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Research Article

Effect of papaya leaf extract on growth performance, carcass characteristics, meat quality and serum biochemistry of broiler chickens

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Abstract

This study was conducted to investigate the effect of supplementing papaya leaf extract (PLES) in drinking water on growth performance, carcass characteristics, meat quality and serum biochemistry parameters of broiler chickens from 0 to 37 days of age in corn-soybean based diet. A total of 520 unsexed one-day-old Cobb-500 broiler chicks were randomly assigned to five treatment groups, with four replicates having twenty-six chicks in each group. Treatment groups were as follows: 0.00, 0.5, 1.00, 1.5 and 2.00 cc of PLES in 1000 ml of drinking water, respectively. The pre-starter, starter and grower diet were fed from 0 to 11, 12 to 26 and 27 to 37 days of age. Body weight, weight gain, feed intake, feed conversion ratio and broiler production efficiency factor (BPEF) were measured for 37 days. Carcass, meat quality and serum biochemical parameters were also measured. The results of the present study showed that non-significantly greater body weight, weight gain and broiler production efficiency factor (BPEF) were observed in PLES groups than control. There was no significant difference in feed intake and feed conversion ratio of broiler chickens in the treatment groups. The relative proportion of dressing characteristics and meat quality in terms of drip loss, cooking loss of breast meat did not alter significantly between the treatments. However, total cholesterol in serum tended ($P<0.10$) to be reduced in the treated groups than control but other (albumin, total protein, high-density lipoprotein) were not influenced by the treatments. Taken together, our results indicate that papaya leaf extract in drinking water can be supplemented as phytobiotic additive to accelerate growth and improve health status of broiler chickens without any adverse effect.

Introduction

As the global population increases, meat production from animal source will need to be increased in order to meet the needs of the 9 billion people predicted to inhabit the world by 2050. So, poultry production is one of the most effective ways to achieve sustainable and rapid production of high quality meat to meet the demand for animal protein. However, the major constraint in poultry production is the high cost of conventional feed ingredients with short supplies which generally costly and contributes largely to the increase in poultry production costs. Poultry scientists, nutritionists and some innovative poultry farmers have therefore prioritized to introduce locally available unconventional feedstuffs, processing by-products and variable herbal plants into poultry diets to improve productivity, immune response, health status as well as minimize the feed cost (Kasapidou et al., 2015; Aroche et al., 2018; Gerzilo et al., 2015, Rahman et al., 2022) as well as used some herbal extract for value addition in meat products (Bithi et al, 2020; Boby et al., 2021 Disha et al., 2020; Akter et al., 2022; Ali et al., 2022).

Papaya (Carica papaya) is a native plant commonly cultivated in tropical countries due to its popular taste and high nutritive value (Gha et al., 2019). Papaya has diverse biological functions due to the high content of proteolytic enzymes such as chymopapain, papain and papaya peptidase which have antibacterial, antiviral and antifungal properties (Baskaran et al., 2012; Maisarah et al., 2013), and are there by extensively used in human traditional and alternative of medicine. Additionally, papaya contain proteolytic enzyme that helps to digestion of protein (Oloruntola et al., 2018a). In poultry, papaya seed and leaf both have been used generally for medicinal action as well as phytogenic additive in the diet of poultry instead of the synthetic chemicals and reducing the unnecessary cost of medicine (Kumar et al., 2014; Valenzuela-Grijalva et al., 2017). Some studies already evaluated that both papaya seed and leaf meal that have been incorporated in diets of poultry as protein supplement as well herbal proteolytic enzymes to enhance digestibility of ingested feed in the tract, thereby accelerating growth, boost up immune response and well-being of birds (Bolu et al., 2009; Nideou et al., 2017). Moreover, the antioxidant properties of papaya seed and leaf have been documented that partly contribute to enhanced growth performance and improved immunity in poultry (Asghar et al., 2016; Sugiharto, 2020). Another study, enzymes in papaya seed and leaf were also responsible for the improved performance, digestibility and antioxidant status of the animal (Oloruntila et al., 2018). Previously, most investigations have examined the nutritive and phytogenic potential of papaya by products including papaya seed and leaf meal effects on the performance of poultry in diets (Sola-ojo and Bolu, 2009; Saleh et al., 2018). To our knowledge from the reviewed literature, no research has been investigated the use of papaya meal or extract either from leaf, seed or by-products on meat quality and serum biochemistry parameters in broiler chickens. Therefore, our study aims to investigate the effects of papaya leaf extract supplementation in drinking water on growth performance, carcass, meat quality and serum biochemistry parameters of broiler chickens.

Materials and Methods

Birds and Housing Management

A total of 520 unsexed one-day-old Cobb-500 broiler chicks were obtained from commercial hatchery. The chicks were weighed uniformly and randomly distributed into five treatment groups, each treatment had four replicates with twenty-six chicks in each. During the first three days of post hatching, room temperature was maintained at 35°C and then was reduced gradually to 23 ± 2°C at the end of 21 days of age, and maintained it until the end of the experiment. Feed and drinking water were freely available to all birds. Birds were inspected daily and dead birds were removed after recording of mortality according to the replicate, date and body weight.

Experimental design and treatment

The experiment had a completely randomized design. Five treatments were considered as follows 0.00, 0.5, 1.00, 1.5 and 2.00 cc of supplementing papaya leaf extract **(**PLES) in 1000 ml of drinking water. The experimental period lasted for 37 days and included three feeding phases pre-starter (0-11 days), starter (12-26 days) and grower (27-37 days) diets. Based on the nutrient contents of the ingredients, the diets were formulated to satisfy the broilers nutritional needs stated by NRC for poultry (NRC, 1994). Composition and nutrient levels of all basal dietsare shown in Table 1.

Table1. Ingredients and calculated nutrient composition of basal diets

Ingredient (%)	Pre-starter (0-11 days)	Starter (12-26 days)	Grower (27-37 days)
Corn	51.70	54.59	56.18
Wheat bran	5.09	5.60	6.00
Soybean meal(44%)	38.70	34.70	32.15
Vegetable Oil	0.75	1.65	2.45
Limestone	0.95	0.95	0.95
Dicalciumphosphate	1.70	1.45	1.24
Iodized salt	0.30	0.30	0.30
Vitamin-mineral remix	0.31	0.31	0.31
Lysine	0.25	0.22	0.22
DL-Methionine	0.25	0.23	0.20
Total	100.00	100.00	100.00
Calculated nutrient content in the diet			
Metabolizable energy(kcal/kg)	3050	3100	3150
Crude protein(%)	22.50	21.00	20.00
Calcium (%)	1.00	0.95	0.89
Available phosphorus (%)	0.45	0.40	0.35
Lysine (%)	1.45	1.33	1.26
Methionine(%)	0.58	0.55	0.50
Cystine(%)	0.39	0.36	0.35
Methionine+Cystine (%)	0.97	0.91	0.85

Measurements of growth performance

All birds and feed intake were weighed at 11, 26 and 37 d of ages on agroup basis.The average values of body weight, weight gain, feed intake and feed conversion ratio (feed to gain ratio) were estimated during 0 to 11, 12 to 26 and 27 to 37 days of age.

Carcass characteristics

Four birds from each group, close to the average live body weight were selected at the end of the experiment. And sacrificed by cervical dislocation for evaluation of carcass traits and meat quality parameters. After five minutes of bleeding, each bird was defeathered and evisceration was performed manually after removal of skin, head, neck and shanks. The carcass was weighed without giblets (liver, heart, gizzardand spleen) and removal of non-edible viscera (small and large intestine). The weight of carcass was expressed as a percentage of pre-slaughter body weight and considered as dressing yield. In addition, the carcass was cut into parts namely breast, thigh, drumstick, wings and back to estimate their weight. The edible offal which includes skin, liver, heart, gizzard and spleen were weighed. Visible fat around the viscera, gizzard and abdominal wall were collected and weighed. The weights of parts were also expressed as a percentage of pre-slaughter body weight of the bird.

Meat quality

Breast muscle was excised from each sacrificed bird and immediately put into sample bags and kept in ice-box at chilled temperature to measure the meat quality traits in terms of drip loss and cooking loss. Drip loss was calculated as the difference between initial and final weight of meat sample after storage at 4°C for 24 hours in normal refrigerator and expressed as a percentage of the initial weight. Deboned breast meat samples were weighed and sealed in zipper bags (size: 14 ×16 cm). Then, the samples were kept in a water bath at 80°C until the internal temperature of 70°C was reached. The cooked samples were allowed to cool in normal running tap water for 10 to 15 minutes and reweighed after removing excess moisture using towel on the meat surface. The cooking loss was calculated based on the weight loss after cooking and presented as a percentage of initial weight. The breast meat color values were measured immediately after deboning on the surface of fresh vertical cut of the meat samples using a Minolta Chromameter (Minolta CR-410, Japan). The chromameter was calibrated with a standard white calibration plate before measuring each water-chilled sample. The surface color (CIE, L*, a* and b*) values were taken from three different locations of each sample and averaged.

Serum biochemical

At 37 days of age, blood samples of four birds from each treatment were collected from wing venous by sterile syringe (approximately 6 ml blood each bird). Collected blood samples were kept into non-heparinized tubes. Serum was separated by centrifugation 3000 rpm for 15 minutes at 4°C, put into eppendorf tubes and then kept at -20°C until being assayed. Serum albumin (ALB), total protein (TP), total cholesterol (CHOL) and high density-lipoprotein (HDL) concentration were measured at 37 days of samples by commercial diagnostic kits (Ratastie 2, FI-01620 Vantaa, Thermo Fisher Scientific Oy, Finland) using an automatic biochemistry analyzer (Serum Biochemistry Analyzer Vet).

Statistical analysis

Data were analyzed using the general linear model (GLM) procedure of SAS statistical program (SAS 9.1, 2009). Analysis of variance (ANOVA) tests were used for analyses of variance accompanied by Duncan's multiple range test to determine the differences between the treatments. The results are presented as mean with standard deviation of the mean. A statistical value of $P<0.05$ was considered as a significant difference and an indicative tendency of significant was considered when value at $P<0.10$.

Results and Discussion

Body weight and body weight gain of broiler chickens

The mean day old body weight, cumulative body weight and body weight gain of broiler chickens in different rearing periods are presented in Table 2, and Figure-1 and 2. The day old body weight of broiler chicks under different treatment groups ranged from 42.46±0.031 to 42.48±0.022 g. As the age increased, the live weight of chicks under different treatment groups increased steadily up to 37 days of age. Among all the treatments, there was no significant difference in the average body weight and body weight gain of broilers under different rearing periods. However, in respect to the final body weight, the body weight gain of broilers was numerically increasing trend as the inclusion level of PLE in drinking water and the highest value was found in T5 group as compared to the other supplemented groups including control (T1) from 0 to 37 days of age. The present findings were in agreement with Sugiharto et al. (2020) who observed that mixture of fermented papaya leaf and seed meal to the diet of crossbred chickens did not show significant effect on body weight gain throughout the study when compared with control group but increasing trend of weight gain was observed in supplemented groups. Another study, Vidanarachchi et al. (2010) found that supplementing diets with different types of prebiotic plant extract did not improve the body weight gain of broilers. It is also similar to the earlier studies of Zdunczyk et al. (2005) and Geier et al. (2009), they observed no beneficial effects on the performance of poultry due to diets supplemented with phytobiotic and bioactive compounds. On the contrary, Oloruntola et al. (2018) and Onyimonyi and Onu (2009) noted that the incorporation of papaya leaf meal in diet of chickens significantly improved body weight gain than that of control group. Similarly, improved body weight gain observed in broilers fed composite mixture of papaya leaf and seed meal diet when compared to control diet (Oloruntola et al. 2020; Banjoko et al., 2020), which contradict the present result. It seems that thesevariations in the efficacy of phytobiotic additive on the performance of broilers that might be due to differences in the content and degree of polymerization of the active ingredients, and multitude environment and management practices, such as the type and composition of basal ingredients used in diets and inclusion level of additives.

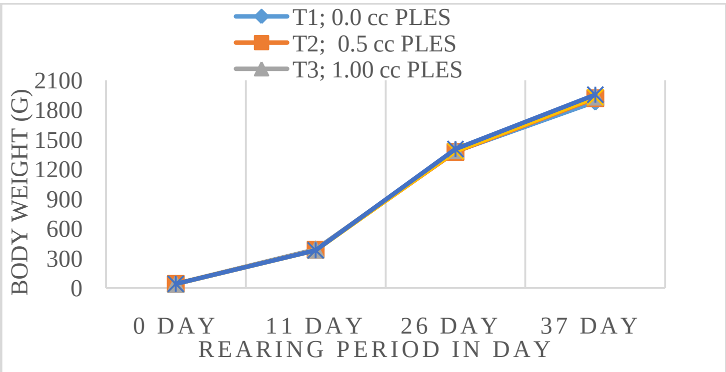

Figure 1: Mean body weight (g) of chicks under different treatments at different rearing period. PLES, papaya leaf extract supplementation.

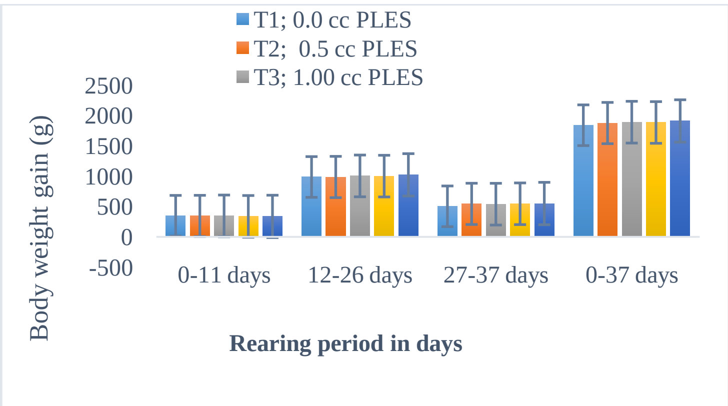

Figure 2: Cumulative body weight gain (g) of broiler chickens under different treatments. PLES, papaya leaf extract supplementation.

Table 2. Effect of papaya leaf extract supplementation (PLES) in drinking water on growth performance of broiler chickens (mean±SD)

Items	T1 (0.0 cc PLES)	T2 (0.5 cc PLES)	T3 (1.00 cc PLES)	T4 (1.5 cc PLES)	T5 (2.00 cc PLES)	P-value
Body weight (g)						
0 day	42.462±0.03	42.462±0.03	42.471±0.04	42.481±0.02	42.471±0.02	0.868
11 day	390.804±4.89	387.308±8.12	388.269±4.77	380.769±9.08	380.096±15.89	0.432
26 day	1378.21±32.34	1373.99±39.10	1393.20±46.16	1382.16±36.71	1402.71±25.41	0.798
37 day	1881.93±62.50	1917.85±14.53	1932.28±56.33	1927.89±49.97	1952.43±45.24	0.377
Weight gain (g)						
0-11 days	348.342±4.92	344.846±8.13	345.798±4.76	338.289±9.07	337.625±5.88	0.431
12-26 days	987.40±30.81	986.68±36.28	1004.93±44.79	1001.39±31.77	1022.61±16.50	0.553
27-37 days	503.72±76.27	543.86±35.44	539.08±56.16	545.73±67.82	549.72±22.77	0.768
0-37 days	1839.47±62.49	1875.39±14.56	1889.81±56.31	1885.41±49.97	1909.96±45.24	0.377
Feed intake (g/bird)						
0-11 days	376.908±7.70	371.539±0.15	374.135±0.25	373.558±0.16	376.635±0.26	0.204
12-26 days	1603.70±34.01	1601.93±36.45	1614.60±19.44	1606.48±15.90	1644.91±10.34	0.153
27-37 days	1209.03±151.67	1289.49±29.50	1271.76±53.15	1274.97±50.78	1291.21±83.33	0.651
0-37 days	3189.63±149.61	3262.96±24.91	3260.49±50.57	3255.00±42.20	3312.76±91.63	0.403
Feed conversion ratio (FCR)						
0-11 days	1.082±0.04	1.078±0.03	1.082±0.01	1.105±0.03	1.117±0.05	0.445
12-26 days	1.625±0.02	1.624±0.02	1.609±0.06	1.605±0.04	1.609±0.02	0.882
27-37 days	2.409±0.09	2.377±0.12	2.372±0.16	2.354±0.19	2.349±0.11	0.975
0-37 days	1.733±0.03	1.740±0.02	1.726±0.04	1.727±0.03	1.734±0.02	0.950
Broiler production efficiency factor (BPEF)						
0-37 days	106.10±2.56	107.80±2.11	109.58±5.57	109.23±4.59	110.13±2.90	0.579

Treatments: T1 mean 0.00 cc supplementing papaya leaf extract (PLES) in 1000 ml drinking water; T2 mean 0.5cc PLES in 1000 ml drinking water;T3 mean 1.00cc PLES in 1000 ml drinking water;T4 mean 1.5cc PLES in 1000 ml drinking water; T5 mean 2.0 cc PLES in 1000 ml drinking water. SD, standard deviation.

Feed intake, feed conversion ratio and production efficiency factor

The impact of different treatments on the cumulative feed intake, feed conversion ratio and production efficiency factor of broiler chickens are presented in Table 2, and Figure 3 and Figure 4. The effect of PLES in drinking water on cumulative feed consumption was found non-significant difference during the entire experimental period from 0 to 37 days of age. Although, the average feed intake of birds was varied numerically within treatments and higher value was noticed in T5 group. The current finding of the study was in agreement with Oloruntola et al. (2020) pointed out that feed intake of broiler chickens did not differ significantly by the inclusion level of papaya composite mixture in diets. Similar results were also noticed by Oloruntola et al. (2018) and Onyimonyi and Ernest (2009) who showed that inclusion levels of PLM in diet had no significant effect on feed intake of broiler chickens. But the findings of Olumide et al. (2022) contradict the current findings and revealed that diet supplementation with inclusion level of papaya seed meal from 0.10 to 0.25% significantly increased feed intake of broilers compared with birds that had non-supplemented diet. However, the numeric increase in feed intake of birds that may be due to the consequence of the faster growth of birds caused by PLES in drinking water, which resulted in higher nutritional requirements (Hossain et al. 2016); usually increase feed intake of birds in order to meet their nutritional requirements (Shrivastava et al., 1981). The cumulative feed conversion ratio (FCR) of birds in different treatments revealed that there was a gradual increasing trend observed with age of birds but the differences between the treatments was non-significant. A non-significant difference in the FCR during the rearing period of 0 to 37 days of age that might be ascribed due to similar feed efficiency of experimental birds in different treatment groups. In agreement with current study result, it has been found that supplementation of papaya leaf meal had no effect on FCR in broiler chickens (Oloruntola et al., 2018). Several authors have also reported same finding regarding the effect of FCR when supplemented phytogenic substances in the diet of broiler chickens (Adegbenro et al., 2017; Sugiharto et al., 2020). On the other hands, some authors observed that the supplementation of diet with inclusion of alone or combination papaya leaf and seed meal mixture significantly improved FCR in broiler chickens (Onyimonyi and Ernest, 2009; Oloruntola et al., 2020) and in laying hens (Tamiru et al., 2021), which opposite with the present findings. The performance of broiler chickens was also evaluated in terms of broiler production efficiency factor (BPEF), which includes average body weight gain divided by FCR with multiplied 100. The values of BPEF were in usual range and non-significant differences in between groups; however, BPEF value was numerically greater in PLES groups than control and the highest value was in T5 group, which indicate that higher inclusion of PLES in drinking water contributes to body weight gain more. According to Kryeziu et al. (2018) and Bhamare et al. (2016) stated that the higher production efficiency factor (PEF) indicate the birds body weight gain is uniform and the flock is in good health, which agrees with the results of this study.

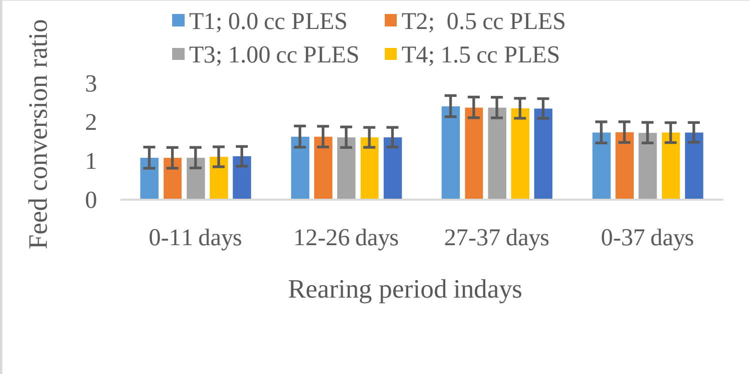

Figure 3: Cumulative FCR of broiler chickens under different treatments. PLES, papaya leaf extract supplementation.

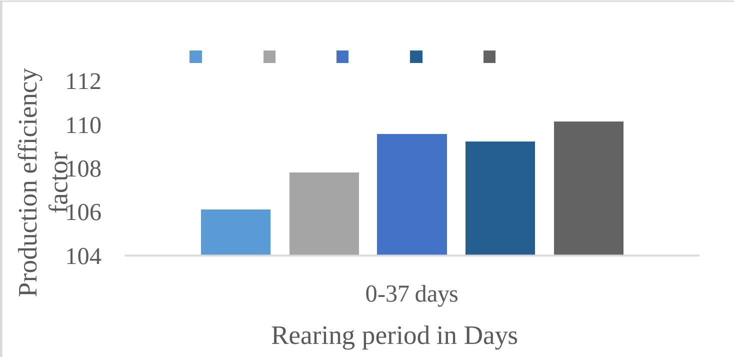

Figure 4: Broiler production efficiency factor under different treatments. PLES, papaya leaf extract supplementation.

Carcass characteristics and meat quality of broiler chickens

Supplemental effect of PLE in drinking water of broiler chickens on carcass traits and meat quality are given in Table 3 and Table 4. The dressing yield, cut-up-parts and relative weight of internal organs of broiler chickens were similar (P>0.05) across all the treatment groups but numerically the highest dressed weight and dressing percentage were observed in PLE supplemented group. These results are in agreement with the earlier researchers (Bolu et al., 2009; Oloruntola, 2019; Banjoko et al., 2020; Oloruntola et al., 2018). In the contrary with these findings, a significant increase in average dressed weight and dressing percentage with supplementation of PLM level in the diets increased (Onyimonyi and Ernest, 2009),was also reported by earlier studies in broilers. The relative organs weight of birds did not alter in across all the treatments in this study indicate that the health status of these birds was not negatively affected due to PLE supplementation in drinking water. The meat quality analysis in terms of meat color, dripand cooking loss of breast meat revealed that there was no difference in meat quality in all treatment groups, indicating that there was no effect of PLE inclusion level in drinking wateron meat quality.

Table 3. Effect of papaya leaf extract supplementation (PLES) in drinking water on carcass characteristics of broiler chickens (mean±SD)

Particulars	T1 (0.00 ccPLES)	T2 (0.5 cc PLES)	T3 (1.00 cc PLES)	T4 (1.5 ccPLES)	T5 (2.00 cc PLES)	P-value
Live wt. (g)	1900.00±10.00	1900.00±20.00	1930.00±36.06	1936.67±37.86	1910.00±20.00	0.367
Dressed wt. (g)	1192.00±54.34	1198.67±18.93	1270.33±49.32	1226.67±59.53	1216.00±60.51	0.405
Dressing yield (%)	61.90±3.70	62.77±0.46	65.81±1.71	64.56±2.82	63.65±2.50	0.401
Head wt. (g)	43.00±5.57	43.33±4.51	38.33±9.29	40.67±2.52	43.33±5.13	0.786
Liver wt. (g)	39.67±2.52	38.33±3.06	38.67±2.89	40.33±4.04	40.67±3.51	0.875
Heart wt. (g)	7.33±1.53	9.33±3.51	10.67±1.53	6.67±1.53	7.33±1.53	0.180
Spleen wt. (g)	1.33±0.58	1.00±0.00	2.00±1.00	1.33±0.58	1.67±0.58	0.415
Gizzard wt. (g)	34.33±6.51	32.33±6.66	34.33±8.62	33.33±5.03	36.67±4.04	0.937
Visible fat wt. (g)	32.67±1.53	24.67±3.51	23.33±9.07	33.00±5.57	24.00±6.56	0.159
Breast meat wt. (g)	399.33±22.74	393.33±34.08	402.67±23.18	404.67±5.03	406.67±5.03	0.943
Thigh meat wt. (g)	187.33±9.02	214.67±20.23	198.67±14.74	203.33±23.09	206.67±18.58	0.466
Drumstick wt. (g)	166.67±15.14	152.67±7.02	160.00±21.17	163.33±10.26	158.00±8.00	0.754
Wing meat wt. (g)	114.00±12.53	102.67±16.26	108.67±17.01	103.67±14.57	115.00±7.55	0.740
Back wt. (g)	244.00±24.88	192.33±47.96	194.67±20.21	198.00±28.48	193.67±11.37	0.220

Treatments: T1 mean 0.00 cc supplementing papaya leaf extract (PLES) in 1000 ml drinking water; T2 mean 0.5cc PLES in 1000 ml drinking water;T3 mean 1.00cc PLES in 1000 ml drinking water;T4 mean 1.5cc PLES in 1000 ml drinking water; T5 mean 2.0 cc PLES in 1000 ml drinking water. Wt., weight. SD, standard deviation.

Table 4. Effect of papaya leaf extract supplementation (PLES) on breast meat quality of broiler chickens (mean±SD)

Items	T1 (0.00 cc PLES)	T2 (0.5 cc PLES)	T3 (1.00 cc PLES)	T4 (1.5 cc PLES)	T5 (2.00 cc PLES)	P-value
Meat color						
L*	50.40± 3.10	51.88± 2.31	52.85± 2.59	50.39± 2.18	52.22± 2.89	0.397
a*	1.46± 0.63	1.37± 1.13	1.75± 0.73	1.22± 0.74	1.30± 0.42	0.786
b*	6.907± 1.15	6.88± 0.77	6.53± 1.43	6.89± 0.66	7.01± 1.33	0.955
Drip loss (%)	6.10±0.22	7.24±1.04	6.69±0.45	5.82±1.30	6.52±0.46	0.306
Cooking loss (%)	26.16±0.13	27.53±5.19	29.84±2.25	25.26±5.90	26.03±1.66	0.608

Treatments: T_1 mean 0.00 cc supplementing papaya leaf extract (PLES) in 1000 ml drinking water; T_2 mean 0.5cc PLES in 1000 ml drinking water**;** T_3 mean 1.00cc PLES in 1000 ml drinking water**;** T_4 mean 1.5cc PLES in 1000 ml drinking water; T_5 mean 2.0 cc PLES in 1000 ml drinking water. SD, standard deviation.

Supplemental effect of PLE in drinking water of broiler chickens on serum biochemical indices are presented in Table 5. The serum biochemical indices were not significantly affected by the treatments but the serum cholesterol level was tended to be reduced in the treated groups than control (T1). The observed reduced cholesterol level as a result of PLE supplementation in drinking water may be due to the activities of phytochemicals such as saponin present in papaya leaf that reduced cholesterol, indicating that papaya leaf has hypocholesterolemic properties. According to Yilkal, (2015) who pointed out that some phytochemicals such as saponin present in leaf meals that has hypocholesterolemic effect and reduce cholesterol uptake in the gut through intra-lumenal physiochemical interaction, which supported to the present study.

Table 5. Effect of papaya leaf extract supplementation in drinking water on serum biochemicals of broiler chickens(mean±SD)

Items	T_1 (0.00 cc PLES)	T_2 (0.5 cc PLES)	T_3 (1.00 cc PLES)	T_4 (1.5 cc PLES)	T_5 (2.00 cc PLES)	P-value
Albumin(g/dl)	1.63± 0.12	1.65± 0.16	1.71± 0.24	1.68± 0.16	1.66± 0.23	0.979
Cholesterol (mg/dl)	191.59± 4.29	185.18± 6.58	184.06±3.66	177.11± 3.87	178.29± 13.31	0.082
HDL (mg/dl)	105.14±11.30	111.32±5.89	108.25±5.99	113.11±7.84	109.71±5.88	0.651
Total protein (g/dl)	3.56± 0.35	3.78± 0.31	3.92± 0.51	3.91±0.37	3.81± 0.52	0.746

Treatments: T_1 mean 0.00 cc supplementing papaya leaf extract (PLES) in 1000 ml drinking water; T_2 mean 0.5cc PLES in 1000 ml drinking water**;** T_3 mean 1.00cc PLES in 1000 ml drinking water**;** T_4 mean 1.5cc PLES in 1000 ml drinking water; T_5 mean 2.0 cc PLES in 1000 ml drinking water. SD, standard deviation.

Conclusion

The findings of this study suggest that the incorporation of papaya leaf extract inclusion in drinking water accelerated growth and decreased level of total cholesterol of broiler chickens than control but satisfactory results are not obtained by this inclusion level. Therefore, further research should be carried out to explore the higher inclusion level of papaya extract to improve production performances, meat quality and health status of broiler chickens.

Conflicts of interest

No potential conflict of interest was reported by the authors.

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