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Effect of Different Levels of Molasses Distillers Condensed Soluble on Broiler Chickens Performance, Carcass Traits and Intestinal Morphology of Broilers

Research Article

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ABSTRACT

An experiment was conducted to investigate the effect of molasses distillers condensed soluble (MDCS) on growth performance, carcass characteristics and intestinal morphology of broilers. A total of 400 one day-old, unsexed Ross 308 broiler chicks were randomly allotted to 20 cages. The dietary MDCS levels incorporated 0% and 4% in the starter and 0%, 4% and 8% in grower diet, respectively. The average daily gain (ADG), average daily feed intake (ADFI) and feed conversion ratio (FCR) were obtained from 7 to 42 days of age. As a result of this study, the dietary inclusion of MDCS had no negative effects on productive performance of broilers or on the microbial population's enumeration, villus width, villus height, crypt depth and carcass traits. Thus it can be concluded that MDCS can be included in broiler dietary up to 8% without any adverse effect on broiler performance.

KEY WORDS broiler, carcass traits, growth performance, intestinal morphology, molasses distillers condensed soluble.

INTRODUCTION

Feed is the main cost component of animal production and often accounts for 70% of total costs of poultry production. The best strategy to reduce cost is use of alternative feed ingredients which have relatively low cost. Molasses is a typical alcoholic distillate in Iran. The molasses distillers condensed soluble (MDCS) is a molasses-based fuel ethanol by-product coming from sugar beet industrial product and which is a mineral-rich liquid, yeast and fermentation of soluble components produced after distillation and alcohol production (Sadr, 2012; Moeini *et al.* 2014). The MDCS have substantial values animal feedstuff by removing the water as the water content, pH and the concentration of some of mineral salts are inhibitors factors for incorporation of MDCS to animal feeds (Veyskarami *et al.* 2009). However, removing the precipitation and related processing steps contribute to the cost of the final products (Chen *et al.* 1981; Archibeque *et al.* 2008). As the recovered by-product of MDCS has a low (pH=4), it is advantageous to raise or even neutralize the pH. This pH adjustment can be achieved by adding sodium hydroxide, ammonia or any other feed grade alkali. Neutralization with ammonia is desirable, because the nitrogen can serve as a protein source in the animal feed (Archibeque *et al.* 2008; Tang *et al.* 2011). Molasses condensed distillers soluble are relatively high in crude protein (CP) (22%; DM basis) and metabolizable energy (ME) (2795 kcal/kg) which makes this by product an attractive supplement for low-quality feeds (Veyskarami *et al.* 2009). Veyskarami *et al.* (2009) indicated that MDCS as a very cheap source of protein and energy could safely used up to 15% in Lori lamb ration. A very scanty report is on the effect of MDCS as a dietary component on the productive performance of poultry. Sadr and Moeini (2011) indicated that it had no adverse effects on ADG, feed intake and feed conversion ratio (FCR) up to 4% in broilers diet. Therefore, the aim of the current study was to understand the limitations associated with feeding higher levels of MDCS.

MATERIALS AND METHODS

Birds, management and diets

A total of 400 day-old Ross 308 broiler chicks were obtained from a commercial hatchery. The average initial body weights of chicken was 120 ± 13 gram. They were randomly allotted to two experimental diets in starter period and five experimental diets in grower period. The birds were reared under standard management conditions. The birds were offered iso-caloric and iso-nitrogenous diets; 7 to 21 day of age (starter period) and 22-42 day of age (grower period). The experimental diets were formulated with two levels (0 and 4%) of MDCS in starter period and three levels (0, 4 and 8%) in grower period replacing with corn and soy bean meal (Tables 1 and 2). Ttreatment 1: chicks in both starter and grower did not feed MDCS (control diet). Treatment 2: 0% in the starter diet and 4% of MDCS in grower period was used. Treatment 3: 0% in the starter diet and 8% of MDCS in grower period was used. Treatment 4: 4% in the starter diet and 4% of MDCS in grower period was used. Treatment 5: 4% in the starter diet and 8% of MDCS in grower period was used. The experimental diets in mash form were formulated to meet requirement according the NRC (1994). Daily feed intake and body weight were recorded in total period and ADG, ADFI and FCR were calculated. The lighting schedule was 23 h of light/1 h dark cycle with an average light intensity of 15 lx was maintained until the end of the experiment. The dietary electrolyte balance was calculated as milli equivalents of (Na+K) - Cl per 1 kg of DM (Mongin, 1981).

Escherichia coli populations enumeration

At 42 d of age, two birds per pen were randomly selected and killed via cervical dislocation. Fresh ileal samples (0.5 g) were diluted with 9.5 mL sterilized distilled water and vortexes until a pH of 6.0 was obtained. One gram of wet sample was diluted with 10 mL of distilled water, of which 1 mL was transferred into 9 mL of sterilized distilled water. The samples were serially diluted from 10^{-1} to 10^{-7} (Barnes and Impey, 1970). One-tenth milliliter of each diluted sample was coated on the medium for enumeration of *E. coli* populations and the results were expressed as colony-forming units, log10 per gram of fresh sample. For detection of *E. coli* in the samples, dilutions of the cells were placed on eosin methylene blue agar (EMB) and incubated at 37 ˚C for 48 h. Purple colonies with fluorescence under a long-wave UV lamp were scored as positive for *E. coli*.

Carcass characteristics and intestinal morphology

At 42 d of age, two birds per pen were randomly selected, tagged, individually weighed. The organs were individually weighed to determine their relative weights. The carcasses were scalded and picked. A two-cm segment of the primary of the jejunum were removed and fixed in 10% buffered formalin for 72 h. Each segment was then embedded in paraffin, and a 2 µm section of each sample was placed on a glass slide and stained with hematoxylin and eosin for examination with a light microscope (Sakamoto *et al*. 2000). The ten longest and straightest villi and associated crypts were measured from each segment. Measurements for the villi height were taken from the tip of the villus to the villus-crypt junction. The crypt depth was defined as the depth of the invagination between adjacent villi and the villus width was measured at the top and bottom of villi. The carcass and abdominal fat weights were obtained as birds were manually removed from the line. Birds carcass were then chilled for 4 h, at which point all birds were manually deboned and the weights were obtained for breasts and back halves of all birds. Relative weights (% of body weight (BW)) were determined for abdominal fat, the carcass, and boneless-skinless breast meat.

Statistical analysis

This study was conducted as a completely randomized design and data were analyzed by using the Analysis of Variances (ANOVA) procedure (SAS, 2003). Least significant range was used to detect the differences (P<0.05) among different group means. All of parameters were analyzed as follows:

$$Y_{ijk} = \mu + (T_i) + (e_{ij})$$

Where:

Y_{ijk}: characteristic that was measured.

µ: overall mean.

T_i: treatment effect.

eij: residual error.

RESULTS AND DISCUSSION

Growth performance

Effects of dietary inclusion MDCS on growth performance of broiler chicks in whole period (42 days) are presented in Table 3. There was no significant difference between MDCS and controls on growth performance (7-42 day, P>0.05).

Table 1 The mean chemical composition of molasses distillers condensed soluble (MDCS)

Dry mater (gr/kg MDCS)	635
Crude protein(gr/kg DM)	232
Ether extract (gr/kg DM)	10
Neutral detergent fiber (gr/kg DM)	45
Ash (gr/kg DM)	212
Gross energy (kcal/kg DM)	3655
Apparent metabolizable energy (kcal/kg DM)	2900
True metabolizable energy (kcal/kg DM)	3115
Ca (gr/kg DM)	11.5
P (gr/kg DM)	5.0
Na (gr/kg DM)	17.5
K (gr/kg DM)	60.5
Cl (gr/kg DM)	16.5
Cu (mg/kg DM)	30
Zn (mg/kg DM)	90
Fe (mg/kg DM)	298

DM: dry matter.

Unfortunately, reports on the value of MDCS in poultry nutrition are scarce. The findings of this study are in agreement to Sadr and Moeini (2011) who reported that MDCS had no significant effect on ADG and FCR in broilers. Shurson (2003) indicated that broilers fed dried distiller's grain with soluble (DDGS) produced higher growth rate and survivability. Dried distiller's grain with soluble (DDGS) is a by-product that was partly similar to MDCS with 26% CP and 3278 kcal/kg true metabolizable energy corrected for nitrogen (TMEn) (Wang *et al.* 2007; Ayasan and Karakozak, 2009).

However, Choi *et al.* (2008) reported that DDGS in broiler diet had no significant effect on productive performance. Tang *et al.* (2011) reported there was no significant difference in weight gain and feed intake, but birds fed diets with 10, 15 and 20% DDGS had poorer ($P<0.05$) FCR than other groups and the overall FCR of chickens fed diets with 0% and 5% DDGS were similar. The DDGS levels in excess of 8% of the starter ration had no deleterious effects on growth; however, the lack of a significant effect did not carry through the grower period (Parsons *et al.* 1989; Lumpkins *et al.* 2003). Electrolyte balance improved metabolize amino acids especially lysine and electrolyte balance in the diet lead to prevented the decrease in performance (Borges *et al.* 2003). The results of this study indicated that the MDCS up to 8% had no negative effect on growth performance compared with control group, thereby; it seems MDCS could effectively be used up to 8%, replacing with corn and soybean meal in broiler diets. There was no interaction between experimental periods ($P>0.05$) on liver weight percentage (Table 3). However, percentage of liver weight in broilers fed diet included MDCS was significantly upper than those fed on control diet ($P<0.05$). Sadr (2012) reported MDCS up to 4% had no significant impact on carcass traits. Lumpkins *et al.* (2004) reported that feeding DDGS up to 18% for a period of 42 days resulted in non-significant differences in processing weights or yields, including carcass, breast, wings, front half and back half.

Table 2 Dietary ingredients and the nutrient content of the starter and grower diets (%)

Ingredient	Starter (7 to 21 d)		Grower (22 to 42 d)		
	0%	4%	0%	4%	8%
Corn	55.77	53.21	65.6	63.46	59.92
Soybean meal (48% CP) %	37.44	35.31	28.71	26.99	24.51
Molasses distillers condensed soluble (MDCS) %	0	4	0	4	8
Poultry fat %	2.77	2.79	1.76	1.64	1.79
Vitamin and mineral premix[1]	0.50	0.50	0.50	0.50	0.50
NaCl	0.31	0.32	0.31	0.31	0.31
DL-methionine	0.21	0.24	0.19	0.22	0.26
L-lysine HCL	-	-	0.08	0.06	0.05
Dicalcium phosphate	1.96	2.00	1.85	1.89	1.93
Oyster shell	0.94	0.93	0.92	0.91	0.95
$NaHCO_3$	0.10	0.10	0.08	0.08	0.08
NH_4Cl (66% Cl) (%)	0	0.60	0	0.35	0.7
Calculated analysis (as fed basis)					
Metabolizable energy (kcal/kg)	2950	2950	3000	3000	3000
Crude protein (%)	21.00	21.00	18.00	18.00	18.00
Calcium (%)	0.90	0.90	0.85	0.85	0.85
Available phosphorus	0.45	0.45	0.42	0.42	0.42
Sodium (%)	0.17	0.23	0.16	0.22	0.23
Choloride (%)	0.22	0.28	0.22	0.28	0.29
Dietary electrolyte balance (DEB) (meq/kg)[2]	262.42	262.42	221.27	221.27	221.27
Lysine (%)	1.12	1.12	0.97	0.97	0.97

[1] Mineral and vitamin premix provided the following per kilogram of diet: vitamin A: 9000 IU; vitamin D_3: 2100 IU; vitamin E: 30 mg; vitamin B_3: 30 mg; vitamin B_{12}: 0.12 mg; Calcium pantothenate: 10 mg; vitamin K_3: 5 mg; Thiamin: 1.1 mg; Riboflavin: 4.5 mg; vitamin B_6: 2.0 mg; Folic acid: 0.5 mg; Biotin: 0.5 mg; Fe: 50 mg; Cu: 10 mg; Mn: 70 mg; Zn: 50 mg; Co: 0.2 mg; I: 1.0 mg; Se: 0.3 mg; Butylated hydroxytoluene (BHT):150 mg.

Table 3 Body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) in broilers

% MCDS in starter	% MCDS in grower	BW (g)	BWG (g/day)	FI (g/day)	FCR (g/g)
0	0	2027	48.3	108.7	2.25
0	4	2011	47.8	110.2	2.3
0	8	2028	48.3	111	2.29
4	4	2014	47.9	110	2.28
4	8	2001	47.6	109.2	2.29
SEM		24.79	1.17	1.2	0.03
P-values		0.94	0.94	0.65	0.64

MCDS: molasses distillers condensed soluble.
SEM: standard error of the means.

Carcass traits

Table 4 shows the results of carcass traits of broiler chicks. The MDCS had no significant impact on carcass traits, except liver weight percentage.

Other research showed that DDGS levels in excess of 14% may result in negative effects on carcass yield, and breast meat yield (Loar *et al.* 2012). Being equal carcass percentage of carcass weight and breast may be due to the same protein digestibility in chicks fed diets containing different levels of MDCS and control groups (Borges *et al.* 2003). With regard to the type and amount of amino acids on carcass, breast and thigh are effective, considering these results, it can be said that the amount and type of amino acids for the growth of these organs have been enough, that there was no difference with the control group (Borges *et al.* 2003). According to studies of Borges *et al.* (2003) electrolyte balance has a positive effect on the rate of protein synthesis, therefore no loss of carcass parts, especially of the breast and thigh can be caused by it.

In the present study liver weight percentage increased in broilers fed to MDCS. It might be due to liver high activity and broiler's age. As nutrient component of MDCS (type, bioavailability and rate) may influence liver activity.

Escherichia coli populations enumeration

Intestinal microbial plays an important role in the health status of host animals and is the first barrier against pathogens from food.

In general, intestinal bacteria may be divided into species that exert either beneficial (such as *Lactobacilli* and *Bifidobacteria*) or harmful (such as *E. coli*) effects on host health (Macfariane and Cummings, 1991). In the current study, treatment with MDCS at different levels had no any significant impact on the microbial population's enumeration (Table 5). It was expected, that's why *E. coli* is a harmful bacteria and might affected growth performance, whereas we did not observe any reduction in growth performance in all groups.

Table 4 Dietary inclusion of MDCS on carcass traits and liver relatively weight (% of BW)

% MCDS in starter	% MCDS in grower	Carcass	Breast	Thigh	Abdominal fat	Liver
0	0	58.7	18.6	17.8	1.7	2.4[b]
0	4	59.3	20.9	17.9	1.9	2.7[a,b]
0	8	58.1	19.7	17	1.6	3.1[a]
4	4	58.8	18.9	16.2	1.6	2.5[b]
4	8	59.5	21.2	18	1.7	2.5[b]
SEM		0.8	0.43	0.3	0.11	0.12
P-values		0.9	0.32	0.36	0.73	0.007

MCDS: molasses distillers condensed soluble and BW: body weight.
SEM: standard error of the means.
The means within the same column with at least one common letter, do not have significant difference ($P>0.05$).

Table 5 The effect of MDCS in diets on *Escherichia coli* counts in ileum of 42-d-old chickens ($\log_{10}$ cfu/g)

% MCDS in starter	% MCDS in grower	*Escherichia coli* counts
0	0	6.57
0	4	6.49
0	8	6.31
4	4	6.16
4	8	6.10
SEM		0.166
P-values		0.4

MCDS: molasses distillers condensed soluble.
SEM: standard error of the means.

Intestinal morphology

The jejunum villus width, villus height and crypt depth are shown in Table 6.

Table 6 Effect of dietary MDCS on morphometry in jejunal mucosa (in µm)

% MCDS in starter	% MCDS in grower	Villus height	Villus width	Crypt depth
0	0	1065.14	228.24	178.56
0	4	1087.68	226.75	180.5
0	8	1081.14	230.62	183.32
4	4	1053.36	232.5	185.6
4	8	1073.19	225.22	186.31
SEM		15.97	5.92	6.25
P-values		0.84	0.98	0.95

MCDS: molasses distillers condensed soluble.
SEM: standard error of the means.

The MDCS treatments had no significant effect on villus width, villus height and crypt depth. Therefore, in this study the chicks were not under stress, and the microbial population has not been changed, so it makes sense that the intestinal villus in experimental groups were not differ significantly from a statistical stand point.

The villi play a crucial role in the digestion and absorption processes of the small intestine, as villi increase surface area and are the first to make contact with nutrients in the lumen (Gartner and Hiatt, 2001).

There is a strong relationship between intestinal mucosal histology and body weight change induced by intestinal function (Awad *et al.* 2006). Increases in villus length (Adibmoradi *et al.* 2006) and villus surface (Awad *et al.* 2006) provide a greater surface area for higher nutrient absorptive potential and thus improve nutrient digestibility (Onderci *et al.* 2006).

Since there was no significant difference between performance parameters, it is seems the length of villus and crypt depth did not vary among various treatment groups.

CONCLUSION

In conclusion, the data reported here indicated that dietary inclusion of MDCS had no adverse effect on growth performance, *Escherichia coli* population's enumeration and morphometric traits of jejunal mucosa. Therefore, it may be concluded that MDCS can be successfully incorporated up to 8% in broiler diets by replacing corn and soybean meal.

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