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Effect of Dietary Inclusion of Rice Distillers Dried Grains with Solubles with and without Enzyme on Growth Performance and Nutrient Metabolizability of Broiler

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Abstract

This experiment was conducted to evaluate the effects of dietary inclusion of rice distillers dried grains with solubles (RDDGS) with and without enzyme on growth performance and nutrient digestibility of broilers. The 240-day-old broiler chicks were randomly allocated to six groups with four replicates. During this experiment starter, grower and finisher period, experimental diets were fed to birds which were isonitrogenous and isocaloric formulated with different levels of RDDGS. They were T1 (control, without RDDGS and enzyme), T2 (control, without RDDGS and with cocktail of enzyme @100g/q feed), T3 (10% RDDGS), T4 (10% RDDGS with cocktail of enzyme @100g/q feed), T5 (15% RDDGS), T6 (15% RDDGS with cocktail of enzyme @100g/q feed). Growth performance parameters like body weight gain, feed intake, FCR, PER and CER were monitored weekly. The results showed that in growth performance parameters, RDDGS inclusion at 10% with and without enzyme had higher body weight gain but feed intake, FCR, PER and CER did not show any significant difference at different inclusion levels as compared to control groups. Nutrient utilization (dry matter, crude protein digestibility and calcium retention) were significantly higher in 10% RDDGS with and without enzyme treatments. Thus, it was concluded that RDDGS can be safely incorporated in broiler chickens diets up to the inclusion level of 15% but best results were seen at 10% inclusion as alternate protein meal for economic broiler production.

Keywords: Broilers, Digestibility, FCR, Performance, Rice Distillers Dried Grains with Solubles

Introduction

One of the fastest growing sectors in Indian agriculture is the poultry industry. The demand for animal products is also increasing day by day with the increasing human population and income sources. Poultry industry is one of the major industries that are supporting the vast population of the world. To meet the meat demand of increasing human population no doubt genetic makeup, feeding and managemental practices, disease prevention etc. are the main factors but major concern is to reduce feed cost for optimal economic returns because the feed constitutes approximately 70% of the total production cost. So, there is an urgent need to explore the various agro-industrial waste and other unconventional feed resources for an economically viable poultry production (Bhatt and Sharma, 2001).

There is need to utilize locally available feed ingredients because of the scarcity of both maize and soybean at reasonable price, India is one of the largest producers of rice in world producing approximately 112.91 million tons of rice and Punjab produces 11.85 million tons of rice in 2017-18 (Govt. of India, 2018). So, a lot of by-products are available from rice processing industry. Among the various by-products of rice, rice distillers dried grains with soluble (RDDGS) is a protein by-product that have the potential to be incorporated in livestock and poultry feed. The major co-product of biofuel ethanol production is distillers dried grains with solubles (DDGS), which is a dried mixture of the solid and condensed liquid fermentation residues (Rausch and Belyea, 2006). Commonly used ingredients for fermentation during bioethanol production are corn, wheat, barley and sorghum. Nowadays due to relative lower price, higher production and easy availability, rice is used as substrate for bioethanol production there by leading to increased availability of by-product rice distillers dried grains with (RDDGS). It contains 45% crude protein and has metabolizable energy around 3300 kcal/kg (IFBAGRO, 2018). With expansion of ethanol plants, the supply of RDDGS is increasing rapidly and poultry nutritionists are making increasing use of it in their diets. Increased protein, fat and digestible phosphorus content can make DDGS an attractive, cost-competitive ingredient for least-cost poultry feed formulations. According to ICAR annual report, addition of rice DDGS up to 10% level did not exert any adverse effect on growth and carcass traits in broiler (ICAR- CARI, annual report, 2014-15). Dinani *et al.* (2019) reported that RDDGS can be safely incorporated upto 12.5% in broiler diets. Thein *et al.* (2020) reported that in grower diet 20% RDDG can be included without any detrimental effect on the growth performances of broilers.

As most of the research work is done on corn, wheat, barley and sorghum DDGS therefore, only a few researches are available in literature regarding evaluation of RDDGS in poultry. Therefore, this study was carried out to evaluate the supplementary effects of different levels of RDDGS with or without enzyme on growth performance and nutrient digestibility of broilers.

Material and Methods

The study was carried out at Department of Animal Nutrition, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India (30056′N, 75052′ E, 247 m above sea level). RDDGS was procured from prodigy foods, Zirakpur, Punjab. The product was then analyzed for dry matter, crude protein, ether extract, crude fibre, total ash, phosphorous estimated by AOAC. (2000) and calcium as per the modified by Talapatra *et al.* (1940).

42 days feeding trial along with metabolic trial was conducted separately in meat type birds to determine the effect of feeding RDDGS in broiler performance. The growth studies in the feeding trial were divided into 3 phases i.e., starter (1-14 days), grower (15-21 days) and finisher (22-35 days) phase as per the recommendation of ICAR. (2013) given in Table 1. In this growth study, 240 sexed chicks were weighed individually at 1 day of age and distributed randomly into 6 treatments having total 10 birds per treatment with 4 replicates. The chicks of all experimental groups were weighed individually at weekly intervals. Average body weights and body weight gains for weekly interval, starter (1-14 days), grower (14-21 days), finisher phase (22-35 days) and for entire experimental periods (1-35 days) were then calculated. Feed Conversion Ratio (FCR) was calculated as a ratio of grams of average feed consumed per grams of average body weight gain per bird. The efficiency of protein utilization is expressed as protein efficiency ratio (PER) and was calculated as grams of body weight gain per gram of protein consumed on phase basis. The efficiency of energy utilization is expressed as calorie efficiency ratio (CER) and was calculated as body weight gain per kilo calories consumed. A metabolic trial of 7 days with 4 days adaptation period and followed by 3 days of collection period was conducted after 35 days of growth trial. Faeces were collected for three consecutive days of each replicate were mixed properly. For three days, total collection method was used for faeces.

Table 1: Percent ingredient composition of experimental diets for RDDGS

	Starter						Grower						Finisher					
Ingredients %	**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	55.38	55.5	48.48	48.4	45.5	45.5	57.2	57.1	52	52.24	48.5	48.6	61.75	61.6	56.4	56.45	53.1	53
DORP	1.8	1.58	9.4	9.3	13.1	12.9	1.06	1.06	7.44	6.9	11.8	12.1	3	3	9.8	9.7	14.1	14.1
GNC	6.2	6.2	10.76	10.84	10.9	11	6	5.9	11.6	11.7	8.42	7.9	3	2.76	5.75	5.7	5.52	5.52
SBM	30	30	14	14	8	8	28.9	29	12	12	9.4	9.4	25.7	26	11.4	11.4	5.6	5.6
Oil	3.1	3.1	3.5	3.5	3.5	3.5	3.55	3.55	3.5	3.5	3.5	3.5	3.6	3.6	3.6	3.6	3.6	3.6
RDDGS	**0**	**0**	**10**	**10**	**15**	**15**	**0**	**0**	**10**	**10**	**15**	**15**	**0**	**0**	**10**	**10**	**15**	**15**
DCP	0.8	0.8	1	1	1	1	0.6	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6
LSP	2	2	1.8	1.8	1.8	1.8	2	2	1.9	1.9	1.65	1.65	1.7	1.7	1.6	1.6	1.5	1.5
Lysine	0	0	0.32	0.32	0.46	0.46	0	0	0.25	0.25	0.32	0.32	0	0	0.19	0.19	0.32	0.32
Methionine	0.2	0.2	0.22	0.22	0.22	0.22	0.17	0.17	0.19	0.19	0.19	0.19	0.13	0.12	0.14	0.14	0.14	0.14
Enzymes**	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1	0	0.1
Additives* (g)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
Total (Kg)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

**Additives include Salt 300g, Vitamin AB2D3K 15g, Vitamin B complex 15g, Trace minerals 65g, Toxin binder 50g, Vitamin B12 20g, Coccidiostat 60g; **Each gram contains: β-Glucanase: 100000 U, Xylanase: 70000 U, Pectinase: 13000U, Cellulase: 4000 U, Acid Protease: 1000 U, Neutral Protease: 1000U, Mannanase: 800 U, α-Glucosidase: 800 U, Amylase: 1000 U, Lipase: 200 U, Phytase: 100 U, α-Galactosidases: 20 U.*

The sample of feed, feed residue and faeces were grounded and analyzed for various proximate parameters. The nutrient retention or metabolizability were calculated for various nutrient. The collected data of different experiments was subjected to statistical analysis using Statistical Analysis System software (SAS, version 9.3) and One-way ANOVA in Software Package for Social Sciences (SPSS, version 24.0) to test the difference between various treatment.

Results and Discussion

The data pertaining to the phase wise (starter phase, grower phase, finisher phase and overall period) growth performance in terms of average body weight gain (ABG), average feed intake (AFI), feed conversion ratio (FCR), protein efficiency ratio (PER) and calorie efficiency ratio (CER) is presented in Table 2 and 3. The data regarding nutrient metabolizability is given in Table 4.

Table 2: Effect of RDDGS inclusion on average body weight gain and average feed intake in broilers

Average Body Weight Gain								
Variables	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**S.E.M.**	**P value**
Starter phase	313.03^{a}	317.52^{a}	337.95^{bc}	344.49^{c}	325.60^{ab}	327.22^{ab}	2.633	≤0.05
Grower phase	301.20^{a}	324.51^{b}	337.45^{c}	345.11^{d}	328.59^{b}	327.84^{b}	2.899	≤0.05
Finisher phase	765.48^{b}	748.23^{ab}	730.12^{a}	720.84^{a}	743.82^{ab}	745.56^{ab}	3.71	0.002
Overall phase	1379.72^{a}	1390.27^{ab}	1405.54^{b}	1410.44^{b}	1398.01^{ab}	1400.62^{ab}	2.874	0.011
Average Feed Intake								
Starter phase	647.83	627.17	632.6	627.9	636	635	2.28	0.089
Grower phase	623.06^{a}	647.12^{b}	646.21^{b}	650.27^{b}	648.35^{b}	645.37^{b}	2.26	≤0.05
Finisher phase	1463.35^{a}	1488.40^{b}	1482.09^{ab}	1478.71^{b}	1489.93^{ab}	1478.45^{ab}	2.62	0.027
Overall phase	2734.25^{a}	2762.70^{ab}	2760.88^{ab}	2756.91^{ab}	2774.29^{b}	2759.10^{ab}	3.85	0.06

The RDDGS inclusion at 10% without enzyme (T_3) or with enzyme (T_4) had significantly higher body weight gain during starter, grower and overall phase as compared to control but reduced body weight gain was observed during finisher phase as compared to control However the RDDGS inclusion at 15% without enzyme (T_5) or with enzyme (T_6) had significantly higher body weight gain as compare to control during grower phase. Moreover, enzyme inclusion in respect to their non-enzyme group had significant effect in T_2 and T_4 only during grower phase. Wang *et al.* (2007a) studied that there was no significant effect on body weight gain by adding the different level of DDGS at any age. Wang *et al.* (2007b) studied when fed on a constant basis there was no significant change in body weight gain at 15% level of DDGS but at 30% level of DDGS birds had lower body weight gain at 0-35- and 0-49-day period. Youssef *et al.* (2013) concluded that there was no significant effect of the addition of DDGS at any studied levels on weight gain during starter, grower, finisher as well as overall period. Thein *et al.* (2020) resulted that there was no significant effect of DDGS inclusion at up to 15% on cumulative body weight gain during 21-28-, 21-35- and 21–42-day periods but at 20% DDGS inclusion lower body weight gain was observed during these periods as compared to control group. Campasino *et al.* (2015) studied that at 5 and 10% there was no significant effect on body weight gain during 0-7-, 0-14- and 0–21-day periods but at 15% level of DDGS inclusion, body weight gain was lower as compared to control and other groups. Moreover, addition of NSPase enzyme with respect of their groups showed no significant effect on body weight gain. Dinani *et al.* (2019) studied that body weight gain did not show any significant difference between different dietary treatments in prestarter (0-2 wks.) and finisher (3-6 wks.) phases as compared to control whereas in starter phase (2-3 wks.) body weight gain was significantly lower in 15% RDDGS group as compared to control. Rao *et al.* (2016) reported that body weight gain of broiler chicken at 35 days of age was depressed significantly at 15% level of rDDGS. Mir *et al.* (2017) stated that feeding of 10% DDGS in broiler diet depressed the broiler performance. Patil (2008) studied that DDGS along with enzyme and acidifier, either singly or in combination showed better growth performance with respect to weight gain as compared to control at the end of fifth week.

The RDDGS inclusion at 10% without enzyme (T_3) or with enzyme (T_4) had significantly higher feed intake during grower phase only and almost similar feed intake in overall phase as compared to control. However, the RDDGS inclusion at 15% without enzyme (T_5) had significantly higher feed intake during grower and overall phase and RDDGS inclusion at 15% with enzyme (T_6) had significantly higher feed intake during grower phase only as compared to control and other groups. Moreover, enzyme inclusion in respect to their non-enzyme group had significant effect in T_2 during grower and finisher phase. Wang *et al.* (2007a) studied feed intake was not significantly affected during starter phase but group with 25% DDGS inclusion ate more at 0-35 and 0-49 day. Wang *et al.* (2007b) studied when fed on a constant basis there was no significant change in feed intake at 15% level of DDGS but at 30% level of DDGS birds had lower body feed intake at 0-35- and 0-49-day period. Youssef *et al.* (2013) concluded that there was no significant effect of the addition of DDGS at any studied levels on feed intake various growth periods. Thein *et al.* (2020) resulted that there was no significant effect of DDGS inclusion at up to on cumulative feed intake during 21-28-, 21-35- and 21–42-day periods but at 20% DDGS inclusion lower feed intake was observed during these periods as compared to control group. Dinani *et al.* (2019) studied that feed intake did not show any significant difference between different treatments in prestarter (0-2 wks.) phase as compared to control whereas in finisher phase (3-6 wks.) feed intake were significantly lower in 15% RDDGS group as compared to control. Rao *et al.* (2016) reported that body feed intake of broiler chicken at 35 days of age was depressed significantly at 15% level of rDDGS.

Effect of RDDGS Inclusion on Feed Conversion Ratio (FCR)

The RDDGS inclusion at 10% without enzyme (T_3) or with enzyme (T_4) had significantly lower FCR during starter and grower phase but was significantly higher at finisher phase but almost similar FCR in overall phase as compared to control. However, the RDDGS inclusion at 15% without enzyme (T_5) or with enzyme (T_6) had significantly lower FCR during starter and grower phase and almost similar FCR during overall phase as compared to control but during finisher phase FCR was almost similar to control supplemented with enzyme fed group and higher than control group. Moreover, enzyme inclusion in respect to their non-enzyme group had significant effect in T_2 during starter, grower and finisher phase. Wang *et al.* (2007a) studied that FCR increased with increase in level of DDGS inclusion in diet, birds fed with 25% DDGS had significantly higher FCR for 0-35- and 0-49-day periods than control group. Wang *et al.* (2007b) studied when fed on a constant basis there was no significant change in FCR at 15 and 30% of DDGS. Youssef *et al.* (2013) concluded that there was no significant effect of the addition of DDGS at any studied levels on FCR various growth periods. Thein *et al.* (2020) resulted that there was no significant effect of DDGS inclusion at 5, 10 and 15% on cumulative FCR during 21-28-, 21-35- and 21–42-day periods but at 20% DDGS inclusion better FCR was observed during these periods as compared to control group. Campasino *et al.* (2015) studied that at 5 and 10% there was no significant effect on FCR during 0-7-, 0-14- and 0–21-day periods but at 15% level of DDGS inclusion, FCR was higher during 0–14-day period as compared to control and other groups. Moreover, addition of NSPase enzyme with respect of their groups showed no significant effect on body weight gain. Dinani *et al.* (2019) studied that FCR did not show any significant difference between different treatments in prestarter and finisher phases as compared to control. Patil (2008) studied that DDGS along with enzyme and acidifier, either singly or in combination showed better FCR as compared to control at the end of fifth week.

Table 3: Effect of RDDGS inclusion on feed conversion ratio in broilers

Feed Conversion Ratio								
Variables	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**S.E.M.**	**P value**
Starter phase	2.07^{c}	1.97^{b}	1.87^{a}	1.82^{a}	1.95^{b}	1.94^{b}	0.017	≤0.05
Grower phase	2.06^{d}	1.99^{c}	1.91^{ab}	1.88^{a}	1.97^{bc}	1.96^{bc}	0.013	≤0.05
Finisher phase	1.91^{a}	1.98^{b}	2.02^{b}	2.05^{b}	2.00^{b}	1.98^{b}	0.01	≤0.05
Overall phase	1.98	1.98	1.96	1.95	1.98	1.97	0.003	0.05
Protein Efficiency Ratio								
Starter phase	2.19^{a}	2.30^{b}	2.42^{c}	2.49^{c}	2.32^{b}	2.34^{b}	0.021	≤0.05
Grower phase	2.24^{a}	2.33^{b}	2.42^{cd}	2.46^{d}	2.35^{bc}	2.36^{bc}	0.016	≤0.05
Finisher phase	2.68^{b}	2.57^{a}	2.52^{a}	2.50^{a}	2.56^{a}	2.58^{a}	0.014	≤0.05
Overall phase	2.45	2.45	2.47	2.49	2.45	2.47	0.004	0.052
Calorie Efficiency Ratio								
Starter phase	0.1611^{a}	0.1688^{b}	0.1781^{c}	0.1829^{c}	0.1706^{b}	0.1717^{b}	0.002	≤0.05
Grower phase	0.1585^{a}	0.1644^{b}	0.1712^{cd}	0.1740^{d}	0.1662^{bc}	0.1666^{bc}	0.001	≤0.05
Finisher phase	0.1687^{b}	0.1622^{a}	0.1589^{a}	0.1573^{a}	0.1610^{a}	0.1627^{a}	9E-04	≤0.05
Overall phase	0.1646	0.1642	0.166	0.167	0.164	0.17	3E-04	0.049

The RDDGS inclusion at 10% without enzyme (T_3) or with enzyme (T_4) had significantly higher PER during starter and grower phase and almost similar PER in overall phase as compared to control. However, the RDDGS inclusion at 15% without enzyme (T_5) or with enzyme (T_6) had significantly higher PER during starter and grower phase and almost similar PER in overall phase as compared to control. Moreover, enzyme inclusion in respect to their non-enzyme group had significant effect in T_2 during starter, grower and finisher phase. Dinani *et al.* (2019) studied that PER was significantly lower in 15% RDDGS group as compared to control and was significantly higher in 7.5% RDDGs group as compared to control.

The RDDGS inclusion at 10% without enzyme (T_3) or with enzyme (T_4) had significantly higher CER during starter and grower phase and almost similar CER in overall phase as compared to control. However, the RDDGS inclusion at 15% without enzyme (T_5) or with enzyme (T_6) had significantly higher CER during starter and grower phase and almost similar CER in overall phase as compared to control. Moreover, enzyme inclusion in respect to their non-enzyme group had significant effect in T_2 during starter, grower and finisher phase. Dinani *et al.* (2019) studied that CER was significantly lower in 15% RDDGS group as compared to control and was significantly higher in 7.5% RDDGs group as compared to control.The inclusion of RDDGS at 10% with enzyme (T_3) and without (T_4) enzyme had higher dry matter metabolizability whereas crude protein and calcium retention was higher in T_3 and T_4 as compared to control. At 15% inclusion of DDGS with enzyme (T_6) and without enzyme (T_5) had better dry matter and calcium retention as compared to control. There was no significant difference in ether extract, crude fibre, organic matter and phosphorous metabolizability among various groups. Thein *et al.* (2020) studied that there was no significant difference in various treatments fed with different levels of DDGS on dry matter and organic matter digestibility. Campasino *et al.* (2015) reported that inclusion of dried distillers' grains with soluble reduced ileal digestible energy at 10 and 15% inclusion, however, inclusion of non-starch polysaccharide degrading enzyme increased ileal digestible energy.

Table 4: Effect of RGM inclusion on nutrient metabolizability in broilers

Nutrient Metabolizability								
Variables	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**S.E.M.**	**P value**
Dry matter	71.92^a	72.27^b	72.96^d	73.24^e	72.71^c	72.16^b	0.141	≤0.05
Crude protein	61.16^a	62.02^{ab}	65.51^c	65.02^{bc}	63.38^{abc}	63.60^{abc}	0.498	0.015
Ether extract	79.8	79.58	78.56	79.56	80.74	79.4	0.258	0.3
Crude fibre	18.62	18.14	17.76	18.26	17.37	19	0.248	0.531
Organic matter	71.81	71.63	72.85	72.13	72.38	71.5	0.211	0.523
Calcium	50.05^a	51.61^{ab}	52.56^b	51.79^{ab}	51.52^{ab}	53.58^b	0.35	0.016
Phosphorous	61.6	63.26	64.16	64.26	63.24	63	0.328	0.175

Conclusion

Thus, it was concluded that RDDGS can be safely incorporated in broiler chickens diets up to the inclusion level of 15% but best results were seen at 10% inclusion as alternate protein meal for economic broiler production.

Conflict of Interests

There is no conflict of interest.

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