significant difference

3.1.5. The effect of aromatic oil (Grow-Nat) in energy efficiency ratio (EER):

The effect of supplemented drinking water with difference level of Grow-Nat on EER was obtained in (table 7). Excluding week 4 the results revealed in significant differences between studied groups. Group A was the highest rank followed by group B in EER and significantly difference ($P<0.05$) from other groups. The addition of differance level of Grow-Nat in drinking water reduces EER these could be attributed with difference in inclusion level and type of EO similar result was obtained by Khosravinia *et al*., (2013) who reported that supplementation of drinking water with SKEO (500 to 2500 mg/l) significantly reduced abdominal fat in both male and female birds raised under normal condition. On the other hand the results were disagreed with those of Platel and Srinivsan (2000) who observed that Addition of essential oils as feed additives stimulate digestive enzymes and may affect lipid metabolism and fat digest ability.

Table 8. Effect of different level of Grow-Nat on energy efficiency ratio of experimental birds

Grow-Nat	Energy efficiency ratio				
(ml/L)	Week 1	Week 2	Week 3	Week 4	Week 5
A	7.66±2.36	3.48±0.46	2.84±0.33	2.90±0.39[a]	2.16±0.95
B	8.46±2.30	3.01±0.24	2.82±0.20	2.19±0.33[b]	2.27±0.16
C	9.78±0.97	3.46±0.46	2.93±0.17	2.09±0.53[b]	2.07±0.69
Significant	NS	NS	NS	*	NS

N=40 birds

Different superscript within the same column means significant differences at $P<0.05$

*= significant differences at $P<0.05$, NS= No significant difference

3.1.6. The effect of aromatic oil (Grow-Nat) in production Efficiency factor (PEF):

The effect of supplemented drinking water with different levels of Grow-Nat on PEF was showed on (table 8) The results revealed in significant decrease (P> 0.05) in PEF with increasing of Grow –Nat level these result disagreed with those recorded by Khosravinia (2015) This ought to be due to difference in inclusion level or essential oil type.

Table 9. Effect of different level of Grow-Nat on production efficiency factor of experimental birds

Grow-Nat (ml)	A (0)	B (0.25)	C (0.5)
Production efficiency factor	210.02±34.59	191.10±34.30	189.37±31.28
Significant	NS	NS	NS

N=40 birds/group

NS= No significant difference

Chapter four

Conclusion and Recommendations

Conclusion

The supplementation of Grow-Nat in different levels (0.0, 0.25 and 0.5 ml/L) in drinking water for broilers resulted in no change in

1- Broiler performance (feed intake, weight gain and feed conversion ratio.
2- The protein efficiency ratio, production efficiency factor and energy efficiency ratio.

Recommendations

The study recommended that

- **The future using of herbal extracted oils depends on the chemical structure, feeding value and characteristics of herbs used way of administrations.**

-More studies on the sutable added level of aromatic essential oils for broiler performance.

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