



Augmenting Feeding Value of Rice Distillers Dried Grain with Solubles Through Dietary Addition of Enzymes in Broilers

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ABSTRACT

Background: Substitution of expensive protein sources like soybean meal with lower cost ingredient like rice distillers dried grain with solubles (rDDGS) would reduce the cost of the feed. Various enzymes supplementation may be used to increase their inclusion level.

Methods: An *in-vivo* study of 42 days was undertaken (n=384) in broilers divided into 12 dietary treatments as per 3×4 factorial design. Two levels of rDDGS consisted of 12.5 and 15% without and with three different types of enzymes xylanase, protease and multienzymes were used to find out substrate specific enzyme.

Result: Overall the growth performance of broiler chicken was significantly lower at 15% rDDGS level as compared to control and 12.5% rDDGS level. However, it was significantly ($P<0.01$) improved by supplementation of any of the three enzymes (xylanase, protease and multienzymes) in 12.5 and 15% rDDGS groups. Nitrogen retention, dry matter and energy metabolizability were significantly ($P<0.01$) improved in all enzymes supplemented groups. The cost of feed per kg live weight and meat yield was significantly ($P<0.01$) lower at 12.5% rDDGS with enzymes supplementation. Thus, it is concluded that the enzymes supplementation can increase inclusion level of rDDGS from 12.5 to 15% for economic broiler production.

Key words: Broilers, Enzymes, Rice DDGS.

INTRODUCTION

The search of alternative feed ingredients in poultry nutrition is a continuous process in the pursuit of economical poultry production. Feed is the major constituent in the poultry production accounts for 65-75% of total recurring expenditure. Feed costs are primarily driven by the cost of protein sources. Substitution of expensive protein sources with lower cost ingredients would potentially reduce the cost of the feed. Poultry industry depends on soybean meal as a source of dietary protein due to its uniform quality and ideal amino acid profile. Instability in its production, indiscriminate exports and higher demand has resulted in its shortage for the poultry industry leading to its higher price. As there is scarcity of soybean at reasonable price, there is need to utilize locally available alternate protein sources (Mandal, 2017). Asia is the primary production region for rice with over 90% of global production. China tops the list of rice production followed by India (Agriculture Statistics, 2018). Now days, certain newer rice by products are available in appreciable quantities and cheaper rate that can be utilized as protein sources from rice processing industries such as rice based distillers dried grain with solubles (DDGS). The DDGS is co-product of the ethanol industry produced during dry milling process. Its availability is increasing due to higher demand for ethanol as biofuel. Commercial traders categorise rice DDGS as a high crude protein and energy ingredient which is priced lower than soybean meal (AAFCO, 2005).

Strategic development of substrate specific suitable enzyme in diet will enhance the nutritive value of diets. No information is available on the appropriate enzyme that is

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specific for broiler diets based soybean meal partially replaced with rice DDGS.

Most of the researches are limited to feeding value of corn, wheat, sorghum, barley based DDGS. Scanty researches were done in rice DDGS regarding its feeding value (Gupta, 2016; Rao *et al.* 2016 and Ranjan *et al.* 2017) in poultry and no data is available regarding augmenting its feeding value through dietary addition of enzymes in broilers. Thus, this study was conducted for substrate specific selection of enzyme for rice DDGS and its effect on the growth performance, nutrient utilization and cost economics of broiler chicken production.

MATERIALS AND METHODS

Experimental layout for feeding different level of rice DDGS

with or without enzymes is presented in Table 1. The experiment was conducted as per 3×4 factorial design in 384 broiler chicks (CARIBRO Vishal variety). The birds were randomly divided into 48 replicates of eight birds each. There were twelve different treatments with 4 replicates for each treatment. Two levels of rice DDGS were taken, the best inclusion level from earlier experiments as first level (12.5%) and then adding over and above the best level of 2.5% DDGS to this level (Dinani *et al.* 2019). Protease, xylanase and multienzymes supplementation under different treatments were used to find out the most suitable enzyme for rice DDGS diets.

Analyzed chemical composition of dietary ingredients (%) as per (AOAC, 2000) on as such basis is presented in Table 2. Ingredients and nutrient composition (%) of pre-starter (0-14 days), starter (14-28 days) and finisher (28-42 days) diets with or without enzymes for different level of rice DDGS are presented in (Table 3) as per ICAR (2013) standard. No detectable aflatoxin B1 and ochratoxin were found in rice DDGS as estimated by thin layer chromatography (AOAC, 2000).

The three commercial enzyme preparations protease, xylanase and multienzymes were used as per manufacturer instructions after assessing their activity as per standard methods compiled by Kamra and Agarwal (2003). Protease

activity was estimated 600,000±849 units per g. Xylanase activity was estimated 150,000±683 units per g. Multienzymes activity were estimated cellulase 15,000, xylanase 18,500±328, beta glucanase 12,500±128, amylase 1500±46, pectinase 150±16, protease 5000±136, lipase 15±3.8 and beta mannanase 400±31. Mixing ratio 50 g per 100 kg feed for protease, 10 g per 100 kg feed for xylanase and 25 g per 100 kg feed for multienzymes were used as per manufacturer instructions.

The research work was carried out from March to November 2017 at the Division of Avian Nutrition and Feed Technology, ICAR-Central Avian Research Institute (CARI), Izatnagar, India as per the guidelines and approval of Institute Animal Ethical Committee (IAEC) and Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA). The phase wise pre-starter, starter, finisher and overall body weight gain (BWG), feed intake (FI) g/bird and feed conversion ratio (FCR) were recorded.

A four day metabolism trial was conducted to study the utilization of dry matter, nitrogen, gross energy metabolizability (GEM), calcium, phosphorous and apparent metabolizable energy (AME) from 24th to 27th day of the feeding trial in all the birds. The percentage retention of these elements was calculated based on their intake and excretion quantities.

Table 1: Experimental layout for feeding different level of rice DDGS with or without enzymes.

Treatment	Experimental design			3×4 factorial design	
	Rice DDGS (%)	No. of replicates	Birds/replication	Total	Enzymes
T1	0.0	4	8	32	-
T2	0.0	4	8	32	Xylanase
T3	0.0	4	8	32	Protease
T4	0.0	4	8	32	Multienzymes
T5	12.5	4	8	32	-
T6	12.5	4	8	32	Xylanase
T7	12.5	4	8	32	Protease
T8	12.5	4	8	32	Multienzymes
T9	15	4	8	32	-
T10	15	4	8	32	Xylanase
T11	15	4	8	32	Protease
T12	15	4	8	32	Multienzymes

Table 2: Analyzed chemical composition of dietary ingredients (%) on as such basis.

Ingredients	Moisture	DM	CP	EE	CF	TA	NFE	Ca	P	GE (kcal/kg)	*ME (kcal/kg)
Maize	8.6	91.3	9	3.9	1.8	1.4	83.8	0.03	0.29	4447	3350
SBM	9.1	90.9	44.5	0.9	6.2	3.1	45.2	0.32	0.68	4097	2400
DORB	10.1	91.8	14	1.6	15.9	5.8	62.6	0.3	1.54	3854	2000
Rice DDGS	8.7	91.3	44.7	6.5	9.1	4.0	35.7	0.62	0.83	4232	2880
Soybean oil	-	-	-	-	-	-	-	-	-	8900	8450
Lime stone powder	1.4	98.6	-	-	-	-	-	33.89	-	-	-
Marbal chip	1.3	98.7	-	-	-	-	-	33.84	-	-	-
DCP	7.2	92.7	-	-	-	-	-	22.92	16.04	-	-

Calculated valuable.

The cost economics of chicken production was analysed taking into consideration the price of feed ingredients, feed consumption during the feeding trial and the prevailing market price at the time of the experiment. The feed cost was calculated as following:

$$\text{Feed cost/kg live weight or dressed yield (INR)} = \frac{\text{Feed consumption (kg)} \times \text{feed cost}}{\text{Live weight or dressed yield (kg)}}$$

Data subjected to test of significance as per 3×4 factorial design were analyzed for mean, standard errors and analysis of variance by Snedecor and Cochran (1989) using statistical package for social sciences (SPSS) 16.0 version and comparison of means were done using Tukey's test (1949).

RESULTS AND DISCUSSION

Growth performance

The results pertaining to growth performance in terms of phase wise body weight gain (BWG), feed intake (FI) in terms of (g/b) and feed conversion ratio (FCR) as influenced by dietary inclusion of different levels of rice DDGS with or without enzymes in the diet of broiler chicken are presented in the Table 4.

Body weight gain

During pre-starter phase, BWG was significantly (P<0.01) higher in control as compared to 12.5 and 15% rice DDGS groups. The BWG was significantly (P<0.01) higher in 15% rDDGS group as compared to 12.5% rDDGS group in pre-starter phase. There was no significant (P>0.05) difference in BWG in starter phase between different levels of rice DDGS. However in finisher and overall phases, BWG was significantly (P<0.01) lower in 15% rDDGS group as compared to control and 12.5% rice DDGS group.

During pre-starter phase, BWG was significantly (P<0.05) higher in protease and multienzymes groups as compared

to xylanase and without enzyme groups. Body weight gain was significantly (P<0.05) higher in xylanase groups as compared to other groups during starter phase. However in finisher and overall phases, BWG was significantly (P<0.01) higher in all enzymes supplemented groups (X, P and M) as compared to without enzyme groups.

Interaction of rice DDGS and enzymes showed that during prestarter phase, BWG was significantly (P<0.01) higher in T2 as compared to T1, T5, T6, T8, T9, T10 and T11 groups. Body weight gain was significantly (P<0.01) higher in T6 as compared to T1, T2, T5, T8 and T11 groups during starter phase. During finisher phase, BWG was significantly (P<0.01) higher in T4, T7 and T8 as compared to T1, T5, T9, T10, T11 and T12 groups. However in overall phase, BWG was significantly (P<0.01) lower in T1, T5, T9, T11 and T12 groups as compared to other dietary treatments. Thus, interaction of rice DDGS and enzymes showed beneficial effects in protease supplemented group in rice DDGS diets.

Our results are in agreement with ICAR-CARI Annual Report (2015), Gupta (2016) and Rao *et al.* (2016). Addition of rice DDGS up to 10% level did not exert any adverse effect on BWG of broiler chickens (ICAR-CARI, 2015). Gupta (2016) reported up to 10% rice DDGS have shown significantly (P<0.05) higher BWG in layers with protease supplementation. Rao *et al.* (2016) reported BWG was not affected by incorporating rice DDGS up to 10%, but depressed significantly at 15% level in broiler.

Feed intake

The results revealed that no significant (P>0.05) difference was observed in feed intake by incorporating different levels of rice DDGS at 0, 12.5 and 15% levels with or without enzymes supplementation (X, P, M) or due to interaction of rice DDGS and enzymes.

Our results are in disagreement with Gupta (2016) and Rao *et al.* (2016). Gupta (2016) reported dietary inclusion of rice DDGS upto 10% showed significantly (P<0.01) higher

Table 3: Ingredient and nutrient composition of experimental diets (%).

Diets	Pre-starter			Starter diets			Finisher diets		
	T1	DDGS -12.5	DDGS -15	T1	DDGS -12.5	DDGS -15	T1	DDGS -12.5	DDGS -15
Ingredients									
Maize	54.42	55.94	56.40	55.63	57.66	58.10	62.00	64.18	64.38
SBM	38.40	25.50	22.90	37.10	24.10	21.40	31.30	18.20	15.70
Rice DDGS	0.00	12.50	15.00	0.00	12.50	15.00	0.00	12.50	15.00
Oil	3.00	1.80	1.52	3.50	2.15	1.90	3.22	1.80	1.60
LSP	1.40	1.30	1.20	1.35	1.20	1.17	1.20	1.00	0.96
DCP	1.82	1.83	1.83	1.55	1.58	1.58	1.45	1.50	1.50
Constant*	0.765	0.765	0.765	0.765	0.765	0.765	0.765	0.765	0.765
Total	100.00	100.00	100.00	100.00	100.0	100.0	100.0	100.0	100.00
Nutrient composition									
CP%	21.99	22.06	22.07	21.52	21.52	21.52	19.50	19.50	19.50
ME**	2998	3001	3001	3050	3050	3050	3100	3100	3100

In diets LSP: Lime stone powder, DCP: Di calcium phosphate *Constant 0.765 included salt 0.4%, trace mineral premix 0.1%, vitamin premix 0.15%, vitamin B complex 0.015%, choline chloride 0.05% and toxin binder 0.05%. (as per ICAR, 2013) ** (kcal/kg) calculated.

Table 4: Effect of feeding different level of rice DDGS with or without enzymes on growth performance.

Treatment	Rice DDGS%	Enzyme	BWG (g/b)				Feed intake (g/b)				FCR			
			Prestarter	Starter	Finisher	Overall	Prestarter	Starter	Finisher	Overall	Prestarter	Starter	Finisher	Overall
T1	0	-	296 ^{ab}	330 ^{ab}	1030 ^{bc}	1657 ^b	331	443	2306	3079	1.12	1.34	2.24	1.86
T2	0	X	321 ^d	330 ^{ab}	1089 ^{def}	1741 ^d	339	459	2304	3101	1.05	1.39	2.12	1.78
T3	0	P	312 ^{cd}	340 ^{bcd}	1089 ^{def}	1742 ^d	346	436	2303	3085	1.11	1.28	2.12	1.77
T4	0	M	312 ^{cd}	344 ^{bcd}	1118 ^{fg}	1775 ^{ef}	342	459	2297	3098	1.10	1.33	2.05	1.75
T5	12.5	-	294 ^a	332 ^{ab}	1044 ^{bcd}	1671 ^{bc}	342	458	2303	3102	1.19	1.20	2.07	1.74
T6	12.5	X	296 ^{ab}	354 ^d	1092 ^{ef}	1744 ^{de}	351	424	2261	3036	1.12	1.38	2.01	1.73
T7	12.5	P	310 ^{cd}	345 ^{bcd}	1149 ^g	1805 ^f	346	476	2305	3126	1.16	1.37	2.05	1.77
T8	12.5	M	294 ^a	334 ^{abc}	1116 ^{fg}	1745 ^{de}	340	459	2285	3083	1.12	1.38	2.38	1.93
T9	15	-	305 ^{abc}	339 ^{bcd}	962 ^a	1607 ^a	341	470	2286	3097	1.13	1.26	2.18	1.81
T10	15	X	295 ^{ab}	350 ^{cd}	1062 ^{cde}	1708 ^{cd}	335	443	2315	3092	1.08	1.37	2.30	1.89
T11	15	P	307 ^{bc}	319 ^a	1003 ^{ab}	1631 ^{ab}	331	440	2309	3079	1.09	1.36	2.29	1.87
T12	15	M	310 ^{cd}	346 ^{bcd}	984 ^a	1641 ^{ab}	340	470	2254	3064	1.12	1.34	2.17	1.81
		Pooled SEM	1.63	1.91	8.86	9.50	2.29	4.33	6.62	10.65	0.01	0.02	0.02	0.01
		rDDGS												
		0	310 ^c	337	1082 ^b	1729 ^b	340	449	2303	3091	1.09 ^a	1.34	2.13 ^a	1.78 ^a
		12.5	298 ^a	342	1100 ^b	1741 ^b	345	454	2288	3087	1.10 ^a	1.33	2.08 ^a	1.77 ^a
		15	304 ^b	339	1003 ^a	1647 ^a	337	455	2291	3083	1.15 ^b	1.35	2.28 ^b	1.87 ^b
		Enzyme												
		-	298 ^a	334 ^a	1012 ^a	1645 ^a	338	457	2298	3093	1.13	1.37	2.27 ^b	1.88 ^b
		X	304 ^{ab}	345 ^b	1081 ^b	1731 ^b	342	442	2293	3076	1.12	1.28	2.12 ^a	1.77 ^a
		P	310 ^b	335 ^a	1080 ^b	1726 ^b	341	450	2306	3097	1.10	1.34	2.14 ^a	1.79 ^a
		M	305 ^b	341 ^{ab}	1073 ^b	1720 ^b	341	462	2279	3082	1.12	1.35	2.13 ^a	1.79 ^a
		Significance												
		rDDGS	*	NS	*	*	NS	NS	NS	NS	**	NS	*	*
		Enzyme	**	**	*	*	NS	NS	NS	NS	NS	NS	*	*
		Interaction	*	*	*	*	NS	NS	NS	NS	NS	NS	NS	NS

Values bearing different superscripts within the column differ significantly *(P<0.01), ** (P<0.05) and NS-Non-significant (P>0.05).

feed intake in layer chicken. Rao *et al.* (2016) reported rice DDGS at 15% level depressed feed intake during in layer.

Feed conversion ratio

The results revealed that during pre-starter phase, FCR was significantly (P<0.05) poor in 15% rice DDGS level as compared to 0 and 12.5% levels. There was no significant (P>0.05) difference in FCR in starter phase between different levels of rice DDGS. However in finisher and overall phases, FCR was significantly (P<0.01) poor in 15% rDDGS level as compared to 0 and 12.5% rDDGS levels.

Effect of with or without enzymes and interaction of rice DDGS and enzymes on phase wise FCR revealed that no significant (P>0.05) difference between different dietary treatments and control. There was no significant (P>0.05) difference in FCR in pre-starter and starter phases with or without enzymes. However in finisher and overall phases, FCR was significantly (P<0.01) better in all enzymes (X, P and M) supplemented groups as compared to without enzyme groups.

Our results are in agreement with ICAR-CARI Annual Report (2015), Gupta (2016) and Rao *et al.*(2016). Addition

of rice DDGS up to 10% level did not exert any adverse effect on FCR of broiler chickens (ICAR-CARI, 2015). Gupta (2016) reported protease enzyme supplementation was found significantly (P<0.05) beneficial in terms of FCR in layer up to 10% inclusion level of rice DDGS. Rao *et al.* (2016) reported rice DDGS significantly (P<0.05) improved feed efficiency at 5 and 10% levels but at 15% level feed efficiency was depressed significantly compared to control in broiler chickens. In our results, poor growth performance at 15% rice DDGS group may be associated with poor energy and protein digestibility. No other research work is available in the literature regarding augmenting feeding value of rice DDGS through dietary addition of enzymes in broilers.

Nutrient utilization

The results pertaining to nutrient utilization as affected by feeding different levels of rice DDGS with or without enzymes are presented in (Table 5). The results revealed that no significant (P>0.05) difference was found in dry matter and gross energy metabolizability, nitrogen retention, calcium and phosphorous retention (%) of the diet by incorporating

Table 5: Effect of feeding different level of rice DDGS without or with enzymes on nutrient utilization (%) and cost economics (Rs. /kg).

Treatment	Rice DDGS %	Enzyme	DMM	Nitrogen	GEM	Ca	P	Feed cost per kg live wt.	Feed cost per kg meat yield
T1	0	-	71.5 ^{abc}	56.8	74.3	36.4	41.2	47.33	66.14
T2	0	X	72.2 ^{bcd}	58.5	74.6	36.5	41.2	47.06	64.07
T3	0	P	72.2 ^{bcd}	57.6	76.5	34.7	42.5	47.17	64.08
T4	0	M	73.5 ^{de}	58.9	76.0	34.5	40.0	46.74	63.46
T5	12.5	-	71.3 ^{ab}	57.8	75.4	34.1	42.1	43.78	59.75
T6	12.5	X	72.7 ^{cde}	58.7	75.5	36.3	42.1	42.46	57.26
T7	12.5	P	73.8 ^e	58.5	76.0	34.9	42.1	41.74	57.54
T8	12.5	M	72.8 ^{cde}	57.8	76.1	36.2	40.9	42.74	58.45
T9	15	-	70.4 ^a	56.0	74.9	34.5	39.5	44.52	60.68
T10	15	X	73.5 ^a	58.5	75.0	34.1	41.4	44.81	61.33
T11	15	P	73.8 ^{de}	57.8	76.5	36.3	40.2	42.84	58.78
T12	15	M	73.7 ^e	57.9	74.7	34.9	42.2	44.64	61.49
		Pooled SEM	0.18	0.15	0.16	0.25	0.26	0.32	0.45
		Rice DDGS							
		0	72.4	57.9	75.3	35.5	41.2	47.15 ^c	64.33 ^c
		12.5	72.7	58.2	75.8	35.4	41.8	42.66 ^a	58.15 ^a
		15	72.9	57.5	75.3	34.9	40.8	44.16 ^b	60.46 ^b
		Enzyme							
		-	71.1 ^a	56.8 ^a	74.8 ^a	35.0	41.0	45.43 ^b	62.07
		X	72.8 ^b	58.5 ^b	76.3 ^b	35.6	41.6	44.52 ^a	60.89
		P	73.2 ^b	57.9 ^b	75.6 ^{ab}	35.3	41.6	44.05 ^a	60.05
		M	73.3 ^b	58.1 ^b	75.0 ^a	35.2	41.0	44.59 ^a	61.06
		Significance							
		Rice DDGS	NS	NS	NS	NS	NS	*	*
		Enzyme	*	*	*	NS	NS	**	NS
		Interaction	**	NS	NS	NS	NS	NS	NS

Values bearing different superscripts within the column differ significantly *(P<0.01), **(P<0.05) and NS: Non-significant (P>0.05).

different levels of rice DDGS at 0, 12.5 and 15% levels and interaction of rice DDGS with enzymes. Enzymes supplementation on nutrient utilization revealed that no significant ($P>0.05$) difference was found between treatments in calcium and phosphorous retention (%). The DMM, nitrogen retention and AME of the diets were significantly ($P<0.01$) increased in enzymes (X, P and M) as compared to without enzyme groups. The GEM was significantly ($P<0.01$) higher in xylanase enzyme groups as compared to multienzymes and without enzyme groups, but there was no significant ($P>0.05$) difference between xylanase and protease enzyme groups.

Our results are in agreement with Gupta (2016). Gupta (2016) reported that DMM, nitrogen, calcium and phosphorus retention (%) of laying hens did not differ significantly ($P>0.05$) up to 10% addition of rice DDGS in layer diet. Similarly Raju *et al.* (2021) reported that rice DDGS could be fed to chicks up to 10% in the diet without affecting nutrient utilization in terms of DM digestibility and protein retention. No other study is available in the literature regarding nutrient utilization of rice DDGS with enzyme supplementation by poultry birds.

In our results, poor energy, DMM and nitrogen retention of rice DDGS may be associated with level and type of crude fiber present and type of protein quality. The rice DDGS is high gross energy and protein feed but their availability to the body is limited. Better nutrient utilization may be associated with improved energy and protein digestibility by enzyme supplementation. Their supplementation hydrolyses fiber fraction, reduces the digesta viscosity and nutrient encapsulation, thereby increases nutrient utilization in the body.

Cost economics

The results pertaining to cost economics in broiler chicken as affected by feeding different levels of rice DDGS with or without enzymes are presented in Table 5. Feeding different levels of rDDGS (0, 12.5 and 15%) levels revealed that feed cost per kg live weight and meat yield was significantly ($P<0.01$) lower in 12.5% rDDGS level as compared to 0 and 15% rDDGS levels. Feed cost per kg live weight was significantly ($P<0.01$) higher in control as compared to 12.5 and 15% rice DDGS level. Enzyme (xylanase, protease and multienzymes) supplementation revealed that feed cost per kg live weight was significantly ($P<0.05$) lower in all three enzymes (X, P and M) supplemented groups as compared to without enzyme supplementation. However, protease enzyme showed numerically lower feed cost per kg live weight as compared to xylanase and multienzymes supplementation. Interaction of rice DDGS and enzymes did not show any significant ($P>0.05$) difference in feed cost. Thus, it concluded that 12.5% rice DDGS with protease found to be most cost effective. Live weight and meat yield due to 12.5% rice DDGS reduced feed cost per kg feed consumed by 9.52 and 9.60 respectively. Protease enzyme supplementation in 12.5% rice DDGS further reduced feed cost per kg live

weight by 3.03%. Multienzymes supplementation found to be most cost effective in corn-soya diet and it reduced feed cost per kg live weight by 1.84%.

Our results are in agreement with Gupta (2016) who reported that increasing the level of rice DDGS from 0 to 10% tended to reduce the feed cost significantly ($P<0.01$) with protease supplementation in layer. No other literature available on the economic aspects of rice DDGS addition. Protease supplemented group showed lower feed cost per kg live weight numerically as compared to xylanase and multienzymes supplemented groups due to relative lower cost of protease enzyme used in this study. There was no significant ($P>0.05$) difference among protease, xylanase and multienzymes supplemented groups per kg live weight gain. Feed cost per kg live weight was reduced significantly ($P<0.05$) in all three enzyme supplemented groups (xylanase, protease and multienzymes) due to better growth performance and nutrient utilization in rice DDGS diet.

CONCLUSION

Thus, it may be concluded that the enzymes (protease, xylanase and multienzyme) supplementation can increase the effective and safe inclusion level of rice DDGS from 12.5 to 15%. The feeding cost of broiler can be cut short by feeding rice based DDGS when there is wide gap between the price of soybean and rice DDGS.

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