RESEARCH ARTICLE

Effects of Dietary Supplementation of Essential Oils as an Alternative to Antibiotic Growth Promoter on Performance of Commercial Broilers

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Abstract

An experiment was conducted to assess the effects of thyme and peppermint essential oils (EO) as an alternative to antibiotic growth promoter (AGP) on the performance of broiler chicken. Total 256 day-old Vencobb broiler chicks were randomly distributed into eight experimental groups with four replicates of eight birds each. Experimental groups were fed with control diet without supplementation of AGP and essential oils (T1), BMD (Bacitracin Methylene Disalicylate) antibiotic @ 500 mg/kg diet (T2), thyme essential oil @ 150 mg/kg diet (T3), 200 mg/kg diet (T4), 250 mg/kg diet (T5), peppermint essential oil @ 200 mg/kg diet (T6), 250 mg/kg diet (T7) and 300 mg/kg diet (T8). The supplementation of thyme oil @ 200 mg/kg and peppermint oil @ 300 mg/kg broiler diet significantly ($p<0.05$) improved b.wt. and b.wt gain. The peppermint oil supplementation @ 300 mg/kg was found to be more beneficial when compared among different oil-supplemented groups. The feed conversion ratio was significantly ($p < 0.05$) improved with peppermint oil supplementation @ 300 mg/kg diet. A significant ($p < 0.05$) reduction in the mean abdominal fat was observed in diet supplemented with higher levels of thyme oil (@ 250 mg/kg diet) and peppermint oil (@ 300 mg/kg diet). Return over feed cost was the highest in broilers assigned diet with AGP; however, it was statistically similar to the basal diet. Considering the net return over fed cost of broilers, use of thyme oil was uneconomical, but supplementation of peppermint essential oil @ 200 and 300 mg/kg diet increased the net return over feed cost and were economical, however less as compared to T1 and T2.

Keywords: AGP, Broiler performance, Essential oil, Thyme, Peppermint.

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Introduction

Dietary use of antibiotic growth promoters (AGPs) has been practiced for decades in commercial poultry to improve production performance. However, the use of AGPs has been banned in many countries due to the trend of antimicrobial resistance and increased consumer demand for antibiotic-free products (Gopi *et al*., 2014). Therefore, various alternatives like probiotics, prebiotics, organic acids, herbal products, and phytogenic compounds, etc. have been tried to replace the AGP. The alternatives must be safe to poultry and human, ensure optimum growth performance and have exerted beneficial effects similar to AGP. One such alternative is the essential oils (EOs), which are derived from various plants as secondary metabolites (Wallace *et al*., 2010). Various herbs and EOs like thymol, carvacrol, eugenol, allicin, cinnamaldehyde and linalool are important health-enhancing alternatives that act as antimicrobial, antibacterial, antioxidant, immune-modulating agent and stimulate endogenous digestive enzymes (Cross *et al.,* 2007). Thymol from thyme (*Thymus vulgaris*) and polyphenolic compounds like menthol, thymol, monoterpene, menthofurane from Peppermint (*Mentha piperita*) are well known for their antibacterial, anticoccidial, antifungal, antioxidant and antimicrobial properties (Pramila *et al*., 2012). They help to improve gut health, feed intake and efficiency in poultry. In view of above facts, the present experiment was designed to validate the effects of dietary supplementation of thyme and peppermint EOs as an alternative to AGP on the performance of commercial broilers.

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Materials and Methods

A total of 256 straight-run commercial day-old broiler chicks of Vencobb strain were randomly distributed to eight treatments (T1 to T8). Each treatment consisted

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of four replicates containing eight chicks per replicate. The eight dietary treatments were: T1 (Control with no antibiotic and no EOs), T2 (Bacitracin Methylene Disalicylate (BMD) @ 500 mg/kg feed), T3 (thyme essential oil @ 150 mg/kg feed), T4 (thyme essential oil @ 200 mg/kg feed), T5 (thyme essential oil @ 250 mg/kg feed), T6 (peppermint essential oil @ 200 mg/kg feed), T7 (peppermint essential oil @ 250 mg/kg feed) and T8 (peppermint essential oil @ 300 mg/kg feed). The essential oil was mixed in different diets after premixing with groundnut oil. However, the basal diets for all the treatments were same and were isocaloric and iso-nitrogenous. Birds were reared in a deep litter system using standard management and health care practices.

The body weight (BW) was recorded at day-old age (BW0) and then at a weekly interval till 6 weeks of age. The BW gain (g) and feed consumption (g/bird) were recorded during the pre-starter phase (0-2 weeks), starter phase (3-4 weeks), and finisher phase (5-6 weeks) and overall experimental period (0-6 weeks). FCR was recorded at weekly interval. At the end of experiment, total of 32 birds (two males and two females from each treatment) were slaughtered for carcass studies. The pre-slaughter live weight was recorded individually and birds were slaughtered for recording eviscerated and giblet weight to calculate dressing percentage and giblet percentage. Economics of each treatment group was calculated replicate wise at the end of the experiment as a return over feed cost (ROFC). The data were analyzed using Completely Randomized Design as per Snedecor and Cochran (1994). Means of replicates under each treatment were considered for analysis.

Results and Discussion

The data on mean body weight (BW) of broilers at day-old age and then at weekly interval is presented in Table 1. At the end of 6th week, dietary treatments T8 and T4 showed significant ($p < 0.05$) improvement in BW as compared to control and other dietary treatments. The BW of broilers supplemented with 300 mg/kg peppermint oil improved BW by 109.25, 163.38 and 291.76 g at the end of 4th, 5th, and 6th week of age, respectively. Similarly, thyme oil @ 200 mg/kg of feed, improved BW by 104.50, 130.38 and 228.41 g at the end of 4th, 5th and 6th week of age, respectively. This indicated that supplementation of thyme oil and peppermint oil @ 200 mg/kg and 300 mg/kg, respectively in broiler diet helps to improve BW. However, the addition of peppermint oil was more beneficial than thyme oil at higher dose level (300 mg/kg) in the present experiment. Present findings are in accordance with the results of Cross *et al.*. (2007), who reported that dietary inclusion of culinary herbs or their EOs improved growth performance in broilers. In contrast, Botsoglou *et al.*. (2004) and Jang *et al.*. (2007) reported that EOs had no beneficial effect on BW.

The BW gain during pre-starter phase, starter phase, finisher phase and overall experimental period is given in Table 1. The BWG of broilers differed significantly ($p < 0.05$) during starter phase and overall experimental period among different dietary treatments. In comparison to control (T1), significantly ($p < 0.05$) higher BWG was recorded in broilers fed 300 mg/kg peppermint oil (T8) and 200 mg/kg thyme oil (T4) during starter phase (2–4 weeks) and overall period (0-6 weeks). Between thyme and peppermint essential oil supplemented groups, significantly ($p < 0.05$) higher BWG (2514.11 ± 80.55 g) was observed in broilers assigned T8 (peppermint oil 300 mg/kg) diet. Minimum and significantly ($p < 0.05$) lower BWG (2221.70 ± 21.62 g) was observed in broilers assigned T1 diet (control). Thus, between thyme and peppermint oil supplemented groups, significantly ($p < 0.05$) higher BWG was obtained in broilers assigned T8 (peppermint oil @ 300 mg/kg) diet. A perusal of the data recorded in the study indicated a significant reduction in BWG of broilers offered 250 mg/kg of thyme oil supplemented diet. Significantly ($p < 0.05$) higher BWG was noticed in broilers offered diet containing 300 mg/kg of peppermint oil. Earlier studies also reported higher BWG in broilers due to supplementation of thyme oil (Bolukbasi *et al.*, 2006; Al-Kassie, 2009) and thyme powder (Khaksar *et al.*, 2012) in their diet. Ocak *et al.* (2008) reported higher BWG in broilers fed with peppermint diet and stated that the EOs act as digestibility enhancers, optimizing the gut microbial ecosystem and stimulating the secretions of digestive enzymes and improve the growth performance in poultry. All these findings supported the present study. In the present study, peppermint oil had its growth-promoting effects on the early stages of life as well as the finisher stage in broilers.

The data on feed intake (g/bird) recorded at a weekly interval as well as pre-starter (0–2 weeks), starter (3–4 weeks), finisher phase (5–6 weeks) and overall experimental period (0-6 weeks) is shown in Table 3. Feed intake of birds fed with T2 and T3 diet was significantly ($p < 0.05$) higher than T6 during the finisher phase (5–6 weeks) and overall experimental period (0-6 weeks). The highest feed intake was observed in T2 followed by T3, T4, T8, T1, T7, T5 and T6. Feed intake was significantly reduced due to inclusion of thyme oil in the diets of broilers. Minimum and significantly ($p < 0.05$) lower feed intake was observed in broilers assigned T5 (thyme oil @ 250 mg/kg) diet amongst the thyme oil supplemented diets. Supplementation of 150 and 200 mg/kg of thyme oil also decreased their feed intake significantly ($p < 0.05$) compared to T2 (AGP) diet. With increasing thyme oil level in the diets, the feed intake was reduced significantly ($p < 0.05$). Lower feed intake in broilers may be due to the flavor of thyme oil as reported by Deyoe *et al.*, (1962). Sengul *et al.* (2008) observed that there was no significant difference in live weight but feed intake differed ($p < 0.01$) at 0–5 weeks of age.

In contrast to thyme oil, with the addition of peppermint oil in the diets of broilers the feed intake was significantly

Table 1: Mean weekly body weights (g) of broilers fed with different treatment diets

Weekly body wt.	Dietary treatments									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	SEM	P value
BW_0	44.41 ± 0.96	42.89 ± 0.18	44.12 ± 0.41	44.54 ± 0.21	44.00 ± 0.55	45.18 ± 0.47	43.87 ± 0.11	43.77 ± 0.23	0.47	0.09
BW_1	163.25 ± 2.80	166.63 ± 4.35	163.31 ± 3.63	171.88 ± 3.13	171.06 ± 1.90	163.13 ± 3.31	169.63 ± 6.29	168.75 ± 3.62	3.83	0.51
BW_2	402.94 ± 7.01	422.85 ± 12.69	413.31 ± 10.02	421.75 ± 2.43	417.06 ± 2.94	415.38 ± 4.90	418.81 ± 4.37	424.59 ± 9.98	7.65	0.58
BW_3	748.94^{c} ± 3.07	809.59^{ab} ± 23.87	793.38^{ab} ± 12.99	821.44^{a} ± 1.87	787.47^{abc} ± 8.74	781.31^{bc} ± 13.26	787.25^{abc} ± 16.05	806.38^{ab} ± 15.66	13.72	0.03
BW_4	1231.75^{c} ± 6.50	1293.85^{abc} ± 37.25	1279.88^{abc} ± 23.60	1336.25^{ab} ± 17.09	1272.48^{bc} ± 19.28	1279.69^{abc} ± 18.91	1289.07^{abc} ± 15.48	1341.00^{a} ± 27.14	22.32	0.04
BW_5	1736.25 ± 10.91	1812.05 ± 59.27	1808.25 ± 39.56	1866.63 ± 23.07	1737.41 ± 33.62	1788.25 ± 24.53	1814.92 ± 27.14	1899.63 ± 51.36	36.80	0.06
BW_6	2266.12^{c} ± 21.59	2386.18^{bc} ± 76.44	2416.69^{abc} ± 57.62	2494.53^{ab} ± 42.05	2382.44^{bc} ± 30.46	2401.83^{abc} ± 30.09	2384.32^{bc} ± 63.65	2557.88^{a} ± 80.46	54.49	0.04

The means bearing different superscript within the row differ significantly ($p < 0.05$)

Table 2: Mean bi-weekly body weight gain (g) of broilers fed with different treatment diets

BW gain	Treatments									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	SEm	P value
BWG 0–2 week	358.52 ± 6.80	379.95 ± 12.57	369.20 ± 10.43	377.21 ± 2.42	373.06 ± 3.48	370.20 ± 5.21	374.95 ± 4.46	380.83 ± 10.17	7.76	0.55
BWG 2–4 week	828.81^{b} ± 11.95	871.00^{ab} ± 28.62	866.56^{ab} ± 7.32	914.50^{a} ± 17.71	855.42^{b} ± 16.82	864.31^{ab} ± 16.41	870.26^{ab} ± 14.6	916.41^{a} ± 21.6	18.74	0.04
BWG 4–6 week	1034.37 ± 18.17	1092.33 ± 58.34	1136.81 ± 34.35	1158.28 ± 31.50	1109.96 ± 22.04	1122.14 ± 19.41	1095.25 ± 56.42	1216.88 ± 55.78	40.41	0.15
BWG 0–6 week	2221.70^{c} ± 21.62	2343.28^{bc} ± 76.53	2372.57^{abc} ± 57.90	2444.99^{ab} ± 42.17	2338.44^{bc} ± 30.95	2356.65^{abc} ± 30.44	2340.46^{bc} ± 63.58	2514.11^{a} ± 80.55	54.62	0.04

The means bearing different superscript within the row differ significantly ($p < 0.05$)

Table 3: Bi-weekly total teed consumption (TFC, g/bird) of broilers fed with different treatment diets

Total feed consumption	*Treatments*									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	*SEm*	*P value*
TFC 0-2 weeks	528.88 ± 5.52	530.10 ± 8.64	531.56 ± 2.75	532.63 ± 3.15	535.13 ± 1.24	534.13 ± 4.26	532.50 ± 3.29	537.81 ± 1.36	4.40	0.88
TFC 2-4 weeks	1276.31 ± 19.72	1349.24 ± 56.46	1347.06 ± 6.16	1329.31 ± 15.96	1288.06 ± 17.39	1302.50 ± 8.00	1289.44 ± 21.72	1361.69 ± 12.67	24.67	0.14
TFC 4-6 wks	2252.09^{bc} ± 25.17	2360.39^{a} ± 53.16	2289.19^{ab} ± 51.68	2232.69^{bc} ± 25.84	2195.84^{bc} ± 16.62	2145.12^{c} ± 29.01	2220.86^{bc} ± 26.10	2189.63^{bc} ± 21.59	33.68	0.01
TFC 0-6 wks	4057.28^{cd} ± 8.61	4239.73^{a} ± 32.81	4167.81^{ab} ± 8.25	4094.63^{bc} ± 25.84	4019.03^{cd} ± 7.91	3981.95^{d} ± 29.35	4042.80^{cd} ± 37.24	4089.13^{bc} ± 22.62	29.51	0.04

The means bearing different superscript within the row differ significantly ($p < 0.05$)

($p < 0.05$) increased. The highest feed intake ($p < 0.05$) was observed in broilers assigned to T8 (peppermint oil @ 300 mg/kg) diet and the lowest in broilers assigned T6 diet (peppermint oil @ 200 mg/kg). Al-Ankari *et al.* (2004) indicated that inclusion of habek mint @ 150 g/kg in diet significantly ($p < 0.05$) improved feed intake of broilers, which supported present findings. The highest feed intake was registered in broilers assigned T2 diet containing AGP, statistically comparable in broilers assigned T3 diet containing 150 mg/kg of thyme essential oil. These findings were in accordance with those of Demir *et al.* (2008), who observed higher feed intake, BW, and BWG in AGP groups compared to mint and thyme powder fed groups.

The data on average weekly feed conversion ratio (FCR) is depicted in Table 4. Supplementation of thyme and peppermint essential oil in the diet of broilers improved FCR. Minimum FCR was noted in broilers assigned thyme oil 200 mg/kg diet (T4) during 5th week and peppermint oil 300 mg/kg (T8) diet during 6th week, while maximum FCR was observed in those assigned T1 and T2 diets (control and AGP). Thus, supplementation of thyme oil 200 mg/kg and peppermint oil 300 mg/kg level in the diets of broilers caused significant ($p < 0.05$) improvement in FCR. Present results were in accordance with the finding of Cross *et al.* (2007) and Ayman *et al.* (2016), who reported that dietary supplementation of essential oil significantly improved FCR in broilers.

The statistical analysis of data on various carcass characteristics (Table 5) like pre-slaughter weight, dressed weight (with giblet), dressing percentage and giblet percentage were non-significant, except abdominal fat weight (g) that exhibited higher values with control, AGP group and peppermint oil @ 200 mg/kg in the diet. Results of the present study were consistent with those of Hernandez *et al.* (2004) and Sarica *et al.* (2005). Al-Kassie (2009) also reported that different levels of oil extract derived from thyme had significant effects on dressing percentage and abdominal fat.

The return over feed cost (ROFC, Rs./bird) of birds fed with different treatment diets differed among each other (Table 6). The cost of feed/bird increased with higher levels of thyme oil supplementation (T3, T4, and T5) than peppermint oil supplemented groups and was lowest in the control group. Therefore, the net ROFC/bird decreased due to the use of different levels of essential oil in the diet, except in T6. Net ROFC/bird was the highest in broilers assigned antibiotic (T2) diet. However, it was similar to broilers offered control (T1) diet. Net ROFC/bird was the lowest in broilers fed T5 diet. Thus, use of thyme essential oil supplementation in the broiler diet was responsible for the reduction in the net ROFC in broilers. The data clearly indicate that the net ROFC/bird was adversely influenced due to the supplementation of essential oil in the diet.

Table 4: Feed conversion ratio (FCR) of broilers fed with different treatment diets

Cumulative FCR	*Treatments*									
	T1	*T2*	*T3*	*T4*	*T5*	*T6*	*T7*	*T8*	*SEM*	*P value*
FCR0-1	1.07 ± 0.01	1.05 ± 0.02	1.09 ± 0.03	1.04 ± 0.02	1.04 ± 0.01	1.08 ± 0.02	1.04 ± 0.03	1.04 ± 0.02	0.02	0.63
FCR0-2	1.31 ± 0.02	1.27 ± 0.02	1.29 ± 0.03	1.26 ± 0.00	1.28 ± 0.01	1.29 ± 0.02	1.27 ± 0.01	1.27 ± 0.03	0.02	0.59
FCR0-3	1.40 ± 0.02	1.34 ± 0.03	1.35 ± 0.01	1.34 ± 0.00	1.37 ± 0.02	1.36 ± 0.02	1.36 ± 0.02	1.36 ± 0.03	0.02	0.45
FCR0-4	1.47 ± 0.02	1.45 ± 0.02	1.47 ± 0.03	1.39 ± 0.02	1.43 ± 0.02	1.44 ± 0.03	1.41 ± 0.03	1.42 ± 0.03	0.02	0.31
FCR0-5	$1.59^{ab} \pm 0.01$	$1.59^{ab} \pm 0.02$	$1.59^{ab} \pm 0.02$	$1.51^{c} \pm 0.01$	$1.64^{a} \pm 0.03$	$1.55^{bc} \pm 0.02$	$1.55^{bc} \pm 0.03$	$1.54^{bc} \pm 0.04$	0.03	0.04
FCR0-6	$1.79^{a} \pm 0.02$	$1.78^{a} \pm 0.05$	$1.73^{ab} \pm 0.06$	$1.64^{bc} \pm 0.03$	$1.69^{abc} \pm 0.02$	$1.66^{bc} \pm 0.03$	$1.70^{abc} \pm 0.04$	$1.60^{c} \pm 0.05$	0.04	0.03

The means bearing different superscript within the row differ significantly (p <0.05)

Table 5: Carcass characteristics of broilers fed with different treatment diets

Carcass traits	*Treatments*									
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	*SEM*	*P value*
Pre-slaughter live wt. (g)	2616.50 ± 127.48	2516.00 ± 157.92	2633.50 ± 107.98	2575.00 ± 150.64	2627.50 ± 160.43	2598.00 ± 190.60	2688.00 ± 247.78	2535.00 ± 206.49	173.80	0.99
Dressed wt. (g)	1728.00 ± 105.85	1719.00 ± 129.02	1810.50 ± 83.35	1739.50 ± 127.98	1766.00 ± 134.18	1764.00 ± 136.80	1833.00 ± 190.80	1720.00 ± 121.37	131.83	0.99
Dressing Percentage (%)	66.16 ± 3.10	68.22 ± 2.03	68.71 ± 0.36	67.40 ± 1.29	67.02 ± 1.12	67.83 ± 0.65	67.97 ± 0.93	68.06 ± 1.14	1.56	0.96
Giblet (%)	7.41 ± 0.26	8.46 ± 1.26	7.19 ± 0.41	7.29 ± 0.33	8.07 ± 0.43	7.45 ± 0.22	7.54 ± 1.10	8.11 ± 1.29	0.79	0.93
Abdominal fat wt. (g)	$45.85^{a} \pm 0.54$	$45.83^{a} \pm 1.01$	$43.38^{bc} \pm 0.60$	$42.85^{bc} \pm 0.52$	$41.83^{c} \pm 0.44$	$44.05^{ab} \pm 0.67$	$42.90^{bc} \pm 0.77$	$41.73^{c} \pm 0.78$	0.69	0.00

The means bearing different superscript within the row differ significantly (p <0.05)

Table 6: Return over feed cost (ROFC, Rs./bird) of different treatment diets

Particulars	*Treatments*							
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8
Income from sell of birds (Rs./bird)	169.73	178.93	181.20	187.05	178.63	180.11	178.80	191.81
Cost of feed (Rs./bird)	111.85	117.39	152.16	161.68	170.67	132.09	139.81	147.16
ROFC (Rs./bird)	58.08	61.54	29.04	25.37	7.96	48.02	38.99	44.66

Conclusion

The broilers fed a diet supplemented with 300 mg/kg peppermint oil had significantly ($p < 0.05$) higher BW and BWG than other dietary treatments. Broilers fed with AGP had the highest feed intake. There was a significant ($p < 0.05$) difference in FCR of birds fed with different treatment diets. Peppermint oil @ 300 mg/kg diet significantly ($p < 0.05$) improved FCR than AGP and control. There was no significant difference in the carcass characteristics of birds fed with different treatment diets, except reduction ($p < 0.05$) in abdominal fat content in oil supplemented diets. Overall results indicated that the birds fed with different levels of thyme and peppermint essential oil in the diet can completely replace AGP, peppermint oil @ 300 mg/kg diet can serve as a good alternative to AGP in broiler diet. The ROFC was highest in broilers assigned diet with AGP; however, it was statistically similar to basal diet. Considering the net ROFC of broilers, the use of thyme oil was uneconomical, but peppermint oil @ 200 and 300 mg/kg diet increased the net ROFC and was economical.

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