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PRODUCTIVE POTENTIAL OF *THYMUS VULGARIS* POWDER: EFFECTS ON GROWTH PERFORMANCE, FEED EFFICIENCY, AND CARCASS TRAITS OF BROILERS

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ABSTRACT

This study investigated the effects of dietary thyme (*Thymus vulgaris*) powder on the growth performance, feed utilization, and carcass characteristics of Ross 308 broilers over a 28-day production period. Ninety-one-day-old chicks were randomly assigned to three dietary treatments: a control diet and two experimental diets supplemented with 0.5 or 1.0% thyme powder, with three replicate pens per treatment. We recorded body weight, body weight gain, feed intake, and feed conversion ratio (FCR), and assessed carcass characteristics at 28 days. We also calculated overall feed efficiency (FE), European Production Efficiency Factor (EPEF), and Relative Performance Index (RPI). Thyme supplementation significantly increased body weight at 2 and 4 weeks of age and improved body weight gain during the second week. Feed intake and FCR were significantly affected during specific experimental periods, with thyme-supplemented birds showing improved FCR. At 28 days, final live body weight, carcass weight, and dressing percentage were significantly higher in both thyme-supplemented groups than in the control group. The calculated performance indices indicated numerically greater overall production efficiency in the supplemented groups, with the 0.5% treatment recording the highest FE (0.782) and EPEF (514.93), whereas the 1.0% treatment recorded the highest RPI (116.96). Overall, dietary supplementation with 0.5 or 1.0% *T. vulgaris* powder improved several growth performance and carcass characteristics of broilers. The 0.5% inclusion level demonstrated the most favorable numerical balance between growth performance and feed utilization efficiency, supporting its potential for further investigation as a phytogenic alternative to antibiotic growth promoters.

***Keywords*:** *Thymus vulgaris*, Broilers, Growth performance, Feed efficiency, EPEF, Carcass characteristics.

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1. INTRODUCTION

The poultry industry faces increasing challenges in maintaining rapid growth and feed efficiency while ensuring bird health and welfare, particularly under intensive production systems and short production cycles (Bist et al., 2024). Antibiotic growth promoters (AGPs) have traditionally been used in broiler diets to modulate intestinal microbial populations, reduce subclinical inflammation, and enhance productive performance (Zou et al., 2022). However, their prolonged use has contributed to the emergence and dissemination of antimicrobial resistance, raising concerns about animal and public health and leading to increasing regulatory restrictions on AGP use worldwide (Moskalov et al., 2026; Reski et al., 2026). Consequently, the AGP removal has increased the demand for safe and effective alternatives, particularly in intensive broiler production systems such as those in the Kingdom of Saudi Arabia, where birds are commonly reared under intensive conditions and subjected to production cycles of approximately 28 days (Paul et al., 2024). Disruption of intestinal microbial homeostasis, gut barrier integrity, and redox balance following AGP withdrawal may adversely affect bird health and productivity, emphasizing the need for alternative nutritional strategies (Ibeagha-Awemu et al., 2025).

Phytogenic feed additives and other biotic-based interventions have emerged as promising strategies for supporting poultry health and performance in antibiotic-free production systems (Alharthi et al., 2023; Al-Baadani et al., 2025; Isomov et al., 2026). Among phytogenic sources, thyme (*Thymus vulgaris* L.) has attracted particular interest because its essential oil is rich in the phenolic monoterpenes thymol and carvacrol (Gholami-Ahangaran et al., 2022). These bioactive compounds possess antimicrobial and antioxidant properties that may contribute to intestinal microbial regulation, physiological homeostasis, nutrient utilization, and productive performance in broilers (Hassan & Awad, 2017; Gholami-Ahangaran et al., 2022; Navalta, 2026).

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Several studies have reported beneficial effects of thyme-derived compounds and *T. vulgaris* products on broiler performance, including enhanced digestive activity and productive efficiency (Ocak et al., 2008; Sadeghi et al., 2012; Khan et al., 2012; Feizi et al., 2013; Pournazari et al., 2017). However, evidence concerning the dietary use of whole *T. vulgaris* plant material remains comparatively limited, and responses appear to vary with inclusion level and experimental conditions. Thyme supplementation at 0.5–1% has been reported to improve growth performance without significantly enhancing immune competence (Gholami-Ahangaran et al., 2019), whereas inclusion levels of 1–3% have been associated with improved feed conversion (Attia et al., 2018). Similarly, lower levels of 0.2–0.8% have been reported to improve body weight gain and influence immune-related responses (Hassan & Awad, 2017). These findings suggest that dietary concentration is an important determinant of the biological efficacy of thyme supplementation.

Thymus vulgaris is a medicinal and aromatic herb rich in bioactive phenolic compounds, particularly thymol and carvacrol, which exhibit antioxidant, antibacterial, antifungal, and anticoccidial activities (Vlaicu et al., 2023). The plant also possesses pharmacological properties, including antispasmodic, expectorant, antiseptic, and antibacterial effects, supporting its potential application as a natural phytogenic feed additive in animal nutrition (Hussain et al., 2024). Consistent with these properties, dietary thyme powder and essential oils have been reported to improve broiler growth performance (El-Sabrout et al., 2023; Soliman et al., 2024; Phupaboon et al., 2025).

The potential of thyme as an alternative to conventional AGPs has also been investigated. Hassan et al. (2024) reported that dietary supplementation with thyme at 1.0%, ginger at 1.0%, or their nanoparticle forms at 0.10% significantly improved body weight gain and feed conversion ratio compared with a diet containing bacitracin methylene disalicylate. However, thyme supplementation at 1.0% and the corresponding nanoparticle treatments did not significantly affect carcass yield or most organ weights, although abdominal fat was reduced compared with the control group (Hassan et al., 2024). In another poultry species, Maulod et al. (2022) reported that dietary inclusion of 0.5–1% thyme powder increased dressing percentage in female Japanese quails, whereas no significant effect was observed in males. The supplementation also improved the proportions of breast, wing, leg, and back compared with the control group.

Overall, the available evidence supports the potential of thyme as a natural phytogenic alternative to AGPs; however, its effects may vary according to inclusion level, preparation, bird type, and production conditions. Further evaluation of practical levels of whole *T. vulgaris* powder is therefore warranted, particularly under short production cycles in intensive broiler systems. Accordingly, the present study evaluated the effects of dietary supplementation with *T. vulgaris* powder at 0.5 and 1.0% on growth performance, feed intake, feed conversion ratio, and carcass characteristics of broiler chickens during a 28-day production period, aiming to assess its potential application as a natural phytogenic alternative to conventional antibiotic growth promoters.

2. MATERIALS AND METHODS

2.1. Flock Management

The experiment was conducted at the Experimental Animal Research Station, King Faisal University, to evaluate the effects of dietary supplementation with thyme (*Thymus vulgaris*) powder on the growth performance and carcass characteristics of Ross 308 broiler chickens. A total of 90 one-day-old, unsexed Ross 308 chicks, with an average initial body weight of 43.6 g, were used. The experimental trial lasted 28 days, during which all birds were maintained under controlled husbandry and environmental conditions.

Upon arrival, the chicks were individually weighed, randomly allocated to their respective experimental groups, and housed in appropriately prepared floor pens. Fresh, clean, and dry litter was provided throughout the experimental period, and litter condition were regularly monitored to maintain adequate hygiene and minimize moisture accumulation. The birds were provided with continuous access to clean drinking water and their respective experimental diets throughout the trial. Feeders and drinkers were checked regularly to ensure adequate feed and water availability and to minimize contamination.

The house temperature was maintained at a level appropriate for the age of the chicks, with a gradual reduction as the birds grew to meet their changing thermoregulatory requirements. Adequate ventilation was provided throughout the experimental period to maintain air quality, remove excess moisture, and minimize the accumulation of harmful gases. A suitable lighting program was implemented to facilitate feed and water consumption and maintain normal bird activity. The birds were monitored daily for their general health status, behavior, and any signs of disease or environmental stress. Routine cleaning and sanitation procedures were followed throughout the experiment to maintain hygienic housing conditions. All birds were managed under the same husbandry and environmental conditions, with dietary treatment being the main experimental variable.

A completely randomized design (CRD) was adopted. Following individual determination of initial body weight, the chicks were randomly allocated to three dietary treatments using a random-number table to obtain comparable initial body weights among treatments. Each treatment comprised three replicate pens, with 10 birds per pen, resulting in 30 birds per treatment. The experimental pen was considered the experimental unit for statistical analysis.

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The experimental diets consisted of a nutritionally adequate basal diet formulated to meet or exceed the nutrient requirements of broiler chickens. The dietary treatments were: (1) an unsupplemented basal diet serving as the control; (2) a basal diet supplemented with 0.5% thyme powder; and (3) a basal diet supplemented with 1.0% thyme powder. We selected these inclusion levels based on levels previously investigated in poultry nutrition studies (Abdel-Ghaney et al., 2017; Maulod et al., 2022; Hassan et al., 2024).

The required quantity of thyme powder was thoroughly mixed with the basal diet before feeding to ensure uniform distribution of the additive throughout the feed. Birds were housed in floor pens under identical management and environmental conditions. Each pen provided approximately 16 ft² of floor space and was furnished with fresh sawdust litter, corresponding to approximately 0.15 m² (1.6 ft²) of floor area per bird. Feed and drinking water were provided *ad libitum* throughout the experimental period.

During the brooding period, ambient temperature was maintained at 32–33°C during the first week and subsequently reduced by approximately 2–3°C per week until reaching 22–24°C. A lighting regimen of 23 h light and 1 h darkness was provided during the first week, followed by 20 h light and 4 h darkness for the remainder of the experimental period. All chicks received the routine vaccination program implemented at the research station. Birds were inspected daily for their health status, while standard husbandry procedures and appropriate biosecurity measures were maintained throughout the experiment. Mortality, if any, was recorded daily. No mortality occurred during the experimental period; therefore, no mortality adjustment was required.

2.2. Growth Performance

2.2.1. ***Body Weight & Body Weight Gain:*** Individual live body weights were recorded at 7, 14, 21, and 28 days of age using a digital balance, with measurements recorded to the nearest gram. Body weight gain (BWG) for each experimental period was calculated as the difference between body weight at the end of the respective period and the corresponding initial body weight.

For statistical analysis, individual body-weight measurements were summarized at the pen level, and the mean body weight of birds within each pen was used as the experimental observation.

2.2.2. ***Feed Intake & Feed Conversion Ratio:*** Feed intake was determined on a pen basis by recording the quantity of feed provided and the residual feed at the end of each experimental period. Feed consumption per bird was calculated from the difference between feed offered and feed remaining, adjusted according to the number of birds in the respective pen during the corresponding period.

Feed conversion ratio (FCR) was calculated on a weekly basis according to Abdel-Moneim et al. (2022), using the following equation:

$$FCR = \frac{Total\ feed\ intake\ (g)}{Total\ body\ weight\ gain\ (g)}$$

The FCR was used as an indicator of feed utilization efficiency, with lower values representing more efficient conversion of feed into body weight gain.

2.3. Overall Production Indices

To provide an integrated assessment of overall productive performance during the 28-day experimental period, three derived production indices were calculated from the primary growth performance and feed intake data: feed efficiency (FE), European Production Efficiency Factor (EPEF), and Relative Performance Index (RPI).

2.3.1. ***Feed efficiency:*** Feed efficiency was calculated as the ratio of cumulative body weight gain to cumulative feed intake over the 28-day experimental period according to Gholami et al. (2024), using the following equation:

$$FE = \frac{Cumulative\ body\ weight\ gain\ (g)}{Cumulative\ feed\ intake\ (g)}$$

Higher FE values indicate more efficient feed utilization for body weight gain.

2.3.2. ***European Production Efficiency Factor:*** The European Production Efficiency Factor was calculated at 28 days of age according to the method described by Marcu et al. (2013), using the following equation:

$$EPEF = \frac{Livability\ (\%) \times body\ weight\ (kg) \times 100}{[age\ (days) \times FCR]}$$

In this equation, livability represents the percentage of birds surviving to the end of the experimental period, body weight is expressed in kilograms, age corresponds to 28 days, and FCR represents the overall feed conversion ratio calculated for the entire experimental period.

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2.3.3. *Relative Performance Index:* The Relative Performance Index was calculated to express the final body-weight performance of each dietary treatment relative to the control group. The control treatment was assigned a reference value of 100 according to the following equation:

$$RPI = [\frac{Final\ body\ weight\ of\ treatment}{Final\ body\ weight\ of\ control}] \times 100$$

An RPI value greater than 100 indicates a higher final body weight relative to the control treatment, whereas a value below 100 indicates a lower relative performance.

All three indices were calculated using the cumulative performance data obtained over the 28-day experimental period. Because these indices were derived from the primary experimental measurements, they were presented as integrated production indicators rather than as additional independently measured variables.

2.4. Carcass Characteristics

At 28 days of age, six birds from each treatment, with body weights representative of the average body weight of their respective treatment groups, were randomly selected for carcass evaluation, giving a total of 18 birds. The selected birds were fasted for 12 h before slaughter and were weighed immediately prior to slaughter.

Birds were humanely slaughtered using appropriate stunning and bleeding procedures. Following slaughter, the carcasses were processed by removing the internal viscera. The liver, heart, and gizzard were separated and weighed, and the gizzard was opened and emptied of its contents before weighing. The legs, head, and abdominal fat were also separately collected and weighed. Carcass weight was determined using a digital balance.

Carcass characteristics and the weights of the evaluated organs and body components were expressed as percentages of live body weight, following the procedure described by Abdel-Moneim et al. (2025).

2.5. Statistical Analysis

The experimental data were analyzed using one-way analysis of variance (ANOVA), with dietary treatment as the main effect, using SAS software (SAS Institute, 2004; SAS/STAT User's Guide, Version 9.1). Prior to analysis, the data were assessed for compliance with the assumptions of normality and homogeneity of variance using appropriate statistical tests.

The statistical model was as follows:

$$Yij = \mu + Ti + eij$$

Where, T_i is the treatment effect, e_{ij} is the experimental error, μ is the general mean, and Y_{ij} is the measured characteristic. Differences among treatment means were considered statistically significant at $P<0.05$. When the ANOVA revealed a significant treatment effect, Duncan's multiple range test was used for post hoc separation of treatment means.

3. RESULTS

3.1. Growth Performance

3.1.1. *Body Weight & Body Weight Gain*: The effects of dietary *Thymus vulgaris* powder supplementation on body weight (BW) and body weight gain (BWG) of Ross 308 broilers are presented in Table 1. Dietary treatment had no significant effect on BW during the first and third weeks of age (P=0.4655 and 0.3214, respectively). However, significant treatment effects were observed at 2 and 4 weeks of age (P=0.0008 and 0.0002, respectively). At 2 weeks, birds receiving 0.5 and 1% thyme powder exhibited significantly greater BW values (571.3 and 579.7 g, respectively) than those in the control group (469.0 g). Similarly, the final BW at 28 days reached 1844.7 and 1882.3 g in the 0.5 and 1% thyme groups, respectively, compared with 1609.3 g in the control group.

Regarding BWG, significant differences were observed during the second week, with the 0.5 and 1.0% thyme groups recording 393.6 and 401.3 g, respectively, compared with 301.0 g in the control group (P=0.0001). During the fourth week, BWG was numerically higher in the thyme-supplemented groups (802.7 and 829.0 g for the 0.5 and 1.0% groups, respectively) than in the control group (639.0 g), however, this difference was not statistically significant (P = 0.0538).

3.1.2. Feed Intake & Feed Conversion Ratio

The effects of dietary thyme supplementation on feed intake (FI) are presented in Table 2. FI was not significantly affected during the first and second weeks (P=0.9986 and 0.1733, respectively). Significant differences were observed during the third and fourth weeks (P=0.0500 and 0.0341, respectively). During the third week, FI was lowest in the 0.5% thyme group (668.7 g), compared with 725.3 g in the control group and 734.3 g in the 1.0% thyme group.

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During the fourth week, the control group recorded the highest FI (1233.0 g), whereas the 0.5 and 1.0% thyme groups consumed 1131.7 and 1202.7 g, respectively.

Table 1: Dietary thyme powder (*Thymus vulgaris*) effects on weekly body weight and body weight gain of broilers

Trait	Week	Treatments (*Thymus vulgaris L.*)			Probability
		(0.5%)	(1%)	Control (0%)	
Body weight, g	1st	177.6 ± 6.35	178.6 ± 7.85	168.0 ± 4.16	0.4655
	2nd	571.3 ± 15.30a	579.7 ± 9.21a	469.0 ± 7.93b	0.0008
	3rd	1042.0 ± 65.09	1053.3 ± 10.91	970.0 ± 9.29	0.3214
	4th	1844.7 ± 43.34a	1882.3 ± 21.72a	1609.3 ± 13.38b	0.0002
Body weight gain, g	1st	133.3 ± 7.21	136.0 ± 7.00	124.3 ± 4.70	0.4517
	2nd	393.6 ± 8.95a	401.3 ± 8.45	301.0 ± 3.78b	0.0001
	3rd	471.0 ± 49.52	473.6 ± 17.79	501.3 ± 4.91	0.7493
	4th	802.7 ± 75.65ab	829.0 ± 28.67a	639.0 ± 22.54b	0.0538

Values (mean ± SE) within the same main effect with different letters in a row differ significantly (P<0.05).

Table 2: Dietary thyme powder (*Thymus vulgaris*) effects on feed intake and feed conversion ratio of broilers

Trait	Week	Treatment (*Thymus vulgaris L.*)			Probability
		(0.5%)	(1%)	Control (0%)	
Feed intake, g	1st	127.7 ± 5.89	127.3 ± 1.20	127.6 ± 6.43	0.9986
	2nd	376.3 ± 15.45	416.3 ± 15.19	389.3 ± 7.42	0.1733
	3rd	668.7 ± 24.53b	734.3 ± 10.91a	725.3 ± 9.38ab	0.05
	4th	1131.7 ± 28.71b	1202.7 ± 19.93ab	1233.0 ± 8.66a	0.0341
Feed conversion ratio	1st	1.06 ± 0.09	1.04 ± 0.05	1.03 ± 0.01	0.6598
	2nd	0.95 ± 0.04b	1.04 ± 0.07b	1.29 ± 0.04a	0.0009
	3rd	1.46 ± 0.17	1.56 ± 0.08	1.45 ± 0.03	0.7616
	4th	1.43 ± 0.14b	1.45 ± 0.06b	1.93 ± 0.05a	0.0150

Values (mean ± SE) within the same main effect with different letters in a row differ significantly (P<0.05).

Feed conversion ratio (FCR) was significantly affected by dietary treatment during the second and fourth weeks. During the second week, FCR decreased from 1.29 in the control group to 0.95 and 1.04 in the 0.5 and 1% thyme groups, respectively (P=0.0009). Similarly, during the fourth week, FCR values were significantly lower in the thyme-supplemented groups (1.43 and 1.45 for the 0.5 and 1.0% groups, respectively) than in the control group (1.93; P=0.0150).

3.2. Overall Production Indices

The overall production indices calculated for the 28-day experimental period are presented in Table 3. Feed efficiency (FE) increased from 0.633 g gain/g feed in the control group to 0.782 and 0.741 g gain/g feed in the 0.5 and 1.0% thyme groups, respectively. Thus, the highest numerical FE was recorded in the 0.5% thyme group.

The European Production Efficiency Factor (EPEF) increased from 363.56 in the control group to 514.93 and 498.29 in the 0.5 and 1.0% thyme groups, respectively. Similarly, the Relative Performance Index (RPI) was 114.63 and 116.96% in the 0.5 and 1% thyme groups, respectively, relative to the control group. Accordingly, the highest numerical RPI was therefore recorded in the 1% thyme group, whereas the 0.5% group exhibited the highest numerical FE and EPEF.

Table 3: Overall Production Indices of Broilers Fed Dietary *Thymus vulgaris* Powder

Indicator	Treatment (*Thymus vulgaris L.*)		
	Control (0%)	Thyme (0.5%)	Thyme (1%)
Feed efficiency (FE), g gain/g feed	0.633	0.782	0.741
European Production Efficiency Factor (EPEF)	363.56	514.93	498.29
Relative Performance Index (RPI), %	100.00	114.63	116.96

All indices were calculated for the 28-day experimental period, with 100% livability because no mortality occurred.

3.3. Carcass Components

The effects of dietary thyme supplementation on carcass characteristics at 28 days of age are presented in Table 4. Dietary treatment significantly affected live body weight, carcass weight, and dressing percentage (P=0.0001, 0.0001, and 0.0186, respectively). Live body weight increased from 1475.83 g in the control group to 1747.83 and 1761.67 g in the 0.5 and 1.0% thyme groups, respectively. Carcass weight increased from 1085.00 g in the control group to 1381.17 and 1395.67 g in the thyme-supplemented groups. Dressing percentage also increased from 73.54% in the control group to 79.02 and 79.35% in the 0.5 and 1.0% groups, respectively. Dietary treatment did not significantly affect relative gizzard weight (P=0.0883), head weight (P=0.1596), or abdominal fat percentage (P=0.4427). Abdominal fat percentage was numerically lower in both thyme-supplemented groups (1.02%) than in the control group (1.25%), but this difference was not statistically significant.

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In contrast, relative liver and heart weights were significantly affected by dietary treatment (P=0.0279 and 0.0062, respectively). Relative liver weight decreased from 2.28% in the control group to 1.76 and 1.85% in the 0.5 and 1% thyme groups, respectively. Relative heart weight also decreased from 0.70% in the control group to 0.58 and 0.52% in the corresponding thyme-supplemented groups.

Relative leg percentage was significantly affected by dietary treatment (P=0.0004). The highest value was recorded in the control group (4.41%), followed by the 0.5% thyme group (3.56%), while the lowest value was observed in the 1.0% thyme group (2.93%).

Table 4: Dietary thyme powder (*Thymus vulgaris L.*) effects on carcass yield at 28 days of age

Trait	Treatment (*Thymus vulgaris L.*)			Probability
	(0.5%)	(1%)	Control (0%)	
Live body weight, g	1747.83 ± 35.03a	1761.67 ± 32.74a	1475.83 ± 35.81b	0.0001
Carcass weight, g	1381.17 ± 37.49a	1395.67 ± 21.83a	1085.00 ± 25.13b	0.0001
Dressing, %	79.02 ± 1.47a	79.35 ± 1.84a	73.54 ± 0.69b	0.0186
Gizzard, %	1.43 ± 0.07	1.39 ± 0.13	1.72 ± 0.09	0.0883
Liver, %	1.76 ± 0.11b	1.85 ± 0.11b	2.28 ± 0.15a	0.0279
Heart, %	0.58 ± 0.01b	0.52 ± 0.02b	0.70 ± 0.04a	0.0062
Legs%	3.56 ± 0.16b	2.93 ± 0.11c	4.41 ± 0.27a	0.0004
Head, %	2.52 ± 0.09	2.49 ± 0.04	2.78 ± 0.16	0.1596
Abdominal Fat, %	1.02 ± 0.15	1.02 ± 0.06	1.25 ± 0.16	0.4427

Values (mean ± SE) within the same main effect with different letters in a row differ significantly (P<0.05).

4. DISCUSSION

4.1. Growth Performance

The present findings demonstrate that dietary supplementation with whole *Thymus vulgaris* powder at 0.5 and 1.0% positively influenced body weight development in Ross 308 broilers, particularly during the second and fourth weeks of the experimental period. The greater final BW in both supplemented groups indicates a favorable productive response to dietary thyme inclusion. However, the absence of significant differences during the first and third weeks suggests that the growth response was not uniform throughout the production cycle. This variation may indicate that the response to phytogenic supplementation depends on bird age, physiological development, and the duration of exposure to dietary bioactive compounds.

The improvement in BW observed in the present study is consistent with Ahangaran et al. (2019), who reported that supplementation with 0.5 and 1% *Thymus daenensis* increased BWG in broilers compared with the unsupplemented control. Similarly, Maulod et al. (2022) found that dietary supplementation with 0.5, 0.75, and 1% *T. vulgaris* powder significantly improved live BW and BWG in Japanese quails. Although the latter study involved a different poultry species, its findings provide additional evidence of the potential growth-promoting effects of whole thyme powder in poultry diets.

The results are also in agreement with Attia et al. (2018), who investigated dried *T. vulgaris* powder at inclusion levels of 10, 20, and 30 g/kg in broilers from 1 to 28 days of age. They reported beneficial effects on productive performance, particularly feed conversion, and suggested that thyme powder could represent a potential alternative to antibiotic growth promoters under hot-climate conditions. The agreement between their findings and the present results is particularly relevant because both studies evaluated dried thyme material during a relatively short broiler production period.

Nevertheless, the response to thyme supplementation is not necessarily consistent across all experimental conditions. Ocak et al. (2008), who evaluated 0.2% dried *T. vulgaris* leaves in Ross 308 broilers, reported that the effects of thyme on productive performance were not consistently significant across all measured traits. Such differences may be related to the dietary inclusion level, plant material characteristics, concentration of active phytochemicals, basal diet composition, bird age, environmental conditions, and experimental duration. In particular, differences between whole dried plant powder and other thyme preparations may influence the amount and availability of biologically active compounds supplied through the diet.

The beneficial growth response observed in the present study may be associated with the phytochemical composition of thyme, particularly its phenolic constituents, including thymol and carvacrol. These compounds have been associated with antimicrobial and antioxidant activities and may contribute to a more favorable intestinal environment and improved nutrient utilization. Attia et al. (2018) discussed the potential contribution of these active constituents to the beneficial effects of thyme supplementation, including the suppression of undesirable microbial populations and the support of antioxidant and physiological functions.

From a biological perspective, improved intestinal conditions and reduced microbial competition for nutrients could potentially contribute to more efficient nutrient utilization and subsequent growth. However, the present study did not include measurements of intestinal microbiota, nutrient digestibility, intestinal morphology, or antioxidant

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status. Therefore, these mechanisms remain plausible explanations rather than demonstrated effects of thyme supplementation in the current experiment.

An additional point is the difference between the numerical responses obtained at the two inclusion levels. Although the 1% group recorded the highest final BW, the difference between the 0.5 and 1% groups was relatively small. This suggests that increasing the dietary inclusion level from 0.5 to 1% did not produce a proportional improvement in final growth. Consequently, the growth response should be interpreted in conjunction with feed consumption and overall production efficiency rather than final BW alone.

4.2. Feed Intake and Feed Conversion Ratio

An important finding of the present study is that dietary thyme supplementation improved productive performance without a corresponding increase in feed intake. In particular, the 0.5% thyme group showed lower FI during the third and fourth weeks while maintaining greater final BW than the control group. This pattern suggests that the growth improvement was not simply attributable to increased feed consumption but may have been associated with more efficient utilization of the consumed diet.

This observation is consistent with Ahangaran et al. (2019), who reported that supplementation with 0.5 and 1% *T. daenensis* increased BWG while reducing feed consumption and FCR in broilers. Similarly, Attia et al. (2018) found that dried *T. vulgaris* powder improved feed conversion in broilers, supporting its potential application as a phytogenic alternative to conventional antibiotic growth promoters. These comparable findings suggest that thyme supplementation may influence feed utilization in addition to its potential effects on growth.

The significant improvement in FCR during the second and fourth weeks is particularly important from a production perspective. FCR reflects the amount of feed required to produce a unit of body weight gain and is therefore a major determinant of broiler production efficiency. The lower FCR values in the thyme-supplemented groups indicate that less feed was required per unit of gain during these periods compared with the control group.

The improvement in feed utilization may be associated with the biological activities of thyme constituents, particularly their potential antimicrobial and antioxidant properties. Thymol and carvacrol may contribute to the regulation of intestinal microbial populations and the maintenance of a favorable intestinal environment. Such effects could potentially improve nutrient availability and utilization, thereby contributing to better FCR. Attia et al. (2018) discussed these possible mechanisms in relation to the beneficial effects of thyme on broiler performance, including its potential influence on undesirable intestinal microorganisms, antioxidant status, nutrient digestibility, and immune function.

However, the lower FI observed in the thyme-supplemented groups should not automatically be interpreted as evidence of improved palatability or reduced maintenance requirements. Feed consumption can be influenced by several factors, including dietary composition, energy density, bird growth rate, environmental conditions, and physiological regulation of appetite. Because palatability, nutrient digestibility, and intestinal physiological responses were not evaluated in the present experiment, the precise mechanism underlying the observed reduction in FI cannot be established.

Furthermore, the absence of significant differences in FI during the first two weeks indicates that the effects of thyme on feed consumption may depend on the stage of growth. The significant differences during the later weeks could reflect age-related changes in feed consumption patterns or differences in the response to prolonged dietary supplementation. These observations highlight the importance of evaluating FI and FCR throughout the production period rather than relying exclusively on cumulative measurements.

Taken together, the improvements in FCR, particularly during the fourth week, combined with the greater final BW and the absence of increased FI, support the potential value of whole thyme powder as a dietary phytogenic additive for improving feed utilization in broiler production.

4.3. Overall Production Efficiency

The overall production indices provide an additional perspective on the productive response to dietary thyme supplementation because they integrate different aspects of growth and feed utilization. In the present study, both thyme inclusion levels produced numerically higher FE and EPEF values than the control treatment, indicating a favorable overall production response. However, the magnitude and pattern of improvement differed between the two supplementation levels. The 0.5% thyme group recorded the highest numerical FE and EPEF, whereas the 1% group exhibited the highest numerical RPI. This difference is important because it demonstrates that the treatment producing the highest final BW does not necessarily provide the most favorable overall production efficiency. Although the 1% group achieved a slightly greater final BW, the 0.5% group showed a more favorable numerical balance between weight gain and feed consumption.

The higher EPEF values in both thyme-supplemented groups are consistent with the improvements observed in final BW and feed utilization. Since EPEF integrates several production-related variables, its increase provides a

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broader indication of the productive response than BW or FCR considered independently. In this context, Golshahi et al. (2025) reported that dietary *T. vulgaris* extract improved efficiency-related production indices, including EPEF, in broilers. Their findings support the potential contribution of thyme-derived phytogenic additives to overall broiler production efficiency, although the use of an extract differs from the whole plant powder evaluated in the present study.

Similarly, Golshahi et al. (2025) reported improvements in overall production efficiency, including EPEF, in broilers supplemented with *T. vulgaris* extract. These findings provide further support for the potential productive benefits of thyme-derived dietary additives. Nevertheless, consider differences in the form of thyme supplementation, phytochemical concentration, and experimental conditions when comparing these findings with the present study.

The observed improvements are also consistent with the broader evidence discussed by Biswas et al. (2024) and Wang et al. (2024), who highlighted the potential of phytogenic feed additives to improve feed efficiency and productive performance in poultry. These additives' beneficial effects are generally linked to their bioactive compounds and their potential influence on gastrointestinal function, microbial balance, and nutrient utilization.

The RPI values further illustrate the difference between maximizing final body weight and achieving favorable overall production efficiency. The higher numerical RPI in the 1% thyme group reflects its greater final BW relative to the control, whereas the superior numerical FE and EPEF in the 0.5% group indicate a more favorable numerical relationship between growth and feed utilization. Thus, the results suggest that the response to thyme supplementation may depend on the production criterion used to evaluate treatment effectiveness.

From an applied production perspective, the 0.5% inclusion level appears particularly promising because it provided the highest numerical FE and EPEF while maintaining a final BW comparable to that obtained with 1% supplementation. This observation may have practical implications when considering the inclusion of whole thyme powder in broiler diets, particularly where feed utilization is an important economic consideration. Nevertheless, because the numerical differences between the two thyme inclusion levels were not necessarily statistically significant, the present findings do not establish 0.5% as an optimal inclusion level. Further investigations involving additional dietary inclusion levels, economic evaluation, and longer production periods would be necessary to identify the most appropriate supplementation strategy.

Overall, the production indices reinforce the favorable response observed in the growth performance results and suggest that whole *T. vulgaris* powder may contribute to improved production efficiency in broilers. These findings support continued investigation of phytogenic additives as potential nutritional tools for improving poultry production and reducing reliance on antibiotic growth promoters (Biswas et al., 2024; Wang et al., 2024).

4.4. Carcass Characteristics

The improvements in live BW and carcass weight observed in the present study indicate that the beneficial response to dietary thyme supplementation extended beyond live growth performance to carcass production. Both thyme inclusion levels increased carcass weight and dressing percentage compared with the control group. The increase in carcass weight is consistent with the greater live BW of supplemented birds, suggesting that the improvement in growth was accompanied by greater carcass mass at slaughter.

The higher dressing percentage in the thyme-supplemented groups is also an important observation because it indicates an increased proportion of live BW represented by the carcass. This response may reflect differences in overall tissue growth and carcass development. However, because individual muscle yields, tissue composition, and detailed carcass deposition patterns were not evaluated, the specific physiological basis for the improvement in dressing percentage cannot be determined from the present results.

The findings are supported, at least in part, by Maulod et al. (2022), who investigated dietary supplementation with 0.5, 0.75, and 1% *T. vulgaris* powder in Japanese quails and reported significant effects on live BW, BWG, and carcass-related characteristics. Although differences in species, genetic background, and production characteristics limit direct comparisons, their results provide additional evidence that whole thyme powder may influence carcass development in poultry.

Nevertheless, the effects of thyme supplementation on carcass characteristics are not consistently reported across studies. Ocak et al. (2008), who evaluated 0.2% dried *T. vulgaris* leaves in Ross 308 broilers, reported no significant effects on carcass weight or carcass yield. This discrepancy may be related to the lower inclusion level used in their experiment, differences in the phytochemical composition of the plant material, or variation in experimental duration and dietary conditions. These differences suggest that the effects of thyme on carcass development may depend on the supplementation level and the characteristics of the experimental feeding program. Regarding non-carcass components, dietary thyme supplementation did not significantly affect relative gizzard weight or head weight. The absence of significant changes in these parameters suggests that thyme inclusion at the tested levels did not produce detectable differences in the relative development of these components under the conditions of the present experiment.

Similarly, abdominal fat percentage was not significantly affected by dietary treatment, despite being numerically lower in the thyme-supplemented groups. This result agrees with Attia et al. (2018), who reported that dried thyme

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supplementation did not significantly affect abdominal fat percentage in broilers. The agreement between these studies suggests that the beneficial effects of thyme on growth and feed utilization do not necessarily translate into significant changes in abdominal fat deposition. Consequently, the numerical reduction observed in the current experiment should not be interpreted as evidence of a significant reduction in fat deposition.

In contrast, relative liver and heart weights were significantly lower in the thyme-supplemented groups. These findings require careful interpretation because organ weights were expressed relative to live BW, which was substantially greater in the supplemented birds. Therefore, the lower relative organ percentages may partly reflect differences in body size rather than actual reductions in absolute organ mass. An increase in the denominator (live BW) can result in a lower relative organ weight even when absolute organ weight remains unchanged or increases.

This distinction is important when interpreting organ weight data because relative organ percentages alone cannot establish whether an organ has undergone reduced development or functional impairment. In this regard, Hassan et al. (2024) reported that thyme supplementation did not significantly affect most relative organ weights in broilers despite improvements in productive performance. Their findings provide relevant context for interpreting the organ weight responses observed in the present study. Nevertheless, because absolute liver and heart weights and relevant physiological or histological indicators were not provided here, no definitive conclusions regarding organ development or function can be drawn.

Another notable finding was the significant reduction in relative leg percentage in the thyme-supplemented groups, particularly at the 1% inclusion level. This response differs from the findings of Maulod et al. (2022), who reported improvements in the proportions of several carcass parts, including the legs, in Japanese quails receiving dietary thyme powder. The discrepancy may be associated with differences in species, genetic background, slaughter age, dietary composition, or carcass-partitioning procedures. In addition, differences in overall body growth may influence the relative proportions of individual carcass components. Therefore, the reduction in relative leg percentage in the present study should be considered independently of the improvements in total carcass weight and dressing percentage.

Taken together, the carcass findings indicate that dietary thyme supplementation improved carcass weight and dressing percentage, while its effects on individual non-carcass components and carcass-partitioning characteristics were variable. These results suggest that the productive benefits of whole thyme powder are not necessarily expressed uniformly across all carcass components. Further studies incorporating absolute organ weights, detailed carcass-part measurements, meat quality characteristics, and tissue composition would help clarify the effects of thyme supplementation on carcass development and quality.

5. CONCLUSION

Dietary supplementation with *Thymus vulgaris* L. powder at 0.5 or 1.0% improved growth performance, feed efficiency, and carcass characteristics of Ross 308 broilers during the 28-day production period. The 0.5% level showed the most favorable numerical balance between growth and feed utilization, supporting its potential as a practical phytogenic alternative to antibiotic growth promoters.

Declarations

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