Ann. Anim. Sci., Vol. 13, No. 1 (2013) 97–107, DOI: 10.2478/v10220-012-0062-y

FEEDING CORN DISTILLERS DRIED GRAINS WITH SOLUBLES (DDGS) AND ITS EFFECT ON EGG QUALITY AND PERFORMANCE OF LAYING HENS*

Jan Niemiec[1], Julia Riedel[1], Tadeusz Szulc[2], Małgorzata Stępińska[1]

[1]Faculty of Animal Science, Warsaw University of Life Sciences, Ciszewskiego 8, 02-786 Warsaw, Poland
[2]Faculty of Biology and Animal Science, Wroclaw University of Environmental and Life Sciences, Chełmońskiego 38c, 51-630 Wrocław, Poland
Corresponding author: jan_niemiec@sggw.pl

Abstract

The purpose of this experiment was to determine the effect of corn DDGS as a feed ingredient on egg quality and performance of laying hens. The experiment was conducted in three feeding groups of 100 hens each (10 replicates of 10 layers). ISA Brown laying hens were administered a feed mixture containing 15% (E1) or 20% (E2) corn DDGS for 18 weeks. The hens from the control group (C) received a standard diet based on soybean meal as the main protein source only. Laying performance, average egg weight, average daily feed intake and feed conversion ratio were recorded over the study period. Egg quality traits (egg weight, thick albumen quality, yolk colour, yolk content, shell content and shell thickness) were evaluated twice: at the start and at the end of the experiment. On both dates, all daily laid eggs from each group were analysed, i.e. 90, 93 and 92 eggs from groups C, E1 and E2, respectively at 31 weeks, and 92, 94 and 81 eggs, respectively at 48 weeks of age. Compared to the other groups, the hens from group E2 (20% DDGS) were characterized by a slight – though statistically significant ($P \leq 0.01$) – decrease in laying performance and by a higher FCR value. The content of DDGS in the feed mixture had no significant effect on mean egg weight nor on daily feed intake. At the end of the experiment, the eggs laid by the hens from group E2 were characterized by significantly poorer ($P \leq 0.01$) albumen and shell quality. Yolk colour in both experimental groups was significantly darker ($P \leq 0.01$) than in the C group. The 15% addition of corn distillers dried grains with solubles to feed mixtures for commercial flocks of laying hens is advisable. At corn DDGS addition exceeding 15%, a slight decrease in production results and deterioration in selected parameters of egg quality shall be expected.

Key words: corn DDGS, laying hens, egg production, egg quality

---

*Author's Project of the State Committee for Scientific Research, Project No. R 12 059 03.

According to the Main Statistical Office (GUS, 2011), the structure of corn utilization in Poland has been changing since 2000, i.e. the area of croplands for silage has been decreasing proportionally to the increasing area of corn croplands for grain. In the year 2002, corn was cultivated on over 318.000 ha, whereas in 2010 – on 342.000 ha of arable lands. One of the factors that influence a change in these proportions is the increasing production of biofuels. Compared to potatoes and rye, corn grain is characterized by the highest yield of ethanol production (Stecka, 2003). According to Shurson and Noll (2005), 100 kg of corn grain enable producing: 36 l of ethanol, 32 kg of distillers dried grains with solubles (DDGS), and 32 kg of CO_2. These authors expected that in the year 2005, the production of DDGS only in the USA would exceed 7 millions of tonnes, whereas within a few successive years it would be estimated to reach 10–14 millions of tones. The distillers dried grain with solubles is an industrial by-product, the quantity of which is estimated to increase in the future. In order to meet environment protection standards, the DDGS requires management. The developed production technology of DDGS allows achieving a product with parameters similar to those of the feed concentrate, that may be easily stored and transported.

As presented by Cozannet et al. (2010), the chemical analysis of corn DDGS demonstrated that, compared to corn grain, it was characterized by a threefold higher content of total nitrogen and fat, and by a very low content of starch that is utilized in the fermentation process, which results in a low level of metabolizable energy. The same authors emphasize that the nutritive values of this product may vary depending on grain quality and processing method.

The objective of this study was to investigate possibilities of applying corn distillers dried grains with solubles (DDGS), a by-product of ethanol production, as a substitute for extracted soybean meal in the feeding of laying hens and to determine the effect of corn DGGS as a feed constituent on quality of eggs and performance of laying hens.

Material and methods

The study was conducted on 300 ISA Brown laying hens aged 31 weeks at the onset of the experiment. The study spanned 18 weeks (31–48 weeks of age). From the beginning of the laying period until the peak of production hens were fed a standard laying diet (Table 1). Before and during the experiment the layers were kept in the same conditions in cages of 10 hens arranged in a three-tier battery. Lighting programme and temperature in the building were according to the ISA Brown Management Guide (www.hendrix-genetics.com, 2008 b).

The experiment was conducted in three feeding groups of 100 hens each (10 replicates of 10 layers): E1 and E2 (experimental) and C (control). Both experimental groups were fed a feed mixture containing 15% (E1) or 20% (E2) of corn DDGS as a replacement for part of soybean meal. The hens from the control group (C) were given a standard laying diet based on soybean meal as the main protein source only. The composition of feed mixtures and their nutritional value are presented in Table 1.

Table 1. Composition (%) and nutritional value of feed used before and in the experiment

Ingredients	Content in diet (%)			
	all groups before the experiment	group C	group E1	group E2
Corn	45.00	45.00	20.00	20.00
Wheat	16.60	16.60	36.40	33.60
Wheat bran	6.40	6.40	7.00	7.00
Soybean meal	21.60	21.60	11.40	9.20
Corn DDGS			15.00	20.00
Soybean oil	0.60	0.60	0.60	0.60
Dicalcium phosphate	0.90	0.90	0.42	0.30
$CaCO_3$	7.76	7.76	8.00	8.06
Lysine			0.16	0.22
Methionine	0.12	0.12	0.10	0.10
Sodium bicarbonate	0.10	0.10	0.10	0.10
Salt	0.30	0.30	0.20	0.20
Enzyme (PX446-012% Layer Phyzyme 500)	0.12	0.12	0.12	0.12
Mineral-vitamin premix	0.50	0.50	0.50	0.50
Nutritional value				
ME MJ/kg	11.31	11.31	11.32	11.30
Total protein (%)	17.00	17.00	16.96	16.96
Crude fibre (%)	2.73	2.73	3.46	3.71
Total Ca (%)	3.28	3.28	3.26	3.26
P available (%)	0.54	0.54	0.51	0.50
Na	0.16	0.16	0.18	0.20
Linoleic acid	1.52	1.52	1.97	2.24
Methionine	0.38	0.38	0.37	0.38
Methionine + cystine	0.70	0.70	0.71	0.71
Lysine	0.84	0.84	0.79	0.80

Feed formulas have been prepared by the Feed Mill in Reguły based on its raw materials accepted as the standard feed. The experimental feed formulas were developed taking into account results of the proximate analysis of corn DDGS (Table 2). The chemical composition was determined according to AOAC methods (AOAC, 2005).

Table 2. Nutritional value of corn DDGS (data from feed analysis)

Nutritional value	Content (%)
Dry matter	90.21
Total protein	25.84
Crude fat	14.85
Crude fibre	8.37
Crude ash	5.27
EM MJ/kg *	14.811

*calculated by method of Smulikowska (Smulikowska and Rutkowski, 2005).

All birds were individually weighed just before the start and at the end of the experiment. Each successive week, the daily egg production, daily egg weight and weekly feed intake were noted in each group. Based on this data, calculations were performed every week for: laying performance (% of lay), average egg weight (g), egg production per hen per day (g), average daily feed intake (g per hen), and feed conversion ratio (FCR – kg of feed per kg of egg weight).

At the start and at the end of the experiment all daily laid eggs from each group were collected. Eggs were subjected to standard quality control with the use of EQM system, version 1.0. Parameters estimated in fresh eggs on both dates were: egg weight (g), thick albumen quality (Haugh units), yolk colour (RCF), yolk content in egg (%), and shell thickness (mm). In order to determine dry shell content in egg (%), the shells were cleaned and dried for 24 hours at a temperature of 110ºC. In total, 90, 93 and 92 eggs were analysed from groups C, E1 and E2, respectively at 31 weeks, and 92, 94 and 81 eggs, respectively at 48 weeks.

The data for each trait were analysed by one-way analysis of variance calculated by the least squares method, separately for different factors: group and age (SPSS 14.0, GLM procedure). Results in tables are presented as least square means (LSM) with the standard error of the mean (SEM).

Results

Over the experimental period, no death cases were reported in any of the groups examined. Both at the onset and at the end of the experiment, the mean body weight of hens was similar in all groups, and the significance of differences between the groups was not statistically confirmed (Table 3). As expected, in all groups, the body weight of hens increased during the period of the experiment. In both experimental groups receiving DDGS, body weight gains were identical and negligibly higher than in the control group.

Table 3. Hens body weight (kg) at the start (BW-31) and at the end (BW-48) of experiment

Group	BW-31 (kg)		BW-48 (kg)		Gain (g)
	LSM	SEM	LSM	SEM	
C	1.68 A	0.013	1.84 A	0.016	+ 160
E1	1.67 A	0.013	1.85 A	0.016	+ 180
E2	1.69 A	0.013	1.87 A	0.016	+ 180

A – Values in columns with the same letter – non significant differences.

At the beginning, the administration of DDGS to feed mixtures for hens did not result in a rapid decrease of laying performance in both experimental groups, and the mean values of this parameter noted in all groups were similar to the standard value (www.hendrix-genetics.com, 2008 a). Nevertheless, in group E2 fed the mixture with 20% DDGS a successive decrease was observed in laying performance. This group was also characterized by the least unvaried values of this parameter

(Figure 1). The laying intensity (%) in this group was significantly lower (P≤0.01) than in groups C and E1 (Table 4). In group E1 (15% DDGS), the laying performance was slightly higher than in group C, but the difference was insignificant.

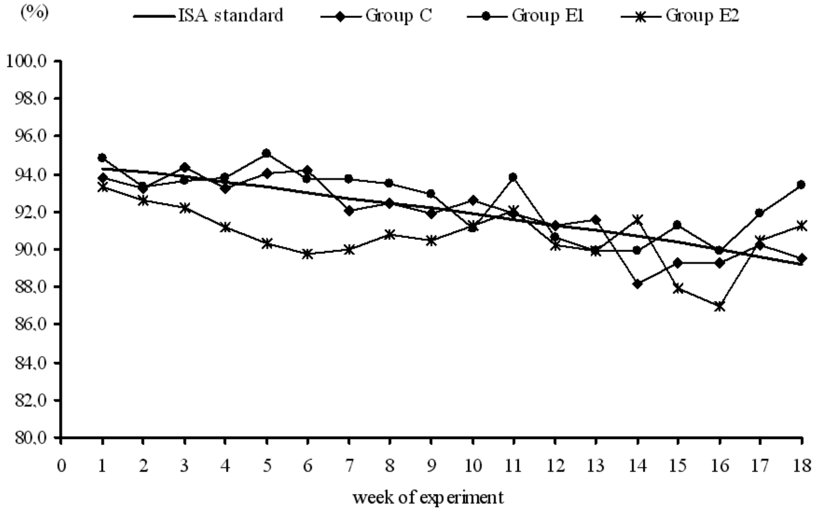

Figure 1. ISA Brown laying production (%) over the experimental period

Table 4. Production results during the period of 18 weeks

Parameters	Group C		Group E1		Group E2	
	LSM	SEM	LSM	SEM	LSM	SEM
Laying performance (%)	91.9 A	0.32	92.5 A	0.31	90.7 B	0.31
Mean egg weight (g)	60.3 A	0.11	60.0 A	0.11	60.2 A	0.11
Feed intake (g/hen/day)	114.1 A	0.05	113.9 A	0.05	113.8 A	0.05
Feed conversion (kg/kg egg mass)	2.07 A	0.01	2.05 AB	0.01	2.09 B	0.01

A, B – Values in rows with different letters differ significantly at P≤0.01.

The mean egg weight in all groups was at a similar level, and the minute differences were not confirmed statistically (Table 4). The mean daily feed intake in the experimental groups was almost identical as in the control group. However, owing to the lower laying performance in group E2, the FCR per kg of egg weight was significantly higher (P≤0.01) in this group than in the other groups (Table 4).

Results of standard qualitative assessment of eggs were presented in Table 5. Over the 18-week experimental period, egg weight was observed to increase significantly (P≤0.01) in all groups (Table 5) but to a different extent in particular groups, i.e. in group C the increase was the highest and reached +6.49 g, whereas in groups E1 and E2 it reached +4.47 g and +3.84 g, respectively.

Table 5. Egg quality parameters analysed on two dates: at the start of experiment (Date I) and at the end of experiment (Date II)

Trait	Group	Date I			Date II			Differences between dates P values
		n	LSM	SEM	n	LSM	SEM	
Egg weight (g)	C	90	54.30 A	0.39	92	60.79 a	0.44	0.000
	E1	93	54.80 A	0.39	94	59.27 b	0.43	0.000
	E2	92	56.08 B	0.39	81	59.92 ab	0.47	0.000
Thick albumen quality (HU)	C	90	89.83 A	0.65	92	83.81 A	0.76	0.000
	E1	93	86.56 B	0.64	94	83.62 A	0.75	0.002
	E2	92	88.46 A	0.64	81	78.07 B	0.81	0.000
Yolk colour (RCF)	C	90	8.03 A	0.12	92	7.40 A	0.11	0.000
	E1	93	7.85 A	0.12	94	8.02 B	0.11	0.315
	E2	92	8.09 A	0.12	81	7.82 B	0.12	0.101
Yolk content (%)	C	90	24.25 a	0.16	92	26.83 A	0.19	0.000
	E1	93	24.72 b	0.15	94	27.38 B	0.18	0.000
	E2	92	24.08 a	0.15	81	27.69 B	0.20	0.000
Shell content (%)	C	90	9.94 A	0.08	92	10.01 a	0.09	0.490
	E1	93	10.07 A	0.08	94	10.04 a	0.09	0.831
	E2	92	9.81 A	0.08	81	9.73 b	0.10	0.512
Shell thickness (mm)	C	90	0.352 A	0.003	92	0.370 a	0.003	0.000
	E1	93	0.361 A	0.003	94	0.372 a	0.003	0.009
	E2	92	0.358 A	0.003	81	0.360 b	0.004	0.668

A, B – Values in columns with different letters differ significantly at P≤0.01.
a, b – Values in columns with different letters differ significantly at P≤0.05.

Throughout the study period, thick albumen quality expressed in Haugh units (HU) decreased in all groups (Table 5). The greatest decline in albumen quality, by as many as 10.39 HU, was determined in group E2 (20% DDGS), followed by group C (by –6.02 HU). In group E1 (15% DDGS), albumen quality deterioration was minimal (–2.94 HU).

At the start of the experiment, there were no differences in yolk colour between groups (Table 5). After 18 weeks of feeding hens with corn DDGS, differences appeared between the control group and experimental groups in which yolks were significantly darker (P≤0.01). In turn, yolk content of egg increased significantly in all groups in the study period (Table 5). The greatest increase in this parameter was noted in group E2, and the least one in group C. At the end of the experiment, its value in the control group was significantly different (P≤0.01) from the values recorded in the experimental groups.

Egg shell quality was assessed with two traits: shell content of egg and shell thickness. Based on the values collated in Table 5, it may be concluded that the quality of shells was good irrespective of analytical period and diet administered to hens. At the beginning of the experiment, no differences in both analysed traits were noted between the groups. In the course of the study, no significant differences were either observed in shell content of egg. In turn, shell thickness increased, though not always significantly, in all groups, whilst in groups C and E1 it was significantly better than at the onset of the experiment. A comparison of values of this trait demonstrates that the improvement in shell quality varied in particular groups, i.e. shell thickness increased by 0.018 mm in group C, by 0.011 mm in group E1, and by 0.002 mm in group E2. Along with an increasing content of DGGS in the feed mixture, the improvement in shell quality was less tangible. Considering both traits of egg shell quality, the values noted in group E2 differed significantly ($P \leq 0.01$) compared to the other groups.

Discussion

Based on the results obtained (Table 3), it may be concluded that the distillers dried grains with solubles introduced to feed mixtures for laying hens had no negative effect on their body weight gain. The positive effect of corn DDGS on body weight values of young hens during rearing was reported by Masa'deh (2011), but only in the birds aged 14–16 weeks. In a study on mature laying hens in the production period (24–76 weeks), Masa'deh and Scheideler (2008), Masa'deh et al. (2008, 2011) did not demonstrate any significant effect of corn DDGS on their body weight. The body weight values and body weight gains of laying hens from the groups receiving feed mixtures with various contents of DDGS were very alike, though lesser gains were observed in the birds fed the mixture with 20–25% of DDGS.

The production results obtained in the study (Table 4) do not differ significantly from findings reported in a previous study by Niemiec et al. (2012) addressing wheat DDGS. The authors did not find it to affect laying performance. Also other authors (Roberts et al., 2007; Masa'deh and Scheideler, 2008; Masa'deh et al., 2008; Green et al., 2010; Masa'deh, 2011) who investigated effects of corn DDGS addition to feed mixtures for laying hens, demonstrated that it had no effect on laying performance, even at 20–30% of the feed mixture. As reported by Green et al. (2010), already 50% addition of DDGS to the feed mixture was observed to significantly diminish the performance. These authors speculated on methionine deficiency as the reason of the reduced laying performance upon corn DGGS administration to birds. Likewise in a research by Gazalah et al. (2011), substituting corn with 40–60% of DDGS had a significant effect on laying performance decline. In contrast, improved laying performance was observed by Jung et al. (2008 a, 2008 b), but only after the application of 3% and 12% of DDGS in feed mixtures. According to Loar et al. (2010), 16% of DDGS in a feed mixture assured the highest laying production, compared with the control groups and groups with different DDGS addition.

The lack of significant differences in the mean egg weight (Table 4) is consistent with results reported by Roberts et al. (2007), Loar at al. (2010) and Ghazalah et al.

(2011). In contrast, it disagrees with the findings of Masa'deh et al. (2008a, 2008b, 2011), Pescatore et al. (2010) and Masa'deh (2011), who showed a tangible tendency for a decreasing egg weight along with an increasing content of DDGS in the feed mixture. A lack of this dependency was observed by Masa'deh et al. (2008b, 2011) and Masa'deh (2011) already in the second laying phase, i.e. after the 46th week of hen life.

The small and insignificant decrease in feed intake noted in the experimental groups (Table 4) is consistent with observations made by other authors. In studies by Roberts et al. (2007), Loar et al. (2010), Masa'deh and Scheideler (2008), Masa'deh et al. (2008, 2011) and Masa'deh (2011), the daily feed intake was alike in all groups irrespective of DDGS content in the diet. In contrast, Pescatore et al. (2010) demonstrated a significant decrease in feed intake. In a research by Green et al. (2010), a significant decrease in feed intake was observed already upon 50% DDGS addition to feed mixtures. Equally strong response was noted by Ghazalah et al. (2011) at DDGS additions of 40% and 60%. As a consequence, they also obtained a significant decrease in FCR, despite a significant decline in laying performance. Contrarily, Roberts et al. (2007), Pescatore et al. (2010) and Jung et al. (2008 a, 2008 b) did not confirm the effect of DDGS content in the diet on the FCR value. In turn, in the present study, as a consequence of lower laying performance in group E2 (20% DDGS) and with the lack of significant differences in the mean egg weight and feed intake, the FCR value was observed to increase significantly ($P \leq 0.01$) (Table 4).

When analysing changes in the value of the evaluated egg quality traits, consideration shall be given to the age of laying hens which affects egg quality, irrespective of the experimental factor. Typical physiological changes due to the age of a flock include an increase in egg weight, deterioration of thick albumen quality and deterioration of shell quality. In contrast, yolk colour is completely independent of hen age (Sauveur, 1988).

As expected, with the advancing age of the laying hens, the physiological increase in egg weight was observed in all groups, with the increase being lesser along with an increasing DDGS ration in the feed mixture (Table 5). At the start of the experiment, the egg weight in group E2 was significantly the highest, but after 18 weeks it did not differ statistically from the values noted in the other groups. Perhaps this was due to a higher content of corn DDGS in the feed mixture, which would be in accordance with a tendency observed by Masa'deh and Scheideler (2008), Masa'deh et al. (2008, 2011), Pescatore et al. (2010) and Masa'deh (2011).

The changes noted in thick albumen quality in the study period do not indicate the effect of the nutritional factor on values of this trait (Table 5). Likewise, such an effect was not demonstrated in experiments conducted by Lumpkins et al. (2005), Masa'deh and Scheideler (2008), Masa'deh et al. (2008, 2011) and Ghazalah et al. (2011). The results obtained did not confirm earlier findings of Niemiec et al. (2012) from a study on the use of corn DDGS in laying hen nutrition, which demonstrated a positive effect of DDGS on thick albumen density. The increase in Haugh units upon administration of DGGS was also noted by Loar et al. (2010) and Pescatore et al. (2010). Also Sauveur (1988) claimed that, when added to a feed mixture, the products of grain fermentation had a beneficial effect on thick albumen density. This author ascribes this effect to the likely influence of an increased quantity of microelements.

The reported increase in yolk content of egg (Table 5) is due to the age of the flock (Sauveur, 1988). Pescatore et al. (2010) demonstrated that the increasing DDGS content in the feed mixture was accompanied by a decreased weight of yolk. This was, however, not confirmed in our study, where in the group with 20% addition of DDGS the increase in yolk content was the greatest.

Yolk colour is a trait that depends on the content and type of pigments in a feed (Nys, 1999). Roberson et al. (2005), Roberts et al. (2007), Loar et al. (2010), Pescatore et al. (2010), Masa'deh and Scheideler (2008) and Masa'deh et al. (2008, 2011) demonstrated a positive effect of dietary corn DDGS on yolk colour. Such an effect was, in turn, not observed by Lumpkins et al. (2005), Jung et al. (2008 a, 2008 b) and Ghazalah et al. (2011). It may be speculated that slightly more intensive colour of yolk in groups E1 and E2 at the end of the experiment (Table 5) resulted from a significant content of yellow pigments in the corn DDGS. Although statistically significant ($P \leq 0.01$), the difference could not be perceptible to a consumer. So negligible differences could be due to the higher content of corn grain in the control diet (45%) than in experimental diets (20%). But DGGS are a more concentrated raw material than pure grain and contain three times higher nutrient levels (except starch) (Świątkiewicz and Koreleski, 2008). Thus we could expect that the total content of xanthophylls in E1 and E2 feeds was higher than in C feed. On the other hand – according to Nys (1999) – an increase in colour intensity by each point on the RCF scale requires the administration of increasing amounts of pigment in the diet.

With the advancing age of laying hens, the quality of egg shells usually deteriorates (Sauveur, 1988). In the reported experiment, no shell quality deterioration occurred; on the contrary, shell thickness was observed to increase (Table 5). Earlier investigations (Roberson et al., 2005; Loar et al., 2010; Koreleski et al., 2011; Krawczyk et al., 2012) did not demonstrate the effect of DDGS on the quality of egg shells; only Pescatore et al. (2010) reported a lower weight and content of shell and lower shell resistance to crushing in the 4th week of administration of the DDGS-containing feed mixture, whereas Ghazalah et al. (2011) showed a decrease of shell thickness along with an increasing DDGS ration in the diet.

Based on the results obtained in the study, it may be concluded that the introduction of corn distillers dried grains with solubles to feed mixtures for commercial laying hens is advisable. With corn DDGS addition exceeding 15%, a slight decrease in production results and deterioration in selected parameters of egg quality shall be expected. Yet, in the total costs of flock maintenance this may be compensated for by a reduced cost of the feed mixture.

References

AOAC (2005). Official Methods of Analysis of AOAC, International 16th Edition. Association of Analytical Chemists, Arlington, VA, USA.

Cozannet P., Lessire M., Métayer J.P., Gady C., Primot Y., Geraert P.A., Le Tutour L., Skiba F., Noblet J. (2010). Valeur nutritive des drêches de blé et de maïs pour les volailles. INRA Prod. Anim., 23: 405–414.

Ghazalah A.A., Abd-Elsamee M.O., Al-Arami A.A. (2011). Use of distillers dried grains with solubles (DDGS) as replacement for yellow corn in laying hen diets. Egypt. Poult. Sci., 31: 191–202.

Green J., Ahn D.U., Persia M.E. (2010). Effect of high concentration of distillers dried grains with solubles on long-term laying hen performance. Poultry Sci., 89, E-Suppl. 1: p. 552.

Jung B.Y., Sedlacek, P., Batal A.B. (2008 a). Effect of high-protein distillers dried grains at various levels on performance of laying hens. Poultry Sci., 87, Suppl. 1: Poultry Sci. Assoc. Ann. Meet. Abstr., p. 28.

Jung B.Y., Sedlacek, P., Batal A.B., Prewitt R. (2008 b). Evaluation of distillers dried grains as a feed ingredient for laying hens and broilers. Poultry Sci., 87, Suppl. 1: Poultry Sci. Assoc. Ann. Meet. Abstr., p. 137.

Koreleski J., Świątkiewicz S., Arczewska-Włosek A. (2011). Rapeseed cake, glycerin and distillers dried grains with solubles used simultaneously as a source of nutrients for hens in second season of laying. Ann. Anim. Sci., 11: 125–133.

Krawczyk J., Sokołowicz Z., Świątkiewicz S, Koreleski J., Szefer J. (2012). Performance and egg quality of hens from conservation flocks fed a diet containing maize distillers dried grains with solubles (DDGS). Ann. Anim. Sci., 12: 247–260.

Loar II R.E., Schilling M.W., McDaniel C.D., Coufal C.D., Rogers S.F., Karges K., Corzo A. (2010). Effect of dietary inclusion level of distillers dried grains with solubles on layer performance, egg characteristics, and consumer acceptability. J. Appl. Poult. Res., 19: 30–37.

Lumpkins B.A., Batal D.N. (2005). Use of distillers dried grains plus solubles in laying hen diets. J. Appl. Poult. Res., 14: 25–31.

Masa'deh M.K. (2011). Dried distillers grain with solubles in laying hen and pullet rations. University of Nebraska – Lincoln. Theses Dissert. Anim. Sci., Paper 35.

Masa'deh M.K., Purdum S.E., Hanford K.J. (2011). Dried distillers grains with solubles in laying hen diets. Poultry Sci., 90: 1960–1966.

Masa'deh M.K., Scheideler S.E. (2008). Dried distillers grains with solubles in laying hens ration (Phase I). Poultry Sci., 87, Suppl. 1: Poultry Sci. Assoc. Ann. Meet. Abstr., p. 137.

Masa'deh M.K., Weber P., Scheideler S.E. (2008). Dried distillers grains with solubles in laying hens ration (Phase II). Poultry Sci., 87, Suppl. 1: Poultry Sci. Assoc. Ann. Meet. Abstr., p. 27.

Niemiec J., Riedel J., Szulc T., Stępińska M. (2012). Feeding wheat distillers dried grains with solubles (DDGS) to laying hens and its effect on performance and egg quality. Ann. Anim. Sci., 12: 105–115.

Nys Y. (1999). Dietary carotenoids and egg yolk coloration. Proc. VIIIth Europ. Symposium on the quality of egg and egg products, Bologna, pp. 3–23.

Pescatore A.J., Rossi P., Cantor A.H., Pierce J.L., Ao T., Macalintal I.M., Ford M.J., King W.D., Gillespie H.D. (2010). Effect of distillers dried grains with solubles and an enzyme supplement on performance and egg quality of brown egg layers. Poultry Sci., 89, E-Suppl. 1, p. 367.

Roberson K.D., Kalbfleisch J.L., Pan W., Charbeneau R.A. (2005). Effect of corn distiller's dried grains with solubles at various levels on performance of laying hens and egg yolk color. Int. J. Poultry Sci., 4: 44–51.

Roberts S.A., Xin H., Kerr B.J., Russel J.R., Bregendahl K. (2007). Effects of dietary fiber and reduced crude protein on nitrogen balance and production in laying hens. Poultry Sci., 86: 1716–1725.

Sauveur B. (1988). Qualite de l'oeuf. In Reproduction des Volailles et Production d'Oeufs. Ed. INRA, Paris, pp. 377–436.

Shurson J., Noll S. (2005). Feed and alternative uses for DDGS. www.ddgs.umn.edu/articles-industry/2005-Shurson-%20Energy%20from%20Ag%20Conf.pdf

Smulikowska S., Rutkowski A. (2005). Editors. Recommended allowances and nutritive value of feedstuffs. Poultry feeding standards (in Polish). 4th Edition. The Kielanowski Institute of Animal Physiology and Nutrition, PAS, Jabłonna, Polish Branch of WPSA, pp. 99–101.

S t e c k a K.M. (2003). Corn as a raw material for distillery industry (in Polish). In: Directions of the use of high energy maize varieties for biofuel production, K.J. Zielińska (ed.). Instytut Biotechnologii Przemysłu Rolno-Spożywczego, Warsaw, The Monographs, pp. 7–10.
Ś w i ą t k i e w i c z S., K o r e l e s k i J. (2008). The use of distillers dried grains with solubles (DDGS) in poultry nutrition. World's Poultry Sci. J., 64: 257–265.
www.hendrix-genetics.com (2008 a). Products, Commercial Layer ISA Brown.
www.hendrix-genetics.com (2008 b). Technical Information, Commercial Layers ISA Brown.

Accepted for printing 6 VIII 2012

JAN NIEMIEC, JULIA RIEDEL, TADEUSZ SZULC, MAŁGORZATA STĘPIŃSKA

Zastosowanie DDGS z kukurydzy w żywieniu kur niosek i jego wpływ na jakość jaj i wyniki produkcyjne

STRESZCZENIE

Celem doświadczenia było określenie wpływu kukurydzianego DGGS (distillers dried grains with solubles) zastosowanego jako zamiennik śruty sojowej w paszy dla niosek na jakość jaj i wydajność nieśną kur. Kury nioski ISA Brown (podzielone na 3 grupy po 100 szt.: 10 powtórzeń po 10 kur w każdej) przez 18 tygodni były żywione mieszanką zawierającą 15% (grupa E1) i 20% (grupa E2) DDGS z kukurydzy. Kury z grupy kontrolnej (C) otrzymywały typową paszę bez udziału DDGS, w której główne źródło białka stanowiła poekstrakcyjna śruta sojowa. W okresie doświadczenia kontrolowano wydajność nieśną (% nieśności), średnią masę jaja (g), średnie dzienne spożycie paszy (g/szt./dzień) oraz wykorzystanie paszy (kg/1 kg jaj). Jakość jaj: masa jaja (g), jakość białka gęstego (jH), kolor żółtka (RFC), udział żółtka w jaju (%), udział skorupy w jaju (%) i grubość skorupy (mm) oceniano dwukrotnie – przed rozpoczęciem i na koniec doświadczenia. W obydwu terminach analizie poddano cały dzienny zbiór jaj z każdej grupy, tj. 90, 93 i 92 jaja odpowiednio z grupy C, E1, E2 w wieku 31 tygodni oraz 92, 94 i 81 jaj w 48. tygodniu, odpowiednio z tych samych grup.

W okresie objętym doświadczeniem w żadnej z grup nie odnotowano padnięć. Nie stwierdzono wpływu żywienia DDGS na masę ciała niosek. W grupie E2 (20% DDGS) stwierdzono, w porównaniu do pozostałych grup, niewielkie obniżenie nieśności i wyższą wartość FCR. Odnośnie obu cech różnice potwierdzono statystycznie ($P \leq 0{,}01$). Nie stwierdzono istotnego wpływu udziału DDGS w paszy na średnią masę jaja i dzienne spożycie paszy. Jaja pochodzące od kur z grupy E2 charakteryzowała pod koniec doświadczenia istotnie gorsza ($P \leq 0{,}01$) jakość białka i istotnie gorsza jakość skorupy ($P \leq 0{,}01$). Kolor żółtka w obu grupach doświadczalnych był istotnie ciemniejszy ($P \leq 0{,}01$) w porównaniu do grupy C. Na podstawie przedstawionych wyników można uznać, że wprowadzenie DGGS z kukurydzy w ilości 15% do mieszanek przeznaczonych dla stad towarowych kur nieśnych jest zasadne. Po przekroczeniu 15% udziału DDGS należy liczyć się z możliwością niewielkiego obniżenia wskaźników produkcyjnych i pogorszenia niektórych cech jakości jaj.