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Research Article

Effects of Dietary Supplementation of Dried Distillers Grain with Solubles (DDGS) and Yucca (*Yucca schidigera*) on Broiler Performance, Carcass Traits, Intestinal Viscosity and Marketing

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ABSTRACT: This study was conducted to determine the effects of diet supplementation of dried distillers' grain with soluble (DDGS) and yucca (*Yucca schidigera*) on broiler performance, intestinal viscosity, carcass traits, and marketing. A total of 360, 21-d-old male broiler chickens were divided into 4 groups as 1: Control (C, corn based diet, without DDGS and yucca (Y) supplementation), 2: DDGS (30%), 3: C + Y (120 mg/kg Yucca) and 4: DDGS (30%) + Y (120 mg/kg) with 6 replicates (15 chicks x 6 replicates). The study was performed between 21 to 42 days of age. As a result, there were no significant differences among the groups in terms of body weight, body weight gain, feed consumption, feed conversion ratio and mortality rate (P>0.05). The carcass traits and effects of different marketing type (whole sale or cutting parts) on profit were compared. A slight decrease was determined in group 4 in terms of leg quarter ratio to cold carcass weight and carcass yield. Intestinal viscosity, bacterial counts and pH values (duodenum and ileum) were not different among the groups (P>0.05). The lowest production cost was determined in DDGS and DDGS+Y groups (P<0.05). Consequently, the supplementation of DDGS and yucca were not improve the performance and carcass traits and the use of 30% DDGS in broiler diets provided significant reduction in production cost and the marketing of broilers as cuts much profitable than wholesale.

Keywords: Broiler, DDGS, yucca, carcass, profit

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Broyler Rasyonlarına Kurutulmuş Tahıl Damıtma Çözünürleri (DDGS) ve Yukka (*Yucca schidigera*) İlavesinin Performans, Karkas Özellikleri, Bağırsak Viskozitesi ve Pazarlamaya Etkisi

ÖZ: Bu çalışma, broyler rasyonlarına kurutulmuş tahıl damıtma çözünürleri (DDGS) ve yukka (*Yucca schidigera*) ilavesinin performans, karkas özellikleri, barsak viskozitesi ve pazarlamaya etkisini belirlemek amacıyla yürütülmüştür. Toplam 360 adet 21 günlük yaştaki erkek broylerler 1: Kontrol (C, mısır bazlı diyet, DDGS ve Yukka ilavesiz), 2: DDGS (%30), 3: C+Y (120 mg/kg) ve 4: DDGS (30%) + Y (120 mg/kg) şeklinde 6 tekrarlı 4 gruba ayrılmıştır (15 piliç x 6 tekrar). Çalışma 21-42 yaşlar arasında yürütülmüştür. Gruplar arasında canlı ağırlık, canlı ağırlık kazancı, yem tüketimi, yemden yararlanma oranı ve ölüm oranı yönünden herhangi bir farklılık bulunamamıştır (P>0.05). Karkas özellikleri ve farklı pazarlama şekillerinin (bütün veya parça halinde) kârlılık üzerine etkileri karşılaştırılmıştır. 4. Grupta but ağırlığının soğuk karkas ağırlığı ve karkas randımanına oranında hafif bir azalma belirlenmiştir. Gruplar arasında bağırsak viskozitesi, bakteri sayıları ve pH değerleri (duodenum ve ileum) arasındaki farklılıklar önemsiz bulunmuştur (P>0.05). En düşük üretim maliyeti DDGS ve DDGS+ Y gruplarında tespit edilmiştir (P<0.05). Sonuç olarak, DDGS ve yukka ilavesi performans ve karkas özelliklerini iyileştirmemiş ve broyler yemlerine %30 DDGS ilavesi üretim maliyetinde önemli azalmalara neden olmuş ve broyler karkaslarının bütün yerine parça halinde satılması daha kârlı bulunmuştur (P<0.05).

Anahtar kelimeler: Broyler, DDGS, yukka, karkas, kâr

INTRODUCTION

Dried distillers grain with solubles (DDGS) is a commercial residual by-product of ethanol industry from grains (corn, wheat, sorghum etc.). Due to high nutrient content (protein 28-30%), it can be used as an alternative feed source especially in poultry and other domestic animals (20, 23, 31). As a feed component, there are some of studies focused on the effectiveness of DDGS on broiler diets (4, 13, 36, 41, 42, 46). However, the inclusion ratio of DDGS and their reported effects on performance and carcass traits are different. For example, Dale and Batal (8) reported that 18% DDGS ratio in diet had a negative impact on performance, while according to Lumpkins et al. (23) the same ratio can be accepted for grower and finisher diets without any negative effect on broiler performance. Wang et al. (42) reported that 15% supplementation of DDGS to diet did not negatively effect on performance, however, 30% of DDGS in diet reduced the weight gain and feed conversation ratio (FCR) in broilers compared to broilers fed without DDGS. Previous reports revealed that the use of DDGS up to 15-20% in broiler diets recommended without negative effect on performance and carcass traits (35, 46, 42). However, the

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level of 30% and over could be accepted as critical ratio in diet due to mostly negative impacts on performance and/or carcass traits (43). Some researchers argued that high temperature applications damaged the lysine amino acid during ethanol production from cereals and this condition lead to negative effects (29). However, if the stated problem is eliminated, high levels of DDGS in poultry diets could be incorporated as an economical product. Therefore, some studies suggested that various herbal extracts or the enzyme supplementation to diets based on DDGS may prevent some of the negative effects observed in broilers (33).

Y. shidigera is a natural, nontoxic product and easy to available to use and a source of saponin, which contains 9-10% active steroid saponin (11). Kutlu et al. (19) reported that, the use of yucca on broiler diets improved the live weight gain and FCR. Similarly, positive effect on FCR was reported in quail (12). There is no study about yucca and DDGS usage together and effectiveness in broilers. Therefore, the aim of present study was to determine the effect of DDGS and *Y. shidigera* on broiler performance, intestinal viscosity, bacterial count and, to decide marketing type (whole sale or as parts) of carcasses according to financial reflections of treatments.

MATERIAL and METHODS

Animals and Diets

A total of 360 Ross Big6 male chicks were obtained from a local commercial hatchery and they were grown until 21 days of age without any treatment. Feeds obtained from a commercial company. DDGS used in the experiment were imported from USA by the distributor. Chicks were individually weighed and allocated to four groups at 21 days-old with six replicate each of 15 chicks (15 chicks x 6 replicates = 90 chicks per group). Maize-wheat-soybean meal based diets were utilized and all of them were formulated using linear programming to be isoenergetic, isonitrogenic. The basal diet was formulated to meet nutrient requirements (26) for 21 to 42 d. Experimental groups were as follows; 1: control group (C, basal diet), 2: DDGS (30%) group, 3: C+Y group (120 mg/kg, *Yucca schidigera*, Ekomix Yucca, Ekol Feed Additive Ltd., Istanbul). and 4: DDGS (30%) + Y group (120 mg/kg). Small amounts of the basal diet were first mixed with the respective amounts of yucca powder as a small batch, and then with a larger amount of the diets until the total amount of the respective diets were homogeneously mixed. The experimental diets used in this study are given in Table 1. Feed and water were provided *ad libitum*. The experiment was performed between 21 to 42 days of age (3 weeks). Chicks were housed on a 1.5m x 1.5 m sized wire separated floor pens covered with dry wood shavings litter. Lighting schedule was 23 h light and 1 h dark throughout the experiment. Each pen contained a round feeder and waterer.

Data Collection

The body weight (BW) as individually and feed consumption (FC) by pen bases were obtained at 42 days. Feed conversion ratio (FCR) and body weight gain were calculated for 21 to 42 days. Mortality was recorded daily when occurred and considered for feed consumption.

For carcass and internal organ traits evaluation, 12 broilers (which were represented group mean live weight) in each group were slaughtered by cervical dislocation at the 42 d. The feathers were plucked, and the carcasses were eviscerated by hand. The carcass, liver, proventriculus, empty gizzard, heart, kidney, empty intestine (large+small intestine) weights were recorded. Individually and part yields were obtained as part weight: carcass weight× 100. Cold carcass weight was recorded after the carcasses had been stored at +4°C for 24 h.

Determination of Intestinal pH and Viscosity

The pH value of the duodenal and ileal samples was determined with a pH meter (Hanna Instruments-8413) and measured using a direct probe by thrusting the probe into the duodenal content. The duodenum (pancreatic loop) was carefully excised. Several eppendorf tubes were filled from each samples, labeled and centrifuged (1500 rpm for 5 min). The supernatant was withdrawn and the viscosity of a 0.5 ml aliquot measured using a Brookfield Digital Viscometer (Model DV- II+PRO, Brookfield Engineering Laboratories, Stoughton, MA) maintained at 40°C.

Determination of Microbial Counts

One g of the digesta samples in the ileum the birds were sampled from 12 animals per each group and diluted with 1 ml serum physiologic (0.85% NaCl), homogenized for 3 minutes. Then the diluted ileal samples were inoculated into different media. Sheep blood agar (Merck, Turkey) was used to determine Gram positive microorganisms, and Eosine methylene blue agar (EMB, MAST Diagnostic, UK) was used to identify *E.coli*. Then inoculates were incubated at 37°C for 24 h. Following the incubation, colonies were counted and amount of the bacteria in the samples were determined quantitatively. The microbial counts were determined as colony-forming units (CFU) per gram of samples as *E. coli, Klebsiella spp. Staphylococcus spp. Enterococcus spp.* Total Gr negative and Total Gr positive were determined.

Economic Analysis

In economic analysis, the production cost (feed, chick, labour, energy etc.) was calculated, carcass weight, percentage of yield (%) and 4 carcass parts (breast, leg quarter, wing and neck) of slaughtered 12 broilers per group (a total 48 broilers) were determined. Two different marketing types (whole sale or sale as parts) and profits were analyzed. The price of control group's diet was 1.228 TL/kg; 30% DDGS groups was 1.124 TL/kg; control + Y group's was 1.235 TL/kg and 30% DDGS + Y group's was 1.131 TL/kg. Whole sale price of chicks was 5 TL/kg; price of breast 6 TL/kg; thigh 5.5 TL/kg; wing 8 TL/kg and neck 0.5 TL/kg. Besides, cutting cost (labour, energy etc.) was accepted as 0.1 TL per kg of carcass.

Statistical Analysis

Data were subjected to ANOVA using General Linear Models of SPSS (34). The model included type of dietary DDGS and Yucca was presented. Pen means served as the experimental unit for statistical analysis. Differences among means were tested using Duncan's multiple-range tests with a 5% level of probability was used. Paired sample t-test was used in comparing profits of two different marketing types.

Table 1. Composition of diets used in the study*

Feedstuffs	Control, kg/ton	DDGS, kg/ton
Corn	524.00	373.70
Wheat	83.43	84.0
Soybean meal	313.01	160.0
DDGS	0.00	303.0
Salt (NaCl)	3.45	1.78
Limestone	16.39	18.37
Vegetable oil	50.05	50.48
DL-Methionine	0.74	0.42
L-Lysine	0.00	2.50
Dicalcium phosphate	5.18	2.00
Vitamin-mineral premix[1]	2.50	2.50
Phytase[2]	0.75	0.75
Enzyme mixture[3]	0.50	0.50
Calculated nutrient composition		
Dry matter, %	88.82	88.86
Crude protein, %	20.27	20.12
Crude oil, %	6.77	8.51
Calcium, %	0.95	0.93
Available phosphorus, %	0.35	0.33
Lysine, %	1.02	1.04
Methionine, %	0.38	0.38
Metabilzable energy, kcal/kg	3166.93	3181.80

*Yucca supplemented and homegenously mixed with control and DDGS diets.

1:Vitamin-mineral premix were provided per kg of diets, Vitamin A, 15.000 IU; Vitamin D3, 2000 IU; Vitamin E, 40.0 mg; Vitamin K, 5.0 mg; Vitamin B1 (thiamine), 3.0 mg; Vitamin B2 (riboflavin), 6.0 mg; Vitamin B6, 5.0 mg; Vitamin B12, 0.03 mg; Niacin, 30.0 mg; Biotin, 0.1 mg; Calcium D-pantothenate, 12 mg; Folicacid, 1.0 mg, Cholinechloride, 400 mg, Manganese, 80.0 mg; Iron, 35.0 mg; Zinc, 50.0 mg; Copper, 5.0 mg; Iodine, 2.0 mg; Cobalt, 0.4 mg; Selenium, 0.15 mg.

2: per kg; 5000 FTU/kg phytase assured.

3:Enzyme mixture contained; β-glukanase 9000 BGU/g, Xylanase 40000 XU/g, Mannanase 1000 U/g, Cellulase 50 FPU/g, pectinase 50 PGLU/g assured.

RESULTS

The performance parameters, carcass parts and financial impact of different marketing ways of broilers are given in Table 2.

Performance parameters such as BW, BWG, FC, FCR and mortality rate were not affected by the treatments (P>0.05). Although not significant, the highest dressing yield was determined in DDGS group (2nd) and a slight decrease was determined in 4rd group Percentage of internal organs to live weight were not affected by the treatments (P>0.05).

The percentage of carcass parts were not differs among the groups. Only the percentage of leg quarter in the 4th group was slightly less than other groups.

According to economic results, the production cost was minimum in the 2nd group and profit between different marketing types (wholesale or as cuts) was significantly different (P<0.05).

There were no significant effect of treatments on intestinal viscosity and duodenal and ileal pH values (Table 3).

The effects of treatments on intestine microorganism numbers (log transformed data) were given in Table 4. The yucca supplementation decreased *E.coli* counts compared to control group (P<0.05); DDGS and DDGS+Y groups were similar with C and C+Y groups. The *Klebsiella spp.* counts were not statistically different among the groups (P>0.05). In the C+Y and DDGS+Y groups *Staphylococcus* counts were higher than those of C and DDGS groups (P<0.01). In the C group the E*nterococcus* and total gram negative microorganisms counts were higher than those of other groups (P<0.01). In the DDGS group total gram positive microorganism count was lower than those of other groups (P<0.01).

DISCUSSION

According to authors' knowledge, there is no study on the use of DDGS and Yucca together in broiler diets. Thus, the data obtained from this study is the first attempt to use of DDGS and Yucca in broiler diets. So we discussed the results by DDGS cited references or yucca cited references in present study.

Performance

In the study, broiler performance traits were not significantly affected by the DDGS and yucca supplementation. It is reported that inclusion of 25% (39) and 30% DDGS (44) to the broiler diets did not have any negative impact on performance parameters. Youssef et al (46) reported that 10-15% DDGS as a protein source could be include without negative effects on broilers' weight gain and feed intake, however especially FCR values decline. Kaya and Şahin (15) reported that, DDGS supplementation to the broiler diets up to 15% improved performance parameters (BW, BWG, FC and FCR). Mortality rate was not affected in the current experiment. Similar results were obtained by Wang et al. (42,44) and Youssef et al. (46), that they had used the diets with 30% and 15% DDGS respectively.

Table 2. Effects of treatments on performance and marketing of broilers

Parameters	Control (n=90)	DDGS (n=90)	C+Y (n=90)	DDGS+Y (n=90)	P
Performance					
Initial BW, g	873.6±8.80	873.8±8.80	847.5±9.60	855.2±8.90	0.103
Final BW, g	2404.9±30.2	2379.8±30.4	2353.1±32.5	2391.1±29.4	0.676
BWG, g	1538.8±31.5	1519.6±33.7	1492.9±35.7	1534.2±30.8	0.759
FC, kg/chick	3472.5±34.1	3466.2±38.7	3397.7±31.3	3520.6±21.5	0.089
FCR, g/g	2.24±0.05	2.19±0.07	2.29±0.08	2.27±0.07	0.749
Mortality, %	1.10±0.02	1.10±0.02	2.20±0.023	2.20±0.024	0.650
Carcass traits					
Cold carcass weight, g	1833.4±44.1	1831.0±45.8	1741.2±54.0	1758.2±48.3	0.454
*Carcass yield, %	71.5±1.10	72.0±0.50	69.7±0.60	69.1±0.50	0.069
*Liver, %	2.28±0.10	2.18±0.06	2.17±0.05	2.30±0.08	0.447
*Gizzard, %	1.80±0.07	1.67±0.07	1.81±0.06	1.67±0.06	0.292
*Heart, %	0.52±0.02	0.51±0.03	0.46±0.05	0.57±0.04	0.163
*Abdominal fat, %	0.75±0.05	0.71±0.05	0.65±0.08	0.70±0.11	0.828
&Breast, %	45.08±0.52	45.91±1.06	45.45±0.32	46.61±0.62	0.236
&Leg quarter, %	40.76±0.48	40.14±0.63	40.89±0.27	39.41±0.37	0.053
&Wing, %	9.76±0.16	9.90±0.22	9.79±0.16	10.06±0.18	0.605
&Neck, %	4.11±0.13	3.79±0.29	3.62±0.14	3.69±0.26	0.227
&Shrinkage, %	0.29±0.05	0.25±0.04	0.25±0.02	0.24±0.03	0.661
Economical traits					
Production cost, TL/chick	7.33±0.03^{a}	6.86±0.07^{c}	7.25±0.03^{a}	6.98±0.02^{b}	0.001
Whole sale revenue, TL/chick	9.17±0.22	9.16±0.23	8.71±0.27	8.79±0.24	0.454
Cutting revenue, TL/chick	10.36±0.25	10.39±0.27	9.89±0.31	10.00±0.28	0.541
Profit^{1}, TL/chick	1.84±0.22^{B}	2.30±0.27^{B}	1.46±0.29^{B}	1.81±0.23^{B}	0.280
Profit^{2}, TL/chick	3.02±0.25^{A}	3.53±0.31^{A}	2.64±0.33^{A}	3.02±0.27^{A}	0.340
T-test	<0.001	<0.001	<0.001	<0.001	

DDGS: dried distillers' grain with soluble, Y: yucca, Y*ucca schidigera,* P: probability, BW: body weight, BWG: body weight gain, FC: feed consumption, FCR: feed conversion ratio.

$^{a-c:}$ Values with different superscript within the same row differ significantly. $^{A-B}$: Values with different superscript within the same column differ significantly. * Percentage of live weight; $^{\&}$ percentage of cold carcass. Profit^{1}: profit of wholesale marketing, Profit^{2}: profit of marketing as cuts.

Table 3. Effects of treatments on viscosity values

Treatments	Viscosity	pH (Duodenum)	pH (İleum)
C	1.660±0.095	6.06±0.14	6.17±0.11
DDGS	1.718±.0.071	6.18±0.05	6.22±0.12
C+Y	1.842±0.106	5.99±0.11	6.25±0.14
DDGS+Y	1.847±0.075	6.08±0.08	6.45±0.09
P	0.838	0.638	0.398

DDGS: dried distillers' grain with soluble, Y: yucca, Y*ucca schidigera,* P: probability.

Table 4. The effects of treatments on intestine microorganism counts (log transformed data)

Microorganism counts, log cfu	C	DDGS	C+Y	DDGS+Y	P
E. coli	2.259 ±0,42^{a}	1.957±0,37^{ab}	0.801± 0,35^{b}	1.281±0,46^{ab}	0.05
Klebsiella spp.	1.039±0,38	0.743±0,32	0.192±0,19	0.182±0,18	0.097
Staphylococcus spp.	0.943±0,34^{b}	0.822±0,35^{b}	2.430±0,25^{a}	2.573±0,05^{a}	0.001
Enterococcus spp.	2.557±0,51^{a}	0.576±0,43^{b}	0.225±0,23^{b}	0.708±0,37^{b}	0.001
Total Gram negatif	3.071±0,17^{a}	1.866±0,42^{b}	0.844±0,37^{b}	1.564±0,48^{b}	0.001
Total Gram pozitif	3.168±0,28^{a}	1.236±0,48^{b}	2.466±0,26^{a}	2.674±0,05^{a}	0.001

DDGS: dried distillers' grain with soluble, Y: yucca, Y*ucca schidigera,* P: probability. $^{a-b:}$ Values with different superscript within the same row differ significantly.

Ahmed et al. (2) reported that yucca extract is a safe product for broilers and yielded better weight gain. The yucca supplementation to corn and DDGS based diets did not affect performance traits in this study. Similarly, yucca extract supplementation to diets in broilers (7,45), in quail (9,11) and laying hens (18) did not affect positively on the body weight, feed intake and feed efficiency and carcass yields of quail (9). On the other hand, Kutlu et al. (19) reported that yucca incorporation to diets improved broiler performance parameters. Also, Begum et al. (5) noted that the addition of 100 mg/kg yucca and caprylic acid to the diet improved growth performance and reduced mortality rate in broiler chickens.

Carcass quality

In the current study, carcass yield, carcass parts, internal organ weights and their ratios to cold carcass or live weight were not influenced by the treatments. The findings of Kaya and Şahin (15) about the use of DDGS are similar with present study. Similar findings were observed by the Lumpkins et al. (23) who reported that the use of 18% DDGS in broiler diets didn't reduce the carcass yield. In contrast to present experiment results, Wang et al. (43), Wang et al. (44) and Min et al. (24) reported that 30 % DDGS levels caused a decrease in carcass yield of broilers. Regarding to internal organ weights, Loar et al. (21) reported that increasing from 8 to 25% DDGS inclusion levels during the grower phase resulted in a linear decrease in liver relative weight. Wang et al. (41) reported that inclusion of 15 or 25% DDGS decreased the dressing percentage, and chickens fed the diet with 25% DDGS was characterized by lower breast weight. Konca et al. (17) reported that 30% DDGS inclusion to diet did not significantly effect on carcass traits in quail. Youssef et al. (46) reported that 10-15% DDGS as a protein source could be include without negative effects on carcass yield, liver weight and heart weight.

On the other hand, some previous reports claimed that inconsistent results related to carcass and parts ratio. Wang et al. (42) noted that DDGS ratio in diets more than 25% and Lukaszewicz and Kowalczyk (22) 15% decreased carcass and breast meat yield in broilers. In contrast to these results, Schilling et al. (32) reported that 18-24 % DDGS incorporation to broiler diets increased breast meat ratio compared to control group.

However, Wang et al. (44) reported that 30% DDGS declined the dressing percentage, breast meat yield and leg quarter. Adamski et al. (1) reported that, 30% inclusion of DDGS did not negatively affect the body weight, slaughter yield, breast, leg, abdominal fat, neck and wings weights in male ducks. Therefore, Adamski et al. (1) suggested that the use of DDGS up to 30% in Pekin ducks, parallel with present study.

Yucca supplementation to control and DDGS diets were not affected carcass and internal organ weights and ratios. In contrast to current results, Sahoo et al. (28) reported that, the breast meat yield of Yucca group (32.23%) was significantly higher than control group (30.33%).

Marketing

The use of DDGS in broiler diets and its impact on performance is important for reducing the feed cost. In this study, the percentage of carcass parts were not influenced by the treatments. However, according to economic results, the production cost was minimum and profit maximum in the DDGS and DDGS+Y groups. In fact that, main effect on reducing the production costs was due to DDGS. So, without negative effects, maximum level of DDGS in diets reflects on production costs and profit. In the present experiment, yucca supplementation did not affect production cost and profit. On the other hand, Sahoo et al. (28) reported that, a profit of 43.68% was received by usage of Yucca supplementation in the diet on live weight basis.

Intestinal viscosity and microorganism counts

In the present study, there were no any significant effect of treatments on intestinal viscosity, pH values and *Klebsiella spp.* counts. However, the yucca supplementation were decreased *E.coli* counts. Similar findings also reported that Wang and Kim (40), the addition of 120 mg/kg Yucca extract reduced the proliferation of *E. coli*. According to the Begum et al. (5) the addition of 100 mg/kg yucca and caprylic acid to the diet reduced caecal *E. coli* counts compared with those fed the control diet in broiler chickens. Alfaro et al. (3) suggested that there might be a beneficial, synergistic effect between the coccidiosis vaccine and the Y. schidigera extract.

In present study, the *Staphylococcus* were increased in control and DDGS based diets. Also the E*nterococcus* and total gram negative microorganism counts were lower in diets containing Yucca and DDGS than control group. *Y. schidigera* supplements can indeed influence the growth and metabolism of microbial populations, even in artificial fermentation systems which eliminate any indirect effects that may be exerted via a host animal (6,10,27,37,38). In several studies (3,25,30,47) the addition of Yucca extract to diets positively affected the intestinal mucosal histology. Kadsunuma et al. (14) obtained that *Y. schidigera* extract and saponins provide useful and basic information for analyzing the effects on the constitution of microflora in intestinal tract. They also said that these results show that the principal responsible agent for antibacterial activity exhibited by the *Y. schidigera* extract may be the saponins.

CONCLUSION

In conclusion, supplementation of yucca to control and DDGS based rations was not improve the carcass traits and DDGS could be used in broiler diets up to 30% without negative effect on performance, carcass yield and profit.

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