RESEARCH ARTICLE

Effects of Essential Oil Blend on Growth Performance, Carcass Traits and Blood Biochemical Profiles of Rainbow Rooster Chickens

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Abstract

The study aimed to evaluate the impact of different levels of essential oil (thymol-cinnamaldehyde-menthol 1:1:1) blend on the growth performance, carcass traits, blood biochemical profiles and gut health of chickens was undertaken on a total of 160-day-old mixed-sex Rainbow Rooster chicks. The chicks were randomly assigned to four experimental groups (T1 to T4), each comprising 40 chicks divided into five replicates of eight chicks. T1 (control) group received no growth promoters, while the T2 group was given Enromycin at 80 g/ton feed. The T3 and T4 groups received the oil blend at 100 and 200 mg/kg of feed, respectively. Body weight gain, feed consumption, and feed conversion ratio were monitored weekly. Blood samples were collected on day 42. Carcass traits were assessed at the end of the trial. Results showed that the essential oil blend and antibiotic-supplemented groups had significantly lower average daily feed intake and improved FCR compared to the control group. There were no significant effects on carcass traits. The serum cholesterol level was significantly lower in the groups supplemented with a blend of essential oils compared to the control group, whereas total protein, albumin and uric acid did not differ among dietary treatment groups. In conclusion, essential oil blend at 100 mg/kg diet could serve as viable alternatives to antimicrobials in poultry production.

Key words: Carcass traits, Essential oil, Growth performance, Gut health, Rainbow Rooster chickens.

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Introduction

The poultry sector is a globally lucrative industry, especially broiler farming, driven by increasing demand for cost-effective, high-quality meat. Successful poultry production relies on effective management practices and well-balanced diets to meet birds' nutritional needs. The use of antibiotics in poultry has been common since the 1960s to enhance growth and overall health (Fernández Miyakawa *et al.*, 2024). However, concerns about antimicrobial resistance and public health risks have led to the search for safe alternatives (Doneria *et al.,* 2025; Izah *et al.*, 2025). Among the available phytogenic feed additives, essential oils have attracted considerable attention owing to their antimicrobial, antioxidant, anti-inflammatory and digestive stimulatory properties (Salinas-Chavira and Barrios-García, 2024; Hossain *et al.*, 2026).

Essential oils, particularly cinnamon, thymol, and menthol, have shown antimicrobial, antioxidant, and digestion-enhancing properties in poultry nutrition. Cinnamon essential oil, rich in cinnamaldehyde, has antimicrobial and digestive benefits (Dey *et al.*, 2023; Zheng *et al.*, 2023; Guo *et al.*, 2024; Doneria *et al.,* 2025), while thymol from thyme oil enhances growth performance and gut health (Chroho *et al.*, 2024; Paul *et al.*, 2025). Menthol, derived from peppermint oil, exhibits antibacterial and antioxidant properties (Tang *et al.*, 2024; Bernard *et al.*, 2025). These essential oils, either used alone or in combination, have shown promising effects on broiler performance by improving nutrient utilization and supporting gut health (Chowdhury *et al.*, 2018; Krauze *et al.*, 2021). Increasing evidence suggests that combinations of essential oil compounds may elicit stronger biological responses than individual components due to complementary mechanisms

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of action and synergistic interactions (Lima *et al.*, 2023; Mondal *et al.*, 2025). Furthermore, phytogenic additives have demonstrated the ability to suppress pathogenic bacteria such as *E. coli* and *Salmonella* while promoting intestinal integrity and functional efficiency (Mondal *et al.*, 2025; Hossain *et al.*, 2026).

Rainbow Rooster chickens are gaining commercial importance as a coloured chicken genotype due to consumer preference and production adaptability; however, limited information is available regarding the effects of targeted essential oil combinations on their intestinal health and productive responses. Although previous studies have evaluated individual essential oils or phytogenic additives in conventional broiler strains, evidence concerning dietary supplementation with a thymol-cinnamaldehyde-menthol blend in Rainbow Rooster chickens remains scarce. Therefore, the present study was undertaken to evaluate the effects of dietary inclusion of thymol-cinnamaldehyde-menthol essential oil blend (1:1:1) on growth performance, carcass traits, and blood biochemical profiles in Rainbow Rooster chickens and to assess its potential as an alternative to antibiotic growth promoters.

Materials and Methods

Experimental Design and Birds

The study protocol was approved by Institutional Animal Ethics Committee of West Bengal University of Animal and Fishery Sciences (No: 763/GO/Re-S/ReRc-L/03/CCSEA/103/2025-26). A total of one hundred sixty-two (162) day-old mixed-sex Rainbow Rooster chicks were randomly divided into four experimental groups, with each group containing five replicates of eight chicks per pen. The dietary groups were categorized as follows: 1) Basal diet without any growth promoter (T1 Control), 2) Basal diet with antibiotic (Enromycin) at 80 g/ton of feed (T2), 3) Basal diet with an essential oil blend at 100 mg/kg of feed (T3), and 4) Basal diet with an essential oil blend at 200 mg/kg of feed (T4). Cinnamon, thyme, and peppermint essential oils were procured from a local market in Kolkata, India, and mixed in a 1:1:1 (v/v/v) ratio to formulate the essential oil blend.

Experimental Diets

In light of lack of specific nutrient guidelines for Rainbow Rooster chickens, the experimental diets were prepared in mash form to fulfill or exceed the nutrient requirements recommended by ICAR (2013) for broiler chickens. Raw ingredients were ground and mixed in a feed mixer according to the specific formula for each bird type. Essential oils were purchased locally in Kolkata, India, and blended with the basal diet. The blended mash feed was packaged in high-density polyethylene (HDPE) bags with inner liners. Rainbow Rooster chickens had *ad libitum* access to feed and clean water throughout the study period of 42 days to ensure their well-being.

Management and Rearing of Birds

Fifteen days prior to the arrival of the chicks, the experimental farm was sanitized using potassium permanganate solution at a ratio of 1:1000. Fumigation was done using a mixture of 20 grams of potassium permanganate and 40 mL of formaldehyde solution per 100 cubic feet. The equipments used for feeding and watering were meticulously cleaned and sanitized. Continuous lighting was provided for the first three days to help the chicks adjust to their new environment, followed by a 23-h light and 1-h dark cycle for the rest of the experiment. Temperature and ventilation were closely monitored. At 14 days old, all birds were administered vaccines for infectious bursal disease, while Newcastle disease vaccines were given at the age of 5 and 21 days.

Measurement of Performance Traits

In this study, the birds' body weight was measured on the initial day and weekly thereafter. The average body weight for each replicate was calculated by averaging the weights of all birds in that replicate. To ascertain the feed intake per bird, the leftover feed was subtracted from the total feed provided, and the result was divided by the number of birds in each replicate. The feed conversion ratio for each replicate was computed as the ratio of body weight gain to the feed intake. Post-mortem examinations were performed to record mortality rates and determine the cause of death.

Estimation of Serum Biochemical Profile

At the end of the experiment, two birds were randomly chosen from each replicate, and blood samples were collected from their wing veins. The blood samples were collected without anticoagulants, and the serum was extracted and stored at -20°C until analysis. The serum metabolite concentrations were analyzed using kits (DiaSys Diagnostic India Pvt. Ltd., Mumbai, India) on biochemistry analyzer (LMSBA-A101, Labmate, Scientific LLC 444 W Lake Street Chicago IL 60606, USA).

Carcass Traits

On day 42, a randomly selected two birds (one male and one female, each with body weights approximating the average weight of that replicate) were taken from each group, and they were euthanized via cervical disarticulation to evaluate carcass traits. The weights of different body parts were meticulously measured and recorded with a digital scale.

Table 1: Effect of essential oil blend derived from cinnamon, thyme, and peppermint (1:1:1) on average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR) of Rainbow Rooster chickens

Attribute	Period	Treatment				SEM	P-Value
		T1	T2	T3	T4		
ADG (g/d)	Day 1-7	15.15	15.27	15.47	15.41	0.146	0.886
	Day 8-21	30.86	30.36	32.40	31.20	0.388	0.303
	Day 22-42	44.92	46.55	49.27	48.64	0.825	0.230
	Day 1-42	35.27	35.94	38.02	37.29	0.462	0.133
ADFI (g/d)	Day 1-7	17.16	17.70	17.47	17.79	0.123	0.278
	Day 8-21	50.47^{a}	46.01^{b}	47.72^{b}	47.72^{ab}	0.580	0.034
	Day 22-42	111.98^{a}	106.00^{b}	107.54^{b}	104.84^{b}	0.876	0.009
	Day 1-42	75.67^{a}	71.29^{b}	72.48^{b}	71.29^{b}	0.516	0.001
FCR (g intake/g gain)	Day 1-7	1.14	1.16	1.13	1.16	0.015	0.908
	Day 8-21	1.65	1.52	1.46	1.53	0.031	0.208
	Day 22-42	2.51^{a}	2.28^{ab}	2.19^{b}	2.17^{b}	0.046	0.024
	Day 1-42	2.15^{a}	1.99^{b}	1.92^{b}	1.91^{b}	0.034	0.022

Means bearing different superscripts in the same row differ significantly (p≤0.05).T1- Control diet, T2- Control diet supplemented with erythromycin at 80 g/ton feed (AGP), T3 & T4- Control diet with essential oil blend @ 100 and 200 g/kg feed. SEM, standard error of means (n=5).

Statistical Analysis

The data on body weight gain, feed intake, and feed conversion ratio underwent one-way analysis of variance using SPSS version 22 in a completely randomized design. For other parameters, individual birds were treated as the experimental unit. A probability value of $P \leq 0.05$ was considered significant. In cases where the treatment effect was significant, Duncan's test was employed to identify differences among the treatment means.

Results and Discussion

Growth Performance and Feed Efficiency

The growth performance of Rainbow Rooster chickens across various experimental groups is illustrated in Table 1. No significant differences in average daily gain were noted among the dietary treatment groups. However, differences in average daily feed intake and feed conversion ratio were recorded among the treatment groups. The groups that received essential oil blends and antibiotics exhibited significantly lower average daily feed intake compared to the control group during the starter (day 8-21) and finisher phase (day 22-42) including the entire experimental duration (day 1-42) ($p<0.05$). Additionally, improved FCR was noted in the groups that were administered essential oil blends and antibiotics during the finisher phase (day 22-42) and the overall entire experimental period (day 1-42) in comparison to the control group ($p<0.05$).

The present study demonstrated that dietary supplementation of essential oil blend improved feed efficiency in Rainbow Rooster chickens by reducing average daily feed intake while maintaining average daily gain, resulting in a significantly improved FCR during the finisher phase and over entire experimental period. These findings suggest that the essential oil blend enhanced nutrient utilization rather than stimulating growth rate directly. The improvement in feed efficiency may be attributed to the well-documented ability of essential oils to stimulate digestive enzyme secretion, enhance bile acid production, improve intestinal barrier integrity, and modulate gut microbial populations, thereby increasing nutrient digestibility and absorption (Zeng *et al.*, 2015; Abdelli *et al.*, 2021; Doneria *et al.,* 2025; Anil *et al.*, 2026). Thymol, cinnamaldehyde and menthol possess complementary biological activities including antimicrobial, antioxidant and anti-inflammatory properties. These bioactive compounds can suppress the proliferation of pathogenic bacteria while preserving intestinal homeostasis, thereby reducing intestinal inflammation and the metabolic cost associated with immune activation. Consequently, dietary nutrients become available for productive functions, leading to improved feed conversion without affecting body weight gain. Similar improvements in feed conversion following dietary supplementation with essential oil blends have been reported in broiler chickens by Hussein *et al.* (2023), Doneria *et al.* (2025) and Mondal *et al.* (2025). However, some studies have reported no significant effects on growth performance, indicating that the response to essential oils depends on factors such as the composition and dosage of the blend, bird genotype, diet composition, environmental conditions and management practices (Windisch *et al.*, 2008; Abdelli *et al.*, 2021). The comparable performance observed between the essential oil and antibiotic-supplemented groups further suggests that the essential oil blend may serve as a promising natural alternative to antibiotic growth promoters for improving feed efficiency in slow-growing Rainbow Rooster chickens.

Table 2: Effect of essential oil blend derived from cinnamon, thyme, and peppermint (1:1:1) on carcass traits of Rainbow Rooster chickens

Attributes	Treatment				SEM	P-Value
	T1	T2	T3	T4		
Slaughter BW (g)	1513.67	1493.00	1530.67	1420.00	20.223	0.235
Eviscerated BW (g)	926.67	922.00	914.00	888.33	11.830	0.729
Dressing percentage	61.20	61.74	59.74	62.57	0.515	0.279
Breast (g)	230.67	267.00	247.33	243.67	5.631	0.132
Frame (g)	226.00	203.33	213.67	209.00	5.096	0.600
Thigh (g)	59.67	63.67	66.33	63.33	1.354	0.429
Drumstick (g)	73.00	74.00	76.00	71.00	1.865	0.861
Wing (g)	44.00	46.33	46.00	46.67	0.897	0.778
Neck (g)	48.33	42.33	43.00	41.33	2.310	0.769
Gizzard (g)	39.67	36.33	39.00	29.33	1.708	0.101
Liver (g)	29.33	28.33	30.00	26.67	0.838	0.588
Heart (g)	8.11	7.62	8.72	7.00	0.432	0.612
Spleen (g)	1.97	2.11	2.00	1.73	0.126	0.804
Bursa (g)	1.82	0.69	1.48	1.22	0.185	0.170
Abdominal fat (g)	34.33	26.27	29.00	27.33	1.528	0.265

T1- Control diet, T2- Control diet supplemented with erythromycin at 80 g/ton feed (AGP), T3 & T4- Control diet with essential oil blend @ 100 and 200 g/kg feed. SEM, standard error of means (n=5).

Carcass Characteristics

The carcass characteristic of Rainbow Rooster chickens in different experimental groups presented in Table 2 revealed no significant differences ($p>0.05$) among the dietary treatment groups, indicating that essential oils supplementation did not influence carcass yield or organ characteristics in Rainbow Rooster chickens. These findings indicate that the improved feed efficiency observed in the essential oil-supplemented groups did not alter nutrient partitioning towards muscle deposition or visceral organ development. Similar observations have been reported by several investigators who found no significant effects of essential oil supplementation on dressing percentage or organ weights in broilers (Hassan *et al.*, 2024; Khan *et al.*, 2024; Mondal *et al.*, 2025). The absence of significant changes in carcass characteristics may be attributed to the relatively moderate inclusion levels of the essential oil blend and the maintenance of normal physiological growth throughout the experimental period. Essential oils primarily exert their beneficial effects by improving digestive efficiency, intestinal health and nutrient utilization rather than directly influencing carcass composition. Furthermore, carcass traits are largely determined by genetic background, age at slaughter, nutritional balance and environmental factors, which may overshadow the relatively subtle effects of phytogenic feed additives (Abdelli *et al.*, 2021). Therefore, the current findings suggest that supplementation with the thymol-cinnamaldehyde-menthol essential oil blend enhances production efficiency without adversely affecting carcass quality.

Blood Biochemical Profile

The blood biochemical profile of Rainbow Rooster chickens in different experimental groups is presented in Table 3. In this study, no significant differences ($p>0.05$) were found in serum total protein, albumin, and uric acid levels across the dietary treatment groups ($p>0.05$). Nevertheless, the serum cholesterol level was significantly lower in the groups that received the blend of essential oils derived from thymol, cinnamaldehyde, and menthol, when compared to the control group ($p<0.05$), while no significant difference was noted in the group that received antibiotics. The lack of significant effects on serum total protein, albumin and uric acid concentrations among dietary treatments indicates that supplementation with essential oil blend did not adversely affect protein metabolism, hepatic protein synthesis or renal function. These findings suggest that the essential oil blend was well tolerated by Rainbow Rooster chickens and did not induce metabolic stress. In contrast, serum cholesterol concentration was significantly reduced in birds receiving the essential oil blend. The hypocholesterolemic effects of essential oils have been widely reported and are primarily attributed to the inhibitory effects of thymol and cinnamaldehyde on hepatic 3-hydroxy-3-methyglutaryl coenzyme A (HMG-CoA) reductase, the rate-limiting enzyme involved in cholesterol biosynthesis. In addition, essential oils may enhance bile acid secretion and cholesterol excretion while improving lipid metabolism through their antioxidant properties (Abdelli *et al.*, 2021; Movahedi *et al.*, 2024; Salinas-Chavira and Barrios-García, 2024; Doneria *et al.,* 2025). Similar reductions in serum cholesterol have been reported in broilers supplemented with essential oil blends

Table 3: Effect of essential oil blend derived from cinnamon, thyme, and peppermint (1:1:1) on blood biochemical profile of Rainbow Rooster chickens

Attribute	Treatment				SEM	P-Value
	T1	T2	T3	T4		
Total protein (mg/dL)	4.15	4.06	3.96	3.83	0.171	0.945
Albumin (mg/dL)	3.48	3.41	2.89	3.19	0.092	0.069
Uric acid (mg/dL)	5.70	5.66	5.56	5.51	0.399	0.999
Cholesterol (mg/dL)	178.32[a]	151.02[ab]	88.79[b]	78.21[b]	15.822	0.036

Means bearing different superscripts in the same row differ significantly ($p \leq 0.05$). T1- Control diet, T2- Control diet supplemented with erythromycin at 80 g/ton feed (AGP), T3 & T4- Control diet with essential oil blend @ 100 and 200 g/kg feed. SEM, standard error of means (n=5).

(Tayeb *et al.*, 2019; Ranwa *et al.*, 2022; Kahiel *et al.*, 2025). The improvement in serum lipid profiles, together with enhanced intestinal health and feed efficiency, further supports the multifunctional role of thymol-cinnamaldehyde-menthol blend as a natural growth promoting feed additives.

Conclusion

In conclusion, dietary supplementation of essential oil blend (thymol, cinnamaldehyde, and menthol 1:1:1 ratio) at 100 mg/kg demonstrated favourable effects on growth performance, and metabolic responses in Rainbow Rooster chickens. The improvement in feed conversion efficiency, together with reduction in serum cholesterol supports the physiological benefits associated with essential oil supplementation. Notably, these responses were comparable or superior to those obtained with antibiotic supplementation. Therefore, essential oil blend inclusion at 100 mg/kg may represent an effective and sustainable nutritional strategy to reduce reliance on antibiotic growth promoters while maintaining productive performance in Rainbow Rooster chicken production.

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