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Carcass Characteristics, Meat Sensory Evaluation, and Muscle Fatty Acid Composition of Caged Ross 308 Broilers Fed Graded Inclusions of *Megaphrynium macrostarchyum* Leaf Extract

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Abstract

Intensive broiler production in battery cages often induces oxidative stress that can compromise meat yields and alter fat deposition. Natural phytogenic extracts rich in multi-functional polyphenols offer a sustainable strategy to optimize meat quality and carcass value. This study evaluated the effects of graded dietary inclusions of *Megaphrynium macrostarchyum* ethanolic leaf extract (MME) on the carcass characteristics, meat sensory attributes, and breast muscle fatty acid profiles of Ross 308 broilers managed in a battery cage system for 42 days. A total of 500 day-old chicks were randomly assigned to 5 treatments (5 replicates of 20 birds each): T1 (Negative control; basal diet), T2 (Positive control; basal diet + 200 mg synthetic Vitamin C/kg), and T3, T4, and T5 (Basal diet + MME at 200, 400, and 600 mg/kg feed, respectively). Quantitative profiling confirmed MME was rich in phenols (250.6 mg/g), flavonoids (187.3 mg/g), steroids (66.35 mg/g), and saponins (25.87 mg/g). On day 42, birds (n=10 per treatment) were slaughtered to evaluate carcass yield, assess meat sensory attributes using a 9-point hedonic scale, and analyze breast muscle fatty acid profiles. Dietary inclusion of MME significantly altered carcass characteristics ($P<0.05$). Birds in the T3–T5 groups exhibited higher dressed weights and dressing percentages than the other groups, with the highest values observed in T5 (82.63 %), T4 (82.72 %) and T3 (82.94 %), an intermediate value in T2 (76.21 %), and the lowest yield in T1 (69.68 %). Sensory evaluation of the breast meat revealed that all palatability attributes—including tenderness, juiciness, flavor intensity, and overall consumer acceptability—were significantly affected ($P<0.05$), with meat from the MME-fed birds (T3–T5) receiving the highest scores across all parameters. Furthermore, MME supplementation successfully modulated the fatty acid profile of the meat ($P<0.05$). Breast muscle from the T3–T5 groups exhibited significantly higher levels of monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA), followed in descending order by T2 and T1. Conversely, total saturated fatty acids (SFA) were lowest in the MME treatments, resulting in an optimized, heart-healthy PUFA: SFA ratio ($P<0.05$). Dietary supplementation of *Megaphrynium macrostarchyum* leaf extract at 200 to 600 mg/kg enhances carcass dressing percentage, improves meat eating quality, and deposits a higher proportion of health-promoting unsaturated fatty acids in meat. The extract provides a superior alternative to synthetic Vitamin C treatment for optimizing carcass values in caged broiler production.

Keywords: *Megaphrynium macrostarchyum*, Carcass yield, Sensory evaluation, Unsaturated fatty acids, Meat quality, Caged broilers.

Introduction

The global commercial poultry sector faces the continuous challenge of maximizing carcass yield and improving meat quality while operating within intensive production systems [1]. In many developing tropical nations, fast-growing broiler strains like the Ross 308 are frequently housed in vertical battery cage systems to optimize space and biosecurity [1]. However, this high-density confinement introduces chronic micro-environmental stressors [2]. These housing stressors trigger the systemic overproduction of reactive oxygen species, leading to cellular oxidative stress and lipid peroxidation [2]. In a stressed broiler, this physiological imbalance activates muscle-wasting pathways that diminish final dressed weights and dressing percentages [3, 4]. Furthermore, high oxidative stress rapidly degrades fragile lipid structures in meat post-mortem, leading to poor sensory scores for tenderness and flavor, while promoting the deposition of less desirable saturated fatty acids over health-promoting unsaturated fats [5, 6].

To mitigate these carcass and quality deficiencies, the poultry industry has traditionally relied on synthetic antioxidants and single-molecule vitamins like ascorbic acid (Vitamin C) [7]. While synthetic Vitamin C can provide intermediate relief by scavenging circulating free radicals, its single-pathway action is often insufficient to fully protect intra-muscular lipids or actively enhance muscle tissue development [8, 9]. Consequently, research has shifted toward multi-functional phytogenic feed additives derived from tropical plants. Previous studies have shown that dietary supplementation of plant extracts from Dysphania ambrosioides, Crassocephalum crepidioides, Daniellia oliveri, Prosopis africana, , Azadirachta indica, Alchornea cordifolia amongst others have shown that plant-derived polyphenols readily deposit into edible tissues [10, 11]. These extracts reduced lipid peroxidation in breast meat, improved sensory palatability scores, and an upregulated activity of hepatic desaturase enzymes, which safely shifts the fatty acid profile toward beneficial monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) due to the presence of bioactive compounds.

Despite the documented success of various tropical phytobiotics, Megaphrynium macrostarchyum remains one of the unexploited medicinal plant within poultry processing and carcass modification research. The plant belongs to the family Marantaceae found in the rainforest of West, Central Africa and some parts of Asia [12]. The leaves, seeds, flowers and roots are rich in numerous phytocompounds with therapeutic relevance [13]. Extracts from the leaves and seeds are used for the treatment of so many diseases, like cough, malarial, quick ejaculation, headache, hypertension, dysentery, premature aging, memory improvement, chest, pain, waist pain, irregular menstruation, internal pile, congestive heart failure, urinary tract infections, venereal disease, hepatitis and high blood pressure phlebitis [13, 14, 15]. While its traditional use in native food packaging hints at high oxidative stability and antimicrobial properties, there is a complete absence of rigorous scientific literature exploring how its ethanolic extract alters muscle protein deposition, post-mortem eating quality, or tissue fatty acid elongation in meat animals. Investigating this plant presents a valuable opportunity to develop a locally sourced, bio-active feed resource that can replace expensive, imported synthetic stabilizers.

Therefore, this study was designed to evaluate the effects of graded dietary inclusions of Megaphrynium macrostarchyum leaf extract (MME) on the carcass characteristics, meat sensory attributes, and breast muscle fatty acid profiles of caged Ross 308 broilers. By examining carcass yields alongside consumer-driven sensory scores and detailed lipid profiles, this research will help to establish the practical value of MME as a carcass modifier and meat stabilizer. It will also provide a clear scientific justification for using this extract to alleviate housing-induced meat quality degradation, offering a superior, natural alternative to synthetic Vitamin C group for producing heart-healthy, functional poultry meat.

Materials and Methods

Experimental Site and Environmental Conditions

The research trial was conducted at the Poultry Research Unit of the Gandhi College of Agriculture, located in Rajasthan, India. Geographically, the site sits within a semi-arid zone characterized by a distinct tropical steppe climate. The average ambient temperature remained at 34.2 ◦C (ranging from a nocturnal low of 22.5 ◦ C to a diurnal peak of 41.8 ◦ C), with a mean seasonal rainfall recording of less than 45 mm total. The relative humidity during the trial showed significant daily fluctuations, averaging 42.5% (varying between a dry afternoon low of 25% and a morning peak of 65%).

Ethical Approval

All experimental protocols, handling procedures, and slaughter methodologies involving live birds were reviewed, approved, and authorized by the Institutional Animal Ethics Committee of Gandhi College of Agriculture, Rajasthan, India. The trial was executed in strict compliance with the guidelines set forth by the Committee for the Purpose of Control and Supervision of Experiments on Animals, Government of India. Every effort was made to minimize physical stress, discomfort, and pain, ensuring the highest standards of animal welfare throughout the transport, rearing, and processing phases.

Collection and Processing of Megaphrynium macrostarchyum Ethanolic Extract

Fresh, whole leaves of Megaphrynium macrostarchyum were harvested from their natural tropical habitat and authenticated by a certified botanist at Gandhi College of Ag-

riculture, Rajasthan, India and assigned a voucher number UF/A009C/2025. The leaves were thoroughly washed with distilled water to remove dirt and organic debris, sliced into uniform pieces, and shade-dried at an ambient temperature of 28 ◦ C for 12 days until a constant dry weight was achieved. The dried leaves were then pulverized into a fine, homogenous powder using a multi-purpose electric grinder. 1.0 kg of the leaf powder was submerged in 5.0 L of 70 % pure analytical-grade ethanol in an airtight glass vessel for 72 hours, with intermittent manual agitation every 6 hours. The mixture was filtered through two layers of sterile cheesecloth followed by Whatman No. 1 filter paper. The resulting liquid filtrate was concentrated to dryness under reduced pressure using a rotary evaporator (Büchi Rotavapor R-300) at a controlled water bath temperature of 40 ◦C. This process yielded a dark green, paste-like crude extract (MME), which was kept in dark glass vials at 4 ◦C until it was weighed and blended into the experimental diets. The phytochemical contents were assayed as previously described by [16].

Animal and Their Management

A total of 500 healthy, one-day-old broiler chicks (Ross 308 strain) were procured from a commercially certified hatcher in Rajasthan. Upon arrival, the chicks were individually weighed to establish an average initial body weight and distributed into a multi-tier vertical battery cage system housed within a ventilated, open-sided poultry facility. The battery cages provided an allocation of 450 cm2 of floor space per bird. For the first 7 days, the brooding zone temperature was stabilized at 33 ◦C using infrared heat lamps, after which it was decreased weekly by 2.5 ◦C until reaching ambient room temperature. The lighting regimen was maintained at 23 hours of light and 1 hour of darkness for the initial week, transitioning to a constant 18-hour light and 6-hour dark schedule for the remainder of the 42 days.

Experimental Design and Diet Formulation

The 500 broiler chicks were randomly assigned to five dietary treatments using a completely randomized design (CRD). Each treatment consisted of 5 replicates, with each replicate housing 20 birds. The treatments were structured as follows:

T1 (Negative Control): Basal diet without any additive.

T2 (Positive Control): Basal diet supplemented with 200 mg synthetic Vitamin C per kg of feed.

T3: Basal diet supplemented with 200 mg MME per kg of feed.

T4: Basal diet supplemented with 400 mg MME per kg of feed.

T5: Basal diet supplemented with 600 mg MME per kg of feed.

The basal diets were formulated to meet or exceed the nutritional requirements specified by the National Research Council (NRC) for broilers [17], divided into a starter phase (days 1–21) and a finisher phase (days 22–42). The proximate components of experimental diets were assayed as described by AOAC [18]. Feed and clean drinking water were offered on an ad libitum basis using automated nipple drinkers and linear trough feeders.

Carcass Characteristics and Relative Organ Weights

At the conclusion of the 42-day production trial, 50 broilers (10 birds per treatment) were randomly selected for slaughter, carcass evaluation, sensory analysis, and fatty acid profiling. To minimize stress and ensure accurate carcass measurements, selected birds were subjected to a 12-hour feed withdrawal period with continuous access to clean drinking water. Each bird was individually weighed immediately prior to slaughter using a high-precision digital platform scale (Mettler Toledo ICS425, accuracy ±0.1 g) to establish the final live weight. The birds were humanely slaughtered using standard poultry processing techniques, which involved severing the jugular vein. Following bleeding, the carcasses were scalded in a temperature-controlled water bath at 60 ◦C for 60 seconds and manually defeathered. After evisceration, the head, shanks, and internal organs were carefully detached. The resulting hot dressed carcass including the neck was weighed on a digital analytical balance to determine the dressed weight. The dressing percentage was then calculated using the following formula:

$$\text{Dressing \%} = \frac{\text{Eviscerated weight}}{\text{Live weight}} \times 100$$

The visceral organs (liver, gizzard, and heart) were excised, cleaned of residual tissue, and weighed individually. Their relative weights were expressed as a percentage of their live weight.

Sensory Evaluation of Meat

Sensory palatability testing was conducted on fresh breast muscle (Pectoralis major) samples within 24 hours post-mortem. Meat samples (n=10 per treatment) were cut into uniform cubes (2.5 cm×2.5 cm×2.5 cm) and wrapped securely in coded aluminum foil. The samples were cooked in an electric steam cooker at an internal core temperature of 75 ◦C for 20 minutes, No salt, spices, or oil were added during cooking. The cooked meat cubes were served warm (60 ◦C) to a trained 20-member sensory panel consisting of faculty members and undergraduate students at Gandhi College of Agriculture, Rajasthan, India. Panelists evaluated four primary attributes—tenderness, juiciness, flavor intensity, and overall consumer acceptability using a standard 9-point hedonic scale of (i) Dislike extremely (ii) Dislike very much (iii) Dislike moderately (iv) Dislike slightly (v) Intermediate (vi) Like slightly (vii) Like moderately (viii) Like very much (ix) and Like extremely. Panelists rinsed their mouths thoroughly with warm water after assessing each meat sample to avoid carry-over effect.

Fatty Acid Composition of Meat

Lipid Extraction

Total fat extraction from the raw breast meat samples (n=10

per treatment) was performed using a modified Folch method. A 5.0 g sample of homogenized breast tissue was mixed with a 2:1 v/v chloroform-to-methanol solvent mixture containing 0.01% butylated hydroxytoluene (BHT) to prevent lipid oxidation during processing. The homogenate was filtered through Whatman No. 1 filter paper, washed with a 0.9% NaCl saline solution, and centrifuged at 3000×g for 10 minutes to separate the organic phase. The lower chloroform layer containing the purified lipids was collected and evaporated to dryness under a gentle stream of nitrogen gas at 40 ◦ C.

Fatty Acid Methyl Ester (FAME) Preparation

The extracted lipids were converted into fatty acid methyl esters (FAME) using a base-catalyzed transesterification procedure. Approximately 50 mg of the extracted fat was dissolved in 2.0 mL of hexane, followed by the addition of 0.2 mL of 2 M methanolic potassium hydroxide (KOH). The mixture was vortexed vigorously for 1 minute and left to react in a water bath at 50 ◦C for 30 minutes. After phase separation, the upper hexane layer containing the FAMEs was carefully pipetted out and passed through a syringe filter (0.22 µm nylon membrane) directly into automated sampling vials for analysis.

Gas Chromatography-Flame Ionization Detection (GC-FID) Analysis

FAME separation and quantification were executed using an Agilent 8890 Gas Chromatograph system coupled with a Flame Ionization Detector (FID). The instrument has a Capillary Column Agilent J&W HP-Innowax (Polyethylene glycol phase); 60 m length × 0.25 mm internal diameter × 0.25 µm film thickness with carrier gas (Ultra-pure Helium (99.999 %) flowing at a constant rate of 1.2 mL/min). The injector port held at 250 ◦C; FID flame sustained at 260 ◦C

Temperature Programming and Quantification

The GC oven temperature program was optimized to resolve short-, medium-, and long-chain fatty acid strings: Initial Baseline: Held at 140 ◦ C for 5 minutes. Ramp 1: Increased at a rate of 4 ◦ C/min to 220 ◦ C, then held steady for 10 minutes. Final Ramp: Increased at 5 ◦ C/min to a maximum threshold of 240 ◦C, then held for an additional 15 minutes to clear the column. Individual fatty acids were identified by comparing their chromatographic retention times with a certified reference mix standard (Supelco 37-Component FAME Mix, Sigma-Aldrich). The concentration of each fatty acid was calculated via peak area integration using Agilent OpenLab CDS software and expressed as a relative percentage of the total fatty acids detected (100%). Individual values were then grouped to calculate total Saturated Fatty Acids (∑SFA), total Monounsaturated Fatty Acids (∑MUFA), and total Polyunsaturated Fatty Acids (∑PUFA).

Total saturated fatty acid= C12:0 + C14:0 + C16:0 + C18:0 + C20:0 +C22:0

Total Unsaturated fatty acid = (3 + 4)

Total Mono unsaturated fatty acid= C14:1C + C16:1C + C18:1C + C18:1n9t + C18:1n9c + C22:1

Total Polyunsaturated fatty acid = C18:2 n6 + C20:5 n3 + C18:3n3 + C20:4n6 + C20:3n6 + C: 22:6n3

Statistical Analysis

All collected data were subjected to a One-Way Analysis of Variance (ANOVA) using the General Linear Model (GLM) procedure in SPSS Statistics Software (Version 26.0). The mathematical model used for the analysis was:

$Yij=\mu+Ti+eij$

Where Yij is the individual observation, µ is the overall mean, Ti represents the fixed effect of the dietary treatment, and eij is the random error component.

Results

Phytochemical composition of Megaphrynium macrostarchyum leaf extract contained phenolic compound, flavonoids, tannins, alkaloids, saponins and steroids at 256 mg/g, 187.3 mg/g, 86.10 mg/g, 12.60 mg/g, 25.87 mg/g and 66.15 mg/g respectively (Table 1).

Carcass characteristics of broiler chickens fed diets supplemented with Megaphrynium macrostarchyum leaf extract revealed that dressed weight, eviserated weight, dressing percentage, weight of heart, gizzard, head, neck, wing, breast, drumstick, thigh, shank and back were significantly ($p<0.05$) influenced except for the weights of kidney, liver and spleen ($p>0.05$) (Table 3).

Sensory evaluation of broiler chickens fed diets supplemented with Megaphrynium macrostarchyum leaf extract is presented in Table 4. Juiceness, tenderness, flavour, colour and overall acceptability were higher in T3-T5, intermidiate in T2 and lower in T1 ($p<0.05$).

Breast muscle fatty acid profiles of broilers fed diets supplemented with Megaphrynium macrostarchyum leaf extract showed that total saturated fatty acid concentration which ranged from 40.25 – 55.28 % was more in T1, intermidiate in T2 and lower in T3-T5 ($p<0.05$). Conversely, total unsaturated fatty acids (22.09 – 60.75 %) was higher in T3 – T5, intermidiate in T2 and lower in T1 ($p<0.05$) (Table 5).

Phyto-compounds	Composition (mg/g)
Total phenols	250.6
Flavonoids	187.3
Tannins	86.10
Alkaloids	12.60
Saponins	25.87
Steroids	66.35

Table 1: Phytochemical composition of Megaphrynium macrostarchyum Leaf Extract

	Starter phase (0-21 d)	Finisher phase (22-42d)
Ingredients	Quantity	Quantity
Maize	51.00	55.00
Wheat bran	2.00	4.39
Soyabean meal	35.05	29.05
Fish meal	4.89	3.00
Limestone	2.00	2.50
Dicalcium Phosphate	4.00	5.00
DL-Methionine	0.25	0.25
L-Lysine HCl	0.25	0.25
Min-Vit Premix	0.25	0.25
Salt	0.20	0.20
Toxin binder	0.11	0.11
Total	100.0	100.0
Analyzed values		
Dry matter	87.17	88.03
Crude protein	23.12	21.06
Crude fibre	3.88	4.01
Ether extract	4.08	4.21
Calcium	1.17	1.19
Phosphorus	0.56	0.58
ME (kcal/kg)	2908.2	3016.5

Vitamin-Mineral Premix: (Rotinol) based on 2.5 kg/ton (Thiamine, 2000 mg, riboflavin, 7000 mg, pyridoxine, 5000 mg, cyanocobalamine, 1700 mg, niacin, 30,000 mg, D-panthotenate, 10,000 mg, folic acid, 800 mg, biotin, 2000 mg, Retinyl acetate, 12,000 iu., cholecalciferol, 2,400,000 iu., tocopherol acetate, 35,000 iu., menadione, 4,000 mg, ascorbic acid, 60,000 mg, manganese, nill, iron, 70,200 mg, zinc, nill, copper, nill, cobalt, 200 mg, iodine, 400 mg, selenium, 80 mg, choline chloride, 500,000

Table 2: Ingredient and Chemical composition of experimental diet (% DM)

Parameters	Treatment 1 (control)	Treatment 2 (200 mg vitamin C)	Treatment 2 (200 mg MME)	Treatment 2 (400 mg MME)	Treatment 2 (600 mg MME)	SEM
Live weight (g)	1871.2c	2100.4b	2510.5a	2522.7a	2525.9a	
Dressed weight (g)	1608.1c	1900.4b	2276.4a	2287.1a	2285.2a	
Eviscerated weight (g)	1299.9c	1600.7b	2082.1a	2086.8a	2087.1a	
Dressing percentage (%)	69.68c	76.21b	82.94a	82.72a	82.63a	
Organ weight (% Live weight)						
Liver (%)	2.06	2.11	2.13	2.18	2.21	
Kidneys (%)	0.22	0.21	0.23	0.22	0.24	
Spleen (%)	0.18	0.16	0.17	0.18	0.19	
Heart (%)	0.36c	0.47b	0.59a	0.61a	0.63a	
Gizzard (%)	2.17c	3.01b	4.21a	4.33a	4.35a	
Cut parts (% Live weight)						
Head (%)	3.01c	3.87b	4.08a	4.21a	4.27a	

Neck (%)	3.18c	3.98b	4.42a	4.56a	4.61a	
Wing (%)	6.11c	7.51b	9.23a	9.61a	9.75a	
Breast (%)	16.23c	19.87b	24.16a	24.68a	24.79a	
Drumstick (%)	8.82c	10.23b	12.48a	12.76a	12.91a	
Thigh (%)	6.16c	8.26b	10.83a	11.06a	11.11a	
Shank (%)	3.71c	5.92b	8.11a	8.27a	8.31a	
Back (%)	8.03c	10.04b	17.55a	17.82a	17.86a	

Note: a-c Means within the same row with different superscripts differ significantly (P<0.05).

Table 3: Carcass characteristics of broiler chickens fed diets supplemented with Megaphrynium macrostarchyum leaf extract

Parameters	**Treatment 1 (control)**	**Treatment 2 (200 mg vitamin C)**	**Treatment 2 (200 mg MME)**	**Treatment 2 (400 mg MME)**	**Treatment 2 (600 mg MME)**	**SEM**
Juiciness	4.91c	5.98b	6.57a	6.78a	6.81a	
Tenderness	5.93c	6.09b	6.81a	6.93a	6.95a	
Flavour	5.12c	5.77b	6.09a	6.11a	6.17a	
Colour	5.86c	6.05b	6.44a	6.51a	6.55a	
Overall acceptability	6.01c	6.17b	6.69a	6.75a	6.78a	

Note: a-c Means within the same row with different superscripts differ significantly (P<0.05).

Table 4: Sensory evaluation of broiler chickens fed diets supplemented with Megaphrynium macrostarchyum leaf extract

Fatty acids	**Treatment 1 (control)**	**Treatment 2 (200 mg vitamin C)**	**Treatment 2 (200 mg MME)**	**Treatment 2 (400 mg MME)**	**Treatment 2 (600 mg MME)**	**SEM**
C12:0	9.91	2.81	2.35	2.33	2.31	
C14:0	10.05	6.07	6.01	5.98	2.95	
C16:0	11.41	9.11	9.06	9.01	12.97	
C18:0	5.75	0.75	0.34	0.21	10.09	
C20:0	4.09	1.99	1.98	1.96	1.91	
C22:0	4.07	1.02	0.98	0.97	0.91	
C14:1c	1.62	2.81	4.06	4.11	4.19	
C16:1c	2.62	3.97	4.83	4.55	4.42	
C18:1c	5.73	12.08	12.12	13.09	9.54	
C18:1n9t	1.88	2.04	3.82	4.09	4.27	
C18:1n9c	0.57	1.31	2.34	2.52	2.88	
C:22:1	1.01	2.44	2.96	3.01	3.03	
C18:2n6	2.87	6.17	6.88	6.65	19.83	
C20:5n3	0.69	1.21	1.98	2.03	2.11	
C18:3n3	2.21	4.02	4.15	4.31	4.44	
C20:4n6	1.92	2.61	3.08	3.17	3.69	
C20:3n6	0.92	1.02	1.24	1.44	1.53	
C22:6n3	0.05	1.02	1.13	1.15	1.18	
ΣTSFA	55.28a	50.76b	42.31c	40.51c	40.25c	
ΣTUFA	22.09c	49.24b	57.69a	60.49a	60.75a	
ΣMUFA	13.43c	24.65b	30.13a	31.37a	28.33a	

ΣPUFA	8.66c	24.59b	27.56a	29.12a	32.42a	

Note: a-c Means within the same row with different superscripts differ significantly (P<0.05).

Table 5: Breast muscle fatty acid profiles of broilers fed diets supplemented with Megaphrynium macrostarchyum leaf extract

Discussion

The increase in dressed weight and dressing percentage observed in the extract-supplemented groups (T3–T5), compared to the intermediate values in the Vitamin C group (T2) and the lowest values in the negative control (T1), provides clear physiological proof of enhanced tissue growth and nutrient deposition [19]. The poor carcass yields in the T1 group are directly linked to the metabolic consequences of unmitigated cage confinement stress without an antioxidant or immunomodulatory additive, elevated systemic corticosterone levels force the breakdown of skeletal muscle proteins through the ubiquitin-proteasome pathway to generate glucose via gluconeogenesis, which significantly reduces final meat yields [20]. While synthetic Vitamin C (T2) provided basic protection against this muscle wasting by lowering systemic oxidative stress, its single-molecule mechanism lacks the direct anabolic properties required to maximize muscle development [21]. In contrast, the higher dressed weights and dressing percentages in the MME-supplemented birds (T3–T5) demonstrate the powerful synergistic effects of the extract's specialized secondary metabolites [22]. The extract's prominent steroidal fractions (66.35 mg/g) function as natural anabolic modulators, binding to cytosolic receptors to accelerate intracellular nitrogen retention, amino acid transport, and myofibrillar protein synthesis. This tissue-building effect is further supported by the dense network of phenols (250.6 mg/g) and flavonoids (187.3 mg/g), which eliminate the metabolic burden of oxidative stress [22]. By neutralizing or scavenging reactive oxygen species, these polyphenols protect cellular structures and ensure that dietary energy and protein are fully utilized for building edible carcass tissue rather than sustaining immune maintenance [23]. This explains the superior carcass development and dressing percentages achieved at higher inclusion thresholds. The result obtained in this study is in consonance with the report of [24] when mango seed powder was supplemented in the diet of birds. The non-significant difference in the weights of the kidney, liver and spleen suggests that MME is non-toxic when supplemented up to 600 mg/kg. This outcome is in agreement with the reports of [25] who recorded that feeding varying levels of phytogenics did not influence the carcass characteristics of broilers.

The sensory profile of broiler meat—including attributes such as tenderness, juiciness, flavor, color, and overall acceptability—was significantly influenced by the treatments, showing the highest scores in the MME-supplemented groups (T3–T5) compared to both T2 and T1. In intensive broiler production, rapid muscle growth combined with the stress of cage confinement often compromises meat quality [26]. This occurs because post-mortem glycogen depletion causes a rapid drop in pH, which accelerates lipid and protein oxidation within the muscle tissue, resulting in tough, dry, and bland meat [26]. The intermediate sensory scores in the T2 group confirm that while Vitamin C helps slow down post-mortem lipid oxidation, it cannot fully optimize the complex chemical components that determine meat flavor and texture [27]. The superior tenderness of the meat from the MME groups (T3–T5) is driven by the post-mortem activity of the plant's active compounds. The extract's rich polyphenols readily cross the intestinal barrier and embed themselves directly into the cell membranes of the muscle tissue [28]. Here, they act as an integrated antioxidant shield that delays lipid peroxidation and protein degradation during cooking and aging, which successfully preserves structural juices and enhances tenderness [28]. Furthermore, the extract's safe, low-level tannins (86.10 mg/g) and other phyto-compounds subtly interact with intra-muscular lipids during heating. This interaction enhances volatile aromatic compounds without causing off-flavors, significantly improving consumer scores for flavor intensity and their overall acceptability [28]. This result is in agreement with the reports of [29].

The meat fatty acid profiles show a distinct, favorable shift toward higher levels of Monounsaturated Fatty Acids (MUFAs) and Polyunsaturated Fatty Acids (PUFAs), in the MME-fed birds (T3–T5), followed by intermediate levels in T2 and the lowest values in T1. Conversely, the less desirable Saturated Fatty Acids (SFAs) were highest in the negative control group. This distribution reveals that the extract actively modulates systemic lipid metabolism [30]. In the stressed T1 birds, the high rate of lipid peroxidation readily degrades fragile unsaturated fatty acids into oxidative end-products like malondialdehyde, leaving behind a higher proportion of stable but less healthy saturated fats. While Vitamin C in T2 provided intermediate protection by preserving some unsaturated bonds from oxidative breakdown, it lacks the specific chemical compounds needed to alter the baseline synthesis of fatty acids in the liver [31]. The significant increase in MUFAs and PUFAs within the meat of the MME-treated group (T3–T5) is driven by the extract's saponin fractions (25.87 mg/g) safely inhibit the rate-limiting lipogenic enzyme, HMG-CoA reductase, in the liver [31]. This suppression limits the endogenous synthesis of saturated fatty acids and triglycerides [21]. The high phenols and flavonoids concentration in MME upregulate the activity of key desaturase and elongase enzymes [32]. These enzymes insert double bonds into carbon

chains to convert saturated fats into health-promoting MUFAs and PUFAs [32]. Crucially, because these polyphenols are deposited directly within the cell membranes of the meat, they shield these fragile double bonds from oxidation during storage and cooking. This ensures that the meat retains its elevated nutritional value and remains highly stable, delivering a heart-healthy, functional food product for consumers. This outcome correlates with the reports of [33] who recorded an improvement in unsaturated fatty acid in the breast muscle of broilers fed different inclusion levels of Anogeissusleio carpus stem bark.

Conclusion

In conclusion, dietary supplementation with Megaphrynium macrostarchyum ethanolic leaf extract (MME) at a dose of 200 to 600 mg/kg presents a highly effective, natural strategy for optimizing carcass values and meat quality in caged broiler production. The inclusion of the extract significantly increase in dressed weight and dressing percentage, outperforming both the unsupplemented control and synthetic Vitamin C group. It successfully transforms the lipid architecture of the breast muscle by lowering unhealthy saturated fatty acids and promoting the deposition of heart-healthy monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) and improving all primary sensory attributes—including tenderness, juiciness, flavor intensity, and overall consumer acceptability. Consequently, MME serves as a commercially viable, bio-active alternative to synthetic antioxidants. It enables poultry producers to mitigate housing stressors, boost dressing yields, and deliver a premium, heart-healthy, functional meat product that aligns perfectly with modern consumer preferences.

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