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EFFECT OF CORN DISTILLERS DRIED GRAINS WITH SOLUBLES (DDGS) IN DIETS WITH NSP-HYDROLYZING ENZYMES ON GROWTH PERFORMANCE, CARCASS TRAITS AND MEAT QUALITY OF PIGS*

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Abstract

The effect of corn distillers dried grains with solubles (DDGS), used in grower-finisher diets with or without supplemental enzymes, on growth performance and carcass and meat quality was determined in an experiment with 48 pigs. Group I (control) received a standard grain-soybean meal mixture without DDGS and without enzymes; Group II was fed a mixture containing 15% (grower) or 20% (finisher) of corn DDGS but without the enzymes; Group III received a mixture containing 15% (grower) or 20% (finisher) of corn DDGS with NSP-hydrolyzing enzymes (200 g t^{-1}). The feed mixtures were isonitrogenous and isoenergetic. All pigs were fattened from 30 to 112 kg. At the end of the experiment all pigs were slaughtered, right carcass sides were evaluated and samples of *longissimus* muscle were taken for analysis. Inclusion of corn DDGS did not significantly affect pig fattening results and meat quality. The addition of NSP-hydrolyzing enzymes to feed mixtures containing corn DDGS tended to positively influence pig performance. The carcasses of pigs receiving the diet with corn DDGS and NSP-hydrolyzing enzymes were characterized by thinner backfat and greater weight of the primal cuts.

Key words: pigs, corn DDGS, NSP-hydrolyzing enzymes, fattening performance, meat quality

The main byproduct of ethanol production is distillers dried grains with solubles (DDGS). The high content of fermentable starch in the grain enables the corn to be used as the principal and most effective grain in the ethanol industry. In the past years DDGS was mostly used in ruminant feeding because of high fibre level and low protein quality. When fed to pigs, the insoluble fibre acts as a digestive tract filler

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that improves the satiety and welfare of pregnant sows (Danielsen and Vestergaard, 1999; Urbańczyk et al., 2001), and when fed to piglets, small amounts of this nutrient significantly increase the development of intestinal villi and beneficial microflora (Montagne et al., 2003; Świątkiewicz and Hanczakowska, 2006; Świątkiewicz et al., 2006). Nowadays, increasing interest in feeding corn DDGS to monogastric animals is observed (Stein and Shurson, 2009; Świątkiewicz and Koreleski, 2008). This is possible due to the modern DDGS drying technology (mostly gentler drying conditions) which improved DDGS quality. The relatively high content of protein in DDGS enables using it as a partial replacement of soybean meal. However, replacement of soybean meal protein with DDGS protein may worsen the amino acid profile, and the use of crystalline lysine should be increased. The available corn DDGS differ in chemical composition and nutritive value (Stein and Shurson, 2009; Belyea et al., 2010). These differences make the diets difficult to formulate. Further studies concerning DDGS quantity and quality, nutrient availability and its effect on animal productivity could help to reduce variation in performance of pigs receiving DDGS.

In the case of most byproducts, including DDGS, it is necessary to use non-starch polysaccharide (NSP) hydrolyzing enzymes. Multi-enzyme additives can improve the nutritive value of feed and its utilization by animals, increase the energy digestibility, and reduce feeding costs (Świątkiewicz and Koreleski, 2006; Zijlstra et al., 2010). Although the nutrient content of DDGS is 2- to 3-fold higher relative to grains, it remains unclear if such improvements can easily translate into improved pig performance, mostly because of the high content of soluble and insoluble fibre in DDGS (Emiola et al., 2009). In addition, the fermentation and drying process during DDGS production may change the characteristics of NSP in the grain. According to the cellulosic biomass compositional analysis by Kim et al. (2008), corn DDGS contains about 16% of cellulose, 8% of xylan and 5% of arabinan. However, the effects of supplementing DDGS with feed enzymes are not always equivalent to the results of adding the same enzymes to original grain (Widyaratne et al., 2009; Zijlstra et al., 2010).

The high content of unsaturated fatty acids (UFA) in corn DDGS as well as its possible negative influence on fat quality and traits important for processing must be considered when estimating the high corn DDGS content in pig diets. It is well known that the fatty acid profile of pig meat reflects the composition of fat in the diet (Averette Gatlin et al., 2002). High quantity of UFA in feed results in soft and oily consistency of fat, difficulties with fabrication and slicing, increased susceptibility to oxidative damage as well as reduction in the shelf life of meat and meat products (Xu et al., 2010 b). Considering the rising soybean meal prices and relatively low price of DDGS (as a byproduct), it may be economically beneficial to use greater amounts of DDGS to reduce diet costs. Further studies related to the effect of feeding high amounts of corn DDGS to fattened pigs on meat and fat quality are still necessary (Xu et al., 2010 a; Benz et al., 2011).

The present study was conducted to determine if corn distillers dried grains with solubles (DDGS), used in grower-finisher diets with or without enzymes, will maintain the growth performance and carcass and meat quality traits.

Material and methods

All the experimental procedures relating to the use of live animals were conducted in accordance with the Local Ethics Committee for Animal Experiments. During the entire study all animals were humanely cared for and were under veterinary supervision.

Animals, housing and management

The experiment was carried out on 48 fatteners derived from Polish Landrace × Polish Large White sows mated to a Duroc × Pietrain boar. At the beginning of the fattening experiment (26±2.0 kg of body weight, BW) animals were divided into three groups, 16 animals in each. The whole fattening experiment lasted from 30 to 112 kg of BW and included two phases: grower (from 30 to 60 kg of BW) and finisher (from 60 to 112 kg of BW). Fatteners were individually kept in straw-bedded pens and individually fed twice a day with restricted feed amounts according to body weight: from 1.8 kg d^{-1} of feed mixture at 30 kg of BW to 3.2 kg d^{-1} at 80 kg of BW and over. Individual body weight of all fatteners was controlled every two weeks. During the trial animals had free access to water. At the end of the fattening experiment all pigs were slaughtered, right carcass sides were evaluated and the samples of *longissimus* muscle were collected for analysis.

Table 1. Nutrient content of the analysed corn DDGS

Item	Content
Chemical composition (%)	
dry matter	89.8
crude protein	26.9
crude fat	10.9
crude fibre	5.5
NDF	27.8
ADF	11.6
ADL	2.3
crude ash	4.8
N-free extractives	41.7
Amino acid profile (%)	
Lys total	0.60
Lys available	0.52
Met	0.58
Cys	0.46
Thr	0.94
Trp	0.15
Mineral content (%)	
Ca	0.62
P total	0.81
Na	0.07

Table 2. Composition and nutrient content of feed mixtures

Item	Experimental groups		
	I control	II DDGS	III DDGS+enz
Grower feed mixtures			
corn DDGS	-	15.0	15.0
barley	33.52	40.48	40.48
wheat	30.0	25.0	25.0
corn	5.0	-	-
wheat bran	5.0	-	-
soybean meal	21.0	15.0	15.0
rapeseed oil	2.8	2.0	2.0
premix (0.5%)	0.5	0.5	0.5
NaCl	0.26	0.25	0.25
fodder chalk	1.3	1.2	1.2
phosphate 1-Ca	0.4	0.3	0.3
L-Lysine	0.17	0.27	0.27
DL-Met	0.05	-	-
NSP-enzymes preparation	-	-	+
Nutrient content in 1 kg of mixture:			
ME (MJ*)	13.2	13.2	13.2
crude protein (g)	180.0	179.0	179.0
Lys (g)	10.20	10.10	10.10
Met+Cys (g)	6.32	6.30	6.30
Thr (g)	6.21	6.31	6.31
Trp (g)	2.12	1.90	1.90
Finisher feed mixtures			
corn DDGS	-	20.0	20.0
barley	41.95	44.31	44.31
wheat	25.0	25.0	25.0
corn	6.0	-	-
wheat bran	6.0	-	-
soybean meal	16.0	7.0	7.0
rapeseed oil	2.8	1.5	1.5
premix (0.5%)	0.5	0.5	0.5
NaCl	0.2	0.19	0.19
fodder chalk	1.3	1.2	1.2
phosphate 1-Ca	0.12	-	-
L-Lysine	0.13	0.3	0.3
NSP-enzymes preparation	-	-	+
Nutrient content in 1 kg of mixture:			
ME (MJ*)	13.2	13.2	13.2
crude protein (g)	160.0	162.0	162.0
Lys (g)	8.60	8.60	8.60
Met+Cys (g)	5.41	5.90	5.90
Thr (g)	5.58	5.57	5.57
Trp (g)	1.90	1.60	1.60

* Metabolizable energy calculated using the equation of Hoffmann and Schiemann (1980).

Diets and treatment

The feed mixtures for all groups contained barley, wheat and corn grain, wheat bran, soybean meal, rapeseed oil, vitamin-mineral additives and crystalline amino acids. The diets were isonitrogenous and isoenergetic. The composition and nutritive value of experimental grower and finisher diets are shown in Table 2. The diets used in the experiment differed in the presence of corn DDGS (15% in grower and 20% in finisher mixture) and NSP-hydrolyzing enzyme preparations. In the present experiment the evaluated corn DDGS (Table 1) was obtained from a commercial ethanol distillery plant. The mixture of NSP enzymes contained endo-1,4-β-xylanase (minimum activity 1000 FXU g-1), endo-1,3(4)-β-glucanase (minimum activity 50 FBG g-1), pentosanase, hemicellulase and pectinase. The enzyme preparation was used in amounts of 200 g per t of feed mixture. NSP-hydrolyzing enzymes were kindly supplied by DSM Nutritional Products Sp. z o.o. in Mszczonów, Poland.

Design of experiment

The design of the present experiment was as follows:

Group I (control) – standard feed mixture without corn DDGS and without NSP enzymes;

Group II (DDGS) – feed mixture containing 15% (in grower mixture) and 20% (in finisher mixture) of corn DDGS without NSP enzymes;

Group III (DDGS+enz) – feed mixture containing 15% (in grower mixture) and 20% (in finisher mixture) of corn DDGS with supplemental NSP enzymes.

Data and sample collection, chemical analysis

During the fattening experiment individual body weight of pigs and their feed intake were measured, while feed conversion and average daily gains from 30 to 110 kg of BW were calculated for every animal.

At the end of the fattening experiment (112 kg of BW) all pigs were slaughtered. After 24 h of storage at +4ºC the quality of carcasses, including the equation for carcass meatiness, was evaluated according to standard methods used at Pig Performance Testing Stations (Różycki and Tyra, 2010). At the same time samples of loin (*longissimus* muscle) from the area of the last thoracic and first lumbar vertebrae, were taken from the right side of carcasses for analysis. Meat acidity was measured with a pH-meter equipped with a Metron OSH 12-00 electrode 45 min and 24 hours after slaughter. The proximate analysis was conducted according to AOAC (2005) standard methods. Meat colour (lightness, redness, yellowness) was measured in slices of fresh meat with a Minolta CR-310 colorimeter. Water holding capacity index was estimated in freshly minced meat according to Grau and Hamm (1953) methods. TBA-RS were analysed after 3 months of storage at –18ºC and meat samples were prepared according to a modified method of Pikul et al. (1989).

The chemical gross analysis of corn DDGS and feed mixtures was performed using conventional AOAC methods (2005). Amino acids were analysed in acid hydrolysates, and sulfur amino acids after initial peroxidation in the colour reaction with the ninhydrin reagent using AAA 400 INGOS automatic analyser. For evaluation of available lysine content the AOAC (2005) Official Method 975.44 was used. The calcium and sodium content was determined with an Avanta Sigma flame atomic absorption spectrophotometer (EN ISO 6869, 2002), while phosphorus content by a molybdovanadate colorimetric procedure of AOAC (2005). The estimation of acid detergent fibre (ADF), neutral detergent fibre (NDF) and acid detergent lignin (ADL) was conducted using Tecator Fibretec System M equipment according to Goering and van Soest (1970) procedures.

Statistical analysis

Statistical analysis of treatment effects was performed by one-way analysis of variance with comparison of means by Duncan's multiple range test at $P \leq 0.05$ and $P \leq 0.01$ levels of significance using the Statistica v 5.1 package.

Results

The chemical composition of corn DDGS used in the present experiment is shown in Table 1. DDGS moisture amounted to about 10%, its organoleptic traits and yellow-golden colour were appropriate for this feed material. DDGS contained 27% protein and 6 g of lysine per kg of feed. The amount of available lysine was 87%. The content of fat, crude fibre, total phosphorus, calcium and sodium was 10.9, 5.5, 0.81, 0.62 and 0.07%, respectively.

Table 3. Effect of experimental treatment on pig fattening results

Item	Experimental groups			SEM*
	I control	II DDGS	III DDGS+enz	
Average daily gains in fattening period (g)				
30–60 kg	761 (100%)	730 (95.9%)	780 (102.5%)	10.751
60–110 kg	970 (100%)	930 (95.8%)	992 (102.3%)	12.917
30–110 kg	879 (100%)	842 (95.8%)	900 (102.4%)	10.402
Average feed conversion ratio (kg/kg)				
30–60 kg	2.60 (100%)	2.69 (103.5%)	2.54 (97.7%)	0.033
60–110 kg	3.13 (100%)	3.29 (105.1%)	3.08 (98.4%)	0.040
30–110 kg	2.93 (100%)	3.06 (104.4%)	2.88 (98.3%)	0.033
Number of days during fattening period				
30–60 kg	39.6 (100%)	41.3 (104.3%)	38.5 (97.2%)	0.607
60–110 kg	51.6 (100%)	54.1 (104.8%)	50.5 (97.9%)	0.775
30–110 kg	91.2 (100%)	95.4 (104.6%)	89.0 (97.6%)	1.171

*Standard error of the mean.

The fattening performance responses of growing-finishing pigs to the feed mixture containing corn DDGS, with or without NSP-hydrolyzing enzymes, are presented in Table 3. During both fattening phases inclusion of corn DDGS in group II did not significantly affect the growth performance, but a slight decrease (about 4% in the entire fattening period) in weight gains and an increase in feed utilization were observed. Supplementation of the corn DDGS diet with NSP-hydrolyzing enzymes (group III) ameliorated the fatteners' performance. During the entire experiment pigs receiving the enzyme preparation showed 6.9% better weight gains in comparison with group II receiving the corn DDGS diet without enzymes and 2.4% better compared to group I fed standard mixture. The differences in feed conversion amounted to 5.9% and 1.7%, respectively. The addition of feed enzymes to the corn DDGS diet shortened the fattening period (30 to 110 kg of BW) by 6.4 days (6.7%) compared to pigs fed DDGS mixture without enzymes, and by 2.2 days (2.4%) compared to the control group. Even though during the entire fattening period (30–110 kg) no statistically significant differences appeared, a tendency towards improved weight gain, feed conversion and fattening length as a result of adding enzymes to the diet containing corn DDGS was observed (P = 0.06–0.08).

Table 4. Results of the carcass quality evaluation

Item	Experimental groups			SEM*
	I control	II DDGS	III DDGS+enz	
Body weight at slaughter (kg)	111.7	111.8	111.6	0.587
Cold dressing yield (%)	78.76	78.36	79.31	0.354
Meat of primal cuts (kg)	24.20	24.15	25.49	0.419
Carcass meatiness (%)	55.20	55.33	58.25	0.650
Loin eye area (cm^2)	61.50	62.94	61.84	1.772
Loin (kg)	9.15	8.83	9.14	0.137
Loin meat (kg)	7.05	7.00	7.33	0.119
Tenderloin (kg)	0.47	0.49	0.49	0.013
Ham (kg)	10.11	9.35	10.61	0.179
Ham meat (kg)	8.09	8.06	8.63	0.167
Meat content in ham (%)	80.0	81.06	81.28	0.395
Neck (kg)	6.91	6.95	7.35	0.110
Neck meat (kg)	5.90	5.92	6.35	0.098
Shoulder (kg)	4.90	5.00	5.05	0.105
Hind shank (kg)	1.25	1.26	1.27	0.015
C backfat thickness (cm)	0.90	0.73	0.69	0.042
Carcass length (cm)	83.5	83.7	84.2	0.312

*Standard error of the mean.

No statistically significant differences in carcass quality traits were noticed between pigs fed standard diets (group I) or feed mixture containing corn DDGS (group II); however, cold dressing yield, meat of primal cuts and backfat thickness were slightly lower in group II (Table 4). Average carcass meatiness of all pigs used in the present experiment ranged between 55 and 58%, being graded as E according to the (S)EUROP pig carcass classification system. Inclusion of corn DDGS in the feed mixture did not affect the carcass meatiness, while enzyme supplementation (group III) improved the carcass meat content by about 3 percentage points (P = 0.08). The carcasses of pigs receiving the diet with corn DDGS together with NSP-hydrolyzing enzymes were characterized by thinner backfat and higher weight of the primal cuts: whole ham, meat of ham, meat of loin, whole neck, meat of neck, shoulder, and hind shank. The differences mentioned above were statistically not significant but in the enzyme group III the average meat content in primal cuts was higher by more than 5% in comparison with groups I and II, which is an economically important benefit.

Table 5. Effect of experimental treatment on meat quality indices of *longissimus* m.

Item	Experimental groups			SEM*
	I control	II DDGS	III DDGS+enz	
pH 45min after slaughter	6.29	6.36	6.38	0.036
pH after 24h cooling at +4ºC	5.57	5.66	5.67	0.033
Chemical analysis (%)				
dry matter	24.24	24.49	24.35	0.119
protein	22.76	22.72	22.84	0.091
fat	1.08	1.18	1.10	0.051
Water holding capacity (%)	18.99	19.41	20.59	0.425
Meat colour, Hunter's scale:				
lightness	45.16	44.77	43.93	0.470
redness	13.25	12.80	13.40	0.120
yellowness	2.26	2.00	1.84	0.096
TBA-RS, mg kg^{-1}	0.721	0.732	0.726	0.025

*Standard error of the mean.

The feed mixture tested in the present experiment did not significantly influence the meat chemical analysis and meat quality indices (Table 5). The corn DDGS as well as NSP-hydrolyzing enzymes had no effect on dry matter, protein and fat content in meat, as well as its acidity. The traits important for meat processing and shelf life, such as water holding capacity and TBA-RS index, also remained unchanged by dietary treatment.

Discussion

The chemical composition of the DDGS used in the current study did not vary from expected values. The content of crude protein and fat in the corn DDGS used in the present experiment was similar to literature data. However, compared with the results of other authors (Stein, 2007; Stein and Shurson, 2009; Tables of DDGS Composition, 2010), the level of Lys, Thr and Trp and crude fibre was relatively low and the level of Met and Cys was slightly higher. The content of available lysine in the corn DDGS was 87%, while that of the most available lysine in soybean meal was about 92%. In comparison, the availability of lysine in wheat DDGS analysed by Cozannet et al. (2010) amounted to 76–85%. This result indicates that during the DDGS drying process the amino groups, in amount of 13% of total lysine, were bound to reducing sugar due to Maillard reaction. The variability in nutrient composition of DDGS is quite common, but its reasons remain unclear. It seems that most of the differences are associated with variation in characteristics of grain quality, processing methods in ethanol plants, fermentation and distillation efficiency, type of yeast, heating procedures including drying temperature and time, and amount of solubles blended with dry material (Belyea et al., 2004; Belyea et al., 2010). The variability in the chemical composition of DDGS was also noticed by Cromwell et al. (1993), Spiehs et al. (2002), Stein et al. (2005, 2006), Fastinger and Mahan (2006), and Pahm et al. (2008). It suggests that protein and lysine concentration and its ileal digestibility represent a main concern when DDGS are fed to pigs and should be analysed.

The amount of corn DDGS inclusion in the diet for fatteners is a challenge due to the variation in nutrient content. The maximal possible content of DDGS in feed mixture, which provides satisfactory energy and protein level and supports unchanged animal performance, is still discussed. In the present experiment the 15–20% inclusion of corn DDGS in grower-finisher feed mixtures did not significantly change the body weight gains and feed utilization. The decline (by about 4%) in the fattening results was statistically non-significant; however, these observations are similar to those found in the literature data (Whitney et al., 2006; Linneen et al., 2008; Moreno et al., 2009 a, 2009 b). The poorer than expected DDGS quality (for example, low lysine availability as a result of improper heating process) may be a possible reason for decreased pig performance observed in some experiments (Stein and Shurson, 2009). Another reason for lower weight gains, noticed by some authors, may be a higher level of fibre in the diet containing DDGS, which negatively affects the feed intake. The fibre present in corn grain is not converted to ethanol during the fermentation process. As a result the digestibility of dry matter and energy in DDGS is lower in comparison with grain and a reduction in animal productivity may occur. The linear reduction in feed intake, feed utilization or weight gains was noticed by Fu et al. (2004), Hinson et al. (2007) and Weimer et al. (2008) when feeding pigs a mixture containing 10, 20 or 30% of corn DDGS.

Supplementation of DDGS feed mixture with NSP-hydrolyzing enzymes can improve its nutritive value. In the present experiment pigs receiving the multi-enzyme preparation performed better by about 6% in comparison to pigs fed the corn DDGS diet without enzymes and slightly better than those fed standard feed mixture. These results were not statistically confirmed (showing only a tendency) but should be underlined because of their practical and economic benefits. Similar results were obtained by Świątkiewicz and Hanczakowska (2011) in an experiment with nursing and weaned piglets and by Emiola et al. (2009) who fed growing-finishing pigs with a mixture containing 30% of wheat DDGS. Improved feed conversion ratio by adding enzyme preparation to feed mixture with corn DDGS was observed by Lee et al. (2011). Wang et al. (2009) noticed about 8% higher weight gains and improved feed utilization in pigs receiving a corn DDGS diet supplemented with carbohydrase enzyme cocktail. The complexity of the problem related to efficiency of exogenous enzymes was shown by Thacker (2009) who found no significant influence of multi-enzyme preparation added to the pig diet containing wheat DDGS.

Other than the effect on pig weight gains and feed conversion, using high content of corn DDGS in grower-finisher diet may also affect the pig carcass characteristics (Fu et al., 2004; Whitney et al., 2006). A slight reduction in carcass yield and loin depth ratio as the concentration of DDGS in the diets increases (up to 20–30%) was observed by Linneen et al. (2008) together with a tendency for decreasing backfat thickness with increasing DDGS level. According to these authors higher content of crude protein in feed mixtures with DDGS, which has been shown to reduce fat accretion, is a possible reason for this result. Cromwell et al. (2011) did not notice any significant differences in dressing percentage in carcasses of pigs receiving up to 45% of corn DDGS, but lower backfat thickness and higher fat-free lean percentage was significant. In the present experiment carcass quality traits of pigs receiving feed mixtures with corn DDGS were not significantly different. Fatteners fed the same diet but supplemented with NSP-enzyme preparation were characterized by higher meat content in primal cuts and lower backfat thickness, which is beneficial, but the differences were not statistically significant. In the experiment by Wang et al. (2009) pigs receiving a similar DDGS diet supplemented with enzyme preparations were characterized by slightly higher lean percentage and 9% larger *longissimus* muscle area. In some studies, adding enzyme preparations to feed mixtures containing corn DDGS (Lee et al., 2011) or wheat DDGS (Thacker, 2009) had no significant effect on carcass traits.

Among the meat quality traits, colour is probably the most important characteristic influencing the attractiveness of meat to consumers. The most desirable colour for fresh pork is bright reddish-pink. In the present experiment meat obtained from pigs fed the mixture containing corn DDGS (group II) was characterized by slightly lower values of lightness, redness and yellowness, but the differences were not significantly different from those of the control group. A linear decrease in yellowness of the meat from pigs fed with DDGS and no effect on lightness were observed by Widmer et al. (2008). No significant effect of corn DDGS in feed mixture with or without the enzyme supplementation on meat colour was noticed by Wang et al. (2009). The present results and those mentioned above indicate that dietary corn DDGS had no detrimental effect on meat colour characteristics.

The main part of pork meat is available for consumers in processed form (sausages, canned meat, smoked meat, etc.) rather than as fresh meat. Traits important during meat processing and storage are water holding capacity and TBA-RS indexes. TBA-RS index provides useful information about the unfavourable oxidative changes in fat. The susceptibility of lipids to oxidation increases with their unsaturation degree and this is the main reason for undesirable changes in meat shelf life, colour and rancidity. In the study of Wang et al. (2009) meat from pigs receiving dietary DDGS was characterized by lower water holding capacity and firmness, while the addition of enzyme preparation increased both of these parameters, but the differences were not significant. In the present experiment inclusion of corn DDGS, rich in unsaturated fatty acids, did not significantly affect the TBA-RS content in meat. These findings demonstrated that feeding pigs with 15–20% DDGS had no detrimental effect on the shelf life of meat. These results remain in agreement with the observations of Lee et al. (2011), Whitney et al. (2006) and Xu et al. (2010 b) who showed no negative effect of corn DDGS inclusion on pork fat quality. In contrast, Cromwell et al. (2011) and Benz et al. (2010) noticed softer and more flexible fat, characterized by much too high iodine value in pigs fed a diet with increasing corn

DDGS content. The results cited above indicate the need to investigate the influence of high amounts of corn DDGS fed to pigs on meat and fat quality.

In conclusion, it can be stated that corn DDGS, in amounts of 15% in grower and 20% in finisher diet, does not significantly worsen the fattening performance and indices of carcass and meat quality. Supplementing feed mixtures containing corn DDGS, with NSP-hydrolyzing enzymes tends to improve the fattening results and the weight of major cuts in carcass. The corn DDGS content in grower-finisher diet does not negatively affect the traits important for meat processing and shelf life.

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Wpływ DDGS z kukurydzy w mieszankach z udziałem enzymów hydrolizujących NSP na wyniki tuczu, cechy półtuszy oraz jakość mięsa świń

STRESZCZENIE

W doświadczeniu przeprowadzonym na 48 tucznikach badano wpływ mieszanek zwierających DDGS z kukurydzy oraz dodatek enzymów paszowych NSP na wyniki tuczu oraz jakość mięsa. Grupę I (kontrolną) żywiono standardową zbożowo-sojową mieszanką paszową; grupę II mieszanką z 15% (grower) lub 20% (finiszer) udziałem DDGS z kukurydzy, bez dodatku enzymów paszowych, natomiast grupę III mieszanką z 15% (grower) lub 20% (finiszer) udziałem DDGS z kukurydzy oraz dodatkiem 200g/t enzymów paszowych. Stosowane mieszanki charakteryzowały się zbliżonym poziomem energii metabolicznej oraz białka. Tucz doświadczalny prowadzono od 30 do 112 kg masy ciała zwierząt. Po zakończeniu doświadczenia wszystkie zwierzęta ubito, prawe półtusze poddano dysekcji oraz pobrano próbki mięśnia *longissimus* do analiz. Na podstawie wyników doświadczenia stwierdzono, że wprowadzenie do mieszanek paszowych DDGS z kukurydzy nie wpłynęło istotnie na przebieg tuczu oraz jakość tuszy i mięsa. U zwierząt żywionych mieszankami zawierającymi DDGS z kukurydzy oraz dodatek enzymów hydrolizujących NSP obserwowano tendencję do poprawy wskaźników tuczu, a tusze tych zwierząt charakteryzowały się nieco cieńszą słoniną oraz większą masą wyrębów podstawowych.