Research Article

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EFFECT OF REPLACEMENT OF SOYBEAN MEAL WITH DISTILLERS DRIED GRAINS SOLUBLES ON PHYSICAL PARAMETERS OF BROILER'S DIET

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ABSTRACT

The conventional protein source, Soybean meal (SBM) was replaced with distillers dried grains with solubles (DDGS) along with or without exogenous enzymes supplementation in broilers diet to perceive the outcomes of replacement, on diverse physical parameters of broiler's diet. The experimental work was conducted on 520 day old commercial broiler chickens randomly divided into thirteen dietary treatments having two replicates (twenty birds in each replicate) in each treatment. The physical parameters of ingredients and different dietary treatment groups like bulk density, modulus of uniformity, modulus of fineness, number of particles/g, surface area/g and particle size were measured. Particle size declined as the DDGS level was increased in starter as well as finisher ration and reverse was true for the surface area and the number of particles per gram. Bulk density was found higher at 45% soybean meal replacement. The dietary treatments having higher DDGS level had lower modulus of fineness and vice-versa. At similar levels of DDGS in the starter and finisher ration, no profound effect of different exogenous enzyme supplementation was reported on different physical parameters of diets. There was no interaction found in the study in case of various enzymes on the surface area and particles/g of diet and remained same in the presence of various enzymes.

Key words: DDGS, Exogenous enzymes, Modulus of uniformity, Modulus of fineness, SBM

In broiler ration, Soybean meal (SBM) is a conventional protein source and, it's escalating prices with uncertainty in production and availability highlight the imperative requirement to move towards alternative protein sources. Present study considered a relatively cheaper protein source co-produced in the ethanol industries i.e. distillers dried grains with solubles (DDGS). Physical properties of feed ingredients like particle size, bulk density play an important role in nutrient utilization e.g. as the particle size of the feed decreases, the surface area of the particles increases which may enhance the enzymatic action on the feed particles leading to increase in dry matter metabolizability and nitrogen retention (Kumar *et al.,* 2017). Feed intake was altered by the physical attributes of feed ingredients that also affected the performance (Pacheco *et al*., 2014). The current research work was, therefore, designed to determine the effect of replacing DDGS and enzyme supplementation on various physical parameters of broiler fed different diets.

MATERIALS AND METHODS

As per BIS (2007) specifications, SBM based control diet (T1) was compounded with the incorporation of maize, fish meal, vegetable oil, mineral mixture and feed additives (Table 1). All other dietary regimes were formulated by replacing 15, 30 and 45% of SBM with DDGS without and with the addition of various exogenous enzymes (25 g/100 kg feed) i.e., protease, phytase and multienzyme, respectively. Various feed additives were measured in adequate amount for premix preparation and thereafter this premix was mixed properly with increasing the amount of feed ingredients for uniform mixing. To avoid lump formation due to addition of vegetable oil, it was incorporated by mixing in small amount of ration firstly and then added this premix into whole ration with proper manual mixing in each treatment. Remaining treatments were formulated as, in T_2, 15% replacement of SBM with DDGS; in T_3, 30% replacement of SBM with DDGS; in T_4, 45% replacement of SBM with DDGS; in T_5, addition of phytase enzyme with 15% DDGS level; in T_6, addition of enzyme phytase with 30% DDGS level; in T_7, addition of enzyme phytase with 45% DDGS level; in T_8, addition of enzyme protease with 15% DDGS level; in T_9, addition of enzyme protease with 30% DDGS level; in T_{10}, addition of enzyme protease with 45% DDGS level; in T_{11}, addition of multienzyme with 15% DDGS level; in T_{12}, addition of multienzyme with 30% DDGS level; in T_{13}, addition of multienzyme with 45% DDGS level. Bulk density of different diets (mass of material per unit volume) was measured by weighing the amount of material (kg) needed to fill specific volume (box) of one cubic meter after tapping and refilling three times and particle size distribution was evaluated by using Ro-tap sieve shaker. 100 g sample was measured and sieved through the set of sieves as approved by American Society of Agricultural Engineers (ASAE, 1983) with sieve numbers 4, 8, 14, 28 and 100 which were arranged in ascending order in a way so that the largest numbered sieve was placed at the bottom and the smallest number at the top. The sample was placed in sieve and shaken for about 10 min until the weighted material on each sieve became constant. Left out samples on sieve numbers 4 and 8; 14 and 28; and 48, 100 and pan were coarse, medium and fine, respectively. Distribution of coarse, medium and fine particles was indicated by modulus of uniformity and mean size of particles was termed as modulus of fineness

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Table 1
Ingredients (%) and chemical composition (% DM basis) of different rations

Composition	Starter ration (0-3 wk)	Finisher ration (3-6 wk)
Ingredient composition (%)		
Maize	57.00	63.00
Soybean meal	31.00	25.00
Fish meal	8.00	7.00
DDGS	0.00	0.00
Vegetable oil	2.00	3.00
Mineral mixture	2.00	2.00
Feed additives*	320.00	320.00
Chemical composition (DM basis)		
Moisture	10.15	11.32
CP	23.18	21.00
CF	4.42	3.96
EE	5.24	5.15
Total ash	7.28	8.14
ME (kcal/kg)**	3005.65	3176.34

*Feed additives include Meriplex-20g, Vitamin, Ventrimix-25g, Coccidiostat (Dinitro-0-Toluamide)-50g, Choline chloride-50g, Lysine-50g, DL-methionine-100g, CTC-25g, [a] 25g of enzyme phytase, [b] 25g of enzyme protease and [c] 25g of multienzyme per 100kg. **calculated values

which was in accordance with the method of Pfost (1976). The calculated data from various physical parameters was statistically analyzed by CRD design (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Different ingredients and their chemical composition (% DM basis) have been presented in Table 1. The proximate composition of SBM was 45.72% CP, 1.71% EE and 4.30% CF, and of DDGS was 45.07% CP, 5.52% EE and 5.9% CF (on dry matter basis). Bulk density measurements of different ingredients like maize, SBM, DDGS and fish meal were 728.93, 456.7, 577.38 and 442.32 kg/m3, respectively (Table 2). Variation in the bulk density of the diets in starter as well as finisher rations was non-significant ($P<0.05$) from the control group up to 30% replacement of SBM with DDGS, but as the level of replacement reached 45%; bulk density increased ($P<0.05$) in all starter as well in finisher ration. Enzyme supplementation did not convey profound effect on the bulk density of ration. Comparative values of bulk density of finisher ration was higher ($P<0.05$) than starter rations which might be due to the incorporation of dietary ingredients in different amount. The observed data of modulus of uniformity for maize, SBM, DDGS and fish meal was 4.63:3.54:1.83, 5.17:3.65:2.18, 5.24:4.32:2.44 and 2.28:4.61:3.11 while modulus of fineness was 4.56, 2.63, 4.25 and 3.72, respectively. Modulus of fineness in starter and finisher control ration was higher ($P<0.05$) compared to other DDGS based diets and with the higher replacement of DDGS level modulus of fineness lowered ($P<0.05$) due to the lesser particle size ($P<0.05$) of diets with higher DDGS level as compared to diet having no or less DDGS. These findings are in line with results as reported by Sihag and Berwal (2008), as the particle size reduced, the modulus of fineness also reduced in similar manner. Particle size of the diet T_1 was significantly higher ($P<0.05$) in starter ration as compared to the diet containing various DDGS levels. Same trend was noticed in finisher ration also. A reduction ($P<0.05$) in particle size parameter was reported by the increasing DDGS level, that may be because of increasing relative proportion of fine particles and decreasing proportion of course and medium particles at higher DDGS replacement level. Surface area (cm^2/g) of the starter control diet having no DDGS was numerically lower but statistically compared to 15% DDGS based diets and with the increasing levels of DDGS, the surface area increased significantly ($P<0.05$). Similar trend of surface was also found in finisher ration as well but the values were lower as compared to starter ration. The increase in surface area could be due to reduction in the particle size of the diets with increasing DDGS level, as DDGS had smaller particle size as compared to soybean in the current study. The findings are in corroboration with Sen and Sihag (2011) and Kumar *et*

Table 2
Bulk density of starter and finisher ration

Ingredients/ treatments	Starter ration (kg/m^3)	Finisher ration (kg/m^3)
T_1	592.47±23.51[a]	604.38±31.42[a]
T_2	598.08±27.72[a]	608.91±33.11[a]
T_3	600.68±29.91[a]	609.93±24.82[a]
T_4	632.32±31.22[b]	643.87±28.71[b]
T_5	599.23±30.43[a]	608.34±25.62[a]
T_6	601.54±25.21[a]	612.51±27.31[a]
T_7	631.49±22.72[b]	644.43±28.21[b]
T_8	597.34±28.41[a]	610.97±33.43[a]
T_9	599.87±33.62[a]	609.86±21.42[a]
T_{10}	630.78±37.32[b]	646.65±28.82[b]
T_{11}	596.78±25.51[a]	607.42±30.51[a]
T_{12}	601.16±29.73[a]	611.16±24.61[a]
T_{13}	634.47±22.12[b]	648.32±29.42[b]

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

Table 3
Modulus of uniformity and modulus of fineness of starter and finisher ration

Treatments	Modulus of uniformity		Modulus of fineness	
	Starter	Finisher	Starter	Finisher
T_1	3.13:4.80:2.07	2.96:4.85:2.19	4.21±0.18^{d}	4.12±0.10^{d}
T_2	3.10:4.71:2.19	2.92:4.81:2.27	4.18±0.16^{cd}	4.09±0.14^{cd}
T_3	2.95:4.69:2.36	2.85:4.76:2.39	3.96±0.22^{b}	3.68±0.09^{b}
T_4	2.87:4.64:2.49	2.78:4.73:2.49	3.74±0.19^{a}	3.41±0.13^{a}
T_5	3.06:4.77:2.17	2.94:4.72:2.34	4.15±0.18^{cd}	3.90±0.16^{c}
T_6	2.97:4.73:2.30	2.87:4.70:2.43	3.94±0.15^{b}	3.66±0.11^{b}
T_7	2.86:4.67:2.47	2.84:4.67:2.49	3.73±0.16^{a}	3.44±0.12^{a}
T_8	3.02:4.75:2.23	2.93:4.80:2.27	4.16±0.20^{cd}	3.97±0.17^{cd}
T_9	2.96:4.70:2.34	2.84:4.78:2.38	3.97±0.12^{b}	3.65±0.13^{b}
T_{10}	2.88:4.66:2.46	2.76:4.76:2.48	3.75±0.20^{a}	3.43±0.10^{a}
T_{11}	3.05:4.78:2.17	2.95:4.74:2.37	4.14±0.14^{c}	3.94±0.12^{cd}
T_{12}	2.95:4.72:2.33	2.89:4.70:2.41	3.94±0.16^{b}	3.63±0.15^{b}
T_{13}	2.84:4.65:2.51	2.78:4.71:2.51	3.72±0.22^{a}	3.40±0.12^{a}

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

Table 4
Average particle size, surface area and particles per gram of starter ration

Treatments	Particle size (Micron)	Surface area (cm^2/g)	Particles per Gram	Particle size (Micron)	Surface area (cm^2/g)	Particles per Gram
T_1	1096.82±42.19^{d}	71.09±0.07^{a}	25456.45±53^{a}	1044.76±32.06^{d}	68.72±0.08^{a}	26796.59±456^{a}
T_2	1033.47±40.44^{c}	72.12±0.05^{ab}	26728.85±137^{b}	990.61±42.05^{c}	69.15±0.04^{ab}	28141.17±252^{b}
T_3	985.13±40.09^{b}	76.94±0.07^{c}	28130.26±242^{c}	940.46±31.01^{b}	75.50±0.08^{c}	29573.76±416^{c}
T_4	934.78±28.81^{a}	80.81±0.09^{d}	29566.67±435^{d}	891.31±21.93^{a}	79.73±0.07^{d}	31078.35±685^{d}
T_5	1030.65±38.32^{c}	72.53±0.08^{ab}	26768.93±192^{b}	986.92±25.50^{c}	70.85±0.05^{ab}	28136.56±376^{b}
T_6	979.31±36.81^{b}	76.17±0.04^{c}	28145.87±327^{c}	936.42±18.40^{b}	75.67±0.08^{b}	29579.56±430^{c}
T_7	924.96±22.40^{a}	80.86±0.09^{d}	29587.62±449^{d}	889.17±16.39^{a}	79.51±0.02^{c}	31084.67±764^{d}
T_8	1028.56±41.89^{c}	72.52±0.09^{b}	26756.76±186^{b}	989.39±26.92^{c}	71.68±0.09^{ab}	28154.69±158^{b}
T_9	976.22±31.20^{b}	76.66±0.05^{c}	28154.87±245^{c}	938.68±22.09^{b}	75.95±0.03^{c}	29584.75±552^{c}
T_{10}	927.78±26.66^{a}	80.82±0.03^{d}	29578.91±421^{d}	890.39±19.39^{a}	79.82±0.05^{d}	31082.24±714^{d}
T_{11}	1025.83±38.57^{c}	71.18±0.08^{ab}	26789.81±197^{b}	992.42±34.97^{c}	72.12±0.09^{b}	28165.47±205^{b}
T_{12}	980.49±27.49^{b}	76.85±0.03^{c}	28164.38±336^{c}	937.43±25.67^{b}	76.13±0.06^{d}	29598.83±458^{c}
T13	921.53±21.06a	80.91±0.08d	29590.43±396d	886.67±29.16a	80.32±0.05c	31096.89±646d

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

al. (2017) as they also found that with higher inclusion level of fine particles, the surface area/g of different dietary regime increased (P<0.05). DDGS based diets had higher (P<0.05) particle per gram as compared to control diet but among different DDGS based diets also, the particles per grams increased significantly (P<0.05). This increase in number of particles per gram might be attributed to the decrease in particle size with increasing DDGS level. However, at same DDGS level, number of particles per gram was similar even after supplementation of different enzymes. These results are in accordance with those reported by Sen and Sihag (2011) as decrease in particle size of diets formulated by inclusion of higher fine ingredients was associated with gradual increase (P<0.05) in number of particles per gram of different diets. Coarse particles proportion was highest in the control diets (starter and finisher diets; 3.13 and 2.96, respectively) as compared to the other dietary treatments, though, a reverse trend was speculated for the fine particles among different diets. Values of coarse and medium particles decreased and that of the fine particles increased with increasing DDGS level in diets. Decrease (P<0.05) in the average particle size of the diets at higher DDGS level could be the reason for this pattern. The results are in line with the results reported by Kumar *et al*. (2017), as the coarse and medium sized portion decreased with in increasing level of DDGS incorporation.

The incorporation of DDGS in the broiler ration by replacing SBM had significant ($P<0.05$) effect on the physical properties of different dietary regimes. Bulk density of rations increased significantly at 45% replacement while particle size, surface area and particles/g varied significantly at 15, 30 and 45% replacement of SBM with DDGS, however no additive effect of exogenous enzyme was reported. Replacement of soybean meal with different levels of DDGS supplementation changed the physical parameters of the broiler diets.

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