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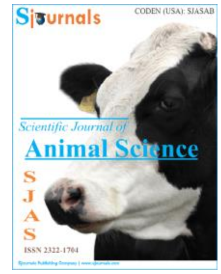

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Original article

Effect of dried Thyme leaf (*Thymus Schimperi R.*) on chicken productivity performance and egg quality

Erdaw Weldes[a,*], Meseret Girma[b], Mengstu Urge[b], Ali Beker[c]

[a]*Animal Feed Processing, Ethiopia Meat and Dairy Industry Development Institute, Ethiopia.*
[b]*Animal and Range Science, Haramaya University, Ethiopia.*
[c]*Animal and Food Science, Oklahoma State University, Ethiopia.*

*Corresponding author: yirwell27@gmail.com

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A B S T R A C T

The feeding trial was conducted to evaluate the effect of thyme leaf as an additive on productive performance and egg quality traits of white leghorn chicken at Haramaya university poultry farm for 11 weeks. One hundred twenty white leghorn (WLH) layers at the age of 26 weeks with average initial body weight of 1216.1±6.62 gram (mean±SD) were randomly allotted to four dietary treatments. The treatments were T1 (Layers ration (LR) with 0% Thyme leaf meal (TLM), T2 (layer's ration with 1% TLM), T3 (layer's ration with 2% TLM) and T4 (layer's ration with 3% TLM). Each treatment group was replicated three times with ten laying hens and two cocks per replicate in completely randomized design (CRD). Samples of feed ingredients, thyme and formulated diets were subjected to chemical analysis before the actual experiment began. Weight of experimental birds was measured at the beginning and at the end of the experiment. The result indicated inclusion of thyme leaf in the layers diet significantly ($p<0.01$) influenced feed intake, final body weight, body weight change and average daily weight gain of birds which were greater in T_2 and T_1 than T_4. The hen-day egg production 57.20±1.09 in T_3 and 59.23±1.09 in T_4 were significantly ($p<0.01$) higher than birds in T_2 and control groups. The feed conversion ratio differs significantly ($p < 0.01$) among treatments ranging 3.28

to 4.70 and the lowest value was recorded in T_3 and T_4, which is an indicator of the best performance of birds. Among egg quality traits, yolk height and index were significantly higher in birds under T_2 and T_3 thanT_1 and yolk weight was higher in T_3 than T_1. The economic analysis showed that the total and net return of birds fed a diet supplemented with thyme is higher than birds fed the control diet. Therefore, thyme leaf can be an imperative feed additive that can be added up to 3% in the layer ration to improve the performance of layers without adversely affecting product quality.

1. Introduction

In Ethiopia, poultry production is an integral part of livestock production practiced by most households in rural, urban and peri-urban areas. It has a key role in poverty alleviation through the provision of food, employment opportunities and income generation for people living with subsistence livelihood. The total chicken population in Ethiopia has been estimated at 56.53 million of which indigenous chicken comprises about 94.31%, hybrid 3.21%, and exotic breeds 2.48%, excluding non-sedentary populations of three zones of Afar and six zones of Somali National Regional State (CSA, 2017). However, with this potential in terms of the flock number, the performance level of chickens is reported to be lower than expected because of various reasons. Poor genetic potential of indigenous eco-types, poor management practices, the existence of various diseases and inadequate nutrition are the major factors known to negatively impact the chicken's performance. Inadequate nutrition due to the shortage of quality feed and the increasing cost of feed ingredients is now a critical problem of most poultry farms and makes people lose interest in this sector.

Improving poultry performance by dietary manipulation has been practiced by nutritionists for many years. Some previous works examined the effects of various feed additives such as probiotics (Musa et al., 2009), prebiotics (Gibson et al., 2004), organic acids (Upadhaya et al., 2014, 2016), enzymes (Bedford and Cowieson, 2012) and medicinal herbs (Ghasemi et al., 2010) on poultry performance. Feed additives in poultry diets are used to boost bird's performance by improving their feed intake, feed conversion efficiency, and health status. The feed additives which are known as an alternative to antibiotics serve as growth promoters by stimulating and improving the feed intake of birds (Ihsan et al., 2017). Since the use of antibiotic growth promoters was banned by the European Union (Neu, 1992), demand for using alternatives to antibiotics has increased from time to time. Nowadays, researchers are focusing on the use of additives that have not negative effects on health and the environment. Hence, many researchers encourage focusing on the use of herbal substances as natural growth promoters. Additives such as herbal extracts and their products are of great importance to humans and animals without undesired side effects (Behnamifar et al., 2015). Besides, there is no complication of drug resistance and residual effect on product due to their consumption.

Studies have described the biological and protective properties of thyme, including antispasmodic, expectorant, antiseptic, antioxidant, antibacterial, anti-inflammatory, immunomodulatory and health-promoting activities of birds (Dhama et al., 2015). Thyme was also reported that it enhance the digestive activity of enzymes like protease, amylase, and lipase, which results in improved digestibility of nutrients (Abdel-Wareth et al., 2012). The study of Mansoub (2011) investigated the effect of different levels of thyme inclusion on the performance of laying hens; and reported best feed conversion ratio, high egg weight and percent of egg production at 2 % inclusion of thyme on layer diet. The finding of Abdel-Wareth et al. (2013) reported that egg weight, egg mass and hen-day-egg production were improved in response to the inclusion of 20 mg/kg of thyme and oregano in the layer diet. Inclusion of 0.2% of thyme and garlic in the diet of laying hens improves the yolk index and increase the lymphocyte in the blood (Ghasemi et al., 2010). However, in Ethiopia there is insufficient information on the use and inclusion level of thyme as a natural feed additive in the poultry diet.

Therefore, the preset study is designed to examine the use of *Thymus schimperi* as feed additive in poultry diet with the following objectives:

- To evaluate the effect of dried thyme leaf as an additive on productivity performance of white leghorn chicken
- To evaluate egg quality traits of white leghorn chicken fed a diet containing dried thyme leaf.

2. Materials and methods

2.1. Nutrient composition analysis

Except for dicalcium phosphate, salt, premix, limestone and amino acids, the representative samples of feed ingredients were randomly taken from top, middle and bottom of the sack. The samples from the same ingredient were mixed together and divided in to four on the plate to take two representative samples. The two representative samples of approximately 500 g each: one was submitted for analysis and the second one was retained as a backup (Herrman, 2001). The representative samples were analyzed by duplicating (two times) for chemical composition. The result of the analysis was used to formulate the treatment rations. Samples were also taken from each treatment ration and analyzed for composition. The feed samples were analyzed for dry matter (DM), ether extract (EE), crude fiber (CF) and ash at Haramaya university animal nutrition laboratory following the procedure of Weende or proximate analysis method (AOAC, 1990). Nitrogen (N) was analyzed by Kjeildhal procedure and CP was determined by multiplying the N value with 6.25. Calcium (Ca) was determined by Atomic Absorption Spectrophotometer method and total Phosphorus in the feed samples was determined by wet digestion procedure, at soil chemistry and central laboratories of Haramaya University. The metabolizable energy (ME) of feed ingridentes and experimental diet were determined by indirect method according to Wiseman (1987) as: $\mathrm{ME}\left(\frac{\mathrm{Kcal}}{\mathrm{kg}}\right) = 3951 + 54.4\mathrm{EE} - 88.7\mathrm{CF} - 40.8\mathrm{ASH}$ Where; EE= Ether extract, CF= Crude fiber

2.2. Experimental diet preparation

After conducting the laboratory analysis, necessary feed ingredients were ground at 5 mm sieve size and mixed at Haramaya University feed processing unit. The experimental diets were a ration without the addition of thyme leaf and ration containing different levels of thyme leaf. The ME and CP levels of the diet was iso- caloric and iso-nitrogenous within the ranges of the recommended levels of 2800-2900 kcal/kg and 16-18% respectively (NRC, 1994). After formulating the experimental diet, the representative samples were randomly sampled and prepared for laboratory analysis to check up the required nutrient level of the diet.

Fresh thyme was collected from Debresina where it is locally available. The leaf part of the thyme was manually collected and air-dried under shade. The dried thyme leaf was prepared and sampled for laboratory analysis. Thereafter thyme was ground and prepared to mix according to the required proportion in the treatment.

Table 1
Proportion of feed ingredients in the treatment diet.

	Treatments			
Feed ingredient (%)	**T1**	**T2**	**T3**	**T4**
Maize	57	49.5	48.3	48.2
SBM	13	13	14	14.89
NSC	14.4	15.3	14.47	12.5
Thyme	0	1	2	3
WS	4.5	10	10	10
Limestone	6.79	6.79	6.79	6.7
Salt	1	1	1	1
Premix general	1	1	1	1
Dicalph	2.2	2.2	2.2	2.5
Lysine	0.1	0.17	0.19	0.17
Methionine	0.01	0.04	0.05	0.04

T1=layers ration(LR) with 0% thyme leaf meal(TLM); T2=LR with 1% TLM; T3=LR with 2% TLM, T4=LR with 3% TLM.

2.3. Experimental design and treatments

A Completely Randomized Design (CRD) with four treatments and three replications was used in the study. A total of one hundred twenty white leghorn layers and twenty-four cocks at the age of twenty-six weeks randomly selected and distributed with 10 layers and 2 cocks to each replicate in the treatment. The treatments were layers ration with 0% thyme leaf meal (control) and ration containing 1%, 2% and 3% of thyme leaf meal designated as T_1, T_2, T_3, and T_4, respectively. The level of thyme addition was based on a previous study in Mansoub (2011) that used a maximum of 2% thyme leaf inclusion and found its effect to be appreciable on performance and important egg quality and blood parameters of laying hens.

2.4. Management of experimental birds

The deep litter housing system was used for the 11 week trial including one week for acclimatization. Before commencing the actual experiment, the house was cleaned, disinfected, maintained and partitioned into experimental pens. Each pen was equipped with watering, feeding troughs, and laying nests which were thoroughly cleaned and disinfected. Before the experiment started, the birds were dewormed against internal parasites. During the experiment, layers were fed on an *ad-libitum* basis at 8:00 and 14:00 hours and had free access to water.

2.5. Measurements

2.5.1. Feed intake

The amount of feed offered to each replicate and refused on the trough excluding contaminants (foreign materials mixed to the feed in the trough) by visual inspection was weighed every day throughout the experiment. Feed intake per bird was determined as the difference between the feed offered and refused divided by the number of birds.

2.5.2. Bodyweight gain

The body weight was measured at beginning and end of the experiment. The body weight gain was calculated as the difference between final body weight and initial body weight. The average weight gain per replicate was determined as the sum of individual weight gain of a bird in each replicate divided by the total number of birds under each replicates.

2.5.3. Egg production

Eggs were collected thrice a day from each pen at 8:00, 13:00 and 17:00 hours. The sum of the three collections along with the number of birds alive each day was recorded and summarized at the end of the period. The rate of laying expressed as the average percentage hen-day was computed following the method of Hunton (1995).

$$\%\text{Hen} - \text{day egg production} = \frac{\text{Number of eggs collected per day}}{\text{Number of hens present that day}} \times 100$$

2.5.4. Egg weight and egg mass

Eggs were collected and weighed immediately after collection for each pen and average egg weight was computed by dividing the total egg weight to the number of eggs. After the mean weight is determined, the following formula was employed to calculate the egg mass per pen on a daily basis (North, 1984).

$\text{EM} = \text{P} \times \text{W}$ Where;

EM = average egg mass /hen/day
P = % hen- day egg production
W = average egg weight in gram

2.5.5. Feed conversion ratio

The feed conversion ratio was determined per replicate by calculating the weight of feed consumed per egg mass (Abou-Elezz et al., 2011). The average feed conversion ratio for each treatment was computed as the average of the replicates for each treatment.

2.5.6. Evaluation of egg quality characteristics

Both external and internal egg quality parameters were measured for each replicate. Egg quality parameters (egg shape, shell weight, shell thickness, albumen height, albumen weight, yolk height, yolk weight, yolk color, yolk index, yolk diameter and Haugh Unit Score) were assessed weekly during the experimental period. For a single test of all quality parameters a total of 36 (3 eggs per replication and 9 eggs per treatment) were randomly taken, and then the average was computed for each quality parameter for the replicate.

The length and width of the egg was measured by using a digital caliper and the egg shape indexes were computed using the following formula (Reddy et al., 1979).

$$\text{Egg shape index} = \frac{\text{width of egg}}{\text{length of egg}} \times 100$$

For internal quality assessment, the egg was weighed and broken on flat glass and each of the components such as shell, shell membrane; yolk, yolk membrane and albumen were carefully separated. After breaking the egg, shell weight and thickness were taken by removing the internal membrane. The shell was weighed using a sensitive balance of 0.01g precision. Shell thickness was measured as the average of the blunt, middle and sharp point thickness of the egg by using a micrometer gauge.

Immediately after breaking the eggs, the height of the albumen was measured by tripod micrometer and its weight was taken by sensitive balance after being separated from the yolk. After separation of the yolk from the albumen, yolk diameter and height were measured using a ruler and tripod micrometer, respectively. The weight of the yolk was measured by a sensitive balance. The yolk color was determined by separating the yolk from the yolk membrane and properly mixes on flat glass and comparing it with the color strips of Roche color fan measurement, which consists of 1-15 strips ranging from pale to orange-yellow. Yolk index was computed using the following formula (Romanoff and Romanoff, 1949).

$$\text{Yolk index} = (\text{Yolk height})/(\text{Yolk diameter})$$

Haugh unit (HU) was calculated using the following formula (Haugh, 1937)

$HU = 100 * \log(h + 7.57 - 1.7w^{0.37})$ Where;

h = observed albumen height (mm), w = weight of egg (g)

2.6. Statistical analysis and models

The data collected during the study period was subjected to analysis by using Statistical Analysis System (SAS) computer software version 9.3 (SAS, 2012). All data analysis except for yolk color has followed the procedure of one-way analysis of variance. When the analysis of variance indicated the existence of a significant difference between treatment means, the difference between treatments was separated using the Tukey test. Significant differences were declared at $p<0.05$. The model used for statistical analysis was;

$Y_{ij} = \mu + T_i + e_{ij}$
Where;
Y_{ij} = individual observation
μ = over all mean
T_i = treatment effect
e_{ij} = random error

Data for yolk color was analyzed by using ordinary logistic regression. The logistic regression model is given below:

$$\ln\left\{\frac{\pi}{1-\pi}\right\} = \beta_0 + \beta_1 * (X)$$

Test H_0: No treatment effect (i.e., $\beta_0=0$) vs. H_1: significant treatment effect ($\beta_1 \neq 0$)
Where;
H_0 = Null hypothesis
H_1 = Alternative hypothesis
β = slope
X = treatment

3. Results and discussion

The result of laboratory analysis and nutrient estimation of feed ingredients and experimental rations are shown in Table 2 and Table 3, respectively. The CP of thyme was nearly the same as the result reported by (Mekuanent et al., 2017). The ether extract (EE) content of thyme (4.15%) in present study was higher than the 2.75% obtained by Hagos (2016) (Table 2).

Table 2
Chemical composition of feed ingredients used to formulate experimental ration.

Chemical components	Ingredients				
	Maize grain	SBM	Thyme	NSC	WS
DM(%)	90.85	94.25	87.6	93	90.15
CP (% DM)	8.9	42.5	12.6	33.4	16.3
EE (%DM)	2.9	7.2	4.15	7.3	2
Ash (%DM)	7.5	6.3	10.2	11.3	11.9
CF (%DM)	3.9	5.1	14.5	16.2	7.4
Ca (% DM)	0.06	0.3	0.132	0.26	0.13
P (% DM)	0.32	0.65	0.21	0.67	0.89
ME(Kcal/kg)	3456 .83	3633.	2474.4	2450	2917.9

DM=dry matter; CP=crude protein; EE=ether extract; CF=crude fiber; Ca=calcium; P=phosphorus; ME=metabolizable energy; SBM=soyabean meal; NSC=noug seed cake; WS=wheat short.

The metabolizsable energy and crude protein contents of treatment rations were nearly iso- caloric and iso-nitrogenous (Table 3). The CP and ME levels were within the ranges of the recommended levels of 16-18% and 2800-2900 kcal/kg respectively for white leghorn layers (NRC, 1994).

Table3
Chemical composition of treatment diets containing different proportions of thyme leaf as an additive.

	Treatments			
Chemical components	T_1	T_2	T_3	T_4
DM (%)	93.4	91.46	91.36	91.02
CP(% DM)	16.53	16.96	16.92	16.61
EE(%DM)	3.09	3.01	3.31	3.22
Ash(%DM)	11.67	11.45	11.01	10.90
CF(% DM)	9.48	9.53	9.89	9.91
Ca(%DM)	3.59	3.64	3.89	3.62
P(%DM)	0.75	0.78	0.77	0.77
ME(Kcal/kg)	2802.08	2802.27	2804.62	2802.43

DM=Dry mater, CP=Crude protein, EE=Ether extract. CF=Crude fiber, Ca= calcium, P=phosphorus, ME=Metabolizable energy, kcal=kilo calorie kg= kilogram, TLM=thyme leaf meal, LR=Layer ration, T1=ration containing 0kg TLM/100LR, T2=ration containing1kg TLM/100kgLR, T3=ration containing 2kg TLM/100kgLR, T4=ration containing 3kg TLM/100kgLR.

3.1. Productivity performance of laying hens

3.1.1. Feed intake

The effect of different dietary inclusion levels of thyme leaf on the productivity performance of laying hens is presented in (Table 4). The lower feed intake value was observed in a group of birds fed a diet supplemented with 3% of thyme leaf meal (Table 4). The decreased feed intake can be attributed to the high inclusion level and strong taste of thyme leaf that may reduce the palatability of feed. Carvacrol and its isomer thymol, which are active components of thyme, are mainly responsible for its flavoring characteristics. Lee et al. (2003) revealed that carvacrol suppressed appetite and consequently reduce the feed intake of birds. In previous studies, effects of thyme on feed intake are variable but the result of the current study agreed with that of Bölükbaş and Erhan (2007) who reported that supplementation of thyme at inclusion levels of 1% significantly decreased the feed intake of birds. However, a result obtained by Abd El-Hack and Alagawany (2015) revealed that supplementation of 0.3, 0.6, and 0.9% of thyme in the layers diet did not show a significant difference among treatments. Mansoub (2011) also noted that there were no significant effects on feed intake of birds when 1 to 2% of thyme powder included in the layers ration.

3.1.2. Body weight change

Birds in T_2 had higher ($p<0.01$) final body weight, body weight change and daily weight gain compared to other treatment groups (Table 4). This improvement could be due to the increased feed intake and decreased egg production trend of birds that readily convert feed in to body weight instead of egg production. In agreement with the current study, Toghyani et al. (2010) described that the low level (0.5%) of thyme inclusion has a significant effect on body weight gain of broiler chicken. Similarly, it has been reported that the highest body weight and daily weight gain of Japanese quail was determined in the group that received 0.45% of thyme essential oil (Gumus et al., 2017). In contrary, the study of Safa and Al-Beitawi (2009) reported that the decreased body weight and daily weight gain of layers were observed when the diet supplemented with 1% thyme powder.The studies have also shown that quail rations supplemented with 0.1% of thyme extract (Mehdipour et al., 2014) and broiler rations supplemented with 0.1 and 0.2% of thyme essential oil were not affect both body weight and daily weight gain (Saleh et al., 2014).

Table 4
Feed intake and performance of white leghorn chicken fed rations containing different levels of thyme leaf meal as an additive.

Parameters	Treatments				SEM	SL
	T_1	T_2	T_3	T_4		
Feed Intake (g/hen/day)	112.60^{a}	110.51^{a}	105.07^{b}	100.69^{c}	0.90	**
Initial BW (g)	1217.70	1221.70	1209.00	1209.00	3.26	NS
Final BW (g)	1239.30^{b}	1255.00^{a}	1221.70^{c}	1220.50^{c}	2.93	**
BWC (g)	21.60^{b}	33.33^{a}	12.67^{c}	11.50^{c}	1.89	**
ADWG (g/hen/day)	0.31^{b}	0.47^{a}	0.18^{c}	0.16^{c}	0.02	**
Total egg/bird(No)	27.67^{c}	32.33^{b}	37.00^{a}	37.33^{a}	1.00	**
HDEP (%)	45.01^{c}	50.38^{b}	57.20^{a}	59.23^{a}	1.09	**
Egg weight(g)	51.50	51.56	51.43	51.76	0.73	NS
Egg Mass (g/hen/day)	23.19^{c}	25.98^{bc}	29.43^{ab}	30.67^{a}	0.69	**
FCR	4.87^{a}	4.26^{a}	3.57^{b}	3.28^{b}	0.14	**

^{a,b,c} Means with in a row with different superscripts are significantly different, *=Significant at (P < 0.05), **=Significant at (P <0.01), NS=Non- significant (P >0.05), SL=Significant level, SEM=Standard error of mean, BW=Body weight, BWC=Body Weight Change, ADWG= Avarege Daly Weight Gain, HDEP=Hen day egg production, FCR=Feed conversion ratio, TLM= thyme leaf meal, LR=layer ration, T1=ration containing 0 kg TLM/100LR, T2=ration containing 1 kg TLM/100 kg LR, T3=ration containing 2 kg TLM/100LR, T4=ration containing 3 kg TLM/100kg LR.

3.1.3. Egg production

It was observed that layer ration supplemented with thyme leaf significantly ($p<0.01$) increase egg production of white leghorn layers (Table 4 and Figure 1). Higher number of eggs per bird and improved hen day egg production (HDEP) was observed on birds fed a diet supplemented with 2 and 3% of thyme. This increment in egg production could be due to the positive effects of thyme in improving digestion and absorption of nutrients (Shahryar et al., 2011). Thyme increases the length of the intestine, depth and width of the villis of the intestine and improves absorption of nutrients resulting in improved egg production (Siimsek et al., 2015). Furthermore, supplementation of phytogenic additives may enhance the period of production because of the presence of phyto-estrogenic compounds such as flavones and isoflavones that can stimulate the growth of small follicles and increasing ovarian weight (Saki et al., 2014). In agreement with the present finding, it has been reported that egg production was higher when birds fed a diet supplemented with 2% thyme powder (Mansoub, 2011). According to Abd El-Hack and Alagawany (2015) total number of eggs per bird was increased due to 0.3% inclusion of thyme to the basal diet. Similarly, a result obtained by Abdel-Wareth et al. (2013) described that improved hen-day-egg production (p<0.01) was observed on Hy-line Brown laying hens fed a diet containing 0.1 and 0.2% of thyme. In contrast, the finding of Zeweil et al. (2006) noted that a diet supplemented with 0.1up to 0.2% of thyme flowers had no significant improvements on egg production of Japanese quail hens.

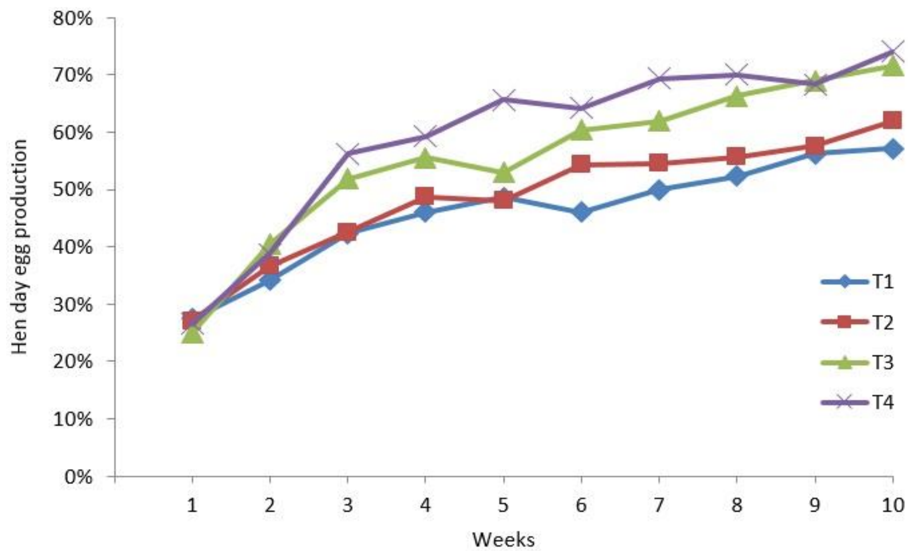

Fig. 1. Weekly average hen day egg production of white leg horn chicks fed a diet containing different levels of dried thyme leaf.

The average hen day egg production increased during the first three weeks in almost all treatments (figure 1). However, egg production fluctuates in most cases from fourth to seventh weeks of the experiment because of the cold weather condition happened on October and then increased during the last three weeks of the experiment.

3.1.4. Egg weight and egg mass

There was no significant (p>0.05) difference in average egg weight among treatment groups (Table 4). The result by Fik et al. (2015) agrees with this study and suggested that the egg weight was not significantly influenced by thyme oil addition. Similarly, Zeweil et al. (2006) noted that using 0.1 and 0.2% of thyme showed no significant improvements on egg weight of Japanese quail. However, the result obtained by Abd El-Hack and Alagawany (2015) indicated that the highest value of egg weight was observed in birds fed 0.3 or 0.6% of thyme in comparison with the control group. Mansoub (2011) and Shahryar et al. (2011) showed that a thyme supplement to a layer diet significantly improved egg weight. The present study demonstrated that egg mass was significantly (p<0.01) higher in T_3 and T_4 compared to the control groups. This increment in egg mass was mainly related to the higher in egg production of this group of birds. This result was in line with the finding of Abd El-Hack and Alagawany (2015) who reported that birds fed 0.3% of thyme had higher (p<0.05) egg mass than those birds fed control diet. Radwan et al. (2008) pointed out the dietary supplementation of thyme (10 g per kg diet) to the layers diet exhibited a significant effect on egg mass. In contrast, the study of Vali and Mottaghi (2016) indicated that the inclusion of 1 to 2% thyme in the Japanese quails' diet did not showed a significant effect on egg mass.

3.1.5. Feed conversion ratio

The lowest value of FCR was observed in T_3 and T_4 and this variation is mainly due to thyme that makes variation in egg production (Table 4). Hirnik et al. (1977) noted that the variation in feed conversion ratio is highly dependent on the number of eggs produced. Birds' exhibited lower FCR and higher egg production are considered as efficient in nutrient utilization. In agreement with the current study, Amad et al. (2011) noted that phytogenic feed additives containing essential oil from thyme improves the feed conversion ratio. Similarly, the study of Bölükbasi et al. (2008) indicated that an inclusion of 100 and 200 mg/kg of thyme essential oil (EO) in layers diet significantly improve the feed conversion ratio. However, the finding of Abd El-Hack and Alagawany (2015) noted that supplementation of layers diet with 3,6 and 9g per kilogram of basal diet did not show a significant difference of feed conversion ratio among treatment groups. According to Saleh et al. (2014), supplementation of feed with 100 and 200 mg/kg of thyme essential oil did not affect the feed conversion ratio.

3.1.6. Egg quality parameters

The effect of thyme leaf on egg quality parameters of white leghorn hens is summarized in (Table 5). Inclusion of thyme did not significantly affect egg shell weight and shell thickness. In agreement with the current study**,** the study of Ali et al. (2007) noted no significant change of shell (weight and thickness) on laying hens fed a diet containing 0.25% thyme leaf. Thyme and oregano leaf did not significantly affect the percentage of albumen, shell and shell thickness in laying Japanese quail (Shahryar et al., 2011). In contrast, according to Bozkurt et al. (2012) supplementation of essential oil of thyme increased egg shell weight, egg shell thickness, and shell breaking strength. Vali and Mottaghi (2016) noted that the inclusion of thyme and cinnamon powders in the Japanis quails diet significantly increased egg shell weight and thickness. Similarly, Kaya et al. (2013) showed that the addition of a mixed herbal product containing *Origanum vulgare, Thymus vulgaris*, thyme oil, origanum oil, garlic oil, anise oil and fennel oil to diets of laying hens can be beneficial to improve egg quality traits such as shell stiffness and thickness.

The addition of thyme leaf in the layers diet did not show significant effect on albumin weight and height (Table 5). The present finding was in agreement with the study of Bölükbaşi and Erhan (2007) who reported that layers diet supplemented with 0.5 and 1% thyme did not show significant change in the percentage of albumin. Similarly, the study by Saki et al.(2014) revealed that dietary inclusion of a mixture of phytogenic feed additives did not show a significant effect on albumen weight, albumen height, Haugh unit and shell thickness. However, the finding of Radwan et al. (2008) indicated that the addition of 1.0% thyme, rosemary and arcilacurcuma longa in the layers diet increased the albumen and yolk weight.

Among egg quality traits, yolk height, weight and index were influenced ($p<0.05$) by dietary inclusion of thyme (Table 5). Birds in treatment T_2 and T_3 significantly ($p<0.01$) exhibited higher yolk height and index comparing to control group. The yolk weight in a group of birds fed a diet at 2% inclusion of had higher than those the control group. The percentage of yolk formation depends on nutrient intakes and thymus increases digestion and absorption of nutrients because of having menthol (Alcicek et al., 2003; Shahryar et al., 2011). The increment in the yolk index is as a result of the stability of yellow pigments in the membrane of the yolk surrounded by the lipid molecules (Kirunda et al., 2001). This author suggested that the antioxidants in the thyme can prevent these lipid molecules from oxidative stress thereby control the yolk from declining its height and increase its width which are key determinants of yolk index. The result reported by Shahryar et al. (2011) agrees with the present study and they suggested that yolk weight was significantly higher in a group of birds fed a diet containing thyme. Similarly, the finding of Mansoub (2011) reported that egg quality parameters were significantly affected by thyme supplementation to the layers diet and the highest yolk index value was observed in a group of birds receive 2% thyme comparing to control group. Nevertheless, the study of Abdel-Wareth et al. (2013) revealed that supplementation of thyme to layers diet did not affect yolk% and yolk index. It has also been reported that addition of garlic and thyme to the diet of laying hens did not significantly affect egg quality characteristics of yolk index, Haugh unit and egg shell thickness (Ghasemi et al., 2010).

With regard to the logistic regression analysis, the yolk color showed a significant difference (pr>chisq <0.0001 at $\alpha = 0.05$) with Wald chi-square value of 112.84 among the treatments. The odd ratio value of T_1 vs T_4 showed that T_1 has 0.001 times the odds ratio of receiving a lower yellowish color score than T_4 (Appendix table 5). The mean for yolk color from SAS output is presented in Table 5 was showed a significance ($p<0.01$) difference among treatment groups. The Roche color fan reading of sampled eggs showed that majority eggs in T_3 failed under the rage of 7 to 9 and T_4 8 to 11 which indicates an increased yolk color reading with increasing level of inclusion of thyme. This might be due to the high carotenoid content of thyme leaf (Hagos, 2016) which is a source for yolk color (Benakmoum et al., 2013). In agreement with the present study Krzysztof et al. (2018) noted that egg yolk was colored with a natural intensive yellow color and preserving appropriate taste and aroma when thyme and ginger were added to layers ration. In contrast with present study the study of Radwan et al. (2008) stated that a group of birds supplemented with thyme leaf showed no significance difference in yolk color. Likewise, yolk (weight, height, diameter, index and color) did not show any significant change due to the addition of 0.25% thyme in the diet of laying hens (Ali et al., 2007).

Table 5
Egg quality parameters of white leghorn chicken fed rations containing different levels of dried thyme leaf as an additive.

	Treatments					
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**	**SL**
Shell weight (g)	5.16	5.23	5.43	5.43	0.13	NS
Shell thickness (µm)	0.33	0.32	0.34	0.32	0.0062	NS
Albumen weight (g)	29.20	28.93	30.60	31.16	0.63	NS
Albumen height (mm)	7.56	7.90	7.90	7.80	0.16	NS
Yolk height (mm)	13.40^{b}	16.03^{a}	15.53^{a}	14.33^{ab}	0.32	**
Yolk diameter (cm)	3.46	3.56	3.53	3.63	0.06	NS
Yolk weight (g)	14.23^{b}	15.20^{ab}	16.26^{a}	15.40^{ab}	0.34	*
Yolk index	0.38^{b}	0.43^{a}	0.43^{a}	0.39^{ab}	0.01	*
Yolk color (*RSP)	1.83^{d}	4.00^{c}	6.56^{b}	9.60^{a}	0.14	**
Egg shape index	74.00^{b}	76.33^{ab}	76.7^{ab}	78.65^{a}	0.79	*
Haugh unit	88.93	89.46	88.63	90.10	0.42	NS

$^{a,\ b,\ c\ and\ d}$ =Means with in a row with different superscripts are significantly different, **=Significant at (P<0.01), *=Significant at (P<0.05), NS=Non- significant, SL=significant level, RSP=Roche Scale Point, TLM=thyme leaf meal, LR=layers ration, SEM=standard error of mean, T1=ration containing 0 kg TLM/100 kg LR/ T2=ration containing 1 kg TLM/ 100 kg LR, T3=ration containing 2 kg TLM/100 kg LR, T4=ration containing 3 kg TLM/100 kg LR.

Table 6
Yolk color points of egg samples from the different experimental diet containing defferent level of thyme as an additive.

	Roche yolk color points											
Diet	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
T1	20	70	0	0	0	0	0	0	0	0	0	90
T2	0	0	10	48	22	10	0	0	0	0	0	90
T3	0	0	0	4	17	14	25	25	5	0	0	90
T4	0	0	0	0	0	0	0	13	25	26	26	90
Total	20	70	10	48	39	24	25	38	30	26	26	360

TLM=thyme leaf meal; LR=layers ration; T1=ration containing 0 kg TLM/100 LR; T2=ration containing 1kg TLM/100LR; T3=ration containing 2kg TLM/100LR; T4=ration containing 3kg TLM/100LR.

The higher egg shape index was shown in a group of birds fed a diet supplemented with 3% of thyme comparing to the control group (Table 5). Similar to the present study, the finding of Mansoub (2011) indicates that supplementation of thyme to layers ration significantly affects egg especial gravity and yolk index. On the other hand, Abd El-Hack and Alagawany (2015) reported that the highest values of the egg shape index, yolk index and Haugh unit score were attained by birds fed a diet containing 0.6% of thyme compared to control group.

Hugh unit score was not significantly (p>0.05) affected by the addition of thyme in the layers ration (Table 5). The result of the current study is in line with the report of Radwan et al. (2008) who noted that the Hugh unit score, as a key indicator of interior egg quality, was not affected by diets supplemented with thyme powder. Ali et al. (2007) also confirmed that layers diet with 0.25% thyme did not change Hough score.

4. Conclusion

A feeding trial was conducted to evaluate the effect of thyme on the performances and egg quality of white leghorn layers. The result indicated that birds in T_2 exhibited significantly ($p<0.05$) higher feed intake, final body weight, body weight change and average daily weight gain than birds in T_3 and T_4. Supplementation of layers diet with thyme leaf significantly ($p<0.01$) influenced the total number eggs per hen, hen day egg production (HDP) and egg mass. The feed conversion ratio (FCR) in T_3 and T_4 was significantly ($p<0.01$) lower than birds in control group. Among egg quality traits, yolk (height, weight, index and color) and egg shape index were significantly ($p<0.05$) affected by the inclusion of thyme in the diet of layers. The highest total, net and marginal return was observed in birds fed a diet supplemented with 3% thyme. In general, the result indicates that thyme leaf can be supplemented up to 3% to the layer ration without adversely affecting the laying performance and egg quality parameters of laying hens. The study results suggest that poultry diet supplemented up to 3% of thyme leaf could be regarded as natural feed additives and sound diets for laying hens.

Further research should be needed to determine the optimal dietary inclusion above this level of thyme on the layers diet and its potential effect on broiler chicken.

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References

Abd El-Hack, M.E.A., Alagawany, M., 2015. Performance, egg quality, blood profile, immune function, and antioxidant enzyme activities in laying hens fed diets with thyme powder. J. Anim. Feed Sci., 127-133.

Abd El-Wareth, A.A.A., Kehrausa, S., Hippenstiela, F., Südekum, K.H., 2012. Effects of thyme and oregano on growth performance of broilers from 4 to 42 days of age and on microbial counts in the crop, small intestine and caecum of 42-day-old broilers. Anim. Feed Sci. Technol., 178, 198-202.

Abdel-Wareth, A.A.A., Ismail, Z.S.H., Südekum, K.H., 2013. Effects of thyme and oregano on performance and egg quality characteristics of laying hens. World Poult. Sci. J., 69, 15-19.

Abou-Elezz, F.M.K., Sarmiento, F.L., Santos, R.R., Solorio, S.F., 2011. Nutritional effects of dietary inclusion of *Leucaena leucocephala* and *Moringa oleifera* leaf meal on Rhode Island Red hens' performance. Cuban J. Agr. Sci., 45, 163-169.

Alcicek, A., Bozkurt, M., Cbuk, M., 2003. The effect of an essential oil combination derived from selected herbs growing wild in turkey on broiler performance. S. Afr. J. Anim. Sci., 33, 89-94.

Ali, M.N., Hassan, M.S., EL-Ghany, F.A., 2007. Effect of strain type of natural antioxidant and sulfate ion on the productive physiological and hatching performance of native laying hens. Int. J. Poult. Sci., 6, 539-554.

Amad, A.A., Manner, K., Wendler, K.R., Neumann, K., Zentek, J., 2011. Effects of a phytogenic feed additive on growth performance and ileal nutrient digestibility in broiler chickens. Poult. Sci., 90, 122811-122816.

AOAC (Association of Official Analytical Chemists), 1990. Association of Official Analytical Chemists. Official Methods of Analysis (13^{th} eds). Washington D.C.

Bedford, M.R., Cowieson, A.J., 2012. Exogenous enzymes and their effects on intestinal microbiology. Anim. Feed Sci. Technol., 173, 76-85.

Behnamifar, A., Rahimi, S., Karimi Torshizi, M.A., Hasanpour, S., Mohammadzade, Z., 2015. Effect of thyme, garlic and caraway herbal extracts on blood parameters, productivity, egg quality, hatchability and intestinal bacterial population of laying Japanese quail. Iran. J. Vet. Med., 9(3), 179-187.

Benakmoum, A., Larid, R., Zidani, Z., 2013. Enriching egg yolk with carotenoids & phenols. Int. J. Nutr. Food Eng., 7(7).

Bölükbaş, C.S., Erhan, K.M., 2007. Effect of dietary thyme on laying hen's performance and E. coli concentration in Feces. Int. J. Nat. Environ. Sci., 1(2), 55-58.

Bölükbaşi, C.S., Erhan, K.M., Özkan, A., 2008. Effect of dietary thyme oil and vitamin E on growth, lipid oxidation, meat fatty acid composition and serum lipoproteins of broilers. S. Afr. J. Anim. Sci., 36, 189-196.

Bozkurt, M., Küçükyilmaz, K., Çatli, A.U., Çmar, M., Bintas, E., Ç€oven, F., 2012. Performance, egg quality, and immune response of laying hens fed diets supplemented with mannan-oligosaccharide or an essential oil mixture under moderate and hot environmental conditions. Poult. Sci., 91, 1379-1386.

CSA, 2017. Central statistics authority of the federal democratic republic of Ethiopia. Ethiopian Agricultural Sample Enumeration. Result at Country Level. Central Statistics Authority, Addis Ababa, Ethiopia. 250-350.

Dhama, K., Latheef, S.K., Mani, S., Samad, H.A., Kartik, K., Tiwari, R., Khan, R.U., Alagawany, M., Farag, M.R., Alam, G.M., Laudadio, V., Tufarelli, V., 2015. Multiple beneficial applications and modes of action of herbs in poultry health and production: A review. Int. J. Pharmacol., 11, 152-176.

Fik, Róbert, H., Veronika, P., 2015. The effect of essential oils on performance of laying hens**.** Anim. Sci. Biotechnol., 48(2), 87-89.

Fisseha, Moges, 2010. Studies on production and marketing systems on local chicken ecotypes in Bure Woreda North-West Amhara. MSc. A thesis submitted to the school of graduate of Hawasa universities, Ethiopia. 3p.

Ghasemi, R., Zarei, M., Torki, M., 2010. Adding medicinal herbs including garlic (Allium sativum) and thyme (Thymus vulgaris) to the diet of laying hens and evaluating productive performance and egg quality characteristics. Am. J. Anim. Vet. Sci., 5(2), 151-154.

Gibson, G.R., Probert, H.M., Loo, J.V., Rastall, R.A., Roberfroid, M.B., 2004. Dietary modulation of the human colonic microbiota: Updating the concept of prebiotics. Nutr. Res. Rev., 17, 259-275.

Gumus, R., Ercan, N., Imik, H., 2017. The effect of thyme essential oil (Thymus Vulgaris) added to quail diets on performance, some blood parameters, and the antioxidative metabolism of the serum and liver tissues. Br. J. Poult. Sci., 19(2), 297-304.

Hagos Hailu, 2016. Determination proximate composition of the wild Abyssinian Thyme Herb (Thyme Schimperi L.) grown in high lands of Southern Tigray, North Ethiopia. Food Sci. Qual. Manag., 50, 2224-6088.

Haugh, R.R., 1937. The haugh unit for measuring egg quality. US Egg. Poult. Manag., 522p.

Herrman, T., 2001. Sampling: procedures for feed. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF-2036. http://www.ksre.k-state.edu/bookstore/pubs/mf2036.pd

Hirnik, J.F., Summers, J.D., Walker, J.P., Szkotnick, W., 1977. Production traits influencing the individual feed conversion ratio. Poult. Sci., 56, 912-917.

Hunton, P., 1995. Egg production, processing and marketing. In: World Poultry Science, Elsevier, Tokyo. 457-480.

Ihsan, M.S., 2017. Impact of supplementation Neem powder (*azadirachta indica*) to diet broiler in immunological, physiological and productive traits. Adv. Environ. Biol., 11(3), 44-51.

Kaya, A., Kaya, H., Macit, M., Celebi, S., Esenbuga, N., Akif, M., Yoruk, M., Karaoglu, M., 2013. Effects of dietary inclusion of plant extract mixture and copper into layer diets on egg yield and quality, yolk cholesterol and fatty acid composition. Kafkas Universitesi Veteriner Fakultesi Dergisi, 19(4), 673-679.

Kirunda, D.F.K., Scheideler, S.E., McKee, S.R., 2001. The efficacy of vitamin E (DL-α tocopheryl acetate) supplementation in hen diets to alleviate egg quality deterioration associated with high temperature exposure. Poult. Sci., 80, 1378-1383.

Krzysztof, D., Julia, R., Dariusz, G., Jan, N., Anna, S., Daniel, R., 2018. Effects of ginger or ginger and thyme extract in laying hens feeding on productive results and eggs quality. Anim. Sci., 57(1), 5-18.

Lee, K.W., Everts, H., Kappert, H.J., Frehner, M., Losa, R., Beynen, A.C., 2003. Effects of dietary essential oil components on growth performance, digestive enzymes and lipid metabolism in female broiler chickens. Br. Poult. Sci., 44, 450-457.

Mansoub, N.H., 2011. Assessment on effect of thyme on egg quality and blood parameters of laying hens. Ann. Biol. Res., 2, 417-422.

Mehdipour, Z., Afsharmanesh, M., Sami, M., 2014. Effects of supplemental thyme extract (*Thymus vulgaris* L.) on growth performance, intestinal microbial populations, and meat quality in Japanese quails. Comp. Clin. Pathol., 23, 1503-1508.

Mekuanent, B., Ajebu, N., Sandip, B., 2017. Effect of feeding thyme (*Thymus schimperi*) on feed intake, digestibility, carcass characteristics and sensory quality of meat of Arsi-Bale sheep fed a basal diet of barley straw. Present to Proceedings of the 25th Annual Confrence of the Ethiopian Society of Animal Production (ESAP).

Mishra, B.B., Kidan, H.G., Kibret, K., Assen, M., Eshetu, B., 2004. Soil and land resources inventory at Alemaya university research farm with reference to land evaluation for sustainable agricultural management and production. Synthesis of working papers, soil sciences bulletin No 1. 123p. Alemaya University.

Neu, H.C., 1992. The crisis in antibiotic resistance. Sci., 257, 1064-1073.

North, M.O., 1984. Commercial chicken production manual. The Avi publishing company, In West port, Connecticut. 26p.

NRC (National Research Council), 1994. Nutrient requirements of poultry. 9th revised edition. National Academy Press, Washington, DC, USA.

Radwan, N.L., Hassan, R.A., Qota, E.M., Fayek, H.M., 2008. Effect of natural antioxidants on oxidative stability of egg and productive and reproductive performance of laying hens. Int. J. Poult. Sci., 7, 134-150.

Reddy, P.M., Reddy, V.R., Reddy, C.V., Rap, S.P., 1979. Egg weight, shape index and hatchability in khaki Campbell duck egg. Indian J. Poult. Sci., 14, 26-31.

Romanoff, A.L., Romanoff, A.J., 1949. The avian egg. New York, John Wiley and Sons Inc. ISBN-13, 978-0471732273.

Safa, S.E.G., AL-Beitawi, N.A., 2009. The effect of feeding of crushed thyme (Thymus valgaris) on growth, blood constituents, gastrointestinal tract and carcass characteristics of broiler chickens. J. Poult. Sci., 46, 100-104.

Saki, A.A., Aliarabi, H., Siyar, H.A.S., Salari, J., Hashemi, M., 2014. Effect of a phytogenic feed additive on performance, ovarian morphology, serum lipid parameters and egg sensory quality in laying hen. Vet. Res. Forum, 5(4), 287-293.

Saleh, N., Allam, T., El-latif, A.A., Ghazy, E., 2014. The effects of dietary supplementation of different levels of thyme (*Thymus vulgaris*) and ginger (*Zingiber officinale*) essential oils on performance, hematological, biochemical and immunological parameters of broiler chickens. Global Vet., 12(6), 736-744.

Shahryar, H.A., Gholipoor, V., Ebrahimnezhad, Y., Monirifar, H., 2011. Comparison of the effects of thyme and oregano on egg quality in laying Japanese quail. J. Basic Appl. Sci. Res., 2063-2068.

Siimsek, U.G., Ciftci, M., Ozcelik, M., Ali, A.M., Tobank, F., Ozhan, N., 2015**.** Effects of cinnamon and rosemary oils on egg production, egg quality, hatchability traits and blood serum mineral contents in laying quails (*Coturnix Coturnix Japonica*). Ankara Üniversitesi Veteriner Fakültesi Dergisi, 62, 229-236.

Statistical Analysis System (SAS), 2012. New version 9.3.

Toghyani, M., Tohidi, M., Gheisari, A.A., Tabeidian, S.A., 2010. Performance, immunity, serum biochemical and hematological parameters in broiler chicks fed dietary thyme as alternative for an antibiotic growth promoter. Afr. J. Biotechnol., 9, 6819-6825.

Upton, M., 1979. Farm management in Africa: the principle of production and planning. Oxford University Press, Great Britain. 282-298.

Vali, N., Mottaghi, S., 2016. The effect of using different levels of cinnamon and thyme powder on egg characteristics and fatty acids profile in Japanese quails. Cent. Inform. Bio-Technol. J. Zool., 5(3), 2319-3883.

Wiseman, J., Lessire, M., 1987. Interactions between fats of differing chemical content: Apparent metabolisable energy values and apparent fat availability. Br. Poult. Sci., 28, 663-676.

Zeweil, H.S., Genedy, S.G., Bassiouni, M., 2006. Effect of probiotic and medicinal plant supplements on the production and egg quality of laying Japanese quail hens. Proceedings of the 12th European Poultry Conference, ZWANS, Verona, Italy, 1-6.

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