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Evaluation of feeding value of rice based dry distillers grains with soluble with or without enzyme supplementation in layer

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Abstract
A biological experiment was undertaken with (4x2) factorial CRD in 45 week old CARI Sonali layers (n=120) assigned to eight treatments (*i.e.* 2 control + 6 test diets) having 15 replicates with one layer in each replicate for ten weeks (45th to 54th week of age). Eight experimental diets (D1 to D8) were prepared by incorporating rice dry distiller grain with soluble (DDGS) without and with protease enzyme at 0, 5, 7.5 and 10% level. All diets had been kept *isocaloric* and *isonitrogenous* in nature. Findings of this experiment revealed the significant (P<0.01) increased in feed intake, egg mass and egg production on DDGS feeding. FCR/kg egg mass, FCR/dozen egg production and Net FCR was significantly improved at 5, 7.5 and 10% inclusion level. Maximum improvement at 10% DDGS inclusion level was observed. Beneficial effect of enzyme addition was found in FCR/kg egg mass and Net FCR. Increasing the level of DDGS from 0 to 10% tended to reduce the feed cost significantly (P<0.01).Thus, it may be concluded that rice DDGS can be safely included in the layer diet replacing costly soybean meal at the inclusion level of 10% for economic layer feeding.

Keywords: Layer, egg production, protease, feed cost economics, rice DDGS

1. Introduction
Soybean meal is the major protein ingredient used in poultry diet. As there is scarcity of both maize and soybean meal there is need to utilize locally available feed ingredients. Thus, it is a major means of modulating the production cost. In India, there is production of huge quantity of raw materials for livestock feeding but out of them only a narrow range of the raw materials are used for poultry feed formulation due to lack of reliable data on their nutrient composition, feeding value and effective inclusion level. Dried distiller grain with soluble (DDGS) is a cereal by-product which is fermented and distilled to obtain alcoholic beverage [1]. The fermentation process concentrates the remaining nutrients approximately three-fold. It has been documented as a promising feed ingredient in the poultry industries because it is highly nutritious and economical [2, 3]. Cereal grain yields about one-third ethanol, one-third CO_2 and one third DDGS [4].
Rice based DDGS is a co-product of the ethanol production process in which rice is used as a raw material. It is an alternative feed ingredient that continues to be produced in large quantities by the dry-grind fuel ethanol industry. The high energy and protein content in rice DDGS makes it smart substitute of an expensive source of energy (corn) and protein (soybean meal) ingredients of animal and poultry feed. Rice DDGS is for rich in protein, very rich in methionine (1.25%) but deficient in lysine (1.28%) [5].
When we add rice DDGS in poultry feed, the cost of feed reduces exponentially, thereby increasing the profitability of farming. Rice DDGS is an excellent feed ingredient for use in layer, broiler, duck, and turkey diets. There is a limited information available on the potential use of rice based DDGS in poultry feeding. Recent research studies [6-8] have shown that DDGS can be added to poultry diets to achieve excellent performance and egg quality provided that accurate nutrient profiles specific to the DDGS source are used.

2. Materials and methods
2.1 Experimental birds, housing & Design
A biological experiment was undertaken in a 4x2 factorial completely randomized design (CRD) with forty fifth week old CARI Sonali layer birds (RIR M x WLH F) (n =120) which

were randomly assigned into eight groups (D1 to D8) in such a way that each treatment have 15 birds per treatment. All the layer birds were reared in battery cages fitted with individual feeder, waterers and dropping trays and reared under standard management conditions. The allocation of birds in each treatment was based on egg production at the start of the experiment. The experiment was conducted for 10 weeks (45th to 54th weeks of age).

2.2 Experimental Diets

Feed ingredients and supplements for formulation of control and test diets were procured from the feed storage and processing unit of the institute. All the feed ingredients were analyzed for proximate constituents, phosphorus [9] and calcium [10] contents prior to formulation of experimental diets as per recommendation of ICAR, New Delhi. From the basal diet as maintained above, eight experimental diets (D1= 0.0% DDGS without Protease, D2= 0.0% DDGS with Protease, D3= 5.0% DDGS without Protease, D4= 5.0% DDGS with Protease, D5= 7.5% DDGS without Protease, D6= 7.5% DDGS with Protease, D7= 10.0% DDGS without Protease, D8= 10.0% DDGS with Protease) were formulated. Every attempt was made to minimize feed spillage/wastage.

2.3 Measurement and analysis

The initial (45th week) and final (54th week) body weights of each bird was measured and feed intake was calculated on a weekly basis. Daily egg production, egg weight, weekly egg mass were recorded and feed conversion ratio (FCR) and net FCR were calculated during the whole experimental period. To arrive at the utilization of nitrogen, calcium and phosphorus a metabolic trial of 4 days was carried out at 5th week of the experimental period employing 15 birds per treatment, following the method of Hill and Anderson [11]. The feed intakes and excreta voided were monitored carefully during the 4 days trial and the excreta were air-forced oven dried for 24 h at 80 °C.

The retention of nutrients was calculated by following formula:

Nitrogen retention: (N intake-N outgo through excreta)/N intake×100

Calcium retention: (Ca intake-Ca outgo through excreta)/ Ca intake×100

Phosphorous retention: (P intake- P outgo through excreta)/ P intake×100

The cost of different rations used in the present study was calculated based on the actual market price of feed ingredients which prevailed at the time of experiment. The cost of feed on per kg egg mass and per dozen egg basis was calculated for a period of 10 weeks as follows:

$$\text{Feed cost/ kg egg mass} = \frac{\text{Feed consumption (kg)} \times \text{feed cost (Rs. /kg)}}{\text{Egg mass (kg)}}$$

$$\text{Feed cost/dozen eggs} = \frac{\text{Feed consumption (kg)} \times \text{feed cost (Rs. /kg)}}{\text{No. of eggs produced}} \times 12$$

2.4 Statistical analysis

The data collected, was analyzed by multivariate, general linear models procedures using the SPSS®IBM Statistics 20 software program (IBM Corporation, Somers, NY, USA). In the study each bird served as an experimental unit. The mean differences were tested by Duncan multiple range test (DMRT) as described by Duncan [12] and differences were considered significant at the 5% level of probability. All the procedures used in the study fully complied with the guidelines approved by the Institutional Animal Ethics Committee (IAEC) of ICAR-Central Avian Research Institute, Izatnagar-243 122 (U.P.)

3. Results and discussion

3.1 Production parameter

Effect of feeding rice DDGS with and without enzyme supplementation on overall (0-10 week) production parameters of layers is presented in Table 1. The rice dry distiller grain with soluble (DDGS) was evaluated for overall productive performance of layers during phase II (45th to 54th wk of age) under this experiment. There is a limited information available on the potential use of rice based DDGS in poultry feeding. However, in the present study a significant ($P<0.01$) higher body weight gain and feed intake was found at different levels of rice DDGS as compared to control group with highest feed intake at 10% inclusion level of DDGS. Addition of protease enzyme have no significant ($P>0.05$) effect on weight gain and feed intake. However, interaction between different levels of DDGS without and with enzyme significantly ($P<0.01$) increase the feed intake. Significantly highest body weight gain was observed at 10% DDGS levels [13], whereas, Masa'deh [14] reported no effect of DDGS feeding on body weight gain of layers. Abd El-Hack [15] reported that increasing DDGS in the diet up to 16.5% is associated with an increase in feed intake of layers, whereas, Roberson *et al*. [16] and Masa'deh [8] pointed out a non-significant effect on feed consumption of birds by feeding maize DDGS up to 15% and 25% level respectively. Similarly, enzyme supplementation had no effects on feed intake [8, 17, 18] and body weight gain of layers [8].

Likewise, FCR/kg egg mass, FCR/dozen egg production and Net FCR was significantly improved at 5, 7.5 and 10% inclusion level of DDGS as compared to control with maximum improvement at 10% inclusion level. Beneficial effect of enzyme addition was found in FCR/kg egg mass and Net FCR. Egg weight during this phase of production significantly ($P<0.05$) increased at different levels of rice DDGS inclusion. Enzyme addition had not proved beneficial in terms of egg weight. Different levels of DDGS have significant ($P<0.01$) impact on overall (0-10 week) egg mass as compared to control group with the highest value at 10% inclusion level. Addition of the enzyme significantly ($P<0.05$) increased the egg mass production. Overall (0-10 week) egg production significantly ($P<0.01$) increased at addition of different levels of DDGS either sole or in combination with enzyme. In agreement to these observations Shalash *et al*. [19] and Shurson *et al.* [20] reported significant improvement in egg mass and egg production at 5% and 10% DDGS levels respectively, whereas, Jung and Batal [18] argued that high protein corn DDGS is an acceptable feed ingredient up to 12% in a standard laying hen diet during peak production. However, contrary to this a non-significant effect of DDGS on egg mass and egg production reported by Roberson *et al.* [16] as well as decline of egg mass and egg production has been reported [14, 21]. Further, in support of our study Ghazalah *et al*. [22] suggested that diet containing DDGS up to 15.45% level with multienzymes supplementation improved the nutritive value of DDGS and thus, resulted in better FCR of layers. However, as reported by this study no significant effects of DDGS levels were observed on egg weight FCR/dozen eggs, FCR/kg egg mass and net FCR [16].

3.2 Nutrient utilization

Effect of feeding rice DDGS with and without enzyme supplementation on nutrient utilization is presented in Table 2. Rice dry distiller grain with soluble contain all the nutrients from grain in a concentrated form except for the majority of the starch, which has been utilized in the fermentation process [23]. Therefore, it can be a rich source of crude protein (CP), amino acids, Phosphorus, B-vitamin and other nutrients in poultry diets [24]. Statistical analysis of data revealed that nitrogen (N) retain (g/b/d), nitrogen retention (%) and DMM (%) of laying hens was significantly affected by dietary inclusion of different levels of DDGS, whereas, N-intake (g/b/d), Ca-retention (%) and P-Retention did not differ ($P<0.05$) with different levels of DDGS. N-Retention (g/b/d) was significantly ($P<0.05$) higher at 7.5 and 10% inclusion of DDGS while N retention was significantly ($P<0.05$) higher at 5, 7.5 and 10% dietary inclusion of DDGS in the layer diet. However, DMM (%) was significantly ($P<0.05$) higher only in 5% inclusion level.

In accordance to our results Bolu [25] reported that nutrients were retained more by broilers fed 10% dietary level of corn DDGS. Similarly, Masa'deh *et al*. [8] prepared diets containing 0, 5, 10, 15, 20, or 25% corn DDGS to laying hens from 47 to 76 weeks (phase II) and reported greater nitrogen and phosphorous retention in hens fed 25% DDGS. However, N and P excretion was decreased as levels of DDGS increased linearly. Whereas, Masa'deh *et al.* [26] found that feeding up to 12.5% DDGS had no negative effect on N and P retention levels. Nitrogen output increased at low levels of DDGS (2.5 and 5.0%), and P output decreased as DDGS levels increased. Protease enzyme addition in layer diets did not showed any significantly ($P>0.05$) beneficial effect in terms of N-intake, N-retain (g/b/d), N, Ca retention and DMM (%) however, numerically better values were observed in all nutrient utilization parameters except P retention where it is enzyme supplementation significantly ($P<0.05$) improved the P retention. In contrast to these results, Deniz *et al*. [21] reported that laying performance declined with 20% corn DDGS. Decreased laying performance may be attributed to the low palatability and high concentration of fibrous constituents, so the hens were not fully able to meet their energy and amino acid requirements.

3.3 Feed cost of layer production

Effect of feeding rice DDGS with and without enzyme supplementation on cost economics of layer (45th to 54th wk of age) is presented in Table 3. Cost of feed (per kg egg mass and per dozen egg production) reduced significantly ($P<0.01$) as the level of the rice based DDGS increased in the diet replacing a part of maize and soybean in layer diet during 2nd (45th to 54th wk of age) phase of production. The data revealed that increasing the level of DDGS from 0 to 10% tended to reduce the feed cost significantly ($P<0.01$) and 10% of DDGS being more effective in terms of Rs/kg egg mass and Rs/dozen egg production. The addition of enzyme was beneficial in terms of cost economics of layer production in rice based DDGS. No literature available on the economic aspects of rice DDGS addition. There is a wide gap between the price of soybean and rice DDGS, therefore it reduces the feeding cost of layer.

Table 1: Effect of feeding rice DDGS with and without protease enzyme supplementation on overall (0-10 week) production parameters of layers

Diet	DDGS (%)	Enz.	Egg wt.(g)	Egg mass (g)	Feed intake (g)	Egg production (%)	FCR/ Dozen egg production	FCR/kg egg mass	Feed intake (g/b/d)	Weight gain (g)	Net FCR
D_1	0	-	50.34	2867.53	6657.07^{a}	81.33	1.40	2.33	95.10^{a}	148.93	2.22
D_2	0	+	51.48	2952.40	6675.13^{a}	82.00	1.39	2.26	95.36^{a}	141.93	2.16
D_3	5	-	51.83	3083.04	7101.60^{b}	84.95	1.43	2.31	101.45^{b}	105.53	2.23
D_4	5	+	52.28	3098.62	6727.87^{a}	84.76	1.36	2.17	96.11^{a}	101.40	2.11
D_5	7.5	-	51.94	3134.34	7059.80^{b}	86.29	1.40	2.26	100.85^{b}	82.87	2.20
D_6	7.5	+	52.45	3216.65	7142.57^{b}	87.62	1.39	2.22	102.04^{b}	73.33	2.17
D_7	10	-	52.12	3180.26	7046.73^{b}	87.24	1.38	2.22	100.67^{b}	216.27	2.08
D_8	10	+	52.64	3273.86	6953.33^{b}	88.86	1.34	2.13	99.33^{b}	154.47	2.03
DDGS (%)											
0			50.91^{a}	2909.97^{a}	6666.10^{a}	81.67^{a}	1.40^{b}	2.30^{c}	95.23^{a}	145.43^{b}	2.19^{b}
5			52.05^{b}	3090.83^{b}	6914.73^{b}	84.86^{b}	1.39^{b}	2.24^{b}	98.78^{b}	103.47^{a}	2.17^{b}
7.5			52.19^{b}	3175.50^{bc}	7101.18^{bc}	86.95^{c}	1.40^{b}	2.24^{b}	101.44^{c}	78.10^{a}	2.19^{b}
10			52.38^{b}	3227.06^{c}	7000.03^{c}	88.05^{c}	1.36^{a}	2.17^{a}	100.00^{bc}	185.37^{c}	2.05^{a}
Enzyme											
-			51.56	3066.29^{a}	6966.30	84.95^{a}	1.40^{b}	2.28	99.52	138.40	2.18^{b}
+			52.21	3135.38^{b}	6874.73	85.81^{b}	1.37^{a}	2.20	98.21	117.78	2.12^{a}
Pooled SEM			0.179	19.254	29.306	0.416	0.005	0.011	0.419	7.389	0.011
Probability											
DDGS			$P<0.05$	$P<0.01$	$P<0.01$	$P<0.01$	$P<0.05$	$P<0.01$	$P<0.01$	$P<0.01$	$P<0.01$
Enzyme			NS	$P<0.05$	NS	$P<0.01$	$P<0.01$	NS	NS	NS	$P<0.01$
Interaction			NS	NS	$P<0.01$	NS	NS	NS	$P<0.01$	NS	NS

NS: Non-significant ($P>0.05$)

Table 2: Effect of feeding rice DDGS with and without protease enzyme supplementation on Nutrient utilization

Diet	DDGS (%)	Enz.	N intake (g/b/d)	N retain (g/b/d)	N-Retention (%)	Ca-Retention (%)	P-Retention (%)	DMM (%)
D1	0	-	2.49	1.22	48.91	36.02	24.30	62.54
D2	0	+	2.53	1.28	50.54	37.57	25.97	63.41
D3	5	-	2.40	1.21	50.28	36.74	24.76	64.91
D4	5	+	2.62	1.35	51.63	38.12	29.31	65.72
D5	7.5	-	2.65	1.42	53.44	37.44	25.98	64.21
D6	7.5	+	2.56	1.39	53.99	39.05	29.66	69.02
D7	10	-	2.70	1.47	54.35	38.00	26.52	67.93
D8	10	+	2.68	1.47	54.50	39.48	31.79	68.24
DDGS (%)								
0			2.51	1.25^{a}	49.72^{a}	36.79	25.13	62.97^{a}
5			2.51	1.28^{a}	50.96^{ab}	37.43	27.03	65.31^{ab}
7.5			2.60	1.40^{ab}	53.71^{b}	38.24	27.82	66.61^{a}
10			2.69	1.47^{b}	54.42^{b}	38.74	29.16	68.08^{a}
Enzyme								
-			2.56	1.33	51.75	37.05	25.39^{a}	64.89
+			2.60	1.37	52.67	38.55	29.18^{b}	66.60
Pooled SEM			0.032	0.030	0.662	0.713	0.835	65.745
DDGS			NS	$P<0.05$	$P<0.05$	NS	NS	$P<0.05$
Enzyme			NS	NS	NS	NS	$P<0.05$	NS
Interaction			NS	NS	NS	NS	NS	NS

NS: Non-significant ($P>0.05$)

Table 3: Effect of feeding rice DDGS with and without protease enzyme supplementation on cost economics of layer (45th to 54th wk of age)

Diet	DDGS (%)	Enz.	Feed cost (Rs.)	
			Per kg egg mass	Per dozen eggs production
D1	0	-	39.75	23.97
D2	0	+	38.58	23.80
D3	5	-	33.61	20.86
D4	5	+	31.63	19.85
D5	7.5	-	30.14	18.77
D6	7.5	+	29.71	18.68
D7	10	-	26.91	16.81
D8	10	+	25.79	16.28
DDGS (%)				
0			39.16^{d}	23.89^{d}
5			32.62^{c}	20.36^{c}
7.5			29.92^{b}	18.73^{b}
10			26.35^{a}	16.55^{a}
Enzyme				
-			32.60^{b}	20.10^{b}
+			31.43^{a}	19.65^{a}
Pooled SEM			0.454	0.258
Probability				
DDGS			$P<0.01$	$P<0.01$
Enzyme			$P<0.01$	$P<0.05$
Interaction			NS	NS

NS: Non-significant ($P>0.05$)

4. Conclusion

Maximum improvement at 10% DDGS inclusion level was observed in terms of production performance and nutrient utilization. Protease enzyme supplementation was found beneficial to improve FCR/kg egg mass, net FCR and cost economics. Thus, it may be concluded that rice DDGS can be safely included in the layer diet replacing a costly soybean meal at the inclusion level of 10% for economic layer feeding.

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