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Effect of replacement of soybean meal with DDGS on the performance and digestibility of broilers supplemented with phytase enzyme

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Abstract
A study was conducted to evaluate the efficacy and utilization of distillers dried grain solubles (DDGS) as a replacer of soybean meal with or without phytase enzyme supplementation on the performance and digestibility in broiler chickens. The experimental work was conducted on 280 commercial broiler chickens randomly divided into 7 dietary treatments having two replicates (twenty birds in each replicate) in each treatment. Maize- soybean meal based diet was offered to control group (T_1) which was formulated according to BIS (2007) recomendations, while treatment groups T_2, T_3 and T_4 were supplemented with 15, 30 and 45% DDGS; T_5, T_6, and T_7 were supplemented with 15, 30 and 45% DDGS along with phytase enzyme @ of 0.25%. The feed intake of birds fed with 45% DDGS was significantly (P<0.05) higher as compared to other treatment groups. Overall body weight gain of birds fed 45% DDGS replaced with soybean meal was significantly (P<0.05) lower as compared to other dietary treatments. Feed conversion ratio (FCR) at higher level of DDGS replacement was significantly (P<0.05) poorer as compared to control as well as other diets. Dry matter metabolizability and nitrogen retention values did not vary significantly (P<0.05) even by the supplementation of enzyme. Gross energy metabolizability also did not differed significantly (P<0.05) in all dietary treatments at lower level of DDGS replacement. No adverse effect of replacement of DDGS was noticed even at higher level on performance and digestibility.

Keywords: Broiler, digestibility, distillers dried grains solubles (DDGS), phytase enzyme, performance

Introduction
In present scenario the poultry farming is gaining strength at fast pace of development all over world especially in India. In poultry production, the most important input cost is the feed accounting up to 70% of the total production cost. There is a big gap between availability and demand of the poultry feed in India. The availability of high-quality diet at least cost is an important factor for the expansion of the poultry industry. Poultry need a steady supply of energy, protein, essential amino acids, minerals and vitamins for maximum performance, faster gain and better health. Traditionally, soybean meal is used as a main protein source in poultry feeding but the cost of soybean meal is soaring. The situation highlights the imperative need of exploration and incorporation of the wide range of unconventional sources of protein. Distillers' dried grain with solubles (DDGS) is one of by-product obtained from the production of ethanol from grain after fermentation of the starch [16]. During fermentation process, the non-fermentable components which are rich in various essential nutrients such as protein, fat, fiber, vitamins and minerals are recovered in a highly concentrated form (approximately 3 fold) as distillers dried grains with solubles [9, 14, 4]. The level of fiber is one of the concerns with respect to use of DDGS in poultry diets due to the potential anti-nutritive factors and dilution of the diet [6]. DDGS inclusion in poultry feed is proving multi-beneficial in terms of improving bird's health, performance and food product quality. Intensive efforts during recent years have been noted to improve the nutritive value of feedstuffs and limited the harmful effects of dietary NSP in poultry diets through the use of various exogenous enzymes [15] (Williams *et al*., 2014). The use of enzymes in DDGS supplemented diet is one of the latest method to alleviate the negative effects linked to the high level of anti-nutritive factors, as well as to overcome limitations on DDGS levels in the diets of mono-gastric animals [17]. Supplementation of phytase in cereal-based diets often results in amplified phytate-bound phosphorus and other minerals accessibility for birds [10]. So, the present study was undertaken to investigate the effect of different levels of DDGS supplemented with phytase enzyme on the

production performance and digestibility of the broiler chikens.

Material and method

The present study was conducted for a period of 42 days with an objective to see the effect of phytase and distillers dried grain solubles on the performance, digestibility as well as metabolizability of birds at Poultry Shed of Department of Animal Nutrition, College of Veterinary and Animal Sciences, Hisar, Haryana (India). Proximate principles of the feed have been done as per AOAC (2007) [2]. A total of 280, day old broiler chicks were kept hygienically on deep litter system in separate pens and brooding was done at 35ºC during the first week and distributed into seven groups having 40 birds in each group. Further each group was sub divided into two replicates with 20 birds in each replicate. Seven diets were formulated for each growth period and Maize-soy based basal diet was formulated as per BIS (2007) specifications [4] to meet out nutrient requirements. The ingredient and chemical composition of the basal diet has been shown in Table 1. The CP and ME requirements during starter (0 – 3 weeks) and finisher (3 – 6 weeks) phases are 23.18 and 21.32%; and 3000 and 3175 kcal/kg, respectively. The control group (T_1) was formulated by incorporation of maize and soybean while chicks in treatment groups T_2, T_3 and T_4 were fed basal diet with DDGS @ 15, 30 and 45% replaced for soybean meal, respectively. Treatment groups T_5, T_6 and T_7 were formulated by addition of phytase enzyme @ 25g/ 100kg of feed in treatment group T_5, T_6 and T_7 respectively. Vaccination was done against prevailing diseases adopting a standard protocol. The weekly record of the feed offered and residual amount was maintained for each replicate to calculate the feed consumption per bird. To calculate body weight gain every bird was weighed individually at weekly intervals and record was maintained up to 6 weeks of age. Calculation of Feed Conversion Ratio (FCR) for each replicate was calculated as follows: FCR=Total feed consumed (g)/Total body weight gain (g). A metabolism trial of four days was conducted at the end of growth period in which two birds from each replicate were randomly selected. Preliminary period of three days was given so that the birds were adapted to the new system of housing and management, after that a collection of representative samples was done regularly in same plastic bottles and bottles were kept in deep freeze to determine moisture and nitrogen contents. Feed offered and weighing records were maintained on daily basis during the whole study.

Table 1: Ingredient and chemical composition (% DM basis) of basal diet.

Feed ingredient	Starter diet	Finisher diet
Maize (kg)	57	63
Soybean (kg)	31	25
Fish meal (kg)	8	7
Vegetable oil (kg)	2	3
Mineral mixture (kg)	2	2
Feed additive (gm)	320	320
Phytase Enzyme (gm)	25	25
Chemical composition		
CP %	23.18	21.32
CF %	4.42	3.26
EE %	3.84	5.15
Total ash %	8.78	8.74
Metabolizable energy** (Kcal/kg)	3000.30	3174.25

*****Feed additives include Meriplex-20g, Vitamin, Ventrimix-25g, Coccidiostat (Dinitro-0-Toluamide)-50g, Choline chloride-50g, Lysine-50g, DL-methionine-100g, CTC-25g, 25g of enzyme phytase.
** Calculated values (Singh and Panda, 1988) [11]

Nutrients availability for each replicate was calculated by dividing the amount of retained nutrients (ingested nutrients – excreted nutrients) with the amount of ingested nutrients. Likewise dry matter retention was also calculated. The gross energy of oven dried feed samples and excreta samples were estimated by following standard procedure using Bomb Calorimeter. The gross heat of combustion in calories per gram of the material was computed by substituting values in the equation: Gross heat of combustion (cal/g)=t×w–(C1+C2+C3)/M, Where, t (Rise in temperature),w (Water equivalent), M (Weight of sample), C1 (Correction in calories for heat of formation of acid), C2 (Correction in calories for heat of combustion of fuse wire), C3 (Correction in calories for heat of combustion of thread, 27.73 cal/20 cm.). From these estimated gross energy values of feed and excreta sample, the metabolizable energy (ME) was worked out by putting the values in equation given by Hill and Anderson (1958) ME = E diet – E excreta - N×8.22. Gross energy metabolizability (%) was estimated as follows: Nitrogen corrected metabolizable energy (Kcal/kg)/ Gross energy of dry feed (Kcal/kg)×100. Data was analysed statistically using general linear model procedure of Statistical Package for Social Sciences (SPSS) 20th version [20]. Analysis of variance (ANOVA) was used to study the differences among treatment means and they were compared by using Duncan's Multiple Range Test (DMRT) as modified by Kramer (1956) at P<0.05 [5].

Result and discussion

The data pertaining to feed intake in broiler chicken at 6 weeks of age under different dietary treatments are presented in Table 2. The statistical analysis of data revealed that overall feed intake did not differed significantly (P<0.05) between different dietary treatments. During 5-6 week of growth period feed intake in dietary treatment group T_4, T_7 containing 45% DDGS with and without phytase enzyme was significantly higher (P<0.05) as compared to the other groups. Similar research findings were also reported [3] as the feed intake was increased at higher level of DDGS which could be attributed to the higher NSP at increased DDGS replacement levels.

Table 2: Effect of feeding different dietary treatment containing various levels of DDGS with Phytase enzyme on feed intake (g/bird) of broiler birds during different growth period.

Treatments	0-2 week	3-4 week	5-6 week	0-6 week
T_1	352.05±3.04	1288.08±16.59	2448.27^{b}±25.63	4088.40±46.15
T_2	342.41±1.43	1281.45±13.15	2433.73^{bc}±28.94	4057.59±32.37
T_3	345.09±2.75	1254.13±11.86	2428.85^{bc}±23.16	4028.07±35.56
T_4	360.22±2.42	1376.73±13.26	2588.18^{a}±25.41	4293.13±49.03
T_5	346.87±1.71	1279.92±18.81	2426.67^{bc}±29.19	4053.46±44.81
T_6	348.70±4.23	1223.93±16.64	2310.95^{c}±35.44	3883.58±56.73
T_7	365.30±2.51	1359.17±24.07	2561.07^{a}±37.91	4242.54±46.32

Means bearing different superscripts in a column, differ significantly (P<0.05)

The average body weight gain of birds during different experimental period is depicted in Table 3. Body weight gain of different DDGS replaced groups having phytase enzyme differed significantly (P<0.05) comparable control and with each other. The result so obtained showed that body weight gain at the end of 2nd week was significantly higher (P<0.05) in basal diet as compared rest of the diet as during this period no effect of DDGS and enzyme was reported. Body weight gain during 6th week is significantly higher in T_1, T_2, T_3, T_5, and T_6 as compared to the diet containing 45% DDGS with or without enzyme. During 6th week the body weight gain is significantly (0.05) higher in treatment containing 30% DDGS supplemented with enzyme phytase as compared to other dietary treatments. Overall body weight gain of groups T_4 and T_7 were significantly (P<0.05) lower as compared to control and with other groups. This might be due to fact that at lower replacement of DDGS, there appeared to be sufficient nutrients metabolism from the soybean meal protein and DDGS to support the normal growth resulting in no harmful effect on growth performance of broiler birds.

Table 3: Effect on average body weight gain (g/bird) of broiler chickens during different growth period under different dietary treatments having DDGS supplemented with phytase enzyme.

Treatments	0-2 wk	3-4 wk	5-6 wk	0-6 wk
T_1	237.06^{a}±8.34	838.47±12.05	1359.23^{b}±22.62	2434.76^{b}±33.45
T_2	224.67^{b}±7.75	847.44±17.27	1350.34^{b}±25.90	2422.45^{b}±34.95
T_3	227.58^{ab}±9.88	847.41±15.75	1392.02^{b}±29.18	2467.01^{b}±49.01
T_4	216.04^{c}±8.29	789.26±13.61	1264.07^{c}±26.01	2269.37^{c}±46.33
T_5	226.56^{ab}±9.94	841.44±18.19	1352.13^{b}±30.69	2412.97^{b}±31.24
T_6	227.55^{ab}±10.8	831.14±13.02	1452.28^{a}±27.79	2520.13^{ab}±36.36
T_7	212.95^{c}±9.55	788.16±14.74	1269.05^{c}±28.04	2269.28^{c}±46.73

Means bearing different superscripts in a column, differ significantly (P<0.05)

The result of the present study depicted that the broiler birds fed during different growth period showed better FCR in the dietary treatments containing 30% DDGS supplemented with phytase enzyme. The overall feed conversion ratio of the dietary treatments T_2, T_3, T_5 and T_6 having 15% and 30% DDGS was significantly (P<0.05) lower than T_4 and T_7 but were comparable to control group. The poor feed conversion ratio was observed in the groups fed with 45% DDGS as the feed intake was higher and body weight was lower.

Table 4: Feed conversion ratio (FCR) during different growth period under different dietary regime.

Treatments	0-2 week	3-4 week	5-6 week	0-6 week
T_1	1.48^{ab}±0.01	1.53^{b}±0.02	1.80^{c}±0.03	1.68^{b}±0.04
T_2	1.52^{b}±0.01	1.51^{ab}±0.01	1.80^{c}±0.02	1.67^{ab}±0.02
T_3	1.51^{ab}±0.02	1.47^{a}±0.02	1.74^{b}±0.01	1.63^{ab}±0.04
T_4	1.52^{b}±0.02	1.74^{c}±0.04	2.04^{d}±0.03	1.89^{d}±0.06
T_5	1.53^{b}±0.01	1.52^{ab}±0.02	1.67^{a}±0.02	1.60^{ab}±0.05
T_6	1.52^{b}±0.01	1.47^{a}±0.02	1.64^{a}±0.05	1.57^{a}±0.02
T_7	1.51^{ab}±0.01	1.72^{c}±0.04	2.01^{d}±0.03	1.86^{d}±0.04

Means bearing different superscripts in a column, differ significantly (P<0.05)

The statistical analysis of data revealed that dry matter metabolizability percent values of the different groups varied non-significantly from the control group with the replacement of soybean meal with DDGS. Results of DM digestibility have been shown in Table 5. The groups where 45% soybean meal was replaced with DDGS had numerically lower DM metabolizability but there was no significant (P<0.05) variation among different group. It showed that birds utilized DM less efficiently at higher level of DDGS. Nitrogen retention percentage also did not differ significantly (P<0.05) from the control group. A gradual pattern of decreasing N retention at higher replacement (i.e. 45% DDGS) level of soybean meal was observed. This declining pattern in N retention might be because of the ability of the birds to retain more nitrogen from the soybean meal source as compared to the DDGS origin. The results were similar in accordance with the study [13] as corn DDGS negatively affected the N retention and DM metabolizability.

Table 5: DM metabolizability and nitrogen metabolizability of the experimental birds under different dietary treatments

Treatments	DM Metabolizability (%)	N_2 retention (%)
T_1	63.93±0.92	61.79±0.40
T_2	63.32±0.49	61.17±0.41
T_3	62.62±0.69	60.78±0.22
T_4	59.81±0.80	58.32±0.34
T_5	62.78±0.85	61.74±0.43
T_6	62.86±0.76	60.15±0.41
T_7	59.61±0.82	58.14±0.46

Gross energy metabolizability percent values (Table 6) of rations in broilers of the dietary treatment group T_2, T_3, T_4, T_5, T_6 and T_7 (65.76, 64.12, 63.88, 65.68, 64.17 and 63.90% respectively) did not differ significantly (P<0.05) from the control group (64.94%). No significant (P<0.05) effect was noticed due to addition of phytase enzyme on GE metabolizability. The GE metabolizability decreased numerically with the increase of DDGS level in the diet. Similar results were also reported [8], as no significant improvement in GE digestibility was noticed by the addition of exogenous enzymes to diet formulated by 30% DDGS but there was significant (P<0.05) improvement in GE digestibility of control diet having corn soybean meal as compared to diet having 30% DDGS.

Table 6: Metabolizable energy (kcal/kg) and percent gross energy metabolizability in experimental birds fed with different levels of DDGS replaced diet containing phytase enzyme.

Treatments	Gross energy of feed (kcal/kg)	Gross energy of excreta (kcal/kg)	Nitrogen corrected metabolizable energy (kcal/kg)	Gross energy metabolizability (%)
T_1	4893.63	1687.72	3178.30±40.12	64.94±2.41
T_2	5062.21	1705.65	3329.40±42.88	65.76±4.35
T_3	5245.14	1854.54	3363.07±44.90	64.12±1.47
T_4	5386.34	1917.71	3440.66±.34.95	63.88±6.26
T_5	5060.88	1708.56	3324.42±45.45	65.68±1.43
T_6	5244.82	1851.24	3366.05±43.32	64.17±3.29
T_7	5381.21	1914.56	3439.04±48.07	63.90±3.38

Conclusion

It can be concluded that upto 45% replacement of DDGS can be done without any harmful effect on performance and digestibility of the broiler chickens. Phytase enzyme supplementation improved the performance of birds at 30% DDGS replacement levels. The effect of enzyme supplementation did not improve the digestibility and metabolizability of different dietary group.

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