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EFFECT OF HIGH LEVELS DISTILLERS DRIED GRAINS WITH SOLUBLES IN PERFORMANCE OF FATTENING PIGS

D. KANEV[1], R. NEDEVA[1], S. IVANOVA[1] and B. SZOSTAK[2]
[1] *Agrarian Academy, Agricultural institutte – Shumen, BG - 9700, Shumen, Bulgaria*
[2]*University of Life Sciences in Lublin, Institute of Animal Nutrition and Bromatology, Faculty of Biology and Animal Breeding, 22-950 Lublin, Poland*

Abstract

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The aim of the experiment was to investigate effect of high levels of wheat Distillers Dried Grains with Solubles (wDDGS), waste of fermented wheat grains, used as a source of protein in the compound feed of fattening pigs. A scientific experiment with total 21 pigs from Danube White breed was carried out. The experiment started at 30 kg of live weight (LW) and lasted till animals reached 110 kg LW. Animals were housed individually and fed *at libitum*. They were allocated to three treatments at 7 animals. First treatment was control (CT). During the growing period, second treatment (ST) and third treatment (TT) – experimental groups were fed by the compound feed containing 300 $g.kg^{-1}$ wDDGS, replacement of bigger part of soybean meal in the diet. During the fattening period, experimental groups were fed by the compound feed diets containing 133.0 $g.kg^{-1}$ wDDGS, replacement of 1000 $g.kg^{-1}$ of soybean meal. In the TT enzyme complex, consisted of endo-1,4-beta-glucanase, endo-1,4-beta-xylanase, endo-1,3(4)-beta-glucanase and lipase, was added. Protein, lysine, calcium and phosphorus were in the same amounts for all three treatments. It was concluded inclusion of 300 $g.kg^{-1}$ wDDGS as a replacement of soybean meal in the compound feed of growing pigs from 30 to 70 kg LW caused a reduction of the average daily gain (ADG) by 250 $g.kg^{-1}$ ($P < 0.05$) in ST and by 230 $g.kg^{-1}$ ($P < 0.01$) in TT in comparison to CT. Feed conversion ratio (FCR) has been decreased by 280 $g.kg^{-1}$ ($P < 0.01$) in ST and by 250 $g.kg^{-1}$ ($P < 0.01$) in TT in comparison to CT. Enzyme inclusion had no effect on ADG and FCR.

Keywords: fattening pigs, wDDGS, enzymes

List of Abbreviations: wDDGS – wheat Distillers Dried Grains with Solubles; LW – live weight; CT – control treatment; ST – second treatment; TT – third treatment; ADG – average daily gain; FCR – feed conversion ratio

Introduction

Many publications have reported part of soybean meal could be replaced by DDGS as an alternative source of protein in diets of growing pigs maintaining their productivity. In world practice DDGS is widely used for feeding pigs (Shurson et al., 2004). Stein and Shurson (2009) concluded that DDGS could be included up to 300 $g.kg^{-1}$ in the diets of growing pigs in all stages of growth, without having a negative effect on their productivity. The same conclusion reached Widmer et al. (2008) by adding 200 $g.kg^{-1}$ of the waste product in the diets. In the same time Linneen et al. (2008) reported the distillery residue could be included in the diets from 100 to 150 $g.kg^{-1}$ as the higher levels leaded to lower growth.

Distillers dried waste product is used more frequently in the feeding of growing pigs in Bulgaria, but its impact on the productivity and welfare of growing pigs is not studied. According to differences reported by the authors, it is necessary to carry out comprehensive studies for identification of its most rational use.

The aim of the experiment was to investigate the effect of high levels of distillers dried waste product with liquid fraction of fermented wheat grains (wheat distillers dried grains

E-mail: Dido.Kanev@gmail.com

with solubles - wDDGS), used as a source of protein in the fattening pigs diets.

Materials and Methods

The experiment was carried out in Experimental farm of Agricultural Institute - Shumen. A total of 21 pigs originated from Danube White Breed were randomly allocated to three groups (one control and two experimental), each containing of 7 animals. The experiment was divided in two sub periods, with growing period starting at 30 kg live weight and ended at about 70 kg live weight and fattening period starting at 70 kg live weight and ended at about 110 kg live weight. Animals were housed individually and fed *at libitum*. Water was available trough nipple drinkers.

Pigs were evenly distributed to one of the following treatments (Table 1). First treatment was control (CT). During the growing period, second treatment (ST) and third treatment (TT) – experimental groups were fed by diets containing 300 g.kg^{-1} wDDGS, replacement of bigger part of soybean meal in the diet. During the fattening period, experimental groups were fed by diets containing 133.0 g.kg^{-1} wDDGS, replacement of 100% of soybean meal according to protein equilibrium. In the TT 0.175 g.kg^{-1} enzyme supplement *Hostazim suis* was included in the compound feed. The enzyme feed supplement consisted of endo-1,4-β-glucanase (EC 3.2.1.4), produced by strain Trichoderma longibrachiatum (IMI SD 135) having a minimum activity of 2000 CU/g and containing pentosanase, hemicellulase, α-amylase and protease as accompanying enzymes. Protein, lysine, calcium and phosphorus were in the same amounts for all three treatments.

A chemical analyses of water, dry matter, crude protein, amino acids, crude fat, crude fibre, calcium, phosphorus and NFE of each component and each of the three compound feeds according to the three treatments as a wholes were made.

Statistical analysis of the data was performed using RK-Ward 0.6.1 statistical software. The effect of wDDGS was evaluated through one-way ANOVA and linear regression. Comparisons between treatments were done by t-test, as differences bellow 0.05 were considered significant.

Table 1
Trial scheme

Items, g.kg^{-1}	Groups		
	1	2	3
I subperiods (30 - 70 kg l.w.)			
Soybean meal	230.0	30.0	30.0
wDDGS*	0.00	300.0	300.0
Enzyme complex	0.00	0.00	0.175
II subperiods (70 - 110 kg l.w.)			
Soybean meal	41.3	0.00	0.00
wDDGS*	0.00	133.0	133.0
Enzyme complex	0.00	0.00	0.175

*wDDGS - wheat Distillers Dried Grains with Solubles

Results and Discussion

The component composition and content of nutrients and energy in 1 kg of compound feed at different subperiods – growing and fattening, are presented in Tables 2 and 3.

Pigs of the three treatments were fed by compound feed with the same components except for wDDGS and enzyme

Table 2
Ration specification at 30 to 70 kg live weight

Components, g.kg^{-1}	Groups		
	1	2	3
Maize	387.5	314.1	313.9
Barley	320.0	290.0	290.0
Soybean meal	230.0	30.0	30.0
Sunflower meal	40.0	40.0	40.0
wDDGS*	0.00	300.0	300.0
Synthetic lysine (98,5 g.kg^{-1})	0.7	3.7	3.7
Premix	5.0	5.0	5.0
Limestone	4.7	9.0	9.0
Dicalcium Phosphate	9.1	5.2	5.2
Enzyme complex (*Hostazim suis*)	0.00	0.00	0.175
NaCl	3.0	3.0	3.0
All	1000.0	1000.0	1000.0
Content in 1 kg of compound feed:			
Metabolizable energy, kcal	2903	3113	3113
Crude protein, g.kg^{-1}	180.3	180.0	180.0
Lysine, g.kg^{-1}	9.5	9.5	9.5
Methionine + cystine, g.kg^{-1}	6.6	7.0	7.0
Threonine, g.kg^{-1}	6.8	5.5	5.5
Tryptophan, g.kg^{-1}	2.3	2.1	2.1
Crude fibre, g.kg^{-1}	53.0	66.2	66.2
Fat, g.kg^{-1}	24.3	36.2	36.2
Ca, g.kg^{-1}	6.0	6.0	6.0
P, g.kg^{-1}	5.0	5.0	5.0

*wDDGS - wheat Distillers Dried Grains with Solubles

supplement - as it is shown in the scheme of the experiment. Produced by alcoholic fermentation and distillation of dried corn or wheat grains in Bulgaria waste product is characterized by good nutritional value. Its nutrient content excels repeatedly the initial feedstuff (Kanev and Stanchev, 2009) wDDGS contains less lysine, threonine and tryptophan compared to soybean meal, which reflected in the content of these amino acids in the compound feed. The amount of crude fiber and fat in the compound feed of experimental animals was higher, due to the inclusion of wDDGS. In this regard, in the TT the enzyme supplement *Hostazim Suisse* was included.

Throughout the experimental period, pigs from the three groups have similar feed intake and intake of nutrient crude protein and lysine. Methionine + cystine were 7% higher in the experimental groups (Table 6). Animals from the ST and TT had a little higher (about 4%) metabolizable energy intake. This was due to the adopted larger amounts of fat (34.48%), according to addition of wDDGS. For the same reasons, threonine intake was smaller by 14.29%, and tryptophan intake by 20.00% in both treatments (ST and TT).

Table 4 shows the results of the pig performance during the first growing period. Average daily gain of pigs in CT was statistically significant by 25.25% ($P < 0.01$) and by 23.41% ($P < 0.05$) in comparison to ST and TT, respectively. Variation coefficient was in the range of C = 5.95 – 16.27 (in ST and CT, resp.). Replacement of big quantity of the soybean meal in the first sub period by 300 g.kg^{-1} wDDGS had a negative effect on the intensity of growth. However, inclusion of enzyme supplement in the compound feeds of TT have been neutralized at minimum this negative effect. Wang et al. (2009) found enzymes could partially alleviate the reduced absorption of nutrients and the reduced growth of pigs when diets with low

Table 3
Ration specification at 70 to 110 kg live weight

Components, g.kg^{-1}	Groups		
	1	2	3
Barley	638.5	546.8	54.68
Wheat	300.0	300.0	300.0
Soybean meal	41.3	0.00	0.00
wDDGS*	0.00	133.0	133.0
Synthetic lysine (98,5 g.kg^{-1})	1.4	1.9	1.9
Premix	5.0	5.0	5.0
Limestone	8.5	10.0	9.8
Dicalcium Phosphate	2.3	0.3	0.3
Enzyme complex (*Hostazim suis*)	0.00	0.00	0.175
NaCl	3.0	3.0	3.0
All	1000.0	1000.0	1000.0
Content in 1 kg of compound feed:			
Metabolizable energy, kcal	2923	2912	2912
Crude protein, g.kg^{-1}	132.0	132.0	132.1
Lysine, g.kg^{-1}	6.0	6.0	6.0
Methionine + cystine, g.kg^{-1}	4.7	5.0	5.0
Threonine, g.kg^{-1}	4.2	4.0	4.0
Tryptophan, g.kg^{-1}	1.6	1.2	1.2
Crude fibre, g.kg^{-1}	52.8	64.6	64.6
Fat, g.kg^{-1}	21.2	26.0	26.0
Ca, g.kg^{-1}	4.5	4.5	4.5
P, g.kg^{-1}	4.0	4.0	4.0

*wDDGS - wheat Distillers Dried Grains with Solubles

Table 4
Productive traits in pigs at 30 to 70 kg live weight

Traits	Groups		
	1	2	3
Feed intake, daily:			
Compound feed, kg	2.178	2.134	2.123
Dry matter, kg	1.845	1.842	1.833
ME*, kcal	6323	6643	6609
Crude protein, g	393.0	384.0	382.0
Lysine, g	21.0	20.0	20.0
Methionine+cystine, g	14.0	15.0	15.0
Threonine, g	15.0	12.0	12.0
Tryptophan, g	5.0	4.0	4.0
Crude fat, g	53.0	77.0	77.0
Live weight, kg			
- initially	30.714	30.857	30.714
- at the end	72.000	62.000	62.200
Average daily gain, kg			
x	0.598ab	0.447a	0.458b
%	100.00	74.75	76.59
Sx	0.037	0.011	0.024
C	16.27	5.95	11.72
Feed conversion ration:			
Compound feed, kg	3.732ac	4.789a	4.680c
%	100.00	128.32	125.40
ME*, kcal	10833	14907	14570
Crude protein, g	673.0	862.0	842.0
Lysine, g	35.0	45.0	44.0

*ME - metabolizable energy
a, c – P<0.01; b – P<0.05

food density containing corn, tapioca and DDGS were fed. Results showed TT pigs had higher growth by 1.84% than ST pigs. These results were similar to those of Kiarie et al. (2012) who found the addition of beta-glucanase and xylanase in diets of growing pigs, had been improved digestibility and had been increased an average daily gain. Results of Whitney et al. (2006) showed inclusion of 300 g.kg^{-1} DDGS in diets had been reduced the intensity of growth and feed utilization compared to diets based on soybean meal or included 100 g.kg^{-1} DDGS. Kees de Lange (2008) reported diets with DDGS contained more potassium, which reduced the growth ability of pigs and leaded to accumulation of calcium salts in their kidneys. However, McDonnell et al. (2011) concluded the inclusion of 300 g.kg^{-1} DDGS had no negative effect on pig's growth if diets had been balanced in net energy and ileal digestibility of amino acids.

Statistically significant differences in feed conversion ratio were observed in the first sub period (Table 4). It was higher by 28.32% ($P < 0.05$) and 25.40% ($P < 0.05$) respectively in pigs ST and TT pigs fed with wDDGS. Accordingly, the utilization of metabolizable energy, protein and lysine were improved in the animals of the control treatment.

In the second sub period, a radical change in the intensity of growth and feed conversion ratio was found (Table 5). Pigs in the both treated groups had a higher average daily gain by 6.20% (for ST) and 3.84% (for TT), and lower feed conversion ratio by 4.46% and 2.56% respectively in comparison to CT. It seems that the decrease in the content of wDDGS to 133.0 g.kg^{-1} in the compound feeds during the fattening period had positive effect on the performance of pigs. This result could be due to the smaller differences in the amounts of threonine in the compound feeds between control and experimental treatment. It is also possible, better growth rate of ST and TT during the fattening phase to be due to the manifestation of a compensation effect in growth in this period.

Table 5
Productive traits in pigs at 70 to 110 kg live weight

Traits	Groups		
	1	2	3
Feed intake, daily:			
Compound feed, kg	3.007	3.024	3.035
Dry matter, kg	2.601	2.641	2.632
ME*, kcal	8789	8806	8838
Crude protein, g	397.0	399.0	401.0
Lysine, g	18.0	18.0	18.0
Methionine+cystine, g	14.0	15.0	15.0
Threonine, g	13.0	12.0	12.0
Tryptophan, g	5.0	4.0	4.0
Crude fat, g	64.0	79.0	79.0
Live weight, kg			
- initially	72.000	62.000	62.2
- at the end	110.857	110.500	111.400
Average daily gain, kg			
x	0.677	0.719	0.703
%	100.00	106.20	103.84
Sx	0.013	0.035	0.024
C	5.19	11.86	7.68
Feed conversion ration:			
Compound feed, kg	4.454	4.26	4.34
%	100.00	95.64	97.44
ME*, kcal	13019	12407	12638
Crude protein, g	588.0	562.0	573.0
Lysine, g	27.0	26.0	26.0

*ME - metabolizable energy

Table 6
Productive traits in pigs at 30 to 110 kg live weight

Traits	Groups		
	1	2	3
Feed intake, daily			
Compound feed, kg	2.539	2.575	2.582
Dry matter, kg	2.175	2.228	2.235
ME*, kcal	7398	7714	7731
Crude protein, g	393.0	392.0	391.0
Lysine, g	19.0	19.0	19.0
Methionine+cystine, g	14.0	15.0	15.0
Threonine, g	14.0	12.0	12.0
Tryptophan, g	5.0	4.0	4.03
Crude fat, g	58.0	78.0	78.0
Live weight, kg			
- initially	30.714	30.857	30.714
- at the end	110.857	110.500	111.400
Average daily gain, kg			
x	637ab	581a	581b
%	100.00	91.21	91.21
Sx	0.018	0.020	0.010
C	7.31	8.45	4.03
Feed conversion ration			
Compound feed, kg	3.987bc	4.463b	4.447c
%	100.00	111.94	111.54
ME*, kcal	11616	13370	13315
Crude protein, g	617.0	678.0	674.0
Lysine, g	30.0	33.0	33.0

*ME - metabolizable energy
a – P=0.059; b – P<0.05; c – P=0.001

In previous studies the inclusion of similar quantities of DDGS at levels 100 g.kg^{-1} and 200 g.kg^{-1} in the compound feeds, had no statistically significant effect on feed intake and feed conversion ratio, growth performance and the price of the compound feed for 1 kg average daily gain in growing pigs from 35 to 110 kg live weight (Kanev, 2008).

During the entire experimental period CT pigs had a higher average daily gain compared to the experimental treatments by 8.79% ($P = 0.059$ for ST and $P < 0.05$ for TT) (Table 6). Feed conversion ratio, metabolizible energy and nutrients correspond to the growth performance of animals. Feed conversion ration was better in CT pigs by 11.94% ($P < 0.05$) compared to ST and by 11.54% ($P < 0.001$) compared to TT pigs. Our results were in the same line to those of O'Shea et al. (2014), which found the inclusion of a similar enzyme based on rapeseed meal and wDDGS in the compound feed had no effect on the intensity of growth of fattened pigs.

Conclusions

Inclusion of 300 g.kg^{-1} wheat distillers dry grains with soluble food (wDDGS) as a replacement of soybean meal in the compound feeds of growing pigs from 30 to 70 kg LW causes a reduction of the growth performance by 25.00% ($P < 0.05$) and 23.00% ($P < 0.01$) and an increase of FCR by 28.00% and 25.00% ($P < 0.01$), respectively in wDDGS (ST) and wDDGS+E (TT) treatment.

Inclusion of the enzyme supplement endo-1,4-β-glucanase and pentosanase, hemicellulase, α-amylase and protease together with 300 g.kg^{-1} wDDGS had no significant effect on growth performance and FCR in pigs from 30 to 70 kg live weight.

Full replacement of soybean meal by wDDGS in the compound feed of fattening pigs from 70 to 110 kg live weight trended to increase ADG by 4-6% and to decrease the feed conversion ratio by 3-4%.

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