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Effects of brewer's spent grain on performance and protein digestibility in broiler chickens

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ABSTRACT

Brewer's spent grain (BSG) is the main waste product from beer production in the most countries; it is often given away and/or used as feed for ruminants. The objective of this study was to evaluate the impact of a gradual replacement of soybean meal with BSG on performance and protein digestibility in broiler chickens. Six diets were formulated in which 0, 5, 10, 15, 20 and 25% BSG replaced soybean meal. A total of 144 Ross-308 broiler chickens divided into 24 pens, and each experimental diet was fed to11-d-old broiler chickens kept in 4 pens. Feed intake, body weight gain and feed: gain ratio were determined for grower (11-24 d), finisher (25-42 d) phases and the overall period of breeding (11-42 d). The ileal protein digestibility was recorded on samples slaughtered at the termination of experiment (d 42), Feed utilization was affected by BSG inclusion only at finisher phase (P<0.05). Feed intake value in control (0% BSG) and 5% BSG groups was greater than that in other groups. Body weight gain in group fed diet with 25% BSG was less than others at grower phase, and feed efficiency was low for this group (P<0.001). Feed: gain ratio was not affected by BSG inclusion at the finisher phase (24-42 d). The ileal digestibility values of protein were significantly increased by some levels of BSG inclusion (P<0.01). To conclude 20% inclusion of BSG at 11-24 d and 5% inclusion of BSG at 25-42 d supports acceptable performance in the broiler chickens.

Key words: brewer's spent grain, broiler chickens, performance, ileal digestibility.

INTRODUCTION

The protein deficiency of feed is more critical than caloric inadequacies in monogastric livestock. Protein sources for poultry feed are expensive and in most cases are directly consumed by man as food [7]. Brewer´s spent grain (BSG), as the main waste product from beer production is a very inexpensive recommendation and can safeguard with same quality size of protein [3, 6]. Brewer´s spent grain is rich of protein and fiber [9]. According to NRC [11] brewer´s spent grain contain 25.3 % protein, 6.3 % fat, 92 % dry matter, approximately 2080 kcal/kg metabolizable energy (ME). It has concentrated source of digestibility fiber, amino acid, B vitamin and phosphorus quantities but this is a poor source for other mineral materials [5]. The results of some studies have shown brewer´s spent grain only can be used for ruminants, that it is resulting of high fiber [2, 15]. However some trials showed BSG can be used for poultry feed [10, 12]. Chemical composition of BSG varies with barley variety, time of harvesting and brewing technology [14]. The objective of current research was to evaluate the influence of enzyme supplemented brewer´s spent grain on feed intake, growth performance and ileal digestibility in the broiler chickens.

MATERIALS AND METHODS

Before diets formulation, fresh BSG was provided from Ariya Company (Aur, Iran) and subsequently air-dried to approximately 97% DM. The chemical composition of BSG showed there were 14 % crude protein, 97 % dry matter, 11.6 % crude fat, 6 % crude fiber and 6.2 % ash. The ingredients were ground through a 5-mm sieve in a

Munch hammer mill and mixed. Six diets with different levels of BSG (0, 5, 10, 15, 20 and 25%) were produced. A total of 144 day-old Ross-308 broiler chickens were placed in litter floored pens and fed a commercial starter diet until 10 days of age. At 11 days of age the birds were randomly assigned to 24 pens (4 pens/treatment and 6 birds/pen), in those the weight and sex ratio were same. Feed and water were provided ad libitum. Diets formulation for different periods of breeding is in table 1. Performance data (feed intake, body weight gain and feed conversion ratio (FCR)) obtained for chickens at 24 and 42 d of age. Pens means served as an experimental unit for statistical analysis. At 42 d of age, two randomly selected birds from each treatment were dissected for collection of ileal contents. For this, uterine area was opened and after specifying ileal, that there is a meckel appendage at the first and its end cecum, ileal was separated and its contents were unloaded in the sterile plastic vessels separately. For unloading the contents, from one end of ileal, distilled water was injected by syringe and continued until complete unloading. For avoiding of fermentation, collected samples should immediately be transferred to oven and dried in temperature of 60°C during 48 hour, then, dried samples were transfered to laboratory. Of course, chromium Oxide 0.4% was added to diets 3 days before killing as an indigestible marker. The concentration of chromium oxide in diets and ileal samples was determined by spectrophotometer in laboratory. The ileal digestibility was calculated as:

$$\text{Ileal digestibility of nutrient} = \frac{\text{concentration of nutrient in diet} - \text{Nutrient excertion from ileum}}{\text{concentration of nutrient in diet}} \times 100$$

$$\text{Nutrient excretion from ileum} = \frac{\text{nutrient concentrations in ileal digesta} \times \text{dietary concentration of chromium oxide}}{\text{Chromium oxide concentrations in ileal digesta}}$$

$$\text{Chromium oxide concentrations in ileal digesta} = \frac{\text{number of absorbed sample}}{\text{standard curve slope} \times 10 \times \text{sample weight}}$$

Table 1. Ingredients and compositions of the experimental diets in different phases

Ingredients (%)	Grower phase[1]						Finisher phase[1]					
	A	B	C	D	E	F	A	B	C	D	E	F
Corn	58.1	54.72	51.34	47.96	44.58	41.18	62.38	59	55.62	52.24	48.85	45.45
Soybean meal	35.63	33.41	31.18	28.96	26.74	24.52	31.66	29.43	27.21	24.99	22.77	20.55
Brewer´s spent grains	0	5	10	15	20	25	0	5	10	15	20	25
Soybean oil	2.46	3.15	3.84	4.53	5.23	5.92	2.41	3.1	3.79	4.48	5.17	5.87
Dicalciumphosphate	1.49	1.4	1.31	1.21	1.12	1.03	1.38	1.29	1.2	1.1	1.01	0.92
Calciumcarbonate	1.05	1.09	1.12	1.15	1.19	1.22	1.02	1.06	1.09	1.13	1.16	1.19
bicarbonate	0.24	0.19	0.14	0.09	0.04	0	0.23	0.19	0.14	0.09	0.04	0
Methionine	0.23	0.22	0.21	0.21	0.20	0.19	0.18	0.17	0.17	0.16	0.15	0.14
Lysine	0.07	0.10	0.13	0.16	0.19	0.23	0.01	0.04	0.07	0.11	0.14	0.17
Mineral supplement	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin supplement	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.18	0.18	0.17	0.16	0.16	0.15	0.18	0.18	0.18	0.16	0.16	0.15
enzyme	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Calculated Composition												
Metabolizable energy Kcal/Kg	2950	2950	2950	2950	2950	2950	3000	3000	3000	3000	3000	3000
Crude protein %	20.61	20.61	20.61	20.61	20.61	20.61	19.23	19.23	19.23	19.23	19.23	19.23

[1]*A: Control; B: diet with 5% BSG; C: diet with 10% BSG; D: diet with 15% BSG; E: diet with 20% BSG; F: diet with 25% BSG.*

Data were subjected to one-way ANOVA using the GLM procedure of SAS (v.9.1.). Means were ranked following Duncan's Multiple Range test, and the level of significance was 0.05 for all comparisons. Orthogonal contrasts of the GLM procedure were used to test significant linear and quadratic relationship between the BSG levels and different factors.

RESULTS

There was not significant effect of BSG inclusion on feed intake at 11-24 d period (Table 2), whereas there was a significant linear reduction in feed intake as the BSG increased (P= 0.0106). As well as, the results showed that, there is a significant difference between diet containing 25% BSG and other diets for body weight gain in the grower phase (11-24 d). This diet resulted to lowest gain. The linear and quadratic relationships were non-significant (P= 0.2553 and P= 0.3035, respectively). Thus from these results, the feed: gain ratio (FCR) increased significantly when increasing levels of BSG toward greater than 20%. In the grower phase (11-24 d) the FCR was 1.65 in the control group (0% BSG), whereas it was 2.17 in the group of birds fed diet with 25% BSG. For the finisher phase (25-42 d), the inclusion of BSG had not significant effect on the body weight gain of birds.

Although at the finisher phase, feed intake in groups fed diets containing BSG was lower than control group; there was no significant difference between different groups for feed: gain ratio. In this phase, there was a significantly linear reduction in feed intake as the dietary inclusion of BSG increased (P= 0.0035). As at all, the inclusion of BSG

in diets had a significant effect only on the feed intake of birds (Table 2, 11-42 d), for other factors there was no significant difference between different groups in the overall breeding period.

Table 2. Performance in the broiler chickens fed various levels of BSG at different phases

Item	Diets[1]							
	A	B	C	D	E	F	SEM	P-vlue
				11-24 d				
Body weight gain(gr)	730.17 ^{a}	698.75 ^{a}	645.32 ^{a}	687.30 ^{a}	691.04 ^{a}	533.13 ^{b}	34.640	0.0122
Feed intake (gr)	1202.29	1205	1076.44	1082.71	1096.46	1139.58	38.201	0.0836
Feed: gain	1.65 ^{b}	1.735 ^{b}	1.69 ^{b}	1.575 ^{b}	1.585 ^{b}	2.17 ^{a}	0.0675	<0.0001
				25- 42 d				
Body weight gain(gr)	1246.75	1162.5	1211.25	1188.5	1151	1096	45.009	0.2911
Feed intake (gr)	2384.5 ^{a}	2329 ^{ab}	2266 ^{b}	2223 ^{b}	2228 ^{b}	2281.5 ^{ab}	36.42	0.0426
Feed: gain	1.91	2.01	1.87	1.87	1.96	2.08	0.0804	0.4085
				11- 42 d				
Body weight gain(gr)	1861.5	1751.75	1713.75	1766.25	1736.5	1625.75	69.24	0.3390
Feed intake (gr)	3388.25 ^{a}	3336.75 ^{a}	3156.5 ^{b}	3147.75 ^{b}	3142.25 ^{b}	3232.5 ^{ab}	56.98	0.0299
Feed: gain	1.82	1.91	1.86	1.78	1.81	1.99	0.061	0.239

Means within the same row without common superscripts differ significantly (P<0.05).

[1] A: Control; B: diet with 5% BSG; C: diet with 10% BSG; D: diet with 15% BSG; E: diet with 20% BSG; F: diet with 25% BSG.

Same as grower and finisher phases, the linear relationship is significant only for feed intake (P= 0.0023) in this period.

The ileal digestibility of protein increased significantly with inclusion of 10% BSG in diet. There was no significant difference between control group and groups fed the diets with 5, 15 and 20% BSG.

Table 3. Ileal digestibility values in broilers fed various levels of BSG

Item	Diets[1]							
	A	B	C	D	E	F	SEM	P-vlue
Protein digestibility (%)	71.16 ^{cd}	76.64 ^{bc}	84.76 ^{a}	76.64 ^{bc}	66.74 ^{d}	83.32 ^{ab}	2.188	0.007

Means within the row without common superscripts differ significantly (P<0.05).

[1]A: Control; B: diet with 5% BSG; C: diet with 10% BSG; D: diet with 15% BSG; E: diet with 20% BSG; F: diet with 25% BSG.

DISCUSSION

It is well known that, the content of insoluble fiber and Non-starch polysaccharides in the diets containing BSG is greater than that in the control diet (0% BSG). Moreover, BSG as a plant protein source contains more lignin and cellulose than soy; therefore the total dietary fiber content would have been even higher in the BSG diets [3, 7]. Some studies showed that, as the inclusion of BSG increased the birds did not compensate for the reduced dietary metabolizable energy (ME) levels by increasing their feed consumption [3, 13]. In these trials there was not significant different for feed intake between diets containing BSG. Although we fixed ME level in the experimental diets with different concentration of BSG, we observed this reduction in feed utilization too.

Our results showed that, the inclusion level of BSG has not significant effect on the feed: gain ratio through overall breeding period and give a significantly increase only about 25% BSG in grower period. This result support previous studies with BSG-fed chickens. Lumpkins et al. [8] reported that diets with 12 to 15% dried grains with soluble (DDGS) from corn did not diminish feed efficiency in broilers. Moreover, Denstadli et al. [3] found that, FCR differed significantly in the control group (1.45) versus groups fed diets with 30 and 40% BSG (1.65 and 1.69, respectively). However, Hussaini et al. [5] suggested that birds fed diet containing 7.5% BSG have a more FCR than control group (0% BSG). Friesen et al. [4] reported that the use of BSG in poultry diets caused a disorder in bowel area and increased the FCR. Although, it found that fibrous material stimulate the gizzard and activate the pancreatic enzymes and bile acids secretion, which in turn is known to be positive for nutrient utilization, insoluble fiber has a low nutritional value [3] and our results showed that inclusion of more than 5% BSG reduced feed intake significantly.

There is a little study on ileal digestibility values of protein in poultry diets containing BSG. Comparison of ileal protein digestibility in control diet (0% BSG) with diets containing BSG (Table 3) showed that the inclusion of BSG in diet increased ileal protein digestibility.

This result disagree with results of Denstadli et al. [3], in which they observed a significant reduction in the protein digestibility as Brewer's dried grain (BDG) replaced the wheat and soy-based control diet, probably due to the

insoluble properties of the BDG protein. For this reason, we used enzyme for all diets in our study. Chesson [1] suggested that the use of enzyme in diets containing BSG increased amino acids digestibility and protein absorption.

CONCLUSION

We conclude that a gradual inclusion of BSG in broiler diets reduced feed utilization at finisher phase (25-42 d) and growth in grower phase (11-24 d). However, the performance in birds fed diets containing up to 20% BSG at the grower phase and 5% BSG at the finisher phase approached that of the control birds. Moreover only if we use the enzyme in diets containing BSG, the protein digestibility would not reduce.

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