EFFECTS OF SUPPLEMENTING DIETS WITH THYMOL ON GROWTH PERFORMANCE AND MEAT QUALITY OF GROWING RABBIT UNDER HEAT SEASON.

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SUMMARY

The aim of this research was to evaluate the effect of different levels of thymol on growth performance and meat quality of fattening rabbits (white Californian) during the summer season. For this experiment, 120 rabbits (35-d-old) were divided into four homogeneous groups and were fed as: control without thymol (T) and the other three groups with thymol T1, T2 and T3 which received 100, 200 and 300 mg / kg diet; respectively. Each of the 4 diets was fed to replicates of 6 rabbits. There were no significant differences ($p>0.05$) in the feed conversion ratio (FCR; range 3.99±0.62, 9.36±6.87, 4.16±0.98 and 7.13±5.43 respectively) across treatments for the 6 week study period. There were no differences ($p>0.05$) between the Thymol and control diet regarding feed intakes, and mortality during the overall six week period**.** Feed supplementation with thymol affected meat hardness. Results indicated the meat from the groups received the dose of 200mg/kg of thymol were more tender than the other groups ($p<0.001$).

Keywords: *thymol, growth performance, meat, rabbits*

INTRODUCTION

Digestive disorders are the cause of the majority of losses in rabbits aged 8 to 10 weeks, the most critical period in rabbit breeding (Krieg *et al.*, 2009; Kimsé *et al.*, 2013). The use of antibiotic can lead to the development of antibiotic resistance as well as common health hazards. 2006, the European Commission banned the antibiotics as growth promoters in feed (Huyghebaert *et al.*, 2011). The interdiction of antibiotic in animal diets needs research of alternative feed additives. Essential oils are being explored as options to antimicrobials, due to their different active substances.

The influence of some active substances of essential oils (thymol, carvacrol, eugenol and cinnamaldehyde) on rabbits, pigs and broilers has been studied (Koné *et al.*, 2016, Michiels *et al.*, 2007 and Hashemipour *et al.*, 2013, Hashemipour *et al.*, 2016). Lee *et al.* (2003) found that thymol and carvacrol feed additive had a positive influence both on performance and health in broiler chickens. Other studies reported the potential on the biological properties of Thymol as an antibacterial, antifungal and antioxidant agent (Mastelic *et al.*, 2008).

The purpose of this study was to determine if thymol added as natural feed supplement had an effect on growth performance and caecal microflora in weaned rabbits.

MATERIAL AND METHODS

Animals and experimental procedure

A total of 120 weaned white Californian rabbits (35 days old; 600 ± 100 g initial body weight), were divided into four groups and submitted to the following dietary treatments (Table 1) for forty-two days: Control diet; diet T (Control diet); diet T1 (100mg/T of Thymol mixed with the Control diet), diet T2 (200mg/T of Thymol mixed with the Control diet), and diet T3 (300mg/T of Thymol mixed with the Control diet) . The rabbits were kept in standard cages (6 animals per cage) in a building with temperatures between 21.5 and 32.8°C, and humidity levels between 60% and 70%. The duration of daily

illumination was 16 h. The rabbits had access to feed (table 1) and water ad libitum. The body weight of rabbits, feed consumption and mortality rates were measured every week during the experiment.

Table (1). Chemical composition of control diet

Nutritive value	%
Humidity	14
Crude fibre	16
Protein	17
Metabolisable Energy (kcal/kg)	2600
Ash	9
Fat content	3
Methionine	0.3
Cysteine	0.35
Threonine	0.68
Tryptophan	0.25
Minerals (mg/kg)	
Manganese	9
Iron	25
Copper	60
Zinc	15
Cobalt	0.2
Iodine	0.2
Vitamin	
Vit A	11000 UI
Vit D	2000 UI
Vit H	30 mg
Additives	
Robindine	66

Growth performance and carcass characteristics

Rabbit performance response variables were determined. Weekly individually body weight (wt.) and wt. gain were measured on all rabbit. Weekly feed consumption (g/d/rabbit), feed conversion ratio (FCR) (g feed/g live body wt. gain), and mortality rate were measured. Dead rabbit were weighed to include their weights in the feed conversion estimation. Feed consumption was calculated, for each subgroup weekly to investigate the feed conversion ratio (FCR) (g feed/g live body weight). FCR was calculated, for each subgroup, as follows: Feed intake for the subgroup (kg) divided by total body weight gained for the same subgroup (kg). The total body weights included dead rabbits during the week. Carcass characteristics (dressing %, front part %, hind part %) were measured at 11 weeks of age.

Carcass characteristics

Five rabbits per treatment were selected, fasted overnight, stunned and euthanized at the end of the feeding trial for carcass evaluation. Each animal was skinned, eviscerated and cut to various body parts or regions and weighed.

Meat quality

The physical analysis was carried out as follows: The pH was determined in the breast muscle at 2 cm depth using a calibrated pH meter (Hanna HI- 99163) as described in Olivo *et al.* The color for the samples of the various treatments was measured at 24h postmortem using a Minolta Chromameter (CR410 Konica Minolta Sensing Inc., Osaka, Japan). (L), (a) and (b) measures determined, where (L) measures lightness, (a) measures redness and (b) measures yellowness.

The textural characteristics of the breast meat were followed using a texture-meter TVT 6700 Texture Analyses (Perten Instruments, Sweden).

Uniform portions of 2x2 cm in thickness and length parallel to the muscle fiber from the middle of the breast and shared vertically were used as the test samples. The samples were compressed to 50% their original height at a crosshead speed of 1 mm/s through a 2-cycle sequence. A 5-cm diameter probe was used in TPA measurements. Textural profile analysis (TPA) is one of the methods that simulate the conditions that the food is exposed to in the mouth (Xiong *et al.* 2006).

Statistical analysis

The results are given as mean ± standard deviation (SD), data were analyzed by an analysis of variance (ANOVA) using the GLM procedure of SAS software and the Chi Square test for mortality.

RESULTS AND DISCUSSION

Growth performance

The effect of treatments on growth traits is shown in Table 2. Initial body weight in 35 days did not differ (P>0.05) among treatments. Overall growth, during the whole feeding period, growth was similar for all experimental groups as slaughter weight was not significantly different except (T1) group with dose 100 mg/kg diet as thymol supplementation (P<0.05). The supplementation diets with thymol had no effect on mortality (P>0.05).

The supplementing with 100 mg/kg dose of thymol decreased the slaughter weight. Overall, there was no significant difference between the control and the experimental groups except for the average daily feed with dose 100 mg/kg of thymol supplementation on week 6 and week 9 (P=0.05 and P<0.05 respectively).

No significant difference (p>0.05) among groups of rabbits was detected for feed conversion ratio (range 1.74-10.31) between the four diets (three dose of thymol treated and control).

Table (2): Effect of treatments on growth performance of weaned rabbits.

Doses	T1	T2	T3	T4	P
Initial BW (g)	677.71^{a}±86.34	687.50^{a}±126.42	691.17^{a}±114.62	683.33^{a}±95.20	0.97
Final BW (g)	1953^{a}±139.15	1718^{b}±166.28	1911^{a}±206.75	1877^{a}±163.83	0.02
Mortality (%)	54.17±20.95	53.33±34.15	33.34±31.18	43.33±19	0.62
Week 6					
ADG (g/d)	29.62±4.63	23.22±4.47	27.86±2.49	24.88±1.48	0.05
FCR	1.99±0.39^{a}	2.667±1.29^{a}	2.64±0.5^{a}	3.08±0.14^{a}	0.21
Week 7					
ADG (g/d)	27.83±8.59	28.29±3.17	33.19±8.105	36.38±3.08	0.14
FCR	2.35±0.54	2.08±0.82	2.164±0.99	1.74±0.39	0.65
Week 8					
ADG (g/d)	27.20±3.39	22.98±8.75	19.58±9.46	23.52±5.62	0.52
FCR	3.74±0.76	3.93±1.97	10.31±13.73	2.84±0.87	0.37
Week 9					
ADG (g/d)	32.63±5.08	24.32±5.07	30.64±4.29	26.97±2.40	0.04
FCR	3.56±0.44	4.83±1.62	4.44±1.75	4.04±0.64	0.51
Week 10					
ADG (g/d)	31.73±6.64	28.26±7.46	33.03±9.19	30.58±3.65	0.75
FCR	4.23±0.95	5.76±1.55	4.43±2.34	4.91±1.93	0.94
Week 11					
ADG (g/d)	33.54±8.01	20.96±9.84	32.78±8.29	24.69±7.77	0.10
FCR	3.99±0.62	9.36±6.87	4.15±0.98	7.13±5.43	0.25

T: control; T1, T2 and T3: different dose of Thymol; BW: body weight; ADG: Average daily weigh gain; FCR: feed conversion ratio

a, b and c: Means in the same rows with different superscripts are significantly different at (P< 0.05).

The results obtained from many studies, showed that dietary supplementation of oregano essential oil to broilers (Botsoglou *et al.*, 2002) at 50 and 100, 150, 300 and 1000 mg/kg had no beneficial effect on growth performance. Cross *et al.*, (2003) indicated that the inclusion of thyme oil had no effect on BW gain of broilers. Lee *et al.* (2003) pointed out that 200 mg/kg of thymol in diet did not affect the BW gain,

feed intake and FCR female broilers. The reason for the lack of effects of thymol, carvacrol, or both on performance may be related to the composition of the basal diet and environmental conditions (Lee *et al.*, 2003).

Growth performance of the rabbits was consistent with the studies of Koné *et al.* (2016), who did not observe significant differences when plant extracts and essential oils was provided to rabbit feed.

In contrast with this study, Hernandez *et al.* (2004) observed that additives containing thymol and carvacrol, papper essential oils (200mg/kg), or sage and rosemary extracts (5000 mg/kg) improved the broilers performance. Additionally, evident antibacterial activity (Botsoglou *et al.*, 2002), the improvement in digestibility (Hernandez *et al.*, 2002), the improvement in digestibility (Hernadez *et al.*, 2004) and in feed utilization (Lee *et al.*, 2003), and the digestive and pancreatic enzymes stimulation (Lee *et al.*, 2003) in response to thyme essential oil ingestion might increase animal performance.

Carcass characteristics

Dressing (%) was insignificantly different with any of tested feed additives (table 3). However, covariance analysis showed that adjusted carcass did not have any significant effects related to dietary feed supplementation.

Table (3). Effect of treatments on carcass characteristics of rabbit meat

	T1	T2	T3	T4	P
Hind part	34.40±2.13	34.59±1.30	34.34±0.86	34.40±1.18	0.99
Intermediate part	26.71±1.38	27.25±1.65	26.83±1.91	26.76±1.06	0.96
Fore part	38.87±1.13	38.15±1.27	38.82±1.6	38.92±1.14	0.82
Scapular fat	0.31±0.15	0.35±0	0.29±0.1	0.39±0.05	0.64
Perirenal fat	0.55±0.07	0.51±0.36	0.74±0.43	0.57±0.15	0.76

Hernandez *et al.* (2004) and Sarica *et al.* (2005) showed that supplementation of combination of tow herb extracts had no effect on chicken carcass charaterisatics. Alçiçek *et al.* (2003) recorded that herb extract had no effect on chicken abdominal fat percentage.

Contrary to our findings, another researcher showed that supplementation of combination of herb extracts increased in percentage of dressing%, front part %, breast meat%, carcass meat%, gizzard weight% and intestinal diameter, as well as decreased abdominal fat% (Awaad *et al.*, 2014).

Meat quality

The effect of the dietary treatments on physicochemical analyses and meat quality parameters of the rabbit meat are presented in Table (4). No significant effect was observed for the pH in the LD muscle 1h after slaughter and the pHu in LD muscle.

Colour parameters (Tabla 4) of the LD muscle: L*(lightness), a*(redness), b*(yellowness) were not significantly influenced by the dietary enrichment in thymol ($p>0.05$).

Thymol supplementation in the diet has a significant effect on the tenderness of the meat (Table4). The meat from lot T2 that received thymol is softer than the controls.

Table (4). Effect of treatments on meat quality of rabbits.

	T1	T2	T3	T4	P
a*	2.94^{a}	3.27^{a}	3.02^{a}	2.96^{a}	0.56
b*	4.74^{a}	4.90^{a}	5.05^{a}	4.75^{a}	0.10
L*	57.36	56.48	56.57	57.31	0.62
pH PM	6.06^{a}	5.95^{a}	5.98^{a}	6.04^{a}	0.28
pH U	5.48^{a}	5.51^{a}	5.52^{a}	5.48^{a}	0.96
Hardness	11.13^{a}	12.78^{b}	8.44^{c}	16.59^{a}	0.001
Cho	4.65^{a}	2.02^{b}	1.14^{b}	3.97^{a}	0.009
Gum	7.37^{a}	4.63^{b}	2.95^{c}	7.89^{a}	0.001

a, b and c: Means in the same rows with different superscripts are significantly different at (P< 0.05).

pH24, colour of the *Longissimus dorsi* (LD) muscle and texture measurement are reported in Table 4. The dietary treatment did not affect the colour parameters and pH of meat.

These results are in accordance with Simonova *et al.* (2010) that did not observe differences in colour parameters on rabbits supplemented with oregano extract in drinking water. Similarly, in pigs, Janz *et al.* (2007) and Simitzis *et al.* (2010) observed no significant influence of dietary oregano oil supplementation on meat colour with data ranged within normal limits.

Colour is generally accepted as one of the major features that consumers evaluate when making a purchase decision. The colour parameters of meat are related to pHu, which influences the oxidation of the meat's haem pigments.

According to Fraysse and Darre (1989), low pH causes discoloration of the meat, whereas high pH gives the meat a darker colour. At high pH levels, oxymyoglobin rapidly turns into a dark red, reduced myoglobin (Ouhayoun and Dalle Zotte, 1993) and the muscle structure is less reflective because of the less compact structure (Bizkova and Tumova, 2010).

The addition of thymol improved the texture of the meat by making it softer.

CONCLUSION

Based on the present results, it can be concluded that thymol supplementation to growing rabbits diets does not have a significant effect on the rate of gain as well as overall weight gain and carcass weight. This may be due to the added levels; in addition this supplementation does affect meat quality.

If further research on the subject were to continue in the future, larger numbers of rabbits must be included to provide adequate sample sizes as well as different levels of thymol must be studied.

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تأثير إضافة الثيمول على الأداء الانتاجى وكفاءة اللحم للأرانب النامية فى الموسم الحار

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الهدف من هذا البحث هو تقييم تأثير استخدام مستويات مختلفة من الثيمول على الأداء الانتاجى وكفاءة اللحم لأرانب التسمين (كاليفورنيا البيضاء) اثناء موسم الصيف. استخدم 120 ارنب عمر 35 يوم ، تم تقسيمهم الى 4 مجموعات وتم تغذيتهم كالتالى: المجموعة الأولى (T) مجموعة الكنترول بدون إضافة الثيمول ، المجموعات الأخرى يضاف الثيمول بمعدل 100 ، 200، 300 مجم/كجم عليقة للمجموعات T2، T3 ، T4 على التوالي. كل مجموعة تحتوى على عدد 6 ارانب. ويتضح من النتائج انه لايوجد فروق معنوية معدل التحويل الغذائي (3.99 ،9.36 ، 4.16 ، 7.13 على التوالي). كذلك لايوجد اختلافات معنوية بين إضافة الثيمول ومجموعة الكنترول بالنسبة للمأكول ونسبة النفوق كمتوسط عام خلال فترة التجربة (6 أسابيع). إضافة الثيمول كان له تأير على طراوة اللحمة فوجد أن إضافة الثيمول بمعدل 200 مجم/كجم عليقة أدى الى طراوة اللحم اكثر من باقى المجموعات ($P<0.001$).

نستخلص من النتائج ان إضافة الثيمول بمستويات مختلفة لم يؤثر على الأداء الانتاجى لأرانب التسمين بينما يؤثر على طراوة اللحم.