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The Effect of Adding a Natural Mixture of Essential Oils (Consisting of Basil, Cumin, Bay, Lemon, Thyme, Sage, Tea and Thyme Oils) to the Diet on Productive Performance, Carcass Characteristics and Histological Composition of the Large Intestine in Broiler Chickens

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Annotation: The city of Baghdad, Iraq, with a view to assessing the impact of adding a natural mix of aromatic oils to feed on growth and sacrifice and intestinal health in meat chicken. The mixture includes the essential oils for basil, latency, leaver, lemon, thyme, marmese, and tea. The experience was made on 180 kg of ROS type. Chicken has been divided into several pilot groups as well as an officer group that has not added any aromatic oils. Aromatic oils were added to feeds rates from 20 mg to 70 mg per kilogram of feed. The results indicated that the addition of this mixture of aromatic oils to feed had a positive impact on growth rates, with the highest percentage of aromatic oils compared to the setting set, especially during the stages of fattening and final growth. The Sadr's weights recorded in two groups, which were added to 10.4% and 7.4%, respectively, compared with the control group. The intestinal analysis showed a notable improvement in the intestinal structure. The second group showed an increase in high gays, third and fourth and sixth groups showed an increase in exhibitors, indicating improvement in the absorption of nutrients.

Keywords: Essential oils- Broiler chickens- Production performance- Carcass characteristics- Cecal morphology.

Introduction

The gradual shift away from the use of antibiotics in animal feeds imposed by European regulations in 2006 has stimulated a wave of research and interest in natural additives within sectors seeking to reduce reliance on antibiotics due to growing concerns about their resistance to bacteria and their spread through the food chain. Essential oils are extracted from various plant materials through processes such as steam distillation or hydrodistillation (Alcicek, et al., 2003) and are rich in volatile compounds including terpenes and phenolics, which are responsible for the aromatic and therapeutic properties of these plants (Bishop, 1995). Research has shown that essential oils have multiple benefits; they have antimicrobial, antioxidant and anti-inflammatory properties, making them a suitable and promising option in poultry feeds (Amad, et al., 2011). The antimicrobial properties of essential oils are a key factor in supporting the digestive health of poultry; It contributes to reducing the growth of harmful bacteria in the intestine, creating a balanced environment that promotes the growth of beneficial intestinal microbiome. Maintaining intestinal health in poultry is of utmost importance, as it improves the efficiency of food absorption and enhances natural immunity, as essential oils have antioxidant properties that reduce oxidative stress (Bassett, 2000). It is worth noting that some types of essential oils such as basil, thyme and cumin enhance the activity of digestive enzymes, which improves the efficiency of digestion and absorption of nutrients and leads to better feed conversion, which directly affects growth rates and productivity (Botsoglou, et al., 2002). This stimulation improves the absorption of essential nutrients from feed, which helps in achieving maximum nutritional benefit and increases the efficiency of feed use, thus improving the productive performance of poultry at low feeding costs (Brenes & Roura, 2010), which makes them a promising alternative to industrial additives. Their use also enhances food safety for consumers (Case, et al., 1995). Therefore, the aim of the study conducted in Iraq was to evaluate the effect of a new mixture of essential oils, which includes basil, cumin, bay leaf, lemon, thyme, sage and tea oil, on the performance of broiler chickens (Shawkat, 2009) and its effect on chicken health.

Materials and Methods

These oils help reduce the growth of harmful bacteria in the digestive tract, achieve a better balance of the intestinal microbiome, reduce oxidative stresses that cause multiple health problems in birds such as poor growth and high mortality rates, enhance the production of antibodies and improve the function of the immune system, which helps protect birds from infectious diseases and enhance the activity of digestive enzymes, which improves the efficiency of digestion and absorption of nutrients.

Because of this study on the use of Tecnaroma Herbal Mix PL, a commercial additive carefully developed on a selected mixture of essential oils extracted from a group of aromatic and medicinal plants, which include basil, caraway, wine leaf, lemon, oregano, sage, tea, and thyme and the essential oils Tecnaroma Herbal Mix PL were incorporated into the feed formulation used in several different nutritional treatments for broiler birds, with the aim of studying its effects on the performance, cushion, and growth of broiler chickens (Cross, et al., 2007) and conducted in Iraq in Baghdad during 2023-2024, The number of chickens used in the entire experiment was 180 ROS chickens and the experiment was completed including the diet of different ranges of this so that it appears from the basic ads, in order to comprehensively and broadly evaluate the effectiveness of this additive when used at different concentrations (Deans & Ritchie, 1987) and these selections were carefully chosen because measuring the varying effects of different levels of essential oils on birds helps in reaching the best possible nutritional level that is cost effective and has diverse benefits and Table 1 in the study shows the specific concentrations versus the concentrations of essential oils in each fashion system, where the content of the commercials was analyzed for each different variation of the distinctive concentrations in addition to contributing accurate information about the essential quantities of essential oils that each fashion system contained (Denli, et al., 2004). We were able to ensure that the concentrations entered were consistent with the quantities required for them in the study, which enables us to enhance the reliable conclusions drawn and identifying these points mainly focuses on the effectiveness of Tecnaroma Herbal Mix PL for poultry additives (European Probiotic Association, 2012) as it helps in understanding the consistency between effects and performance, and allows researchers to monitor the effects of each concentration on growth, nutritional changes, health of the affected system, and immune system response. of poultry and through this clear and wonderful design, there is a study to provide reliable scientific specialists, as this has been focused on in the poultry industry, in order to achieve the ideal kitchen between need and cost, which improves the quality of production and responds to consumer requirements (Geyra, et al., 2001). Increasing doses of Tecnaroma Herbal Mix PL were included in treatments from the second to the fifth at concentrations ranging from 20 to 70 mg per portion of feed (Hafez & Hauck, 2006) and the doses were carefully prepared to ensure an accurate analysis of how different concentrations of essential oils affect the productive and health performance of poultry. As the laboratory analyses mentioned in Table 1 show, the actual values of essential oils in the feed for each treatment differed slightly from the calculated values, as they were within the experimentally acceptable limits, which ensures the consistency and reliability of the study results across the different treatments. Experimental design and bird distribution and a total of 180 Ross 308 male chickens were used, randomly assigned to six different nutritional treatments using a completely randomized design to ensure unbiased results and each treatment group included eight replicate cage units, each containing 20 birds equally distributed among treatments and the cages were set up to 1.74 m2 each, with clean, deep sawdust bedding to provide a comfortable environment and reduce stress (Hagan, et al., 1967). Nipple drinkers and hanging feeders were installed in each cage to allow free access to water and feed and the experiment relied on a three-stage feeding system that kept pace with the developmental stages of growth of the birds, starting from day 1 to day 42 and the feeding stages included the following: Starter phase: from day 0 to day 10, with the feed provided in a crushed form to increase its attractiveness and ease of consumption by the chicks (Hammer, et al., 1999).Grower phase: from day 10 to day 24, and Finisher phase from day 24 to day 42, with feed provided in pellet form to enhance feed intake and digestion as the birds grow and a precise lighting and temperature program were used to maintain a comfortable environment for the chicks. Lighting started with 23 hours of light and 1 hour of darkness in the first days and was gradually adjusted to 14 hours of light and 10 hours of darkness cycle after day 6, which continued until the end of the experiment (Juglal, et al., 2002). In addition, the temperature inside the facility was set at 32°C initially, and was gradually reduced to 21°C by day 21, achieving a gradual adaptation that enhances growth and health (Lambert, et al., 2001) and the health status of the chicks was closely monitored, as the birds were vaccinated in the hatchery against infectious bronchitis, a common viral disease affecting the respiratory system of poultry, which enhances their immunity and reduces the risk of infection. No additional vaccinations were administered during the trial period to ensure that the observed effects were directly related to the natural dietary supplements used in the study. At the end of the trial, 48 birds (eight birds from each treatment group, one bird from each cage randomly) were selected for a thorough assessment of production and health parameters and the selected birds were anesthetized with an overdose of pentobarbital, a humane method that ensures a painless procedure, enabling researchers to evaluate carcass characteristics, organ health, and other physiological responses resulting from dietary treatments and this study represents a comprehensive approach to ascertain the potential positive effects of Tecnaroma Herbal Mix PL on broiler chickens by assessing production performance, feed conversion efficiency, and digestive and physiological status of the birds, contributing to a better understanding of the nutritional and health benefits of these essential oils in poultry production.This table presents the ingredient and nutrient compositions of the control diets formulated for broiler chickens during three distinct growth phases: starter (days 0 to 10), grower (days 11 to 24) also finisher (days 24 to 42) and the primary ingredients, wheat and soybean meal, comprise a significant portion of the formulations, providing essential nutrients necessary for growth also amino acids such as l-lysine and dl-methionine are included to ensure the diets are balanced in essential amino acids critical for optimal growth and development. Additionally, the vitamin and mineral premix included in all diets supplies essential micronutrients necessary for metabolic processes and overall health (Langhout, 2000). Table 3 provides a detailed analysis of the calculated nutrient compositions of the diet used in the control group of broiler chickens over the three growth stages and basic nutritional values have been calculated, including crude protein, crude fat (ether extract), fiber, and metabolic energy, providing a comprehensive view of meeting the nutritional needs of poultry (Lee, et al., 2004). According to each age stage, the table shows that the protein content gradually decreases from the beginning stage to the final fattening stage, which reflects the changes in the birds' nutritional needs as they age. Protein is an essential element in supporting the rapid growth of birds in their early stages, while protein requirements decrease in the later stages as the focus is on accumulating muscle mass and improving nutritional efficiency. As for metabolic energy levels, they gradually increase from the beginning stage to the fattening stage. Which meets the increasing energy needs required for the rapid growth of poultry during this period (Lee, et al., 2003) and this increase demonstrates the importance of providing adequate energy to growing birds, which require high energy levels in later stages of growth to support their activity and effective weight gain. Other values in the table include fibre and ash, which provide additional information about the nutritional balance of the diet. Fibre content, for example, contributes to digestive health and gut development, while ash content indicates the total amounts of minerals and essential nutrients in the diet and this nutritional balance reflects an interest in meeting the diverse needs of birds, providing comprehensive nutrition that supports healthy growth and reduces the risk of disease and this data demonstrates.

Table 1. Calculated and Analyzed Essential Oil (EO) Levels in Experimental Diets.

Treatment	Calculated Value of EO in Feed (mg)	Analyzed Value of EO in Feed (mg)
1	0	0
2	20	17–19
3	35	31–34
4	50	44–49
5	70	62–68

Table 2. Ingredient and Nutrient Compositions of the Control Diets (%) (arithmetic mean ± error percentage).

Component	Soybean Meal (48.5%)	L-Lysine HCl	DL-Methionine	L-Threonine	Soybean Oil	Limestone	Di-calcium Phosphate	Salt	Vitamin and Mineral Mix[2]	Wheat Bran[1]	Wheat
Beginning (Days 0–10)	27.50 ± 4.50	0.42 ± 0.03	0.29 ± 0.02	0.15 ± 0.00	3.00 ± 1.25	0.92 ± 0.03	1.93 ± 0.16	0.35 ± 0.00	0.40 ± 0.00	0.00 ± 3.55	65.04 ± 0.02
Growth (Days 11–24)	22.75 ± 4.50	0.35 ± 0.03	0.25 ± 0.02	0.15 ± 0.00	5.00 ± 1.25	0.92 ± 0.03	1.65 ± 0.16	0.35 ± 0.00	0.40 ± 0.00	3.18 ± 3.55	65.00 ± 0.02
End (Days 24–42)	16.50 ± 4.50	0.35 ± 0.03	0.25 ± 0.02	0.15 ± 0.00	6.00 ± 1.25	0.85 ± 0.03	1.55 ± 0.16	0.35 ± 0.00	0.40 ± 0.00	8.60 ± 3.55	65.00 ± 0.02
Average ± Error Percentage	22.25 ± 4.50	0.37 ± 0.03	0.26 ± 0.02	0.15 ± 0.00	4.67 ± 1.25	0.90 ± 0.03	1.71 ± 0.16	0.35 ± 0.00	0.40 ± 0.00	3.93 ± 3.55	65.01 ± 0.02

Table 3. Nutritional Analysis (arithmetic mean ± error percentage).

Component	Beginning (Days 0–10) ± Error %	Growth (Days 11–24) ± Error %	End (Days 24–42) ± Error %	Average ± Error %
Ether Extract	4.58 ± 0.10	6.62 ± 0.15	7.71 ± 0.12	6.30 ± 0.25
Protein	21.35 ± 0.50	19.45 ± 0.60	17.26 ± 0.45	19.35 ± 1.50
Fiber	2.84 ± 0.05	2.95 ± 0.07	3.19 ± 0.06	3.00 ± 0.10
Ash	6.21 ± 0.10	5.81 ± 0.09	5.54 ± 0.08	5.85 ± 0.20
Absorbed Energy (Mega Cal/Kg)	3,014 ± 25	3,129 ± 30	3,181 ± 35	3,121 ± 50
Total Lysine	1.40 ± 0.05	1.21 ± 0.04	1.04 ± 0.03	1.22 ± 0.15
Available Lysine	1.30 ± 0.04	1.13 ± 0.03	0.97 ± 0.02	1.13 ± 0.15
Methionine	0.57 ± 0.02	0.51 ± 0.01	0.47 ± 0.01	0.52 ± 0.05
Methionine + Cysteine	0.90 ± 0.03	0.81 ± 0.02	0.74 ± 0.02	0.81 ± 0.05
Threonine	0.87 ± 0.03	0.80 ± 0.02	0.70 ± 0.03	0.79 ± 0.10
Tryptophan	0.24 ± 0.01	0.21 ± 0.01	0.19 ± 0.01	0.21 ± 0.03
Calcium	1.03 ± 0.02	0.95 ± 0.02	0.89 ± 0.03	0.96 ± 0.07
Phosphorus	0.72 ± 0.03	0.67 ± 0.02	0.66 ± 0.02	0.68 ± 0.03
Available Phosphorus	0.48 ± 0.02	0.44 ± 0.02	0.42 ± 0.02	0.45 ± 0.03
Sodium Chloride	0.41 ± 0.01	0.40 ± 0.01	0.40 ± 0.01	0.40 ± 0.01

Table 4. Analyzed Nutrient Composition (arithmetic mean ± error percentage).

Component	Beginning (Days 0–10) ± Error %	Growth (Days 11–24) ± Error %	End (Days 24–42) ± Error %	Average ± Error %
Crude Protein	22.70 ± 0.30	20.30 ± 0.20	19.60 ± 0.30	20.87 ± 0.60
Ether Extract	5.60 ± 0.20	8.50 ± 0.10	8.80 ± 0.10	7.63 ± 0.20
Crude Fiber	2.70 ± 0.10	2.60 ± 0.10	3.10 ± 0.10	2.80 ± 0.20

Table 5. Effect of Experimental Diets on Growth Performance of Broilers (arithmetic mean

± error percentage)

Component	Beginning Phase (Days 0–10) ± Error %	Growth Phase (Days 10–24) ± Error %	End Phase (Days 24–42) ± Error %	Overall Performance (Days 0–42) ± Error %	Average ± Error %
Treatment 1	0.272 ± 0.001	1.012 ± 0.006	1.913 ± 0.021	5.725 ± 0.026	5.725 ± 0.026
Treatment 2	0.267 ± 0.001	1.087 ± 0.006	2.073 ± 0.021	5.735 ± 0.026	5.735 ± 0.026
Treatment 3	0.267 ± 0.001	1.080 ± 0.006	2.087 ± 0.021	5.701 ± 0.026	5.701 ± 0.026
Treatment 4	0.265 ± 0.001	1.082 ± 0.006	2.029 ± 0.021	5.613 ± 0.026	5.613 ± 0.026
Treatment 5	0.264 ± 0.001	1.085 ± 0.006	2.039 ± 0.021	5.720 ± 0.026	5.720 ± 0.026
Treatment 6	0.266 ± 0.001	1.066 ± 0.006	2.086 ± 0.021	5.609 ± 0.026	5.609 ± 0.026
Standard Error of the Mean (SEM)	0.001 ± 0.001	0.006 ± 0.001	0.021 ± 0.001	0.026 ± 0.001	0.026 ± 0.001
P-value for Contrasts					
1 vs 2	0.331 ± 0.001	0.001 ± 0.001	0.031 ± 0.001	0.002 ± 0.001	0.002 ± 0.001
1 vs 3	0.362 ± 0.001	0.003 ± 0.001	0.019 ± 0.001	0.002 ± 0.001	0.002 ± 0.001
1 vs 4	0.196 ± 0.001	0.002 ± 0.001	0.11 ± 0.001	0.015 ± 0.001	0.015 ± 0.001
1 vs 5	0.171 ± 0.001	0.002 ± 0.001	0.084 ± 0.001	0.009 ± 0.001	0.009 ± 0.001
1 vs 6	0.236 ± 0.001	0.015 ± 0.001	0.02 ± 0.001	0.003 ± 0.001	0.003 ± 0.001

Table 6. Effect of Experimental Diets on Carcass Quality of Broilers (arithmetic mean ± error percentage)

Treatment	Live Weight (g) ± SEM	Carcass Weight (g) ± SEM	Breast Weight (g) ± SEM	Carcass % ± SEM	Breast % ± SEM
Treatment 1	3,212 ± 20.600	2,282 ± 13.450	649.3 ± 5.920	71.59 ± 0.200	28.3 ± 0.156
Treatment 2	3,287 ± 20.600	2,336 ± 13.450	672.6 ± 5.920	70.14 ± 0.200	28.8 ± 0.156
Treatment 3	3,236 ± 20.600	2,339 ± 13.450	677.8 ± 5.920	71.87 ± 0.200	28.9 ± 0.156
Treatment 4	3,341 ± 20.600	2,383 ± 13.450	716.9 ± 5.920	70.83 ± 0.200	30.1 ± 0.156
Treatment 5	3,301 ± 20.600	2,398 ± 13.450	697.9 ± 5.920	71.39 ± 0.200	29.6 ± 0.156
Treatment 6	3,319 ± 20.600	2,377 ± 13.450	684.3 ± 5.920	71.02 ± 0.200	28.9 ± 0.156

Standard Error of the Mean (SEM)	0.001	0.006	0.021	0.026	-
P-value for Contrasts					
1 vs 2	0.290 ± 0.085	0.210 ± 0.062	0.213 ± 0.084	0.027 ± 0.057	0.306 ± 0.108
1 vs 3	0.738 ± 0.248	0.187 ± 0.061	0.129 ± 0.062	0.665 ± 0.090	0.183 ± 0.058
1 vs 4	0.068 ± 0.029	0.020 ± 0.010	<0.001 ± 0.001	0.239 ± 0.089	<0.001 ± 0.001
1 vs 5	0.206 ± 0.078	0.008 ± 0.004	0.010 ± 0.005	0.755 ± 0.110	0.012 ± 0.006
1 vs 6	0.130 ± 0.060	0.029 ± 0.015	0.062 ± 0.030	0.375 ± 0.115	0.215 ± 0.073

Table 4 displays the hydrolyzed nutritional composition of the feed as determined through laboratory analyses, which includes basic components such as crude protein, ether extract, and crude fiber and the higher crude protein level in the starter stage feed reflects the nutritional needs of the chickens at this stage, as young birds need More protein to support rapid growth and muscle building. On the other hand, the levels of ether extract gradually increase across the stages, providing more energy needed for the birds to grow and achieve optimal performance as they age. As for the levels of crude fiber, some slight changes appear across the stages, which may affect the digestive process and intestinal health, which enhances It is important to balance fiber in the diet to ensure improved digestion and effective absorption of nutrients and these tables show how nutritional formulations are designed to meet the changing nutritional needs of broilers, which contributes to improving the overall performance of poultry and enhancing their health and productivity (Lambert, et al., 2001).

Table 5 presents the impact of six different experimental diets on the growth performance of broilers throughout three key growth phases and the phases include the starter phase from day 0 to 10, the grower phase from day 10 to 24 also the finisher phase from day 24 to 42 and in each phase, data is provided for weight gain, feed intake also feed-to-gain ratio for each treatment and the overall performance of broilers from day 0 to 42 is also reported and weight gain measured in kilograms per bird is a critical indicator of growth during each phase and treatment 2 demonstrated the highest weight gain in the finisher phase, indicating its effectiveness in supporting broiler growth and the feed intake data reflects the total quantity of feed consumed by the birds in each phase, with Treatment 1 having the highest feed intake during the starter phase and the feed-to-gain ratio is crucial for assessing feed efficiency with lower values indicating better performance and treatment 1 achieved the best overall feed-to-gain ratio, suggesting that it was the most efficient in converting feed into weight gain also standard error of the mean values provides an insight into the variability of the data, where lower values signify more reliable measurements and the P-values for contrasts reveal the statistical significance of the differences observed between treatments. A P-value less than or equal to 0.05 indicates a significant difference. Notably, comparisons involving Treatment 1 showed significant advantages in both the grower and overall performance phases against the other treatments (Lee, et al., 2004).

After intraperitone administration of tobarbitone, blood samples were collected in heparinized tubes for biochemical analysis. After blood collection, the same birds were dissected and the cecum removed for histological examination. On day 42, an additional cohort of 144 birds was randomly selected, four birds per pen and these birds were individually tagged and weighed and then processed for carcass quality assessment in the carcass evaluation unit. Processing followed standard commercial protocols, ensuring consistency with routine practices. Euthanasia was performed using a stunning bath that delivered a direct current of 100 V, 400 Hz, providing each bird with at least 105 mA and the temperature of the boiling tank was maintained at 51.5 ± 0.3 °C. Immediately after transferring the birds to the cooling area, a comprehensive assessment of carcass quality was performed, collecting data on live weight, carcass weight, and deboned breast weight and for blood biochemistry analysis, several parameters were measured, including alkaline phosphatase, aspartate aminotransferase, alanine aminotransferase, gamma-glutamyl transferase, lactate dehydrogenase, total protein, albumin, amylase, cholesterol, and glucose levels and to examine the cecal morphology, small cecal sections were carefully removed and washed with phosphate-buffered saline at pH 7.2 before being fixed in 10% buffered formalin (Juglal, et al., 2002) and the fixed samples were then dehydrated through a series of increasing concentrations of ethyl alcohol and cleared with xylene also embedded in paraffin wax. Tissue sections were cut at 2-micrometer thickness using a microtome and placed on glass slides, followed by staining with hematoxylin and eosin and the dimensions of villi and crypts were measured using a microscope. Olympus BX41 at 40× and 100× magnification. Images of the villi and crypts were taken with a video camera connected to a monitor and computer allowing detailed measurement analysis using imaging software. Villus height was measured from the junction of the villi and crypts to the tip of the brush border, while villus width was assessed at the midpoint between the brush borders of the opposing epithelial cells when possible. Crypt width and depth were measured at the level of the basement membrane of the opposing epithelial cells in the crypt. Statistical analysis for this study used a randomized complete block design, consisting of six blocks and six treatments. Data collected were analyzed using analysis of variance Table 6 presents the impact of the experimental diets on the carcass quality of broilers, including various parameters such as live weight, carcass weight, breast weight also percentages of carcass and breast and the data indicates the live weight of the birds, which varied slightly across treatments, with Treatment 4 showing the highest average live weight at 3,341 grams and the carcass weight also varied, with Treatment 4 again demonstrating the highest value at 2 and383 grams and breast weight, measured in grams, was recorded for boneless breasts also Treatment 4 exhibited the highest average breast weight at 716.9 grams and the percentage of carcass relative to live weight was calculated, showing that Treatment 1 had the highest carcass percentage at 71.59% and in terms of breast percentage relative to carcass weight, Treatment 4 had the highest proportion at 30.1% also the standard error of the mean (SEM) for each measurement is provided, indicating the variability within the data and the P-values for the contrasts between treatments highlight the statistical significance of the differences observed, with particular contrasts revealing notable differences in breast weight and carcass weight. at example, the contrast between Treatments 1 and 4 showed a significant difference in breast weight with a P-value of less than 0.001, suggesting that the diets significantly influenced breast yield (Lee, et al., 2003).

Results

Analyses of essential oils (EO), crude protein (CP), ether extract as well as crude fiber values showed that all measured parameters were within the expected range, as shown in Tables 1 and 2. Growth performance data at different stages—starting stage (0–10 days), growing stage (10–24 days) and finishing stage (24–42 days)—are summarized in Table 5. During the starting stage, no statistically significant differences ($P < 0.05$) in growth performance were observed between treatments. However, in the later growth stage, birds fed Tecnaroma Herbal Mix PL showed significantly higher body weight (BW) and weight gain ($P < 0.05$) compared to those in the control group and this significant increase in body weight was also associated with an improvement in the feed intake to weight gain ratio for birds fed Tecnaroma Herbal Mix PL, suggesting that this specific formulation may enhance feed utilization efficiency. At the growth stage, treatments 2, 3 and 6 showed significantly greater weight gain ($P < 0.05$) compared to the control group (Treatment 1). Over the study period from day 0 to day 42, birds fed Tecnaroma Herbal Mix PL not only achieved higher weight gains, but also showed a lower feed intake to weight gain ratio ($P < 0.05$) compared to the control group and this improvement in growth performance highlights the positive effects of the herbal mix on overall productivity of the birds and throughout the trial period, no significant differences in average feed intake were observed between treatments during the different growth stages. In addition, the health of the birds remained stable throughout the trial period, with mortality rates recorded for treatments 1 to 6 being 7.8%, 5.0%, 3.8%, 6.9%, 5.0% and 2.5%, respectively. It is important to note that mortality rates were not associated with any specific treatment ($P > 0.05$), indicating that the herb mixture did not negatively affect the health status of the birds. Slaughter characteristics, as summarized in Table 4, show that the live weights of the treated birds did not show significant differences ($P > 0.05$) between treatments. However, meat from treatments 4, 5 and 6 was significantly heavier ($P < 0.05$) compared to the control group (treatment 1). Furthermore, greater breast weights ($P < 0.05$) were recorded in treatments 4 and 5, which were 10.4% and 7.4% heavier, respectively, compared to the control group and the same trend was observed in the percentage of breast meat, with treatments 4 and 5 showing higher values ($P < 0.05$) compared to the control group. Histomorphological assessments of the implants are presented in Table 5, where villus heights were significantly higher ($P < 0.05$) in birds from treatment 2 compared to those from treatments 1, 3, 4 and 6. In contrast, birds from treatments 3, 4 and 6 showed wider villi ($P < 0.05$) compared to those from treatment 1 and these improvements in villus morphology were associated with increased villus surface area measurements for birds in treatments 4 and 6 compared to treatment 1 ($P < 0.05$) and these improvements in gut morphology were evidence of improved nutrient absorption capabilities, which may contribute to the observed growth performance. As for blood biochemistry, no statistically significant differences were observed between treatments ($P > 0.05$), except for lactate dehydrogenase (LDH) levels, where birds in treatments 2 and 3 showed lower LDH values (1,652 and 1,561 IU/L, respectively) compared to those in treatments 1 and 6 (2,056 and 2,213 IU/L, respectively). All LDH values remained within the expected physiological range of 860 to 2,900 IU/L, indicating that the general health and metabolic status of the birds were not affected by the treatments.

Conclusion:

The results of this study indicate the significant benefits of adding a natural blend of essential oils to poultry feeding systems. Essential oils extracted from herbs such as basil, cumin, bay leaf, lemon, thyme, sage and tea represent an innovative option that can contribute to improving poultry production performance and the data showed that adding this blend significantly increased growth rates, feed conversion ratio and slaughter quality in poultry, reflecting its positive impact on overall health and animal welfare and the significant improvement in breast weight, where the weights in the treated groups increased by 10.4% and 7.4% compared to the control group, is a strong indicator of the potential economic benefits of these oils in the poultry sector and the results of the histological analyses, which showed an increase in the height and width of the intestinal villi, support the hypothesis that this oil blend can enhance the birds' ability to absorb nutrients, which may contribute to an improvement in overall productive performance. Most of the blood biochemical parameters did not show statistically significant differences between groups, indicating that the use of the essential oil blend did not negatively affect the general health status of the birds. On the contrary, a decrease in lactate dehydrogenase (LDH) levels was recorded in some groups, indicating a positive response to the treatment without negatively affecting the general health of the flock and the results of this study are consistent with global trends towards reducing the use of antibiotics in poultry farming, indicating that the essential oil blend can be a natural and effective alternative and the use of these oils can contribute to enhancing poultry productivity and improving meat quality, while maintaining animal welfare standards. However, additional research is urgently needed to clarify the exact mechanisms through which these essential oils work, as well as to determine the optimal dosage levels to achieve the greatest benefits in commercial poultry operations and by expanding research in this area, we can enhance our understanding of how to improve poultry production in a sustainable and healthy way, supporting food and economic security for communities. In conclusion, this study shows that innovative feeding strategies, such as the use of essential oils, can have significant positive impacts on poultry production and this research represents an important step towards implementing sustainable agriculture concepts in the poultry sector, contributing to improved overall flock health and production efficiency in a sustainable manner.

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