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EFFECT OF CORN DDGS ON BROILERS PERFORMANCE AND MEAT QUALITY

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Abstract

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The effects of graded levels of corn distillers dried grains with soluble (DDGS) as partial replacement for soybean meal in diets for broilers were observed. In the first experiment 900 males of ROSS 308 were used and they fed diets with 0, 60, 120 and 180 g/kg DDGS in grower diets (Control group, D6, D12 and D18) from 9th to 35th day of age. In the second experiment 800 broilers both sex of COBB 500 were used and they fed diets with 0 and 200 g/kg DDGS in grower diets (Control group and D20) from 9th to 35th day of age. Until age 30th day there were not significant differences among the groups in live weight in the first experiment. But at 35th day of age the live weight of chickens fed 60 and 120 g/kg DDGS (2498.5 g and 2496.3 g) was significantly higher ($P < 0.05$) than in Control group (2425.9 g, without DDGS). In the second experiment, from 23th to 35th day of age significantly higher ($P < 0.05$) live weight had group fed diet without DDGS in comparison with chickens fed 200 g/kg DDGS. The difference between groups at 35th day of age was 75.7 g. Feed conversion ratio was similar in all groups in both experiments. There was not observed significant effect of DDGS on weight and proportion of abdominal fat. Feeding DDGS had significant effect ($P < 0.05$) on decrease the lightness (L*) of breast meat in the first experiment, which was not confirmed in the second experiment.

live weight, feed conversion ratio, abdominal fat, lightness of meat

Production of bioethanol worldwide dramatically increases. Cereals, sugar beet and sugar cane are the basic raw materials for ethanol production. From one kilo of corn grains can be gained almost 0.32 kg of ethanol and 0.33 kg of distiller's grains (McAloon *et al.*, 2000). Cereal distillers' grains are very good material for livestock feeding. Classical distillers' grains are liquid and perishable. Therefore, they are dried and DDG (dried distillers' grains) are produced or they are dried together with the soluble and then DDGS (dried distillers grains with soluble) are produced. All nutrients of raw material are more concentrated in DDGS except nitrogen free extracts, because they are fermented to alcohol. DDGS are mainly source of crude protein; the contents of fat, minerals and fiber are also increased in comparison with the raw material (Belyea *et al.*, 2004; Zeman and Tvrznik, 2007). Corn DDGS generally contains approximately 27% of crude protein, 10% of fat, 0.8% of P and 0.7% of S and they are suitable feed for both cattle and poultry (Leaflet, 2008). The crude protein is of high quality because it includes yeast protein, only the content of lysine is low. There also can be contained unfermented mainly nonstarch polysaccharides, which can negatively affect the quality of litter and nutrient digestibility (Cromwell *et al.*, 1993; Zeman and Tvrznik, 2007). In the diets the DDGS can be combined with rapeseed meal because of its good amino acid profile and this way amino acid profile of the diet can be increased (Min *et al.*, 2009). For maximizing the yield of ethanol today's technologies use several consequent distillations which can cause decrease in its nutrient quality. The amount and quality of DDGS are very variable depending mainly on raw material quality. DDGS has the same dry matter and energy content like corn and content of other nutrients is from 2.5 to 3 times higher than in corn. The risk of contamination by mycotoxin in "new generation" DDGS is very low, because the quality of

raw material affects the yield of ethanol (Zeman and Tvrznik, 2007). For increasing the nutrient quality or digestibility of DDGS it is possible to use exogenous enzymes to the diets or extrusion (Oryschak *et al.*, 2010a). The quality of DDGS is influenced mainly by quality of raw material, type of fermentation and temperature at drying (Spiehs *et al.*, 2002). Higher amount of DDGS in the diets can negatively affect the quality of pellets (Wang *et al.*, 2007a). The DDGS from wheat have higher content of crude protein and fiber (36–39%, 8% respect.) and lower content of fat in comparison with corn DDGS (Thacker and Widyaratne, 2007; Ortín and Yu, 2009; Oryschak, 2010b).

The aim of the study was to find the effect of replacement of soybean meal (SBM) for corn DDGS with high quality in grower diets on growth, feed efficiency and carcass quality in broilers.

MATERIAL AND METHODS

Birds housing and growth performance

Two experiments with broiler hybrids were carried out. In both experiments all chickens were fed the same commercial diet till 9th day of age. On this day all chickens were weighted and divided into experimental groups so that the average weight was the same in all groups without any significant differences. In both experiments housing was provided in pens with wood shavings and according to technological guide for ROSS 308 and COBB 500 and in accordance with regulation 2007/43/ES. In both experiments chickens were fed till 35th day of age, when the experiment finished. Pelleted feed and water were available *ad libitum*.

Experiment 1: In the first experiment 900 males of ROSS 308 were used. In 9th day of age all chickens were individually weighed and chickens with extremely low or high weight were selected to decrease the variability between groups at the start of the experiment. Therefore only 800 chickens were divided into four experimental groups (2 × 100 chickens in each group) according the proportion of SBM (soybean meal) and DDGS in the diets. DDGS were not used in the control group. In the groups D6, D12 and D18 were used 60, 120 and 180 g/kg of DDGS. The composition of the diets is shown in the Tab. I. Analyzed content of nutrients is shown in the Tab. II. The diets were formulated to have similar energy and protein contents.

Experiment 2: In the second experiment 800 chickens both sex of hybrid COBB 500 were used. In 9th day of age all chickens were individually weighed and chickens with extremely low or high weight were selected to decrease the variability between groups at the start of the experiment. Finally only 600 chickens were divided into two experimental groups (3 x 100 chickens in each group) according the proportion of SBM and DDGS in the diets; control group without DDGS and D20 with 200 g/kg of DDGS in the diets. The composition of the diets is shown in the Tab. I. Analyzed content of nutrients is shown in the Tab. II. The diets were formulated to have similar energy and protein contents.

In both experiments all chickens were individually weighted at 9th, 16th, 23th, 30th and 35th day of age. Feed consumption per pen was recorded and dead chickens were weighed to precise calculate feed conversion ratio.

Carcass characteristics

Ten chickens with average weight were chosen from each group at the end of both experiments (35th day of age). The chickens were slaughtered and the content of abdominal fat, color and content of fat in breast meat were measured.

The color parameters (L*, a*, b*) were measured on the raw muscles and on the skin of thigh using a spectrophotometer (CM-2600d, Konica Minolta,

I: *Composition of experimental diets (g/kg)*

	Experiment 1				Experiment 2	
	Control	**D6**	**D12**	**D18**	**Control**	**D20**
Wheat	370.8	370.8	370.8	370.8	300.0	300.0
Maize	279.0	236.5	192.7	161.6	340.0	230.0
Soybean meal	278.2	250.0	222.5	192.0	280.0	184.0
DDGS	**0**	**60**	**120**	**180**	**0**	**200**
Rapeseed oil	40.0	50.0	61.0	61.0	30.0	50.0
L-lysine HCl	1.00	1.70	2.10	2.70	2.00	2.00
DL-methionine	2.00	2.00	1.90	1.90	2.00	2.00
Calcite	13.00	13.00	13.00	14.00	19.00	16.00
NaCl	2.50	2.50	2.50	2.50	2.00	2.00
bolifor MCP	10.50	10.50	10.50	10.50	17.00	6.00
AMV BR-2*	3.00	3.00	3.00	3.00	5.00	5.00

* Premix provided per kg diet: retinol, 13500.00 IU; cholecalciferol,499.80 IU; alpha tokopherol, 35.10 mg; menadione, 3.00 mg; thiamine, 2.25 mg; riboflavine, 6.00 mg; pyridoxine, 5.10 mg; cobalamine, 0.02 mg; calcium panthothenate, 11.01; Niacinamide, 32.49 mg; folic acid, 1.50 mg; biotine, 0.26 mg; betaine, 45.00; cholinchloride, 250.20; Fe, 75.00mg; Cu, 15.00 mg; Mn, 115.20 mg; Zn, 108.00 mg; Se, 0.30 mg; I, 1.05 mg; Co, 0.25 mg

II: *Nutritional composition of distillers dried grains with solubles (DDGS, as-fed basis) and feed used in experiments 1 and 2*

			Experiment 1				Experiemnt 2	
Nutrient	**Unit**	**DDGS**	**Control**	**D6**	**D12**	**D18**	**Control**	**D20**
Dry mater	%	90.03	89.95	90.42	90.63	90.47	87.81	88.68
Metabolizable energy *	MJ	6.10	10.49	9.76	9.86	9.54	10.58	9.65
Crude protein	%	26.80	20.00	19.7	20.00	20.20	20.50	20.40
Fat	%	10.80	6.30	7.49	9.13	9.74	5.50	8.95
Ash	%	4.56	4.99	4.86	4.92	4.99	5.55	4.89
Fibre	%	7.72	2.51	2.45	2.86	3.12	1.93	2.47
Starch	%	5.63	42.7	38.40	38.4	36.20	42.9	36.80
Sugar	%	0.86	3.24	3.00	3.12	2.52	3,72	2.76
Calcium	%	0.11	0.92	0.87	0.29	0.82	1.00	0.78
Phosphor	%	0.82	0.60	0.60	0.62	0.64	0.76	0.58
Lysine	g/kg	12.30	11.80	11.70	10.6	11.70	1.35	1.20
Methionine	g/kg	6.07	4.06	4.05	5.05	4.23	6.50	6.80
Vit. A	m. j./kg	1160	10700	9300	8930	9440	10900	11000
Vit. E	mg/kg	9.06	57.00	54.40	52.1	59.5		

* calculated value MEn = 0.3431 * % fat + 0.1551* % crude protein + 0.1669 * % starch + 13.01 * % total sugar MJ Kg^{-1} (MacLeod, 2002)

Osaka). In this method, higher L* values are lightness, a* values express redness, and b* values express yellowness. Color measurements were taken on the cross cut of the breast muscle. Total lipids content was analyzed by extraction with petroleum ether (Soxhlet method).

Statistical analysis

Data obtained from these experiments were analyzed using the single factor analysis of variation. Data of live weight were followed by Scheffe test. Abdominal fat content, color and content of fat in breast meat were followed by the Kruskal-Wallis analysis using the software package Unistat 5.1 (UNISTAT Ltd, ENGLAND).

RESULTS AND DISCUSSION

Growth performance

Experiment 1: The live weight of chickens in the weekly intervals is shown in Tab. III. At the begining of the experiment there wasn't significant differences in live weight. Chickens in groups D6, D12 and D18 grew significantly better ($P < 0.05$) than chickens in the control group till the 23th day of age. Next week there was not any significant difference among the groups. At the end of experiment in 35th day of age the chickens in groups D6 and D12 (2498.5 g and 2496.3 g) were significantly heavier ($P < 0.05$) in comparison with chickens in control group (2425.9 g). The difference in weight between the best group D6 and control group was 72.6 g. The feed conversion ratio was very similar in all groups (Tab. IV). The main reason for mortality was SDS (Sudden Death Syndrome).

Experiment 2: The live weight of chickens in the weekly intervals is shown in Tab. III. There was not significant difference between the groups till 23th day of age. From this weighting to the end of experiment the live weight of chickens was significantly higher ($P < 0.05$) in the control group in comparison with chickens in D20 group. The difference between groups at 35th day of age was 75.7 g. The feed conversion ratio was almost the

III: *Average weight of broilers (g)*

	Age (day)				
Experiment 1	**9**	**16**	**23**	**30**	**35**
Control	266.9 ± 1.52	598.6 ± 4.50^{a}	1161.7 ± 8.24^{a}	1902.5 ± 13.93	2425.9 ± 18.07^{a}
D6	264.6 ± 1.54	630.3 ± 4.10^{b}	1211.2 ± 8.35^{b}	1949.6 ± 13.15	2498.5 ± 16.88^{b}
D12	264.3 ± 1.54	631.6 ± 4.48^{b}	1217.2 ± 7.98^{b}	1911.5 ± 12.27	2496.3 ± 15.67^{b}
D18	264.8 ± 1.46	637.6 ± 4.06^{b}	1220.3 ± 7.95^{b}	1917.9 ± 11.58	2449.4 ± 15.12
Experiment 2					
Control	217.4 ± 0.91	537.4 ± 2.78	1088.9 ± 6.61^{a}	1756.0 ± 12.80^{a}	2267.5 ± 18.39^{a}
D20	218.0 ± 0.90	536.6 ± 2.64	1068.0 ± 5.53^{b}	1706.1 ± 10.25^{b}	2191.8 ± 15.83^{b}

Different superscripts (a,b) indicate statistical significant difference between groups ($P < 0.05$)

IV: *Feed conversion ratio (kg/kg) and mortality (%)*

	Experiment 1				Experiment 2	
	Control	**D6**	**D12**	**D18**	**Control**	**D20**
Feed conversion ratio	1.68	1.66	1.59	1.65	1.65	1.67
Mortality	6	6	5	4	6.6	5.6

V: *Effect of feeding DDGS on carcass weight, share of abdominal fat from carcass, fat in breast muscle and lightness of breast muscle*

	Experiment 1				Experiment 2	
	Control	**D6**	**D12**	**D18**	**Control**	**D20**
Carcass weight (g)	1840 ± 16.9	1874 ± 12.8	1843 ± 15.8	1876 ± 15.3	1778.0 ± 28.0	1721.3 ± 14.3
Weight of abdominal fat (g)	34.9 ± 2.16	33.8 ± 2.63	36.1 ± 1.55	37.2 ±1.91	11.8 ± 2.02	19.5 ± 3.65
Abdominal fat share (%)	1.9 ± 0.11	1.8 ± 0.14	2.0 ± 0.08	2.0 ± 0.1	0.66 ± 0.11	1.13 ± 0.21
Fat in breast muscle (%)	1.63 ± 0.07^{a}	2.02 ± 0.21	1.70 ± 0.22	2.27 ± 0.25^{b}	1.44 ± 0.22	1.88 ± 0.28
L*	58.8 ± 0.67^{a}	55.0 ± 1.41	54.9 ± 0.91	54.3 ± 0.97^{b}	52.4 ± 0.84	51.9 ± 1.00
a*	–1.09 ± 0.15	–0.62 ± 0.48	–0.68 ± 0.17	–0.67 ± 0.23	–0.55 ± 0.14^{a}	0.64 ± 0.30^{b}
b*	10.1 ± 0.26	9.6 ± 0.30	10.1 ± 0.39	10.6 ± 0.31	9.9 ± 0.33^{a}	11.7 ± 0.32^{b}

Different superscripts (a,b) indicate statistical significant difference between groups ($P < 0.05$)
L*– lightness, a* – redness, b* – yellowness

same in both groups (Tab. IV). The main reason for mortality was SDS.

Shim *et al.* (2011) also published higher growth of chickens fed higher amount of DDGS (≥ 8%), till 18th day of age but at 42nd day of age there was not any difference among the groups. Wang *et al.* (2007a) also did not find significant effect of higher levels of DDGS in the diets for broilers on their performance, only at including 25% of DDGS they observed higher feed consumption and consequently higher feed conversion ratio in comparison with chickens fed diets without DDGS. In the same year Wang *et al.* (2007b) published that feeding 15% DDGS from 1st to 42nd day of broilers age did not affect their growth and carcass quality. Swiatkiewicz and Koreleski (2008) recommended from 5 to 8% of DDGS to the starter and from 12 to 15% DDGS to the grower and finisher for broilers.

Carcass characteristics

Tab. V shows weight of abdominal fat and its proportion from carcass weight, fat content in the breast meat and color of the breast meat. For the analysis of carcass quality chickens with almost the same weight were used and consequently there was not significant difference in the carcass weight too. The feeding of DDGS had no significant effect on weight of abdominal fat and its proportion from the carcass.

On the other hand with increasing DDGS level the content of fat in breast meat also increased in the first experiment. Significant difference was found between C and D18 groups ($P < 0.05$), but this trend was not confirmed in the second experiment. Similar results published Shim *et al.* (2011). But they found significantly higher proportion of abdominal fat in male broilers already at feeding 60 g/kg of DDGS. They also discussed insignificantly positive effect of DDGS on weight of carcass. Feeding of DDGS also can increase ($P < 0.05$) concentration of unsaturated fatty acids in the broilers meat (Choi *et al.*, 2008).

DDGS significantly ($P < 0.05$) affected the lightness of breast meat in the first experiment; L* was higher in C in comparison with D18 ($P < 0.05$). The effect was not confirmed in the second experiment. The effect of DDGS on broilers meat lightness also observed Schilling *et al.* (2010); with increasing level of DDGS (from 60 to 240 g/kg) the lightness insignificantly decreased. On the other hand, Corzo *et al.* (2009) published insignificantly higher lightness at feeding 80 g/kg DDGS in comparison with control group without DDGS. The feeding of DDGS had not effect on a* and b* values in the first experiment, however in the second experiment significantly higher ($P < 0.05$) both a* and b* values were observed in breast meat of chickens from D20. Choi *et al.* (2008) observed significantly higher b* values in leg muscle after feeding DDGS. Adamski *et al.* (2011) did not observed any effect of 300 g/kg DDGS on meat color in ducks but they found significant ($P < 0.05$) effect of this DDGS level on higher fat content in breast meat.

CONCLUSION

The results show that it is possible to use quality corn DDGS in the grower diets from 9th day till 35th day of age for broilers to 120 g/kg without any adverse effect on growth and feed conversion ratio. The DDGS had not any effect on carcass quality concerning weight and abdominal fat content. The amount of DDGS in the broiler diets depends mainly on their highly variable quality.

SUMMARY

The aim of the study was to find the effect of replacement of soybean meal (SBM) for high quality corn DDGS on growth, feed efficiency and carcass quality in broilers. The study was divided into two experiments. In the first experiment 900 males of ROSS 308 were used. In 9th day of age 800 chickens were selected and divided into four experimental groups (2 × 100 chickens in each group) according the proportion of SBM and DDGS in the diets Control group, D6, D12 and D18 (0, 60, 120 and 180 g/kg). In the second experiment 800 chickens both sex of hybrid COBB 500 were used. In 9th day of age 600 chickens were selected and divided into two experimental groups (3 × 100 chickens in each group) according the proportion of SBM and DDGS in the diets Control group and D20 (0 and 200 g/kg). For carcass charasterictic ten chickens with average weight were chosen from each group at the end of both experiments (35th day of age). The chickens were slaughtered and the content of abdominal fat, color and content of fat in breast meat were measured. The color parameters (L*, a*, b*) were measured on the raw muscles and on the skin of thigh using a spectrophotometer (CM-2600d, Konica Minolta, Osaka). In the first experiment chickens in groups D6, D12 and D18 grew significantly better ($P < 0.05$) than chickens in the control group till the 23th day of age. Next week there was not any significant difference among the groups. At the end of experiment in 35th day of age the chickens in groups D6 and D12 (2498.5 g and 2496.3 g) were significantly heavier ($P < 0.05$) in comparison with chickens in control group (2425.9 g). The difference in weight between the best group D6 and control group was 72.6 g. In the second experiment there was not significant difference between the groups till 23th day of age. From this weighting to the end of experiment the live weight of chickens was significantly higher ($P < 0.05$) in the control group in comparison with chickens in D20 group. The difference between groups at 35th day of age was 75.7 g. The feeding of DDGS had not significant effect on weight of abdominal fat and its proportion from the carcass. DDGS significantly ($P < 0.05$) affected the lightness of breast meat in the first experiment; L* was higher in Control group in comparison with D18 ($P < 0.05$). The effect was not confirmed in the second experiment.

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