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Effect of Feeding Different Levels of Rice Distillers Dried Grains with Soluble (RDDGS) on Performance of Broiler

Niharika Singh, Meenu Dubey*, Raina Doneria, M.K. Gendley, O.P. Dinani and R.C. Ramteke

Department of Animal Nutrition, College of Veterinary Science and A.H., Anjora
Chhattisgarh Kamdhenu Vishwavidyalaya, Durg

ABSTRACT

Rice distillers dried grains with solubles (RDDGS) is a co-product of rice-based ethanol production that can be a valuable source of energy, digestible amino acids, and available phosphorus in poultry feeds. The present study was conducted for 5 weeks to study the effect of different dietary inclusion levels of rice DDGS on performance of broiler chickens. The diets were prepared using conventional feed ingredients: maize, deoiled soybean cakes, soy oil, rice DDGS and premixes containing trace minerals and vitamins. The average body weight of chicks at the end of pre-starter and starter phase was significantly ($P<0.05$) higher in birds fed diet with 10 and 15% rice DDGS as compared to control, however, at 35 d the difference in body weight was not significant amongst the group. No significant effect of rice DDGS inclusion on weekly and cumulative feed intake was observed. The cumulative FCR up to 3 weeks was significantly ($P<0.05$) better in all the treatment groups irrespective of level of rice DDGS, however, at the end of experiment the difference amongst the group was not significant. No significant effect of different dietary inclusion levels of rice DDGS on metabolizability of DM was observed. The N and Ca balance also did not vary significantly among the groups, however, the P balance was significantly ($P<0.05$) higher in all the treatment groups irrespective of level of rice DDGS. Birds fed diet with 10% DDGS gave best response in terms of net profit per kilogram of body weight. It is therefore concluded that rice DDGS can be incorporated at 10% level in broiler feed.

Key Words: RDDGS, Growth, Nutrient utilization, Broiler chickens

INTRODUCTION

Poultry is one of the fastest growing segments of the agriculture sector in India and is one of the key industries to provide feed security to a large population in terms of energy and protein as well as employment to people. A major constraint affecting the growth of the poultry industry in India is price and availability of feed resources. Feed costs are primarily driven by the cost of protein sources. With increasing feed prices, the interest in using alternative feed sources like DDGS in poultry diets has escalated during recent years. Distillers dried grain with solubles (DDGS) is a co-product of ethanol industry which is obtained from grains through a process of dry milling. The DDGS is a unique feedstuff that provides high levels of protein, energy, digestible fibre and minerals (Schingoethe *et al.,* 2009). Chemical analysis on as such basis indicated that rice DDGS is high in protein (44.68%) and gross energy 4232 kcal/kg (Dinani *et al.,* 2019). It is also more nutritious than the cereals from which it is made up of, as it contains other nutrients recovered from fermented grains. The DDGS is being used either wet or dry but performance is usually similar whether fed as wet or dried products (Koger *et al.,* 2010). Furthermore, DDGS also contains moderate level of fat and readily digestible fibre which contributes to the higher energy concentration. The high energy and protein content of DDGS makes it a very attractive resource for partial replacement of some of the more expensive traditional energy (maize) and protein (soybean meal) ingredients used in animal feeds. Keeping in view the above facts, the present experiment was planned to study the effect of different dietary inclusion level of rice DDGS on growth performance, nutrient utilization and economics of rearing broiler chicken up to 35 d of age.

MATERIAL AND METHODS

The experiment was conducted in the poultry shed of College of Veterinary Science & A. H., Anjora, Durg.

*Corresponding author; Email: drmeenu.dubey@gmail.com; Mobile No. 09926130785

A biological experiment of five weeks duration was conducted following completely randomized design (CRD). A total of 180, day-old Ross AP strain broiler chicks were reared under deep litter system. The chicks were divided into 4 dietary treatment groups (T_1-T_4). Each group had 3 replicates of 15 chicks in each. The diets were formulated as per ICAR (2013) specification for pre-starter (0-14 d), starter (15-21 d) and finisher (22-35 d) stages. The pre- starter diets contained 22% CP and 3000 kcal ME, starter diet contained 21.5% CP and 3050 kcal ME, and finisher diet contained 19.5% CP and 3100 kcal ME/kg feed. Four types of diets were formulated for each phase using maize, soy DOC, rice DDGS, soy oil, premixes containing minerals, vitamins and feed additives. Diet I served as control with no rice DDGS, diet II, III and IV contained 5%, 10% and 15% rice DDGS respectively replacing soy DOC and some part of maize (Table 1). All the diets were made iso-caloric and iso-nitrogenous. The body weight of individual bird was recorded every week and gain in weight was calculated. Weekly and cumulative feed consumption was recorded and feed conversion ratio was calculated in each treatment group. A metabolism trial of 4-day duration was conducted between d 30-35 to determine the nutrient balance (N, Ca and P) in the broilers. The sample of diet and excreta were analyzed for various proximate principles, namely N (AOAC, 2000), Ca (Talapatra *et al.,* 1940)

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

Particulars (%)	Pre starter				Starter				Finisher			
	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Maize	55.72	55.90	55.92	53.54	55.72	55.90	55.92	53.54	55.72	55.90	55.92	53.54
Soy DOC	37.95	33.55	28.26	25.57	37.95	33.55	28.26	25.57	37.95	33.55	28.26	25.57
RDDGS	-	5.00	10.00	15.00	-	5.00	10.00	15.00	-	5.00	10.00	15.00
Soy oil	2.86	2.00	2.12	2.14	2.86	2.00	2.12	2.14	2.86	2.00	2.12	2.14
DCP	1.28	1.31	1.34	1.34	1.28	1.31	1.34	1.34	1.28	1.31	1.34	1.34
LSP	1.08	1.10	1.11	1.13	1.08	1.10	1.11	1.13	1.08	1.10	1.11	1.13
Premix*	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Salt	0.35	0.35	0.31	0.30	0.35	0.35	0.31	0.30	0.35	0.35	0.31	0.30
Methionine	0.14	0.13	0.12	0.10	0.14	0.13	0.12	0.10	0.14	0.13	0.12	0.10
Lysine	0.07	0.07	0.18	0.22	0.07	0.07	0.18	0.22	0.07	0.07	0.18	0.22
Soda bicarb	0.09	0.09	0.14	0.16	0.09	0.09	0.14	0.16	0.09	0.09	0.14	0.16
Choline	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chemical Composition (%)												
Moisture	11.92	11.5	11.78	12.41	11.24	12.42	11.92	12.12	10.47	10.21	10.88	11.21
CP	21.94	21.86	22.01	21.94	21.56	21.60	21.72	21.68	19.57	19.61	19.52	19.63
CF	3.52	3.79	4.56	4.88	3.41	3.78	4.28	4.7	4.3	4.44	4.56	4.70
EE	4.71	4.22	3.52	3.72	5.29	5.52	5.71	5.21	6.6	6.72	6.79	6.5
Total ash	7.02	6.88	6.80	6.36	7.21	6.01	7.91	7.52	6.81	6.31	6.87	6.41
Ca	1.04	1.05	1.10	1.07	1.10	1.07	1.04	1.08	1.10	1.21	1.23	1.21
P	0.63	0.62	0.65	0.64	0.61	0.67	0.63	0.70	0.7	1.12	1.1	1.1

RDDGS -rice distillers dried grain with soluble, Soy DOC-Soy deoiled cake, DCP-dicalcium phosphate, LSP Limestone powder; *Trace mineral and vitamin premix; Trace mineral premix per kg diet contained CoCo3 0.20 mg, ZnO 112.0 mg, Fe(So4)3 85 mg, MnSo4 105 mg, CuSo4 22.5 mg, Sodium salenite 0.30 mg and potassium iodide 2.5 mg. Vitamin premix per kg diet contained vitamin A 15.60 MIU, vitamin D3 5.25 MIU, vitamin B1 3.60 mg, B2 12.0 mg, B6 8.0 mg, B12 0.02 mg, biotin 0.18 mg, Ca D pantothenate 15.0 mg, vitamin E 120 mg, folic acid 5.0 mg, vitamin K 4.0 mg and niacin 57.5 mg

and P (Fiske and Subbarao, 1925) to determine the nutrient balance. Data obtained were analyzed statistically (snedecor and Cochran, 1998).

RESULTS AND DISCUSSION

Data pertaining to the comparative proximate composition of rice DDGS and soy DOC are presented in table 2. Nutrient content of RDDGS is comparable to soy DOC. Previous researchers (Dinani *et al.,* 2019; Gupta *et al.,* 2015; Rao *et al.,* 2016) reported 45% CP in RDDGS. Dietary inclusion of rice DDGS at different levels accrued significant variation in average body weight of chicks at the end of pre-starter phase (0-14 d). The body weight was significantly (P<0.05) higher in birds fed diet with 10% and 15% rice DDGS as compared to control. Inclusion of rice DDGS irrespective of level of inclusion significantly (P<0.05) improved the live weight as compared to control at day 21 (Table 3). Amongst the treatment group the difference in body weight was not significantly different during this phase. The findings corroborate well with the results of Shim *et al., (*2011) who reported increased weight gain in broilers fed 8, 16 or 24% DDGS during the starter (0-18 d) period. No significant effect of different dietary inclusion levels of rice DDGS on average body weight was observed at the end of finisher stage (Table 3). The findings are in accordance with the observations of previous researchers (AbdEl-Hack, 2015; Choi *et al.,* 2008 and Youssef *et al.,* 2013) who reported no adverse effect on growth performance when corn DDGS was included in broiler diet. In contrast, reduction in body weight gain was reported by Dinani *et al.* (2019) when RDDGS was included at 15% level in broiler feed. Reduction in body weight gain was also reported by some other researchers (Loar *et al.,* 2010; Sonu *et al.,* 2018) when higher level of corn DDGS was incorporated in broiler feed. On the other hand, higher body weight gain at 42 d in Japanese quail was reported by El – Abd (2013) when corn DDGS was used at 50 and 100% level.

The weekly feed intake due to different inclusion levels of rice DDGS differed non-significantly amongst the groups during pre-starter and starter phase (Table 3). The cumulative feed intake at the end of 35 d was 2965.9, 2879.8, 2858.1 and 2959.4 g in groups T_1, T_2, T_3 and T_4, respectively. No significant effect of different inclusion levels of rice DDGS on cumulative feed intake was reported in the study. The findings are in accordance with the results of earlier researcher (Romero *et al.,* 2012) who reported no significant difference in feed intake for hens fed corn DDGS up to 20 %. Dinani *et al.* (2019) also observed that rice DDGS up to 12.5% level in broiler feed did not have any significant effect on feed intake, but at 15% level significant (P<0.05) reduction in feed intake was observed. Deniz *et al.* (2013) and Thein *et al.* (2020) also reported that the use of 20% DDGS in the diets significantly depressed the feed intake of birds. Abd El Hack (2015) reported that increasing DDGS in the diet up to 16.5% was associated with an increase in feed intake while increasing the level up to 22% led to a marked depression in feed intake.

The feed conversion ratio was significantly

Table 2.Comparative proximate composition of soy DOC with rice DDGS

Attributes (%)	Soy DOC	Rice DDGS
Dry matter	91.17	90.51
Moisture	8.83	9.49
Crude protein	45.77	42.10
Crude fat	1.40	7.11
Crude fiber	6.70	9.05
NFE	39.23	48.82
Total ash	6.90	4.89
Acid insoluble ash	2.43	1.20

Table 3. Effect of different dietary inclusion levels of rice distillers dried grains with solubles (RDDGS) on feed intake, body weight gain and FCR

Days of Observation	Groups				P Value
	T_1	T_2	T_3	T_4	
Average weekly body weight (g)					
0	42.97±1.17	43.26±1.24	43.83±0.17	43.09±0.54	0.90
07	156.43±2.02	165.51±2.52	162.89±5.49	172.72±2.77	0.06
14	401.83^{a}±4.71	426.45^{ab}±18.84	456.16^{b}±12.16	464.26^{b}±18.12	0.02
21	829.06^{a}±13.41	882.24^{b}±6.01	882.25^{b}±17.53	888.73^{b}±4.73	0.02
28	1384.22±49.86	1364.46±19.26	1403.51±24.93	1441.15±16.39	0.38
35	1970.30±60.13	2002.56±29.49	1993.27±28.71	2016.06±37.04	0.87
Cumulative feed intake					
0-7	139.86±2.89	138.86±0.14	142.33±3.28	139.13±0.08	0.68
0-14	443.02±6.80	428.96±0.34	439.43±10.34	436.53±6.83	0.57
0-21	1041.62±31.86	989.36±1.39	1011.23±23.35	1009.43±19.67	0.45
0-28	1906.91±70.23	1790.91±3.74	1825.00±26.35	1865.46±34.31	0.29
0-35	2965.99±70.71	2879.81±25.90	2858.08±43.72	2959.38±85.24	0.52
Cumulative feed conversion ratio					
0-7	1.09±0.05	1.03±0.01	1.07±0.03	0.97±0.02	0.12
0-14	1.22^{b}±0.12	1.12^{ab}±0.05	1.06^{a}±0.02	1.03^{a}±0.02	0.01
0-21	1.32^{b}±0.02	1.18^{a}±0.08	1.20^{a}±0.01	1.19^{a}±0.01	0.01
0-28	1.42±0.05	1.35±0.02	1.34±0.008	1.33±0.03	0.37
0-35	1.53±0.01	1.47±0.01	1.46±0.01	1.50±0.07	0.53

[a,b]Means in the same row with different superscript (a,b) differ significantly

(P<0.05) better in groups T_3 and T_4 as compared to control during pre-starter phase. The cumulative FCR at 21 d was significantly (P<0.05) better in all the treatment groups as compared to control, however at the end of finisher stage the effect of rice DDGS inclusion on cumulative FCR was not significant (Table 3).The findings corroborate well with previous reports (Youssef *et al.,* 2013: Lumpkins *et al.,* 2004) which indicated no negative effect on FCR when DDGS was used in broiler feed. In contrast, some researchers (Deniz *et al.,* 2013; Ghazalah *et al.,* 2011; Jiang *et al.,* 2013; Loar *et al.,* 2011; Wang *et al.,* 2007) observed negative effect on F: G ratio when DDGS was incorporated in the broiler feed. Better feed conversion ratio in Japanese quail was reported by EI-Abd (2013) when chicks were fed 50 and 100% corn DDGS.

Table 4. Effect of different dietary inclusion levels of rice distillers dried grain with soluble (RDDGS) on DM, CP and EE utilization in broilers

Particulars		Groups				P Value
		T_1	T_2	T_3	T_4	
Dry matter	Intake (g)	129.99±5.55	115.72±4.96	117.34±0.82	122.77±14.44	0.61
	Outgo (g)	22.58±1.77	21.82±1.35	23.63±3.38	21.32±4.02	0.82
	Balance (g)	107.40±8.42	93.90±2.85	93.70±5.32	101.44±12.15	0.54
	Metabolizability(%)	82.51±3.02	81.14±1.42	79.83±3.98	82.46±1.16	0.56

No significant effect of different dietary inclusion levels of rice DDGS on metabolizability of dry matter was observed in birds of different groups (Table 4). The findings corroborate well with the results of Ghazalah *et al.,* (2011) and Shalash *et al.,* (2009) who reported no significant variation among DDGS levels for DM, OM, EE and NFE digestibility. The findings are not in line with observations of previous researchers (Abdelrahim *et al.,* 2011; Gibb *et al.,* 2008 and Sahin *et al.,* 2013) who reported decreased digestibility of DM, OM and crude protein with increased levels of corn DDGS.

No significant effect of different dietary inclusion levels of rice DDGS on N intake, N outgo, balance and per cent N retention was observed in the study (Table 5). The findings are not in line with the results of Dinani *et al.* (2019) who reported decreased N retention (%) when rice DDGS was included at 15% level in broiler feed. Swiatkiewicz *et al.* (2014) also reported decreased N retention, when DDGS was used in the broiler feed. Min *et al.* (2011) reported increased N in excreta with the inclusion of DDGS in the broiler feed. Similarly, no significant difference was observed in the intake, outgo, balance and per cent retention of Ca in the birds of different groups. The P intake was significantly (P<0.05) higher in birds fed diet with 10 (T_3) and 15% (T_4) levels of rice DDGS as compared to control, however the difference in P intake between group T_1 and T_2 was not significant. The outgo of P by the birds of different groups did not vary significantly, however, the P balance was significantly (P<0.05) higher in all the treatment groups irrespective of level of rice DDGS. Increase in the level of rice DDGS gradually increased the value of P balance as a result the per cent retention of P was significantly (P<0.05) high in all the treatment groups as compared to control (Table 5). Phosphorus bioavailability of DDGS coming from ethanol plants was expected to be higher than that in typical beverage plant due to the fermentation process involved in ethanol production. The reason behind this may be the alteration of phytate structure under increased heat causing more phosphorus release. In addition, fermentation was believed to reduce phytic acid in DDGS (El Hag *et al.,* 2002).

The relative economics of raising broiler on diet with different inclusion levels of rice DDGS was calculated based on total cost of rearing of bird up to 35 days and the amount received from the selling of bird

Table 5. Effect of different dietary inclusion levels of rice distillers dried grain with solubles (RDDGS) on N, Ca and P balance in broilers

Particulars		Groups				P Value
		T_1	T_2	T_3	T_4	
Nitrogen	Intake (g)	4.05±0.17	3.74±0.16	3.67±0.02	3.95±0.46	0.63
	Outgo (g)	1.03±0.07	1.04±0.05	1.011±0.14	1.01±0.12	0.94
	Balance (g)	3.02±0.23	2.57±1.54	2.65±0.16	2.83±0.35	0.58
	Retention (%)	74.23±2.82	71.13±1.31	72.37±4.06	73.46±1.76	0.76
Calcium	Intake(g)	1.54±0.06	1.41±0.06	1.46±0.01	1.57±0.18	0.68
	Outgo(g)	0.53±0.05	0.55±0.03	0.57±0.14	0.53±0.06	0.95
	Balance(g)	1.01±0.09	0.86±0.04	0.88±0.14	1.03±0.10	0.56
	Retention (%)	65.16±4.2	60.94±1.68	60.56±9.65	65.73±2.35	0.74
Phosphorus	Intake (g)	1.01±0.04	1.27±0.05	1.35±0.009	1.40±0.16	0.59
	Outgo (g)	0.34±0.19	0.32±0.01	0.34±0.05	0.31±0.06	0.84
	Balance (g)	0.66^{a}±0.05	0.95^{b}±0.05	1.01^{b}±0.06	1.09^{b}±0.10	0.02
	Retention (%)	65.34^{a}±3.28	74.73^{b}±1.48	74.79^{b}±4.5	77.54^{b}±2.17	0.03

[a,b]Means in the same row with different superscript differ significantly

@ ₹ 80/- kg live weight. The total cost of rearing per bird was ₹ 121.66, 118.02, 116.35 and 117.9 and the net profit per kg body weight was ₹ 18.25, 21.06, 21.63 and 21.52 in group T_1, T_2, T_3 and T_4 respectively. In the experiment, birds fed diet containing 10% RDDGS gave best response in terms of net profit per kilogram of body weight.

CONCLUSION

Rice DDGS is a viable feed ingredient and can be incorporated up to 15% level in broiler feed without any adverse effect on growth performance and nutrient utilization, however inclusion level 10% of rice DDGS was more economical as compared to other levels of inclusion. It is therefore recommended to include rice DDGS up to 10% level in broiler feed.

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