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Research Article

EFFECT OF RICE DISTILLER DRIED GRAIN WITH SOLUBLES ON GROWTH PERFORMANCE, NUTRIENTS METABOLIZABILITY AND HAEMATO-BIOCHEMISTRY IN BROILER CHICKEN

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ABSTRACT: The present study was carried out to investigate the effect of dietary inclusion of rice distiller dried grain with solubles on growth performance, nutrients metabolizability and haemato-biochemistry in broiler chicken. A total of four hundred (400) day-old Vencobb-400Y broiler chicks were into five treatment groups by using a completely randomized block design (CRD), each consisting of eight replicates containing ten chicks in each. For all three feeding phases, rice DDGS was incorporated at the rate of 0, 2.5, 5.0, 7.5 and 10 kg/100 kg as a partial replacement of soybean meal in the corn-soya-based diets, which were developed on standardized ileal digestible amino acid basis. There was no statistical difference found in cumulative feed consumption between the treatment groups. In all treatment groups, there was a substantial rise in body weight gain (p<0.05), however, there was drop at 10% level of inclusion (p<0.05) compared to control group. The cumulative feed conversion ratio (FCR) was not significantly impacted by the addition of rDDGS. At various rDDGS inclusion levels, the hematato-biochemical profile was unaffected. Nutrient metabolizability remained unaffected over a range of inclusion levels. It is concluded that, rDDGS can be safely added to broiler diets at inclusion levels of up to 7.5% for better performance, as a partial replacement for soybean meal in broiler ration.

Keywords: Growth performance, Heamato-biochemistry, Nutrient metabolizability, Rice distiller dried grain with solubles.

INTRODUCTION

One of the agricultural sectors in India that is growing quickly is broiler farming. Over the past few decades, most broiler strains have demonstrated a noticeable increase in production because of important advancements in diet and genetics. Broilers can reach a body weight of 2.5 kg in 35 days with a feed conversion ratio of 1.5 [1]. Feed constitutes the primary component of broiler production, representing 70-75% of the overall recurring expenses. The cost of feed is largely influenced by the prices of protein sources. One of the most crucial protein sources in broiler feed is soybean meal. In recent years, fluctuations in production, unregulated exports, and increased demand have contributed to a shortage, causing increased prices [2].

In this case, research on the potential and effectiveness of alternative protein sources is required. A byproduct of the alcohol production process is rice DDGS (rDDGS). When distillers separate the starch from the grains, certain enzymes and yeasts convert it to alcohol. Most of the remaining nutrients consist of essential proteins, fats, and vitamins [3]. These days, broiler feed formulae incorporate distiller's dried grains with solubles (DDGS). In India, rDDGS is the most popular and readily available protein source. The incorporation of DDGS into broiler diets offers

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numerous benefits, such as its abundant availability, sufficient protein content, complementary amino acid composition, presence of microbiological phytase, yeast biomass, and its efficacy in enhancing broiler chicken performance when appropriately combined with other feed components [4].

The main issues with using DDGS in broiler diets are that depending on the grain source and drying method, its digestibility and amino acid content may change. The digestibility of amino acids (AA), particularly lysine, in chicken feedstuffs is decreased by the formation of insoluble amino acid-carbohydrate complexes due to overheating during the drying process [5]. Compared to the original grain, the DDGS contains higher crude fiber and non-starch polysaccharides (NPS). Studies have shown that adding low and moderate amounts of DDGS to broiler diets regularly improves performance. However, different research may produce quite diverse results about how adding rDDGS affects growth performance [6, 7, 8, 9]. The current experiment was performed to examine the effects of various dietary inclusion levels of rDDGS on growth performance, nutrient metabolizability, and haemato-biochemistry in broiler chicken up to 42 days of age, taking into account the aforementioned fact and the paucity of literature regarding the effect of feeding rDDGS in broilers.

MATERIALS AND METHODS

Deep litter system was used to raise the birds. The study was finished with the committee's approval and in compliance with the guidelines for the management and supervision of animal experimentation (CPCSEA).

Experimental birds and experiment design

The study was conducted in the Department of Animal Nutrition of West Bengal University of Animal and Fishery Sciences in Kolkata, India. A total of 400-day-old chicks were selected and randomly assigned to five treatment groups, designated as T_1, T_2, T_3, T_4, and T_5, each comprising 80 birds. Each treatment group was further divided into 8 replicates, with each replicate containing 10 birds. Broiler pre-starter, broiler starter, and broiler finisher are five corn-soy-based iso-caloric and iso-nitrogenous broiler diets that were developed in accordance with the BIS, 2007 using standardized ileal digestible amino acids as recommended by the breeders. rDDGS was added at the rates of 0, 2.5, 5.0, 7.5, and 10 kg/100 kg as a partial replacement of soybean meal for all three feeding phases pre-starter (0-11 days), starter (12-22 days) and finisher diets (23-42 days) for treatment group T_1, T_2, T_3, T_4 and T_5, respectively (Table 1).

Housing, light management and experimental diets

The broiler chickens were housed in an asbestos-roofed traditional poultry shed. During the first three days, the shed was divided into thirty 12-square-foot pens, each with a dirt floor, rice husk beds, and corrugated paper coverings. The floor space of every broiler chicken in the shed was 1.25 square feet. During the 42-day experiment, broilers were exposed to both natural and artificial light every single day. The nutritional values of each of the iso-caloric and iso-nitrogenous diets were also analyzed in the analytical lab (Table 1). All experimental birds received mash-based feed and unlimited access to healthy, clean drinking water during the trial period. Throughout the trial, all of the experimental broiler chickens were kept in a brooder/grower house with typical sanitary conditions, adhering to all biosecurity protocols. On days five and twenty-one, broilers were vaccinated against Newcastle disease using the NDB_1 and Lasota strains, respectively and against infectious bursal disease on day twelve.

Growth performance parameters

The experimental birds were offered known quantity of feed each day, and the refusal was recorded in the next day. The difference between the feed that was offered and the feed that was refused was computed and expressed as g/day/replicate in order to determine the actual feed consumed by each duplicate (within a group) on a particular day. At the end of the experiment, total feed consumption (CFI) was calculated using similar formulas for feed consumption, which was expressed as g/week/replicate. The live weights of each individual bird were recorded from every replication within the group on the initial day, followed by weekly measurements thereafter. In order to establish how much feed each replicate (in a group) actually consumed on a certain day, the difference between the feed that was provided and the feed that was refused was computed and expressed as g/day/duplicate.

Up to the end of the experiment, the mean live body weight (g/bird/week) was determined and kept constant at weekly intervals. The difference between a week's body weight and the week prior was used to calculate body weight growth (BWG). The FCR values for each group were calculated weekly based on live weights and feed consumption. Feed efficiency (CFCR) was calculated using the formula CFCR = CFI / CBWG.

Blood collection for haemato-biochemistry parameters

After the trial period, hemato-biochemical parameters were assessed. Eight birds were chosen at random from each treatment group for hemato-biochemistry. Out of 5 ml blood, three milliliters of the blood samples were centrifuged for biochemical study. The remaining 2 ml of EDTA coated blood sample were used to estimate the hematological profile. The Wintrobe's tube [10] and the acid hematin method [11] were used to quantify hemoglobin and PCV in whole blood as soon as it was drawn. The normal protocol was followed for TEC, TLC, and DLC [12]. Using standard kits and a semi-auto biochemistry analyzer (Span Diagnostic Ltd.), the biochemical properties of serum, including albumin, total protein, glucose, globulin, creatinine, triglycerides, cholesterol, HDL, LDL, AST, ALT and ALP were determined.

Metabolizability trial

A metabolism study was conducted to determine the nutrient utilization following 5-day collecting period. From each replication, one bird was selected and placed in each of the twenty metabolic cages, which could accommodate two birds each. The birds were fed finisher feed containing 0.5% titanium dioxide as an external marker. The amount of droppings produced during this time was recorded, as was the total feed intake for each duplicate in the relevant dietary group. Several proximate principles were analyzed in the feed and excreta sample [13]. As an inert indicator of the diets and excrement, titanium dioxide was used [14]. The nutrients' metabolizability coefficient (MC) of the nutrients was calculated as follows.

$$\text{MC \%} = 100 - [100 \times \frac{\text{\% Titanium oxide in diet}}{\text{\% Titanium dioxide in faeces}} \times \frac{\text{\% Nutrient in faeces}]}{\text{\% Nutrient in diet}}$$

Statistical analysis

Using a completely randomized design and one-way ANOVA, the data on growth, feed intake, FCR, hemato-biochemistry parameters, and nutrient metabolizability were analyzed using SPSS version 22 in accordance with conventional statistical procedures [15].

RESULTS AND DISCUSSION

Proximate composition

The proximate composition of rDDGS were analyzed on a dry matter basis and expressed in percentages (Table 2). It is comparable to soy DOC in terms of proximate composition and is a strong source of protein with little crude fiber. A range of 44–46% protein in rDDGS was described by earlier researchers [16, 17, 2, 18]. In contrast to our findings, one study reported a crude protein content of 30% in rDDGS, which may be attributed to variations in grain composition, drying temperature, and preparation methods. [19]. 28.5% CP was found in Chinese rDDGS made by fermenting rice and bran, according to another study [20].

Growth performance

The growth performance in terms of body weight, feed intake, and feed conversion ratio (FCR) for each treatment group have been presented in Table 3. The average body weight increases significantly ($p < 0.01$), with the 2.5% rDDGS inclusion level group achieving the highest body weight and the 10% inclusion group achieving the lowest. While a higher degree of inclusion did not show any additional benefits, it appears that adding rice DDGS to the Vencobb-4000Y broiler diet increased net protein accretion up to certain level.

The presence of microbiological phytase in rDDGS, which increases phosphorus bioavailability, may also contribute to the treatment groups' superior results. Additionally, rDDGS has a substantial amount of yeast biomass, which may be advantageous for gut health and development as well as useful for immune system stimulation [5]. A higher NSP level and the inability of chickens to effectively utilize the high dietary fiber of rDDGS may be the cause of the reduction in growth performance at a higher level of rDDGS inclusion. According to some studies [21, 6, 22, 7, 2, 18, 9], DDGS inclusion at a 10-15% level did not exhibit any harmful effect on body weight growth, which contradicts our findings and is likely the result of different sources and compositions of DDGS used in formulating the diet.

There was no significant difference in feed intake between the treatment groups ($p > 0.05$). Although this effect was nonlinear, it appears that adding rDDGS to the diet had some detrimental effects on feed intake during the beginning period. Because young chicks have a natural preference for feed of particular type [23], the rDDGS inclusion may alter the color of the formulated diet. This is evident in lower feed intake in rDDGS inclusion groups compared to T_1. Birds consumed more feed to compensate the dilution effect of the NSP in order to meet their energy and nutrient needs [25]. This is because rDDGS was added to the diet [18, 24], which suggests a higher level of NSP in DDGS that was not digested by the birds' endogenous enzymes.

Table 1. Ingredient and chemical composition of pre starter, starter and finisher broiler diet.

Particular	Pre starter (0-11 days)					Starter (12-22 days)					Finisher (23-42 days)				
	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5	T_1	T_2	T_3	T_4	T_5
Ingredient composition (g/kg)															
Maize	540	543	546	548	551	593	595	598	600	603	612	614	617	619	620
Soybean meal	380	355	330	306	281	327	302	278	253	228	303	279	254	229	205
Rice DDGS	0	25	50	75	100	0	25	50	75	100	0	25	50	75	100
Soybean oil	36	33	30	26	23	40	36	33	29	26	48	45	41	38	35
Di calcium phosphate	19.91	19.67	19.42	19.18	18.93	17.78	18.39	16.61	19.39	18.21	16.13	16.08	16.04	16.30	17.60
Limestone powder	10.09	9.70	9.33	9.94	9.57	8.99	9.14	9.91	9.44	9.10	8.29	8.4	8.56	8.7	8.84
Sodium chloride	3.24	3.27	3.29	3.32	3.35	3.25	3.28	3.31	3.33	3.36	3.26	3.3	3.32	3.34	3.36
DL-Methionine	3.18	3.17	3.15	3.13	3.10	2.75	2.74	2.72	2.70	2.68	2.78	2.10	2.3	2.28	2.26
L-Lysine	1.64	2.13	2.62	3.11	3.60	1.47	2.57	2.45	2.00	3.43	0.88	1.36	1.86	2.34	2.84
L-Threonine	0.84	0.96	1.09	1.22	1.35	0.66	0.78	0.90	1.04	1.12	0.56	0.66	0.82	0.94	
Maduramycine 1%	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
BMD	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
Toxin binder[1]	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
Sodium bicarbonate	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Organic trace mineral premix[2]	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
Vitamin premix[3]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Choline chloride	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Antioxidant[4]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Nutrient composition															
ME (kcal/kg)[5]	3008	3008	3008	3008	3007	3086	3086	3086	3086	3086	3167	3167	3167	3167	3167
Crude protein (%)[6]	21.75	22.15	21.90	21.85	22.10	19.87	20.05	20.12	19.94	19.96	19.08	18.96	19.1	19.12	18.94
Ether extract (%)[6]	6.16	5.90	5.78	5.59	5.41	6.62	6.43	6.24	6.06	5.87	7.52	7.34	7.53	6.96	6.83
Crude fiber (%)[6]	3.55	3.61	3.66	3.71	3.76	3.34	3.40	3.45	3.50	3.55	3.24	3.29	3.35	3.40	3.45
Calcium (%)[6]	0.95	0.87	0.92	0.90	0.87	0.86	0.84	0.87	0.90	0.82	0.76	0.73	0.79	0.74	0.77
Available phosphorus (%)[5]	0.45	0.45	0.45	0.45	0.45	0.42	0.42	0.42	0.42	0.42	0.38	0.38	0.38	0.38	0.38
Dig. Lysine (%)[5]	1.18	1.18	1.18	1.18	1.18	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.95	0.95
Dig. Methionine (%)[5]	0.60	0.60	0.60	0.60	0.60	0.54	0.54	0.54	0.54	0.54	0.48	0.48	0.48	0.48	0.48
Dig. Methionine + cysteine (%)[5]	0.88	0.88	0.88	0.88	0.88	0.80	0.80	0.80	0.80	0.80	0.74	0.74	0.74	0.74	0.74
Dig. Threonine (%)[5]	0.77	0.77	0.77	0.77	0.77	0.69	0.69	0.69	0.69	0.69	0.65	0.65	0.65	0.65	0.65

[1]NiltoxTM, Zeus Biotech Limited, Mysore, India.
[2]Contains (per kg): Zn proteinate, 50 g; Fe proteinate, 30 g; Cu proteinate, 10 g; Se proteinate, 0.5 g; Mn proteinate, 50 g; I, 4 g; Cu proteinate, 0.4 g (Zeus Biotech Lmited, Mysore, India).
[3]Contains (per kilogram): vitamin A, 80,000,000 IU; vitamin D3, 16,000,000 I.U; vitamin E, 64 g; vitamin K, 8 g; vitamin B1, 6.4 g; vitamin B2, 40 g, niacin, 96 g, pantothenic acid, 64 g; vitamin B6, 12.8 g; folic acid 6.4 g; vitamin B12, 0.164 g; and biotin, 0.24 g.
[4]Endox, Kemin Industries, Inc., USA.
[5]Calculated values.
[6]Analysed values.

Though quantitatively superior in treatment groups (T_2 to T_5), the cumulative feed conversion ratio, did not differ substantially across treatment groups on the 42[nd] day. According to reports [26], the birds fed 15% DDGS did not exhibit a significant change in feed conversion ratio when compared to the control, which is consistent with the results of the current investigation. Better FCR in rDDGS inclusion groups was also reported during the starting phase [18], although the effect was not the same at the end of the experiment. However, a small number of investigations [21, 27, 28, 24] found that less improvement in FCR was observed with increasing levels of rDDGS.

Nutrients metabolizability

The nutrient metabolizability (%) findings (Table 4) suggests that at different levels of DDGS

Table 2. Chemical composition of rice DDGS.

Sl. No.	Nutrient	Mean	SE
1	Dry matter	90.87	0.41
2	Organic matter	94.85	0.13
3	Ash	5.15	0.13
4	Crude protein	40.24	0.66
5	Ether extract	7.69	0.60
6	Crude fiber	6.26	0.16
7	NFE	31.53	1.35
8	AIA	1.45	0.10

inclusion, the metabolizability of the nutrients showed no significant difference (p >0.05) between the treatment groups.

The current results are consistent with those of other studies [7, 18] who found that the addition of DDGS up to 15% had no effect on the metabolizability of crude protein and organic matter. The metabolizability of DDGS protein is almost equal to the metabolizability of the protein from all other sources in the diet. A different age (4th week) and a larger inclusion level (up to 15%) may have contributed to the lower nitrogen retention seen in one study [2], which contraindicates our results.

Heamato-biochemical parameters

The hematobiochemical parameter results (Table 5) show that there is no significant difference (p>0.05) in blood components between the different rDDGS inclusion level groups. Dietary inclusion levels of DDGS (up to 30%) was found to have no negative effect on hemoglobin concentration [29], which is likely related to differing climatic conditions. In contrast, the Hb and PCV of experimental birds were within the normal physiological range.

Similarly, broiler chicks fed rDDGS combinations with or without enzymes showed no discernible changes in hematological components at varying dietary doses [30]. In contrast to the current study, one study [7] found that broiler diets containing up to 15% DDGS had improved blood hemoglobin levels at 42 days of age. According to a different study [31], broiler chickens' PCV and Hb values were significantly (p < 0.01) improved when rDDGS was added above a 5% level in comparison to the control diet. In tune with earlier publications, there were no significant differences in TEC or DLC across treatment groups [29, 32].

While there was no significant difference (p> 0.05) in the biochemical parameters of glucose, total protein, albumin, globulin, A/G, creatinine, triglyceride, cholesterol, HDL, LDL, serum enzyme SGOT, SGPT, and alkaline phosphatase between treatment groups, there was a significant decrease (p < 0.05) in serum cholesterol

Table 3. Effect of different dietary inclusion level of rice distiller dried grain with soluble (rDDGS) on performance in broiler.

Parameters	Groups					SEM	Contrast	P Value	
	T_1	T_2	T_3	T_4	T_5			Linear	Quadratic
Body weight gain (g)	2535.75^{ab}	2590.5^{a}	2527.12^{ab}	2565.75^{ab}	2408.87^{b}	42.72	0.048	0.047	0.052
CFI (g)	4034.75	3870.00	3909.37	3914.50	3784.25	59.07	0.074	0.020	0.879
CFCR	1.59	1.50	1.55	1.53	1.57	0.03	0.051	0.961	0.020

Table 4. Effect of different dietary inclusion level of rice distiller dried grain with soluble (rDDGS) on nutrient metabolizability (%) in broiler.

Parameters	Groups					SEM	Contrast	p Value	
	T_1	T_2	T_3	T_4	T_5			Linear	Quadratic
Dry Matter	70.6	71.19	71.35	72.15	71.05	0.58	0.75	0.48	0.39
Ether Extract	74.46	73.65	74.57	75.96	72.33	1.02	0.51	0.67	0.35
Crude Protein	67.48	68.02	68.35	67.56	67.35	0.44	0.75	0.72	0.27
Crude fiber	20.66	21.04	23.35	20.44	21.04	0.74	0.37	0.96	0.24
NFE	80.92	81.65	81.59	81.72	81.05	0.94	0.98	0.93	0.60

Table 5. Effect of different dietary inclusion level of rice distiller dried grain with soluble (rDDGS) heamato-biochemical profile

Attributes	Groups					SEM	Contrast	p Value	
	T_1	T_2	T_3	T_4	T_5			Linear	Quadratic
Hematology									
Hb g/dl	10.39	10.58	11.07	10.99	10.41	0.23	0.147	0.485	0.24
PCV (%)	31.34	32.07	33.44	33.22	31.39	0.71	0.134	0.508	0.019
TEC (10^6 /cc)	2.24	2.28	2.35	2.37	2.23	0.07	0.533	0.743	0.131
TLC (10^3/cc)	22.46	22.72	22.80	22.63	22.75	0.19	0.758	0.428	0.473
Neutrophil (%)	25.12	23.85	24.50	24.00	25.14	0.37	0.065	0.959	0.016
Eosinophils (%)	5.12	5.14	5.12	4.80	5.00	0.51	0.095	0.758	0.989
Basophils (%)	1.12	0.85	1.12	0.75	1.14	0.31	0.847	0.895	0.587
Monocyte (%)	4.25	4.57	4.87	4.75	4.85	0.40	0.801	0.286	0.575
Lymphocytes (%)	64.30	65.57	64.37	65.62	63.85	0.86	0.542	0.806	0.313
Biochemical									
Blood glucose (mg/dl)	203.25	213.37	205.62	207.0	208.0	8.21	0.93	0.90	0.76
Total protein(g/dl)	3.87	3.50	3.67	3.74	3.86	0.25	0.82	0.77	0.35
Albumin (g/dl)	1.46	1.36	1.44	1.32	1.41	0.06	0.43	0.47	0.38
Globulin (g/dl)	2.40	2.14	2.22	2.41	2.44	0.21	0.80	0.60	0.38
Albumin: Globulin	0.62	0.66	0.66	0.60	0.58	0.05	0.67	0.36	0.33
Creatinine (mg/dl)	1.09	1.25	1.30	1.23	1.22	0.07	0.35	0.33	0.09
AST (IU /L)	191.37	194.50	197.37	191.25	190.0	5.41	0.87	0.73	0.38
ALT (IU/L)	20.87	21.87	20.62	21.62	21.75	0.83	0.75	0.57	0.87
ALP(IU/L)	43.87	42.50	41.37	42.00	42.00	1.14	0.61	0.25	0.30
TGL (mg/dl)	113.42	133.07	95.13	120.03	96.49	9.79	0.46	0.14	0.52
Cholesterol (mg/dl)	125.14	127.14	136.67	136.81	127.29	6.76	0.59	0.51	0.21
HDL (mg/dl)	81.22	83.64	85.41	86.52	82.33	4.27	0.90	0.70	0.39
LDL (mg/dl)	38.62	38.46	41.07	41.38	38.62	2.21	0.78	0.68	0.37

levels in the 15% rDDGS group and a significant decrease ($p < 0.05$) in serum triglyceride levels in the 12.5% and 15% rice DDGS groups when compared to the control [32]. The current results are consistent with those of [29], who found that broiler chickens given DDGS at rates of 0, 2.7, 5.4, and 8.1% in the starter phase and 0, 2, 4, and 6% in the finisher period had comparable levels of total blood protein, serum albumin, ALT, and creatinine. One research finding revealed that increasing maize DDGS levels significantly ($p < 0.01$) raised blood triglycerides, cholesterol, and LDL for hens fed a diet containing 22% DDGS which did not support the current findings. Likewise, 10% rice DDGS significantly ($p < 0.01$) increased serum albumin, total serum protein, blood A/G ratio, and serum glucose value while significantly ($p < 0.01$) decreased the serum lipid profile (triglycerides, cholesterol, LDL, and VLDL) [31]. As rDDGS levels increased in the Kuroiler chicken diet, serum globulin levels increased as well, indicating improved immunomodulatory and disease-resistant capabilities [24].

CONCLUSION

The present study suggests that rice distillers dried grains with soluble (rDDGS) can be used as an alternative protein source and can replace soybean meal up to 7.5% in the diet without having any negative effects on health or nutrient utilization.

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