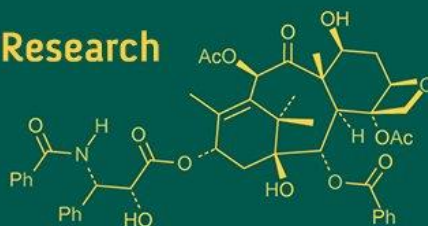


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Effect of dietary inclusion of Rice Distillers Dried Grains Solubles (RDDGS) with or without enzyme on serum biochemical profile and carcass characteristics in broilers

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Abstract

The present study was carried out to assess the effect of dietary inclusion of rice distillers dried grains solubles (RDDGS) with or without enzyme supplementation on growth performance and cost economics in broiler chickens. A total of two-hundred and forty (240), day-old commercial broiler chicks were randomly allocated into six dietary groups (T₁, T₂, T₃, T₄, T₅ and T₆), each with four replicates of 10 birds. The experimental diets included: T₁ (control diet with conventional feed ingredients), T₂ (control diet with enzyme), T₃ (12.5% RDDGS), T₄ (12.5% RDDGS with enzyme), T₅ (15% RDDGS) and T₆ (15% RDDGS with enzyme). The study was conducted over 42 days, with feed and water provided ad libitum. Results revealed serum parameters like glucose, total protein, albumin, globulin, A/G ratio, creatinine, Ca, P, ALT and AST did not alter due to the dietary inclusion of RDDGS at different levels (12.5 and 15%), with or without enzyme supplementation, while serum triglycerides and total cholesterol content significantly ($p < 0.01$) reduced due to inclusion of RDDGS at 12.5 or 15% in the diets with or without enzyme. Incorporation of 12.5% RDDGS along with enzyme (T₄) improved live weight (2562.75 ± 24.73 g) and carcass weight (1945.50 ± 20.53) as compared to other treatment groups (T₁, T₂, T₃, T₅ and T₆) whereas no significant effect ($p > 0.05$) was observed on dressing percentage, primal cuts and visceral organ weights. The physical properties and proximate composition of meat did not show any significant difference across all treatment groups. The feeding of RDDGS levels of 12.5% and 15%, respectively with or without enzyme supplementation do not have any adverse effects on the carcass traits, physical properties and proximate composition of broiler's meat, but inclusion of protease enzyme shown beneficial effect in reducing serum triglycerides and total cholesterol level.

Keywords: Broiler chickens, RDDGS, enzyme supplementation, carcass characteristics, serum biochemical profile

Introduction

Feed constitutes nearly 70% of total poultry production cost, making it a critical factor influencing profitability. The rising cost and inconsistent availability of conventional feed ingredients, particularly maize and soybean meal, along with competition with human food resources, necessitate the exploration of alternative feed ingredients. In this context, distiller dried grains solubles (DDGS), a by-product of the bio-ethanol industry, has emerged as a promising and economical feed resource. DDGS is a protein-rich ingredient composed of approximately 65% distillers grains and 35% solubles (AAFCO, 2005) [1]. The fermentation of starch during ethanol production results in concentration of nutrients, especially protein and phosphorus (Ruan *et al.*, 2017) [21]. Despite its nutritional advantages, higher levels of non-starch polysaccharides (NSPs) in DDGS can limit nutrient digestibility and metabolizable energy availability (Pedersen *et al.*, 2007) [18].

In India, the expansion of the ethanol blending programme has significantly increased DDGS availability, with production projected to rise from 3.2 million metric tons in 2024-25 to 4.2 million metric tons in 2025-26 (BioEnergy Times, 2025). Among various types, rice distiller dried grains solubles (RDDGS) has gained attention due to its substantial nutritional value, containing around 44-50% crude protein and appreciable energy levels (Gupta *et al.*, 2015, Talsani *et al.*, 2021 and Khose *et al.*, 2021) [11, 26, 12].

However, its utilization in broiler diets is constrained by NSP content (Barekatin *et al.*, 2013) [3]. Supplementation of exogenous enzymes such as protease has shown potential in improving nutrient digestibility and utilization in RDDGS-based diets (Dinani *et al.*, 2022; Pont *et al.*, 2023) [8, 19]. Although most studies have emphasized multi-enzyme combinations, limited information is available on the use of protease alone, particularly in high-protein rice DDGS. Therefore, the present study was undertaken to evaluate the effect of dietary inclusion of rice distillers dried grains solubles (RDDGS), with or without protease supplementation on serum biochemical profile and carcass characteristics in broiler.

Materials and Methods

Experimental birds and diets

The experimental protocol was approved by the Institutional Animal Ethics Committee (IAEC) under Ref. no: 281/go/ReBi/S/2000/CPCSEA/CVSc/TPTY/052/Animal Nutrition/2024 dated: 07.05.2024. Two hundred and forty (240), day old commercial broiler chicks were randomly (CRD) allocated to six treatment groups (T₁, T₂, T₃, T₄, T₅ and T₆), with four replicates of each containing 10 birds. The experiment was carried out from day-old to 42 days of age in three phases (pre-starter, starter and finisher). Isocaloric and isonitrogenous experimental diets were formulated for broiler pre-starter (0-7 days), starter (8-21 days) and finisher (22-42 days) phases as per the nutrient requirements of broilers (BIS, 2007) shown in Table 1, 2 and 3. The basal diet (maize and soybean meal) was control (T₁), while the other experimental diets consists of basal diet with protease enzyme (T₂), 12.5% RDDGS (T₃), 12.5% RDDGS with protease enzyme (T₄), 15% RDDGS (T₅), 15% RDDGS with protease enzyme (T₆). The enzyme protease was procured from Kemin Industries South Asia, Pvt. Ltd., Chennai marketed as KEMZYME® PROMACH 5; it was supplemented at a dose of 300 mg/kg.

Data collection

Blood samples were collected during slaughter from two birds per replicate and serum was separated by centrifugation at 3000 rpm for 10 minutes. The serum was stored at -20 °C until analysis. Serum biochemical parameters, including glucose, total protein, albumin, triglycerides, total cholesterol, creatinine, calcium, phosphorus and enzyme activities (ALT and AST), were analyzed using an A15 automated biochemical analyzer with Biosystem kits. At the end of the growth trial, two birds per replicate (eight birds per treatment) were randomly selected for carcass evaluation. Birds were fasted for 10 hours with free access to water prior to slaughter (Halal method). After bleeding, carcass weight was recorded and the head, shank and skin were removed. Evisceration was carried out to collect giblets (heart, liver and gizzard). Primal cuts and giblets were weighed and their percentages were calculated based on carcass weight. Dressing percentage was determined using eviscerated carcass weight relative to live body weight. Meat quality parameters like pH was measured using a digital pH meter after homogenizing meat samples with distilled water. Drip loss was estimated after 24 hours of storage at 4 °C, while water holding capacity (WHC) was determined by a centrifugation method using NaCl solution. Cooking loss was calculated from weight differences before and after cooking. Lipid

oxidation (TBARS) and free fatty acid content were determined using standard procedures and proximate composition was analyzed as per AOAC (2019) [2]. Statistical analysis of the experimental data was performed using one-way ANOVA as described by Snedecor and Cochran (1994) [24] and differences among treatment means were assessed using Duncan's multiple range test (Duncan, 1955) [9] with SPSS Version 21.0 software.

Results and Discussion

The results pertaining to effect of feeding different levels of RDDGS with or without enzyme on serum biochemical profile are presented in Table 4. The serum biochemical profile of broilers fed diets containing 12.5 and 15% RDDGS with or without enzyme showed no significant differences in serum glucose, total protein, albumin, globulin, A/G ratio, creatinine, calcium, phosphorus and liver enzymes (ALT and AST) across treatments. These findings are in agreement with earlier reports by Kumar *et al.* (2022) [14], Raju *et al.* (2022) [20], Dinani *et al.* (2018) [7], while Gacche *et al.* (2015) [10] reported that total serum protein, serum albumin, ALT and creatinine were similar in all the groups, however, AST level increased ($p < 0.05$) with increasing levels of DDGS in the diet. However, serum triglycerides and total cholesterol levels were significantly ($p < 0.05$) reduced in birds fed higher levels of RDDGS at varying levels 12.5 and 15% inclusion with or without enzyme supplementation. Similar reductions in lipid parameters have been reported by several authors (Dinani *et al.*, 2018, Shirisha *et al.*, 2021 and Kumar *et al.*, 2022) [7, 23, 14]. The reduction in lipid profile may be attributed to the presence of unsaturated fatty acids and fermentation by-products in RDDGS, which enhance lipid metabolism (Min *et al.*, 2012 and Raju *et al.*, 2022) [16, 20] and reduce cholesterol synthesis (Crowell, 1999) [6]. Overall, inclusion of RDDGS up to 15% with or without enzyme supplementation did not negatively affect serum biochemical constituents, while improving lipid profile in broilers.

The effect of feeding rice distillers dried grains solubles (RDDGS) with or without enzyme on carcass characteristics in broilers is presented in Table 5. The live weight (g) and carcass weight (g) were significantly ($p < 0.01$) higher in diet incorporated with 12.5% RDDGS with enzyme (T₄), while no significant differences were observed among the other treatments (T₁, T₂, T₃, T₅ and T₆). The dressing percentage, weight of primal cuts (breast, thigh, drumstick and leg) did not show any significant ($p > 0.05$) difference among the treatments T₁ to T₆. The present results align with Kim *et al.* (2016) [13] also observed that low-fat DDGS at 12% level improved carcass yield in broilers. Furthermore, the results agree with the findings of Kumar *et al.* (2017) [15], who demonstrated that replacing soybean meal with DDGS up to 15%, with or without lysine supplementation, did not significantly affect carcass traits in broilers.

The effect of feeding RDDGS with or without enzyme on the physical properties of meat is presented in Table 6. The results indicated no significant differences in pH, drip loss, water holding capacity, cooking loss, TBARS and free fatty acid content among the treatments. The present results are in agreement with the findings of Min *et al.* (2012) [16], who reported that, there was no significant difference in pH, drip loss and free fatty acid content of breast muscle of birds. Similarly, Schilling *et al.* (2010) [22] reported no significant

effect on cooking loss when broilers fed diets containing up to 24% RDDGS. However, TBARS values which is indicative of lipid oxidation, increased with higher levels of RDDGS inclusion (18% and 24%) as reported by Schilling *et al.* (2010)^[22].

Incorporation of RDDGS at varying levels (12.5 and 15%) with or without enzyme showed no significant ($p > 0.05$) differences in proximate composition (DM, CP, EE and total

ash %) broiler's meat among the treatments (Table 7). These findings are in agreement with Schilling *et al.* (2010)^[22] who reported no significant effect of RDDGS inclusion on broiler meat composition. Similarly, Srikala (2017)^[25] also reported no significant differences in the proximate composition of meat in quails fed diets with graded levels of RDDGS with or without spent brewer's yeast.

Table 1: Ingredient composition (%) of broiler pre-starter, starter and finisher experimental rations

Ingredients	Pres-starter						Starter						Finisher					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Maize	52.89	52.89	62.79	62.79	63.17	63.17	53.98	53.98	62.54	62.54	63.63	63.63	59.78	59.78	67.87	67.87	65.87	65.87
Soybean meal	40	40	18.71	18.71	15.8	15.8	37.9	37.9	17.7	17.7	13.6	13.6	31.5	31.5	11.6	11.6	11.2	11.2
RDDGS	-	-	12.5	12.5	15	15	-	-	12.5	12.5	15	15	-	-	12.5	12.5	15.0	15.0
Palm oil	2.5	2.5	1.2	1.2	1.0	1.0	3.8	3.8	2.5	2.5	2.75	2.75	4.535	4.535	3.5	3.5	3.5	3.5
Calcite	2.0	2.0	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.75	1.75	1.9	1.9	1.9	1.9
DCP	1.25	1.25	1.24	1.24	1.2	1.2	1.2	1.2	1.24	1.24	1.2	1.2	1.25	1.25	1.2	1.2	1.1	1.2
Salt	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Lysine HCl	0.2	0.2	0.6	0.6	0.67	0.67	0.1	0.1	0.5	0.5	0.6	0.6	0.1	0.1	0.35	0.35	0.35	0.35
DL-Methionine	0.2	0.2	0.1	0.1	0.3	0.3	0.1	0.1	0.1	0.1	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.1
Toxin binder*	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Trace mineral**	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Vitamin Premix***	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Coccidiostat****	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Liver tonic	0.08	0.08	0.075	0.075	0.075	0.075	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
E care Se	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Phytase	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.01	0.01	0.01	0.01	0.01	0.01
Protease	-	0.03	-	0.03	-	0.03	-	0.03	-	0.03	-	0.03	-	0.03	-	0.03	-	0.03
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Feed cost/kg diet (Rs.)	37.78	37.79	36.86	36.87	39.35	39.36	37.58	37.59	37.2	37.21	38.21	38.22	36.95	36.96	36.01	36.02	37.27	37.28

*Toxin binder (Each kg contains: Phyllosilicates :800g, Surfactant: 100 g, Mycotoxin destroyer complex:100g) ** Trace Mineral (Manganese: 54 g, Zinc :52 g, Copper: 4g, Cobalt :0.1 g, Iron :30 g, Chromium :0.2 g, Iodine :1 g and Selenium :100 ppm) *** Vitamin premix: (Each kg contains: Vit-A: 50MIU, Vit-D3: 10MIU, Vit-B1: 4g, Vit-B2: 20g, Vit-B6: 6g, Vit-B12: 0.08g, Niacin:48g, Calcium-D pantothenate: 32g, Vit-K3:6g, Vit-E: 20g, Folic acid: 4g) ****Coccidiostat (3-5, Dinitro-O-Toluamide: 25 percent w/w).

Table 2: Nutrient composition (% DM) of ingredients used in experimental diets

Nutrient (%)	Maize	Soybean meal	RDDGS
Dry matter	89.57	89.59	92.31
Organic matter	96.15	89.13	94.93
Crude protein	8.95	45.53	63.19
Ether extract	3.52	1.30	3.48
Crude fiber	1.78	7.48	5.79
Total ash	3.84	10.87	5.49
Acid insoluble ash	0.42	4.11	2.25
Nitrogen free extract	81.91	34.82	22.05
ME(kcal/kg) *	3402	2393	3998
Calcium	0.02	0.21	0.68
Phosphorous	0.13	0.38	0.84

* calculated values

Table 3: Nutrient composition (% DM) of Pre-starter, starter and finisher experimental diets fed to broilers

Nutrient	Pre-starter						Starter						Finisher					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Dry matter	91.29	91.52	91.42	91.11	91.33	91.07	91.35	90.47	90.57	90.62	91.04	91.32	90.38	90.6	90.08	90.54	90.47	90.81
Organic matter	92.85	92.83	92.89	92.95	92.02	91.75	92.02	91.97	92.78	92.91	92.98	92.84	92.23	92.29	92.27	92.44	92.54	92.6
Crude protein	23.01	23.07	22.98	23.02	22.99	22.96	21.96	22.01	21.91	21.96	22.08	21.92	20.16	20.14	19.94	19.89	19.88	19.91
Ether extract	4.92	4.97	4.49	4.76	4.52	4.51	5.11	5.05	4.95	5.03	4.87	4.85	5.65	5.54	5.17	5.21	4.97	4.95
Crude fiber	4.31	4.33	4.2	4.17	4.26	4.21	4.79	4.76	4.49	4.59	4.48	4.56	5.02	4.99	5.02	5.01	5.12	5.13
Total ash	7.15	7.17	7.11	7.12	7.17	7.05	7.98	8.02	7.21	7.07	7.01	7.15	7.76	7.7	7.72	7.56	7.46	7.4
Acid insoluble ash	1.08	1.06	1.06	1.03	1.05	1.11	1.79	1.76	1.62	1.61	1.56	1.58	1.77	1.72	1.53	1.58	1.47	1.44
Nitrogen free extract	60.61	60.46	61.22	60.93	61.06	61.27	60.16	60.16	61.44	61.35	61.56	61.52	61.41	61.63	62.15	62.33	62.57	62.61
ME (kcal/kg) *	3006	3010	3013	3019	3020	3014	3100	3100	3100	3098	3097	3100	3200	3200	3203	3198	3199	3200
Calcium	1.02	1.01	1.01	1.02	1.02	1.01	1.01	1.03	0.99	0.97	0.98	0.99	0.98	0.97	0.94	0.93	0.93	0.95
Total phosphorus	0.69	0.68	0.7	0.7	0.72	0.72	0.58	0.58	0.56	0.57	0.6	0.6	0.58	0.6	0.56	0.56	0.6	0.6
Lysine (%) *	1.41	1.41	1.4	1.4	1.43	1.43	1.35	1.35	1.3	1.3	1.31	1.31	1.12	1.12	1.01	1.01	1.1	1.1
Methionine (%) *	0.59	0.59	0.56	0.56	0.79	0.79	0.51	0.51	0.56	0.56	0.77	0.77	0.45	0.45	0.52	0.52	0.74	0.74

*Calculated values

Table 4: Effect of dietary inclusion of rice distillers dried grains solubles (RDDGS) with or without enzyme on serum biochemical profile in broilers

Parameter	Treatments					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Glucose(mg/dl)	220.75±5.39	210.25±8.52	228.00±6.75	232.75±13.17	213.25±4.91	235.25±9.05
Total protein(g/dl)	3.19±0.04	3.44±0.07	3.16±0.04	3.34±0.11	3.20±0.05	3.40±0.10
Albumin(g/dl)	1.69±0.05	1.75±0.03	1.74±0.04	1.62±0.11	1.72±0.09	1.71±0.07
Globulin(g/dl)	1.50±0.04	1.70±0.04	1.42±0.04	1.72±0.17	1.48±0.11	1.68±0.14
A/G ratio	1.13±0.06	1.03±0.02	1.23±0.06	0.98±0.15	1.19±0.13	1.05±0.14
Triglycerides (mg/dl) *	108.01 ^a ±1.25	107.88 ^a ±0.74	104.27 ^b ±2.27	103.52 ^b ±1.67	101.83 ^b ±1.89	100.60 ^b ±1.07
Total cholesterol (mg/dl) *	144.46 ^a ±3.59	143.78 ^a ±1.92	136.60 ^b ±1.80	137.52 ^b ±2.05	135.33 ^b ±2.30	134.77 ^b ±1.17
Creatinine (mg/dl)	0.38±0.03	0.44±0.04	0.38±0.04	0.43±0.02	0.41±0.03	0.34±0.03
Calcium (mg/dl)	9.92±0.22	9.80±0.16	10.16±0.10	9.93±0.23	10.01±0.11	10.19±0.32
Phosphorous (mg/dl)	4.29±0.23	4.72±0.16	4.67±0.24	4.53±0.41	4.90±0.22	4.40±0.19
ALT(U/L)	20.78±0.90	19.26±1.33	21.38±3.34	22.64±2.13	19.90±1.59	23.14±2.10
AST(U/L)	212.78±3.25	207.73±5.80	211.07±1.63	208.31±4.03	214.97±3.55	213.96±4.21

^{ab}Values bearing different superscripts in a same row differ significantly *($p < 0.05$).

Table 5: Effect of dietary inclusion of rice distillers dried grains solubles (RDDGS) with or without enzyme on carcass characteristics in broilers

Carcass trait	Treatments					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Live weight (g)**	2385.50 ^b ±19.45	2405.75 ^b ±18.61	2373.00 ^b ±24.34	2562.75 ^a ±24.73	2401.25 ^b ±12.35	2391.50 ^b ±15.80
Carcass weight (g)**	1788.63 ^b ±16.21	1811.75 ^b ±23.95	1794.25 ^b ±20.26	1945.50 ^a ±20.53	1809.75 ^b ±8.85	1809.63 ^b ±12.03
Dressing %	74.98±0.33	75.31±0.74	75.61±0.18	75.91±0.25	75.38±0.35	75.67±0.22
% of carcass weight						
Breast	27.54±0.42	27.32±0.37	27.69±0.36	27.29±0.17	27.20±0.36	27.09±0.54
Thigh	13.16±0.17	12.93±0.17	13.08±0.20	12.97±0.09	13.17±0.17	13.1±18
Drumstick	10.76±0.14	10.58±0.14	10.70±0.17	10.61±0.08	10.77±0.14	10.72±0.15
Leg	23.92±0.31	23.51±0.31	23.78±0.37	23.58±0.18	23.94±0.30	23.82±0.33
Heart	0.83±0.03	0.77±0.03	0.80±0.03	0.81±0.03	0.76±0.04	0.78±0.04
Liver	2.48±0.06	2.47±0.03	2.42±0.04	2.43±0.06	2.46±0.05	2.47±0.05
Gizzard	2.76±0.06	2.70±0.07	2.68±0.09	2.71±0.06	2.68±0.04	2.74±0.05
Giblet	5.99±0.12	5.95±0.06	5.90±0.11	5.95±10	5.90±0.98	5.98±0.11

^{ab}Values bearing different superscripts in a same row differ significantly ** ($p < 0.01$)

Table 6: Effect of dietary inclusion of rice distillers dried grains solubles (RDDGS) with or without enzyme on physical properties of meat in broilers

Physical properties of meat						
Parameter	Treatments ^{NS}					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
pH	5.97±0.05	6.03±0.04	6.04±0.05	6.08±0.03	6.01±0.04	5.98±0.03
Drip loss (%)	6.73±0.06	6.70±0.08	6.74±0.01	6.74±0.02	6.73±0.01	6.73±0.09
Water holding capacity (%)	70.56±0.41	70.76±0.13	70.58±0.03	69.76±0.71	69.63±0.08	70.36±0.06
Cooking loss (%)	22.40±0.30	23.20±0.25	22.82±0.34	22.62±0.27	22.56±0.28	23.30±0.24
2-TBARS (%)	1.11±0.004	1.11±0.002	1.14±0.004	1.12±0.018	1.12±0.014	1.11±0.014
Free fatty acids (%)	0.14±0.004	0.15±0.001	0.14±0.004	0.15±0.002	0.15±0.001	0.15±0.001

NS-Not significant ($p > 0.05$)

Table 7: Effect of dietary inclusion of rice distillers dried grains solubles (RDDGS) with or without enzyme on meat proximate composition (%) in broilers

Proximate composition (%)						
Parameters (%)	Treatments ^{NS}					
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
DM	27.09±0.24	26.94±0.07	27.41±0.08	27.05±0.13	26.98±0.18	27.24±0.06
CP	21.22±0.25	20.84±0.14	20.96±0.21	20.69±0.23	21.14±0.18	20.65±0.03
EE	1.74±0.04	1.71±0.02	1.79±0.04	1.85±0.11	1.89±0.03	1.92±0.07
TA	1.23±0.02	1.15±0.03	1.13±0.02	1.29±0.07	1.22±0.01	1.17±0.06

NS-Not significant ($p > 0.05$)

Conclusion

The feeding of RDDGS levels of 12.5% and 15%, respectively with or without enzyme supplementation do not have any adverse effects on the carcass traits, physical properties and proximate composition of broiler's meat, but inclusion of protease enzyme with RDDGS shown

beneficial effect in reducing serum triglycerides and total cholesterol level.

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