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Effects of Lysine and Methionine Concentration in Diet on Performance, Slaughter Variables and Serum Biochemical Profile in Slow Growing Chicks fed Rice Based Distillery Dried Grain with Solubles

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ABSTRACT

Background: The feeding value of rice-distillery dried grain with solubles (r-DDGS) for dual-purpose chicks was assessed in two feeding experiments.

Methods: Day-old *Srinidhi* chicks (n=360) were divided into 6 equal groups with 10 replicates of 6 chicks each and fed r-DDGS at 0 or 15% in diet alongwith normal (100%) or higher (110 and 120%) concentration of lysine (Lys) and methionine (Met) individually (experiment 1). In the 2nd experiment, day-old *Vanaraja* chicks (n=390) were divided into 5 equal groups with 13 replicates of 6 chicks each and fed r-DDGS at 0 or 15% in diet alongwith normal (100%) or higher (110%) concentration of Lys and Met, either individually or in combination.

Result: Rice-DDGS significantly (P≤0.05) depressed body weight (BW), which was totally countered by Met at 110% concentration (expt. 1). In the expt. 2, r-DDGS showed no effect on BW and FCR, except at 4 weeks, where FCR was similar in the control and the 110% Met groups. Abdominal fat content decreased in the r-DDGS groups with excess Met concentration (110%) in diet. It is concluded that Met in excess (110%) of normal concentration enabled inclusion of r-DDGS at 15% in the diet of dual-purpose chicks.

Key words: Lysine, Methionine, Rice-DDGS, Slow growing chicks.

INTRODUCTION

Rice-based distillers dried grain with solubles (r-DDGS) is a potential alternate protein source for use in the poultry diet. Corn-DDGS has been found to be a good source of protein in the diet of chickens (Raju *et al.,* 2012). Rice-based DDGS (r-DDGS), on the other hand, is less researched upon, though it is a good source of protein (48.4% CP) (Dey *et al*., 2019), amino acids (Xue *et al.,* 2012) and other nutrients.

In a previous study conducted at this lab, r-DDGS could be fed to Vanaraja chicks upto 10% in diet without affecting performance, while beneficial effects on performance were observed at 5% in diet (Raju *et al*., 2021). Similarly, in broiler chicken and layer chicken, r-DDGS was found safe at 10 and 7.5% in diet, respectively (Rama Rao *et al*., 2016; Singh *et al*., 2021), whereas 15% level significantly (P≤0.05) depressed the layer performance (Rama Rao *et al*., 2016). Similar negative effects were observed with r-DDGS at 15% in broiler chicken (Dinani *et al.,* 2018; 2019), while no detrimental effects were reported with 10% r-DDGS in laying chickens (Gupta *et al.,* 2018). Besides, beneficial effects of r-DDGS on immunity were observed at moderate levels in broiler (Dinani *et al*., 2018) and layer (Gupta *et al*., 2017) diets.

Poor amino acid digestibility (Kim *et al.,* 2009) has been considered the main limiting factor for using DDGS at higher levels in chicken diet. Supplementation of critical amino acids like lysine and methionine at additional levels to diets containing higher levels of DDGS may counter this reduced amino acid digestibility and thus improve performance of chickens. Unlike the corn-DDGS, no published report is available about the amino acid digestibility in r-DDGS. In the present study, the possible beneficial effects of supplementation of lysine and methionine over and above the normal allowances on dual-purpose chicks fed r-DDGS at a higher level (15%) were evaluated during the nursery phase of rearing.

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MATERIALS AND METHODS

The effect of r-DDGS inclusion in diet at 15% alongwith normal or higher concentration of lysine (Lys) and methionine (Met) on slow growing dual-purpose chicks

meant for backyard farming was evaluated in 2 feeding experiments during July-December 2019 at ICAR-Directorate of Poultry Research, Hyderabad, India.

Rice-DDGS samples and experimental diets

The r-DDGS was procured from a local source (M/s Haritha Bio Products India Pvt. Ltd, Karimnagar, Telangana, India) and analysed for proximate composition (AOAC, 2016). The amino acid profile of r-DDGS was analysed employing wet chemistry (courtesy Evonik, Mumbai, India). A maize - soya bean meal based diet was compounded to serve as the control, whereas another set of experimental diets was formulated to contain r-DDGS at 15% in diet. In this set of experimental diets containing r-DDGS, Lys and Met were maintained at normal (100%) or higher levels (110 and 120% of that of normal levels) (experiment 1) (Table 1).

In the 2nd experiment, r-DDGS was included in diet at 15% and evaluated with normal (100%) or higher levels (110% of that of normal levels) of Lys and Met, either singly or in combination, thus forming a total of 5 experimental diets including one maize-soyabean meal based control diet (Table 1). All the diets were maintained *isocaloric* and *isonitrogenous*.

Chicks and management

The chicks used in both the experiments were slow growing dual-purpose type multi coloured chickens developed by ICAR-DPR for rural poultry farming. In the 1st experiment, a total of 360 day-old *Srinidhi* chicks were divided into 6 groups with 10 replicates of 6 chicks each, while in the 2nd experiment, a total of 390 day-old *Vanaraja* chicks were divided into 5 groups with 13 replicates of 6 chicks each and housed in raised wire floor SS battery brooders. The diets were fed *ad libitum* from 0 to 6 weeks of age.

Data collection

The effect of r-DDGS on body weight, feed intake and FCR (feed/body weight gain) was assessed at weekly intervals. At 6 weeks of age, about two to three ml of blood was collected through the brachial vein from one chick in each replicate (10 and 13 chicks per treatment in experiments 1 and 2, respectively) into non-heparinised tubes. Subsequently, serum was separated and analysed for the concentrations of total protein (expts. 1 and 2) and cholesterol (expt. 2) using reagent kits (Qualigens, Mumbai, India). The antibody response to ND virus inoculation was assessed in terms of HI titres in expt. 1 during the last week of experiment in 10 chicks per each treatment group.

Further, one chick from each replicate was killed at the end of both the experiments and data on dressing yields and weights of visceral and lymphoid organs were recorded. Abdominal fat was collected as per Fancher and Jensen (1989). The weights were expressed as percent pre-slaughter live weight. The experiment was conducted as per the guidelines of the Institute's Animal Ethics Committee with the due approval.

Statistical analysis

The data were subjected to one-way analysis of variance under completely randomised design (Snedecor and Cochran, 1968) using SPSS software (version 15) and the means were compared by multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

In the expt. 1, r-DDGS significantly depressed body weight of chicks at 3 and 6 weeks of age (Table 2). Rice-based DDGS was found safe for broiler chicken upto 12.5%, while

Table 1: Ingredient and nutrient composition of the experimental diets (%).

DDGS % in diet	0	15	15	15	15	15	15
AA%	100	100	110 Lys	120 Lys	110 Met	120 Met	110 Lys+110 Met
Expt./s	1,2	1,2	1,2	1	1,2	1	2
Maize	64.80	65.50	65.50	65.50	65.502	65.502	65.50
DORB	9.29	9.172	8.963	8.849	8.999	8.925	8.89
r-DDGS	0.00	15.00	15.00	15.00	15.00	15.00	15.00
Soyabean meal	21.00	5.20	5.30	5.30	5.30	5.30	5.30
DL-Methionine	0.18	0.063	0.063	0.064	0.136	0.21	0.137
L-Lysine HCl	0.08	0.376	0.485	0.598	0.374	0.374	0.485
Constants*	4.65	4.69	4.69	4.69	4.69	4.69	4.69
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Nutrients							
ME, kcal	2808	2806	2804	2802	2805	2804	2803
CP	16.03	16.01	16.02	16.00	16.03	16.01	16.01
Lysine	0.876	0.875	0.962	1.050	0.875	0.875	0.962
Methionine	0.438	0.394	0.394	0.395	0.466	0.538	0.466
TSAA	0.713	0.712	0.712	0.712	0.784	0.856	0.784

*contained salt, minerals, vitamins, toxin binder, coccidiostat and choline Lys: Lysine Met: Methionine.

Table 2: Effect of rice-DDGS in diet alongwith varied lysine (Lys) and methionine (Met) concentration on performance of *Srinidhi* chicks (expt.1).

r-DDGS, 15% in diet	AA %	Body wt, g		Feed intake, g		FCR	
		Wk-3	Wk-6	0-3 wks	0-6 wks	0-3 wks	0-6 wks
-	100	274.1^{a}	710.0^{a}	422.3	1467.8	1.54^{c}	2.07^{b}
+	100	247.4^{b}	643.2^{b}	401.7	1415.8	1.62^{b}	2.22^{a}
+	110 Lys	242.4^{b}	686.1^{ab}	402.9	1449.5	1.66^{b}	2.11^{ab}
+	120 Lys	242.2^{b}	679.3^{ab}	419.5	1438.4	1.73^{a}	2.12^{ab}
+	110 Met	269.7^{a}	702.8^{a}	433.7	1484.0	1.61^{bc}	2.11^{ab}
+	120 Met	260.0^{ab}	700.7^{a}	423.9	1459.9	1.63^{b}	2.09^{b}
	P	<0.001	0.04	0.19	0.51	<0.001	0.08
	SEM	2.85	6.54	4.23	10.42	0.01	0.02

Means in a column having different superscripts differ significantly (P<0.05) (n=10).

Table 3: Effect of rice-DDGS in diet alongwith varied lysine (Lys) and methionine (Met) concentration on slaughter and serum biochemical variables in *Srinidhi* chicks (expt.1).

r-DDGS, 15% in diet	AA %	RTC %	Liver %	Giblets %	Abd. fat %	ND titres, log 2	Serum protein, g%
-	100	62.5	2.20	0.55	5.81	6.10	4.00
+	100	61.7	2.23	0.54	5.69	6.00	3.47
+	110 Lys	61.8	2.30	0.53	5.67	6.20	3.62
+	120 Lys	62.2	2.14	0.52	5.74	6.30	3.13
+	110 Met	62.4	2.14	0.56	6.09	5.90	3.51
+	120 Met	63.3	2.12	0.56	5.93	5.90	3.42
	P	0.91	0.53	0.90	0.64	0.90	0.56
	SEM	0.42	0.03	0.01	0.08	0.11	0.13

n=10.

at further higher level of 15%, significant depression in growth was reported (Dinani *et al.,* 2019), but when used at 12.5% in combination with rice gluten meal (15%) adverse effects were noticed on the intestinal histomorphometry and microbiology (Dinani *et al.,* 2018). Lysine concentration at either 110 or 120% of normal (100%) level showed no effect on body weight at 3 weeks, whereas Met supplementation over and above the normal concentration significantly (P≤0.05) improved body weight, which was on par with that of control group at 110% and the body weight at 120% Met concentration was intermediate between control and r-DDGS with normal amino acid level (100%) groups. At 6 weeks of age, body weight of chicks fed r-DDGS was significantly (P≤0.05) improved at 110 and 120% Met concentration, while the response with Lys supplementation in excess was intermediate. Kim *et al*. (2009) recorded low standardised ileal digestibility of all the indispensable amino acids in corn-DDGS in comparison to soyabean meal in pigs. In broiler chickens, apparent ileal digestibility of Lys and Met was reduced with corn-DDGS inclusion in diet (Foltyn *et al.,* 2014).

Amino acids in DDGS are known to be less digestible to chickens causing their deficiency when DDGS is used in diet (Stein *et al.,* 2006). Thus the poor growth rate observed in the current study with 15% r-DDGS alongwith the improvement recorded with amino acid supplementation over and above the normal levels could be attributed to the low amino acid digestibility of r-DDGS, more particularly that of Met. Lysine digestibility of corn-DDGS was reported to be similar to that of corn in broiler chicks (Lumpkins and Batal, 2005), which could probably explain the reasons for lack of response to Lys supplementation as recorded in the current study. On the contrary, Fastinger *et al.* (2006) found decreased Lys availability in dark colored corn-DDGS, indicating the negative effects of excess heating during drying on the Lys availability in roosters. These conflicting results could be due to the differences in source of raw material used (Stein *et al.,* 2006) and the process involved in the production of DDGS.

Feed intake was not affected at both 3 and 6 weeks of age. Feed conversion efficiency was significantly lowered by r-DDGS feeding at both 3 and 6 weeks of age, which could be attributed to its poor digestibility. Increased Met concentration in diets containing r-DDGS significantly (P≤0.05) improved the feed conversion efficiency, which was similar to that of control group at both the ages. The dressing yields and weights of abdominal fat and organs were not affected (Table 3). Similarly, the serum total protein concentration and HI titres against ND virus were also not affected by the experimental diets.

In the expt. 2, r-DDGS inclusion in diet at 15% significantly (P≤0.05) reduced body weight of chicks at both 3 and 6 weeks of age (Table 4). Additional supplementation of Lys alone (110%) did not improve body weight in the groups fed r-DDGS either at 3 or 6 weeks of age. However, Met concentration at 110% resulted in significantly (P≤0.05)

Table 4: Effect of rice-DDGS in diet alongwith varied lysine (Lys) and methionine (Met) concentration on performance of *Vanaraja* chicks (expt.2).

r-DDGS, 15% in diet	AA%	Body wt., g		Feed intake, g		FCR	
		Wk-3	Wk-6	0-2 wks	0-6 wks	0-3 wks	0-6 wks
-	100	325.2^{a}	932.2^{a}	248.0^{b}	1886.3	1.79^{d}	2.10^{b}
+	100	314.0^{b}	891.1^{b}	265.1^{a}	1911.6	1.92^{a}	2.23^{a}
+	110 Lys	312.8^{b}	901.9^{b}	260.1^{a}	1887.9	1.90^{ab}	2.18^{ab}
+	110 Met	325.3^{a}	915.3^{ab}	260.7^{a}	1862.3	1.82^{cd}	2.12^{b}
+	110 Lys+110 Met	321.8^{ab}	915.0^{ab}	262.3^{a}	1855.4	1.85^{bc}	2.11^{b}
	P	0.02	0.04	0.05	0.71	0.001	0.006
	SEM	1.64	4.47	1.93	13.45	0.01	0.01

Means in a column having different superscripts differ significantly (P<0.05) (n=13).

Table 5: Effect of rice-DDGS in diet alongwith varied lysine (Lys) and methionine (Met) concentration on slaughter and serum biochemical variables in *Vanaraja* chicks (expt. 2).

r-DDGS, 15% in diet	AA%	RTC, %	Liver, %	Giblet, %	Abd. fat, %	Spleen, %	Serum total protein, g%	Serum cholesterol, mg%
0	100	58.9	2.05	4.83	1.94^{c}	0.22^{abc}	4.73	122.8
-	100	58.0	2.11	4.80	2.70^{a}	0.27^{a}	5.24	119.7
+	110 Lys	59.9	1.99	4.66	2.45^{ab}	0.20^{bc}	5.21	128.4
+	110 Met	61.6	2.01	4.76	2.08^{bc}	0.17^{c}	5.08	119.6
+	110 Lys + 110 Met	60.4	1.91	4.71	1.80^{c}	0.24^{ab}	5.34	117.3
	P	0.29	0.32	0.89	0.002	0.01	0.16	0.43
	SEM	0.56	0.03	0.06	0.09	0.01	0.08	1.95

Means in a column having different superscripts differ significantly (P<0.05) (n=10).

higher body weight of chicks at 3 weeks of age than that of non-supplemented r-DDGS group and comparable to that of the r-DDGS-free control group. However, effect of Met supplementation at excess level on BW was non-significant at 6 weeks of age. On the other hand, the body weight of chicks with Met supplementation at 110% in combination with Lys (110%) at 3 weeks as well as at 6 weeks of age was intermediate between the non-supplemented r-DDGS fed group and the control (no r-DDGS) group and comparable to that of the Met alone group indicating no added advantage of Lys supplementation over and above the normal level of supplementation. Feed intake at 2 weeks was significantly (P≤0.05) higher in the groups fed r-DDGS compared to control and the additional supplementation of Lys and Met showed no effect.

Feed conversion efficiency was significantly (P≤0.05) poor with r-DDGS alongwith normal Lys and Met concentration. Methionine supplementation at 110% either alone or in combination with Lys significantly (P≤0.05) improved FCR, which was comparable with that of control at 3 weeks and on par with control at 6 weeks of age. The results indicate beneficial effects of excess Met supplementation on feed conversion efficiency in the chicks fed r-DDGS, whereas supplementation of Lys alone at additional level showed only marginal improvement in FCR. As detailed earlier in the paper, the improved growth rate and feed conversion efficiency recorded in the study with Met supplementation in excess were probably due to the poor digestibility of r-DDGS in chicks.

Dressing yields and weights of organs were not affected, except for abdominal fat and spleen weight (Table 5). Abdominal fat content increased with r-DDGS feeding and Met supplementation (110%) significantly (P≤0.05) decreased to a level, which was similar (when supplemented alone) or comparable (in combination with Lys) to the control group. Increased abdominal fat content with r-DDGS was probably a result of impaired fat metabolism and Met in excess could counter the same through its role in limiting body fat deposition (Andi, 2012) by way of reducing the activity of fatty acid synthase (lipogenesis) and increasing the activity of hormone sensitive lipase (lipolysis) (Takahashi and Akiba, 1995). Spleen weight, though was significantly affected, no trend could be observed. Serum concentration of total protein and cholesterol was not affected by the dietary treatments.

CONCLUSION

The results of both the experiments indicate negative effects of r-DDGS on growth performance and feed conversion efficiency in slow growing dual-purpose chicks during the juvenile phase and Met supplementation in excess (110-120%) of the normal concentration could successfully counter the same, while Lys in excess concentration (110-120%) only showed marginal beneficial effects.

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