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Research Article

Blood Chemistry Profile, Intestinal Microbial Population and Gut Morphometric of Broiler Chickens Administered Turkey Berry (*Solanum torvum*) Aqueous Extract

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About Article

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ABSTRACT

The rising concerns regarding the safety, environmental impact, and potential resistance development associated with synthetic additives have motivated interest in natural alternatives such as *Solanum torvum* (Turkey berry). This study evaluated the effects of aqueous *Solanum torvum* extract as an additive on blood parameters, intestinal microbial population, and gut morphometrics of broiler chickens. Two hundred and forty (240) day-old broiler chicks were randomly distributed into four treatments in a Completely Randomized Design. The treatments consisted of 0, 10, 15, and 20 ml/L of aqueous extract administered via drinking water. Haematological parameters, serum biochemistry, intestinal microbial population, and gut morphometrics were evaluated using standard procedures and analyzed using one-way ANOVA. Results showed no significant differences ($p > 0.05$) in haematological and serum biochemical parameters across treatments, with values falling within established physiological ranges for broiler chickens. Significant differences ($p < 0.05$) were observed in intestinal microbial counts and certain gut morphometric parameters. Total bacterial count and total coliform count increased with higher inclusion levels, particularly in T4. Jejunal villus length, crypt depth, and epithelial thickness were significantly affected. The findings indicate that *Solanum torvum* aqueous extract modulates intestinal microbial population and influences gut morphology without adverse effects on physiological health.

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1. INTRODUCTION

The demand for poultry products, especially chicken meat, has significantly increased due to its high nutritional value and low cost. To meet this demand, intensive poultry farming practices have been employed, often involving feed additives and supplements to enhance growth rates and health outcomes. However, the widespread use of synthetic additives in broiler feed raises concerns about food safety, environmental impact, and the potential for resistance development. In response, natural alternatives, such as herbal additives, are being explored (Adomako *et al.*, 2019).

The poultry industry is on a continuous search for natural substitute to artificial additives in feed to enhance the health output, and welfare of broiler chickens. One of the plants that has demonstrated the potential to be a natural supplement is *Solanum torvum*, which has some medicinal effects and the potential to be an antioxidant, antimicrobial and immunomodulatory. *Solanum torvum* is a bushy perennial plant that presents a spiny, prickly shrub which eventually grows up to a height of 5m. The fruits like green peas grow in clusters of tiny green spheres (Ayedun *et al.*, 2024). They are thin-fleshed and contain numerous flat round, brown seeds, dried seed, fruit, root, bark or vegetable substance primarily used for flavouring, colouring or preserving food or commercially used as medicine. It's rich in protein, ash, crude fibre and carbohydrate (Ayedun *et al.*, 2024).

Haematological indices of an animal serve as a pointer to its physiological state (Khan & Zafar, 2005). Most clinical investigations and nutritional indices of an animal are carried out using its blood (Aderemi 2004). However, the physiological state of an animal determines the volume and constituents of its blood. This includes infection, stress, toxicity, and reproductive state (Khan & Zafar 2005).

The gut microbiota composition can affect growth parameters, such as growth rate, by influencing feed digestion and nutrient adsorption (Motoi, 2021). The relationship between microbes, such as *Campylobacter*, *Escherichia coli*, *Lactobacilli*, and *Enterobacteria*, and the production performance has been investigated (Iqbal *et al.*, 2020). It has been suggested that gut microbes metabolize phytobiotics into simpler metabolites to transform them into absorbable metabolites, whereas phytobiotics affect the population of gut microbes by interfering with their metabolic activities (Iqbal *et al.*, 2020). Therefore, this study investigated the effect of *S. torvum* aqueous extract on haematology, serum biochemistry, and intestinal microbes of broiler chickens.

2. LITERATURE REVIEW

2.1. Effects of *solanum torvum* on blood chemistry profile

There is limited, but growing evidence suggesting that dietary supplementation of *S. torvum* is positively associated with the serum biochemical parameters in broilers without any negative effects on liver or kidney functions. Sriptonan, and Jandeeakajom (2023) found that turkey berry powder supplementation had a significant reduction on serum cholesterol levels in broilers without altering the normal ranges of total protein, albumin, AST, and ALT, indicating hypolipidemic and hepatoprotective properties explainable by the presence of phenolic and flavonoid compounds in the plant. Equally, Ayedun *et al.*

(2024) noted that *S. torvum* leaf meal at 0.2- 0.6 improved the carcass characteristics and the health of the inner organs, and the profiles of serum biochemistry showed no toxicity in the range of Practical inclusion levels. These results are consistent with general phyto-genic studies: Paredes-López *et al.* (2024) found that 0.01% ethanolic leaf extracts of related tropical plants (*Morinda citrifolia* and *Artocarpus altilis*) moderately but significantly raised blood glucose and triglycerides, but not liver enzymes (AST/ALT). Taken together, these findings indicate that *S. torvum* aqueous extract can potentially have similar lipid-lowering and oxidative-stress-reducing actions through the phenolic-mediated inhibition of lipid peroxidation and the stimulation of endogenous antioxidant enzymes.

2.2. Effects of *solanum torvum* on intestinal microbial population

Phytogenics containing polyphenols and alkaloids, including *S. torvum*, have the ability to selectively regulate the gut microbiota by inhibiting pathogenic bacteria whilst promoting useful lactic acid bacteria. Direct evidence on the *S. torvum* aqueous extract is still scanty, however, similar studies offer solid mechanistic evidence. Paredes-Lopez *et al.* (2024) discovered that 0.01% *M. citrifolia* ethanolic extract reduced the number of *Staphylococcus aureus* in the ileal mucosa and broiler content significantly without adversely affecting the populations of *Lactobacillus*, and improved the gut health. The antibacterial activity of *S. torvum* fruit extract against Gram-positive pathogens (including *Staphylococcus aureus*) by in vitro screening of the selected herbal plants has corroborated the potential prebiotic-like behavior of *S. torvum* fruit extract. Abdel-Moneim *et al.* (2025) also demonstrated that nanoparticles based on polyphenols positively affected the beneficial microbial balance and pathogen load in the caecum which are correlated with the beneficial effects on feed efficiency. These changes in microbial ecology are highly ascribed to the interruption of bacterial cell membranes by saponins and flavonoids of *S. torvum*.

2.3. Effects of *solanum torvum* on gut morphometric parameters

The enhanced intestinal morphology with a higher villus height (VH), lower crypt depth (CD) and a higher VH: CD ratio is a major predictor of the improved gut barrier integrity and nutrient absorption. Ayedun *et al.* (2024) clearly incorporated morphometric assessment of the digestive tract and added that 0.6% inclusion of the 0.6% of the broilers in the meal containing *S. torvum* leaf meal, increased overall gut integrity. The evidence of related phyto-genics supports is strong: Abdel-Moneim *et al.* (2025) also noted linear positive changes in the ileal villus height and VH: CD ratio in broilers fed on curcumin nanoparticles, ascribing the effect to decreased inflammation and improved epithelial proliferation. Paredes-Lopez *et al.* (2024) also observed greater crypt depth and VH: CD ratio at 21-28 days of treatment with the extract of *A. altilis* and *M. citrifolia* which is associated with higher performance indices. These morphological changes are associated with the anti-inflammatory and antioxidant effects of plant secondary metabolites that counter oxidative damage of the enterocytes and facilitate the regeneration of villus.



3. METHODOLOGY

3.1. Experimental site

All experimental procedures were observed at the poultry unit of the Agricultural Technology Department, Federal Polytechnic Ilaro, Ogun State Nigeria. It is located in Yewa South Local Government area of Ogun State, Nigeria, with coordinates latitudes 6°37'46"N and 6°55'42"N and longitude 2°47'24"E and 3°6'48"E (Google Earth, 2023).

3.2. Sources and preparation of *Solanum torvum* extract

Solanum torvum leave was harvested from a government reserved forest at Ilaro, Ogun State Nigeria. It was rinsed and air dried at room temperature, chopped into smaller pieces and later grounded into powder to form *Solanum torvum* leaf meal. Ten (10) grammes of the grinded leaf meal of turkey berry was soaked with 1liter of distilled water, the mixture was kept for 48 hours after which it was sieved to remove the leaf shaft (Okusanya & Akinlade, 2024). The aqueous extract was stored in an air tight container for further use. Aqueous extraction was selected due to its safety for in vivo poultry studies, relevance to ethno veterinary practices, and avoidance of organic solvent residues that could negatively affect bird health (Putri *et al.*, 2023). Extracts were freshly prepared daily by dissolving measured quantities of powdered leaves in potable water, filtered, and administered immediately.

3.3. Experimental birds and management

Before the arrival of day old chicks, the brooder house with other equipment was cleaned and then disinfected. Wood shavings were be spread on the floor and turned at intervals during brooding to maintain the liter quality. Feeding troughs as well as drinkers were arranged and well-spaced in the brooder house. The brooder house was pre heated to about 33 °C, with the use of a digital hygrometer, the temperature and relative humidity were closely monitored. Two hundred and forty (240) day old broiler chicks were procured from a reputable hatchery and brooded for one week. Birds were fed with commercial feeds (broiler starter & broiler finisher). Feed and Aqueous extract *Solanum torvum* were administered.

3.4. Experimental design and treatments

The treatment groups were arranged in a completely Randomized Design. Birds were randomly assigned into 4 treatments groups. Each treatment had three (3) replicates with each replicate containing 20 birds. The following are the treatment groups:

- Treatment 1 (Control): Feed and water to ad libitum daily
- Treatment 2 (10 ml/l): *Solanum torvum* aqueous extract of 10ml/litre of water daily
- Treatment 3 (15 ml/l): *Solanum torvum* aqueous extract of 15ml/litre of water daily
- Treatment 4 (20 ml/l): *Solanum torvum* aqueous extract of 20ml/litre of water daily

The range of concentration of 10 to 20mL/L- is selected because of the previous findings on the bio-efficacy of aqueous extracts of *S. torvum*, already established ethnoveterinary use, and to allow the demonstration of dose-dependent effects. Tannins and saponins are examples of phytochemical constituents

that are known to have an inhibitory effect on concentrations higher than this range (Firdous *et al.*, 2018).

The extract was administered through drinking water rather than being added to feed because homogenous intake was desired, thermal degradation that accompanies feed processing was avoided, and the administration of the extract was similar to traditional delivery channels of phytogenic additives in poultry production (Zaikina *et al.*, 2022; Obianwuna *et al.*, 2024).

3.5. Data collection

Data were collected on haematological parameters, serum biochemistry, gut microbial population and morphometric.

3.6. Determination of haematology and serum biochemical parameters

At the end of the experiment, 2 birds from each replicate were selected for blood evaluation. A sample of blood was collected through the wing web vein into bottles containing Ethylene Diamine Tetra-Acetic acid (EDTA) for haematological parameters (packed cell volume (PCV), red blood corpuscles (RBC), white blood cells (WBC), Haemoglobin (Hb), heterophils, lymphocyte and differential counts (lymphocyte, heterophil, eosinophil, basophil, monocyte) ratio were calculated (Bordoloi *et al.*, 2012). Likewise, samples of blood were collected into sterile sample bottles free of anticoagulants to determine serum biochemical characteristics. Using commercial diagnostic kits, each serum sample was tested for cholesterol, total protein, albumin, globulin, aspartate aminotransferase (AST), alanine transaminase (ALT), and alkaline phosphatase (ALP) (Alagbe *et al.*, 2023).

3.7. Determination of bacterial count in the gastrointestinal tract

The bacterial population in the gastrointestinal tract (GIT) of the birds was done using the standard plate method, as described by Nugroho *et al.* (2022). At the end of the experiment, 2 randomly selected birds from each replicate were humanely slaughtered and a sample was collected for microbiological analysis (duodenum, ileum and jejunum). Analysis was carried out using Micro-plate reader to identify the intestinal microbes. The sample was mixed with saline water and incubated at 35 °C for 8 hours. After incubation, visible colonies were counted using a digital colony counter. Colony forming units (CFU) per gram of digesta were calculated using the formula:

$$\text{CFU/g} = \frac{\text{Number of Colonies} \times \text{Dilution factors}}{\text{Volume of Plate (mL)}}$$

3.8. Gut Morphometric parameters evaluation

Intestinal samples were fixed in 10% phosphate buffered formalin for a minimum of 48h, and 4.0µm. Sections were prepared as described by Kim *et al.* (2015). The sections were stained with standard Hematoxylin-eosin solution, villus height, villus width (mid-point), and crypt depth were measured at 100 × magnification under light microscopy. The Villus Surface area was calculated using the formula = (2π) × (VW/2) × (VL), where VW = villus width and VL=villus Length (Sakamoto *et al.*, 2000).



3.9. Statistical analysis

Collected data were subjected to One way Analysis of Variance (ANOVA) using SPSS. Significant differences among treatments were determined using Duncan's Multiple Range Test of the same statistical package (Duncan 1955).

4. RESULTS AND DISCUSSION

4.1. Effect of *solanum torvum* aqueous extract inclusion on haematological parameters of broiler chicken

The effect of *Solanum torvum* aqueous extract as an additive

on the haematological profile of broiler chickens is presented in Table 1. Packed cell volume values ranged between 27.00 – 28.00% while haemoglobin ranged from 9.04 – 9.37 g/dl. Red blood cell counts ranged from 2.54 – 2.57 $\times 10^6/\mu\text{l}$ while white blood cell values ranged between 11.53 – 11.73 $\times 10^3/\mu\text{l}$. Lymphocytes ranged between 62.00–63.33%. There is no significant differences observed in all parameters measured. Supplementing with *Solanum torvum* aqueous extract raised the white blood cell (WBC) count, indicating a stronger immunological response.

Table 1. Haematological parameters of broiler chicken administered *solanum torvum* aqueous extract as additive.

Parameters	T1	T2	T3	T4	SEM±	P-Value
PCV (%)	28	27.67	27	27.33	0.67	0.81
Hb (g/dl)	9.37	9.27	9.04	9.14	0.22	0.78
RBC ($\times 10^{12}/\text{L}$)	2.57	2.56	2.54	2.55	0.04	0.95
WBC ($\times 10^9/\text{L}$)	11.53	11.6	11.73	11.7	0.22	0.89
Lymph (%)	62	62.67	63	63.33	0.71	0.71
Heterophils (%)	28.67	28.33	27.67	27.33	0.88	0.83
Monocytes (%)	6.67	6.33	6.67	6.33	0.42	0.91
Eosinophils (%)	2.67	2.67	2.67	2.67	0.21	1.00

PCV- Packed Cell Volume, Hb- Haemoglobin, RBC- Red Blood Cell, WBC- White Blood Cell, Lymph – Lymphocyte.

4.2. Effect of *solanum torvum* aqueous extract inclusion on serum biochemical parameters of broiler chicken

The results of the experiment carried out to determine the effect of turkey berry (*Solanum torvum*) aqueous extract on the serum biochemistry of broiler chickens are presented in Table 2. The Total protein values ranged between 3.50 - 3.70 g/dl, globulin value ranged between 2.95 - 3.08 g/dl, albumin/

globulin values ranged between 0.18 - 0.22 g/dl, aspartate aminotransferase values ranged, between 176.50 - 178.00 μL , alanine aminotransferase values ranged between 21.00 - 23.80 μL , alkaline phosphate values ranged between 241.00 - 263.30 μL , blood urea nitrogen values ranged between 1.23 - 1.28 mmol/L, creatine values ranged between 0.48 - 0.50 mg/dl.

Table 2. Serum biochemical parameters of broiler chicken administered turkey berry (*Solanum torvum*) aqueous extract as additive.

Parameters	T1	T2	T3	T4	SEM	PValue
TP (g/dl)	3.60	3.50	3.63	3.70	0.042	0.45
Glb (g/dl)	3.05	2.95	3.08	3.03	0.028	0.47
Alb/Glb	0.18	0.19	0.18	0.22	0.009	0.24
AST (μL)	177.50	176.50	177.00	178.00	0.323	0.79
ALT (μL)	22.00	21.00	23.80	22.50	0.582	0.45
ALP (μL)	241.00	233.00	263.30	247.80	6.43	0.58
BUN (mmol/L)	1.25	1.23	1.28	1.28	0.012	0.97
Creatine (mg/dl)	0.48	0.48	0.48	0.50	0.005	0.80

Key: TP - Total Protein, Glb – Globulin, ALB/GLB – Albumin/Globulin, AST - Aspartate Aminotransaminase, ALT – Alanine Transaminase, ALP - Alkaline Phosphatase, BUN – Blood Urine Nitrogen.

4.3. Effect of turkey berry aqueous extract on total bacterial count (TBC), Total coliform count and total fungi count

The total bacterial count (TBC) in the intestinal samples of broiler chickens showed significant differences ($P < 0.05$) across treatments (T1 - T4). Total Bacterial Count Values

ranged from 4.00 in T3 to 5.80 in T4. Birds' in T4, which received the highest level of turkey berry aqueous extract, recorded the highest TBC value (5.80), while T3 recorded the lowest (4.00). Statistical analysis showed that TBC values in T2 (5.10) were significantly higher than T1 (4.60) but not as high as T4 (5.80). Total coliform count (TCC) also showed



statistically significant differences among the treatments ($P < 0.05$). T4 exhibited the highest TCC values of 2.30, while T3 had the lowest value (1.65). T1 (2.00) had intermediate values, suggesting moderate microbial load. However, no

statistical significant differences observed in total fungal count (TFC) among treatments ($P > 0.05$). TFC values ranged from 2.60 in T3 to 3.50 in T2, indicating minor variation across treatments.

Table 3. Effect of *solanum torvum* aqueous extract on the intestinal microbial population of broiler chicken.

Parameters	T1	T2	T3	T4	SEM	P – Values
TBC	4.60 ^{bc}	5.10 ^b	4.00 ^c	5.80 ^a	0.378	0.00
TCC	2.00 ^{ab}	2.15 ^a	1.65 ^b	2.30 ^a	0.138	0.02
TFC	3.00	3.50	2.60	3.05	0.182	0.15

TBC: Total Bacterial Count; TCC: Total Coliform Count; TFC: Total Fungal Count.

4.4. Ileum, duodenum and jejunum morphometry

The ileum, duodenum and jejunum morphometric results are presented in Table 4. The ileum villus width and length did not differ significantly ($p > 0.05$) among treatments. Crypt depth showed significant variation ($p < 0.05$), with Treatment 3 (1.37 μ m) recording the deepest crypts compared to other groups. Epithelial thickness also differed significantly ($p < 0.05$), with Treatment 2 (0.26 μ m) having the thickest epithelium. Other parameters, including crypt width and muscle thickness, showed no significant differences.

The duodenum morphometric analysis showed no significant differences ($p > 0.05$) across all measured parameters (villus

width, villus length, crypt depth, crypt width, muscle thickness, epithelial thickness). This suggests that *Solanum torvum* extract did not significantly alter duodenal morphology.

The jejunum morphometry results showed villus length differed highly significantly ($p < 0.05$), with Treatment 1 (12.25 μ m) recording the longest villi, while Treatment 3 (0.95 μ m) recorded the shortest. Crypt depth also differed significantly ($p < 0.05$), with Treatment 2 (1.48 μ m) having the deepest crypts. Epithelial thickness showed significant variation ($p < 0.05$), with T1 (0.25 μ m) being the highest and T3 (0.15 μ m) the lowest. Other parameters, including villus width, crypt width, and muscle thickness, were not significantly affected.

Table 4. Effect of turkey berry (*Solanum torvum*) aqueous extract inclusion on gut morphology of broiler chicken.

GI Segment	T1	T2	T3	T4	SEM $\pm$	P-value
Ileum						
VW (μ m)	1.37	2.53	2.05	2.05	0.17	0.090
VL (μ m)	6.34	8.41	7.55	7.58	0.41	0.390
CD (μ m)	1.23a	0.94b	1.37a	1.00b	0.07	0.036
CW (μ m)	0.89	0.82	0.97	0.81	0.09	0.270
MT (μ m)	3.42	2.70	3.09	2.23	0.29	0.560
ET (μ m)	0.15b	0.26a	0.18b	0.16b	0.01	0.009
Duodenum						
VW (μ m)	1.64	1.35	1.95	1.56	0.15	0.61
VL (μ m)	6.90	7.10	7.58	6.37	0.54	0.91
CD (μ m)	1.11	1.22	1.43	1.54	0.83	0.27
CW (μ m)	0.85	0.88	1.09	0.85	0.05	0.27
MT (μ m)	2.33	2.29	2.86	3.09	0.19	0.39
ET (μ m)	0.22	0.17	0.18	0.18	0.18	0.79
Jejunum						
VW (μ m)	1.99	2.87	1.82	2.21	0.17	0.14
VL (μ m)	12.25a	10.56b	0.95d	8.82c	1.35	0.00
CD (μ m)	0.86a	1.48a	0.97b	1.16b	0.85	0.25
CW (μ m)	0.69	1.13	1.48	0.90	0.14	0.25
MT (μ m)	3.05	2.50	2.80	2.81	0.34	0.97



ET (μm)	0.25a	0.19b	0.15b	0.18b	0.13	0.07
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abcd : Means on the same row having different superscript were significantly ($p < 0.05$) different. SEM: Standard error of mean, GIT: Gastrointestinal tract, VW: villus width, VL: villus length, CD: crypt depth, CW: crypt width, MT: muscle thickness, ET: Epithelial thickness. T1: 0 ml TBAE/Litre of water; T2: 10 ml TBAE/Litre of water; T3: 15 ml TBAE/Litre of water; T4: 20 ml TBAE/Litre of water

4.5. Discussion

Across all haematological parameters measured, no statistical significant differences ($p > 0.05$) were detected among treatment groups. This finding suggests that supplementation with aqueous extract of Turkey berry, at the tested inclusion levels, did not markedly alter the haematological profile of the birds within the experimental period. Packed cell volume values fall within the normal physiological range for poultry (PCV: 22–35%, Hb: 7–13 g/dl) and suggest no anaemia, dehydration, or nutritional deficiency. The consistency implies that the treatments did not impair oxygen-carrying ability. Okon *et al.* (2022) reported similar PCV stability in broilers fed unconventional diets, concluding that values around 27 – 30% indicated good blood health. Haemoglobin levels closely mirrored PCV values, confirming the reliability of oxygen transport capacity. The uniform haemoglobin concentration suggests treatments neither caused anaemia nor enhanced erythropoiesis. Hassan *et al.* (2024) linked stable haemoglobin levels in poultry with adequate nutrition and absence of stressors. The narrow range observed in red blood cell counts indicated uniform erythropoietin activity across treatments. Since RBC counts remained within the normal limits, none of the diets induced dehydration. Bello *et al.* (2023) observed comparable RBC consistency in poultry fed alternative feed resources, confirming that stable counts signify safety of dietary interventions. White blood cell stability indicates that none of the treatments triggered immune suppression or stimulation. The animals maintained normal immunological competence. Adewale *et al.* (2021) noted that stable WBC counts in poultry fed unconventional diets signify the absence of pathological challenges. Lymphocytes high percentage values obtained confirm strong adaptive immune capacity. The uniformity of treatments indicates that immunity was not compromised. Nwosu *et al.* (2023) reported lymphocyte stability in indigenous poultry under varied feeding regimes, linking it to resilience and health. Heterophil are primary defence cells; their stability suggests the absence of stress or bacterial infection. The normal heterophil-lymphocyte balance indicates good health. Okon *et al.* (2022) highlighted that stable heterophil counts and ratios reflect absence of physiological stress in poultry. Uniform monocyte levels indicated no chronic infection or inflammation. This stability reinforces that the treatments did not challenge the immune system. Umar and Ibrahim (2025) observed consistent monocyte percentages in small ruminants fed agro-industrial by-products, interpreting stability as a marker of health. Eosinophils remained constant at 2.67% across all treatments. The lack of variation suggests the absence of parasitic infection or allergic reactions. This parameter strongly supports the safety of the treatments. Adedeji *et al.* (2025) also reported no eosinophil fluctuations in poultry-fed cassava-based diets, indicating good sanitary and nutritional conditions.

The findings of this study revealed that the administration of turkey berry aqueous extract had no significant effect on serum biochemical indices of broiler chickens. The non-significant changes observed across treatments indicate that the extract did not impair liver function, protein metabolism, or kidney function. This suggests that turkey berry extract is safe and non-toxic at the levels tested. The stability of liver enzymes alkaline phosphatase (ALP), aspartate aminotransferase (AST), Alanine Aminotransferase and kidney markers (urea and creatinine) confirms that the extract does not cause hepatic or renal damage. The findings of the current study align closely with existing research on the safety and efficacy of turkey berry (*Solanum torvum*) aqueous extract in poultry diets. Adewale *et al.* (2018) demonstrated that dietary inclusion of turkey berry leaf extract did not significantly alter serum protein levels or enzyme activities in broiler chickens, indicating no adverse effects on metabolic processes. Similarly, Okonkwo and Eze (2020) reported no significant changes in liver function markers, such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (ALP), following supplementation with *Solanum torvum* extracts. These results corroborate the safety of turkey berry as a feed additive in poultry, suggesting that it does not induce hepatotoxicity or disrupt liver function. Additionally, Mensah *et al.* (2021) found that renal indices, including blood urea nitrogen and creatinine, remained unaffected by turkey berry supplementation, further supporting its non-toxic profile. These studies collectively reinforce the conclusion that turkey berry aqueous extract can be safely incorporated into broiler diets without impairing serum biochemical parameters when administered under controlled conditions. Similarly, Agyemang *et al.* (2023) evaluated the impact of turkey berry leaf extract on lipid profiles and reported no significant changes in serum cholesterol or triglyceride levels, indicating that the extract does not disrupt lipid metabolism. These findings are consistent with the current study's results, which showed no adverse effects on serum lipid parameters, further highlighting the potential of turkey berry as a safe dietary supplement for improving poultry health without compromising metabolic homeostasis. The inclusion of turkey berry aqueous extract in broiler diets had a notable effect on the intestinal microbial population, particularly on bacterial and coliform counts. The significant increase in total bacterial count and total coliform count in T4 (20 ml TBAE/Litre of water) suggests that higher doses of turkey berry extract may support the growth of certain microbial communities or reduce the presence of harmful bacteria, allowing beneficial microbes to flourish. This aligns with the findings of Abd El-Hack *et al.* (2020) who reported that phytogetic feed additives often modify gut microbiota by altering pH and creating an unfavorable environment for pathogens. The lack of significant changes in total fungi count across treatments suggests that turkey berry aqueous



extract might not have a strong anti-fungal activity, or the fungal population in the intestine may be less susceptible to the phytochemical present. This agrees with Kamboh *et al.* (2017), who reported that though herbal extracts can influence bacterial communities, their anti-fungal properties are often limited unless combined with other anti-fungal agents.

The outcomes of this study suggested that *Solanum torvum* extract produced varying effects on gut morphology, with considerable modifications in the ileum and jejunum but little influence in the duodenum. In the ileum, the lack of substantial changes in villus breadth and length suggests that the extract had little influence on villus size. However, the considerable increase in crypt depth (T3 15 ml TBAE/Litre of water) implies accelerated epithelial proliferation and tissue turnover, which facilitates absorptive surface renewal (Brenes and Roura, 2010). Similarly, the increased epithelial thickness found in T2 (10 ml TBAE/Litre of water) supports greater mucosal integrity, providing a stronger barrier against pathogens and better absorptive capability. These findings confirm recent observations showing phytobiotics increase gut health by increasing epithelium and crypt formation (Simitzis, 2017).

No significant impacts were identified in duodenal morphology, which shows that turkey berry extract exerts negligible influence in this digestive region. The duodenum largely assists in enzymatic digestion, and the absence of alterations supports past studies indicating phytogetic additions often act more powerfully in the jejunum and ileum, where nutrient absorption is predominated (Sugihartos *et al.*, 2021).

The jejunum displayed the most significant results. The highly significant reduction in villus length in T3 (15 ml TBAE/Litre of water) indicates that excessive dose of turkey berry extract may affect absorptive efficiency, as villus height correlates favourably with nutrient absorption (Ghimpeteanu *et al.*, 2022). On the other hand, crypt depth was enhanced in T2 (10 ml TBAE/Litre of water), suggesting greater mucosal renewal and resilience (Abdullah *et al.*, 2010). Epithelial thickness was reduced in T3 (15 ml TBAE/Litre of water), further indicating that excessive inclusion could damage gut barrier integrity. These data imply a dose-dependent impact, where moderate supplementation improves gut morphology but excessive dosage is deleterious. Similar observations have been made with other phytobiotics, which exhibit advantages at optimal levels but harmful effects at larger concentrations (Alghirani *et al.*, 2021).

Overall, *Solanum torvum* extract indicated potential as a phytogetic feed supplement, boosting ileal and jejunal crypt growth and epithelial thickness, which may increase intestinal health. However, the decline in villus length and epithelial thickness at higher dosages highlights the necessity of dose optimization. These findings correspond with recent reports that phytogetic extracts can boost intestinal health and replace synthetic growth promoters when correctly provided (Panda *et al.*, 2018).

5. CONCLUSION

The results demonstrated that the inclusion of turkey berry extract at varying levels did not significantly alter key hematology and serum biochemical parameters. These findings indicated that turkey berry extract is safe and non-toxic at the

tested levels in broiler chickens. Treatment T3 (15mls of Turkey berry aqueous extract into 1 liter of water) reduced harmful bacteria the most, while T4 had the highest Total Bacteria Count. The extract had little effect on Total Fungi Count. This shows that turkey berry can support gut health when used at the right level. The stability of these parameters suggests that the phytochemicals present in *Solanum torvum*, such as alkaloids, saponins, flavonoids, and phenolic compounds, do not exert adverse effects on the metabolic or physiological health of the birds. This supports the potential use of Turkey berry as a natural feed additive in poultry production, offering a safe alternative to synthetic additives without compromising the health or growth performance of broilers.

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