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EFFICIENCY OF MULTIENZYME COMPOSITION IN THE TRITICALE BASED DIETS FOR PIGS

Summary of doctoral dissertation
Biomedical sciences, zootechny (13 B)

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LIETUVOS VETERINARIJOS AKADEMIJA

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MULTIENZIMINĖS KOMPOZICIJOS EFEKTYVUMAS KIAULIŲ RACIONUOSE SU DIDESNIU KVIETRUGIŲ KIEKIU

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INTRODUCTION

The areas for under triticale growing are rapidly increasing with the increasing possibilities of triticale use in Lithuania. Triticale is a valuable grain feed for fattening pigs. If compared with other cereal crops (barley, wheat, rye, oats), triticale has higher energy value (13.0–13.5 MJ/kg), more protein (11.7–13%) and less fibre (2.0–2.5%). However, triticale grains contain antinutritional compounds (such as non–starch polysaccharides, bitter glucosides, etc.) that depress the digestive process and nutrient assimilation and what often leads to lower weight gains and poorer carcass quality. Especially when pig diets are compared of higher amounts (over 50–60%) of triticale. Other authors indicate that triticale in the diets of pigs may account for even up to 60–85%, and that this amount has no negative influence on pig growth and the quality of carcass and meat. Trials with the crops congeneric to triticale such as rye and wheat indicated that hard degradable anti–nutritional compounds can be partly hydrolized using enzymes – carbohydrases. However, there are no sufficient data as regards the efficacy of a specific enzyme composition and its content in triticale based diets used to fatten pigs till their slaughter weight. Lately, special attention is paid to meat quality, but lock of comprehensive studies makes it difficult to describe the effects of various enzymatic compositions on the quality indicators of carcass, meat and backfat.

The purpose and aims of the study. The purpose of the study was to investigate the possibilities of the use of multienzyme composition containing for xylanase – 1800 U/g, β–glucanase –700 U/g, α–amylase –70 U/g, protease –0,8 U/g in the triticale based diets for fattening pigs.

Alongside with this purpose, the following tasks had to be fulfilled:

1. to determine the effects of different amounts of multienzyme composition in the diets of pigs on the intensity of pig growth, food intake;
2. nutrient digestibility;
3. carcass quality;
4. meat quality;
5. quality of intramuscular fat;
6. backfat quality;
7. economic indicators
8. to determine the optimum level of the multienzyme composition in triticale based diets for pigs on the basis of the research data.

Novelty of the Research. The multienzyme composition composed of xylanase (1800 U/g), β–glucanase (700 U/g), α–amylase (70 U/g) and protease – (0.8 U/g) enzymes has been investigated alongside with its usage possibilities in triticale based (60–70%) pig diets. Such investigation has been carried out in Lithuania for the first time.

The effects of different amounts of multienzyme composition on the growth rate of pigs, nutrient digestibility and meat quality have been determined.

The effects of different amounts of multienzyme composition on pig performance during the whole fattening peri have been investigated.

The most suitable amount of multienzyme composition in triticale based (60–70%) pig diets has been determined.

Practical Meaning of the Study. The use of enzymes or their compositions in the diets of pigs allons to improve the growth of pigs and their feed conversion, also to lower the costs of pig growing without worsening the quality of carcass meat and backfat. The trial data is available to feed manufactures, pig breeders and other specialists of animal production.

MATERIALS AND METHODS

In 2004–2005, two trials with German x Norwegian Landrace crossbred pigs were carried out at the Institute of Animal Science of the Lithuanian Veterinary Academy. The experimental design is presented in Table 1. The groups of 14 pigs each were used in Trial 1 and four groups of 10 pigs each were used in Trial 2. The pigs were allotted into the groups by the principle of analogues according to their parentage, age, weight and gender. In both trials the initial weight of pigs was 30 kg. The finish weight was from 100 to 115 kg. In both trials the pigs were fed twice daily with wet compound feed prepared according to the feeds and supplements available on farm and the recommended standards (Jatkauskas et al., 2002; Animal production reference book, 2007). Different amounts of the multienzyme composition were gradually mixed into the feeds. During the feed preparation, the above mentioned supplements were first mixed into smaller amounts of feeds (5–7 kg), and later they obtained mixture was gradually introduced into lager (100 kg and 400 kg) amounts of feeds.

State of pig health. In the trials the health state of all pigs has been observed health problems recorded and analysed, all veterinary medication recorded, too.

Growth rate of pigs. The growth rate of pigs was determined by individual weighing at the start of the trial, every month and at the end of the trial. The pigs were weighed before their feeding in the morning. The analysis of the weighing data indicated total and average daily gains in different months, periods and during the whole treatment.

Table 1. **Experiments design**

Groups	No. of pigs	Amount of triticale in the compound feed, %		Addition of multienzyme composition „Vilzim MR”	
		Weight of pigs kg			
		30–60 kg	over 60 kg	g/kg	%
I trial					
I	14	60	70	–	–
II	14	60	70	0,35	0,035
III	14	60	70	0,50	0,050
II trial					
I	10	60	70	–	–
II	10	60	70	0,75	0,075
III	10	60	70	1,00	0,100
IV	10	60	70	1,25	0,125

Food consumption. Feeds allotted for each separate pen were weighed individually every day before feeding. The amount of given feed was daily regulated with the aim to have no remains until the next feeding.

Chemical composition of feeds. Feed samples were taken for analysis once a month (Pašarų tyrimo metodai, 2003) and analysed at the Analytical Laboratory of the LVA Institute of Animal Science. The feeds were analysed for: dry matter, crude protein, crude fat, crude fibre, crude ash, calcium, phosphorus according to the standard methods (AOAC, 1990a), organic matter, by subtracting the content of crude ash from the content of dry matter, nitrogen–free extracts (NFE) by subtracting the contents of crude protein, crude fat and crude fiber from the content of organic matter, amino acids by the method of effective liquid chromotography (*Shimadzu*). The level of metabolizable energy (MJ/kg) was calculated by the chemical composition of feeds and digestibility coefficients found in the literature (Jeroch et al. 2004).

Feed digestibility. During the trials when the pigs gained 60–70 kg weight, nutrient digestibility was determined by the classic *in vivo* method (Томмэ, 1969) according to the scheme presented in Table 2. From this purpose, three castrates from every group in Trial 1 and from control, group 3 and group 4 in Trial 2 were selected by the analogue principle and placed into special individual pens. The length of preparatory period was 6 and that of the recording period – 5 days. During the experimental period both feeds given to each individual animal and the excrements were weighed individually. Also feed samples from every group were collected and analysed.

Table 2. **Nutrient digestibility trials design**

Trial	Groups	No. of pigs	Main components of compounds feed	Addition of multienzyme composition "Vilzim MR"	
				g/t	%
I	I	3	Triticale 60–70%	–	–
	II	3		350	0,035
	III	3		500	0,050
II	I	3	Triticale 60–70%	–	–
	III	3		1000	0,100
	IV	3		1250	0,125

The chemical composition of the feed samples and theexcrements was analysed for the dry matter (DM), crude protein (CP), crude fat (CF_{at}), crude fibre (CF_{ibre}) and crude ash (CA) contents. Organic matter (OM) and nitrogen– free extracts (NFE) were computed respectively by the formulas OM= DM – CA and NFE= OM – CP – CF_{at} – CF_{ibre}. Nutrient digestibility coefficients were computed by the formula:

$$DC = \frac{(A - B) \times 100}{A}$$

DC – digestibility coefficient (%); A – nutrient intake (kg); B – amount of excreted nutrients (kg).

Chemical composition of feeds and excrements. Feed and excrements were analysed at the Analytical Laboratory of the LVA Institute of Animal Science for the content of: dry matter, crude protein, crude fat, crude fibre, crude ash according to the standard methods (AOAC, 1990a), organic matter by subtracting the content of crude ash from the content of dry matter and nitrogen–free extracts (NFE) by subtracting the contents of crude protein, crude fat and crude fibber from the content of organic matter.

Carcass quality. Control slaughtering of pigs was performed at the end of the trial. Pig carcasses were evaluated by the rules approved in 2003 regarding production control of breeding pigs, assessment, information collection and distribution. Lean meat content of carcasses was also determined for all groups of pigs according to the regulations approved in 2001 for pig estimation by the weight and quality of the carcasses.

Physicochemical indicators of meat and backfat. Thre pigs were selected on analogous principles from each group for the assessment of meat and backfat quality at control slaughtering. Samples of (*M.longisimus dorssi*) (600 g) and backfat (100 g) were taken from each pig for physico–chemical analysis. The samples were analysed at the Analytical Laboratory for the LVA Institute of Animal Science for chemical composition of meat (dry matter, crude protein, crude fat, crude ash according to standard methods (AOAC, 1990 a.); tryptophan – by the method of E. Miller using, p–dimethylamine benzaldehide (Miller, 1967); oxyproline – by the method of I. Spize and D. Chambers (Методические рекомендации, 1977); meat pH – by the potentiometer method using laboratory pH–meter (Методические рекомендации, 1977); water holding capacity – by the method of R. Grau and R. Hamm described by G. Gumeniuk and N. Tcherkasskaya (Гуменюк, Черкасская, 1977); cooking losses by the method of E. Shilling (Методические рекомендации, 1977); colour intensity – by the method of Hornsy (Методические рекомендации, 1977); fat melting temperature – by capillar method (Методические рекомендации, 1977); backfat hydrolysis number – by the standard method (AOAC, 1990b); fatty acid content in backfat and meat fat– by the method of Folch et al. (1957). Methyl esters of fatty acids were produced by the method of Christopherson Gloss (1969). Methyl esters of fatty acids were identified by the gas chromatograph *"Shimadzu GC2010"* with the flame ionization detector.

Economic indicators. The main economic indicators were estimated at the end of the trial. The price (LTL) per one tonne of feeds was calculated by adding up individual prices for feedstuffs and supplements. The price (LTL) per kg weight gain was calculated by dividing the price of feeds from the trial weight gain of pigs in separate groups. The price (LTL) of feeds per growing one pig was calculated by dividing the price of feeds from the number of pigs in separate groups. All the calculations were done with regard to the most efficient dosage of multienzyme composition and the consumption of feeds and enzymatic preparations.

Statistical data analysis. The research data were processed with R–statistical package (Version 1.8.1 ISBN 3–900051–00–3) for computing arithmetic mean ($\bar{x}$), root–mean–square deviation (SD), standard error (±SE), significance of difference between the groups by Stjudent‘s criteria (t), degree of significance (P). Significance of difference between the small groups (n=3) was additionally evaluated by non parametrical Mann–Whitney–Wilcoxon‘s sum rating criteria.

RESULTS

Effect of multienzyme composition on pig growth. Trial has lasted for 114 days. The pig growth data during Trial 1 are presented in Table 3. At the start of the trial, the weight of the pigs in all groups was almost the same. The pigs in Group 2 fed compound feed containing 60 and 70% triticale, respectively, at the growing (up to 60 kg weight), and finishing (over 60 kg weight) periods and supplemented with 0.035% of multienzyme composition gained weight similary as the control pigs fed triticale based diets without enzymatic supplementation (P>0.4–0.5). Feeding of pigs with triticale based diets with 0.05% multienzyme composition supplementation showed a tendency towards higher weight gains. At the growing and finishing periods, pigs in Group 3 gained daily on the awerage 12.7% (P>0.1) and 9.4% (0,1>P>0,05) more than the control pigs. However, the differences were statistically insignificant. During the whole trial, daily gains of the pigs in Group 3 were 11% higher (P<0.05) than those of the control pigs. The efficiency of 0.05% multienzyme composition in the diet of Group 3 pigs was especially displayed at the early period of growth (from 30 to 40 kg weight) when the average daily gain was 682 g or 18% (P<0.05) higher than that of control pigs (578 g) fed triticale without enzymatic supplementation. This weight has resulted in better growth of Group 3 during the whole experimental period.

Table 3. **Growth rate of pigs** (I trial)

Item	Groups		
	I (n=14)	II (n=14)	III (n=14)
	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE
Weight of pigs, kg			
At the start	30,5±1,25	30,4±0,99	31,0±0,96
At the end	102,3±3,02	104,7±2,02	105,1±2,31
Average daily gain, g			
At 3–5 months of age	615±38,80	601±24,05	693±18,85
At 5–7 months of age	693±49,09	709±29,73	758±28,82
During the trial	648±37,42	655±13,54	719±17,43*
Compared with control group: *P<0.05 – Stjudent‘s test.			

The length of Trial 2 was 98 days. The results of pig growth during Trial 2 are presented in Table 4. Supplementation of triticale (60%) based diets with 0.075% and 0.1% of multienzyme composition did not result in any higher weight gains at the growing period (up to 50 kg weight) compared with the control pigs fed triticale without enzymatic supplementation (P>0.5). However, a tendency towards lower weight gains was observed with 0.125% multienzyme composition supplementation of the diet for the pigs in Group 4. The average daily weight gains of the pigs in Group 4 were 13.8% (P>0.1) lower than those of the control pigs, but the differences were statistically insignificant.

Table 4. **Growth rate of pigs** (II trial)

Item	Groups			
	I (n=10)	II (n=10)	III (n=10)	IV (n=10)
	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE
Weight of pigs, kg				
At the start	27,4±1,81	28,2±1,96	28,4±1,63	27,9±1,72
At the end	111,8±2,45	104,0±2,20*	108,7±2,77	108,4±2,39
Average daily gain, g				
At 3–5 months of age	832±57,17	778±59,22	853±63,28	717±37,48
At 5–7 months of age	892±33,81	863±28,15	937±31,58	966±33,72
During the trial	877±37,46	837±33,01	911±32,54	884±30,51

Weight gains of the pigs in the finishing period (over 50 kg weight) fed 70% triticale based diets supplemented with 0.075% of multienzyme composition did not differ significantly if compared with the control pigs. A tendency towards higher weight gains was observed when the diets of pigs were supplemented 0.1% and 0.125% of multienzyme composition. In the finishing period, daily weight gains of the pigs in Groups 3 and 4 were, respectively, by 5 (P>0,4) and 8.3% (P>0.1) higher if compared with the control pigs, though the differences were insignificant. Thus, supplementation of the diet with the highest dose (0.125%) of multienzyme composition resulted in the highest weight gains for pigs in Group 4. During the whole experimental period, there were almost no differences for the weight gains between the control and experimental pigs. However, the results from the trials showed that the weight gain of the pigs in Group 2 fed 0.075% multienzyme composition was 7% (P<0,05) lower at the end of the trial in comparison with the control group. To sum up, the results from the two trials indicate that 60–70% triticale diet supplementation with 0.05% multienzyme composition was most efficient.

Effect of multienzyme composition on food consumption. In Trial 1, the lowest food consumption per kg gain was determined for the pigs in Group 3 that were fed triticale based diet with 0.05% multienzyme composition. Food consumption per kg gain in this group was 3.4, 6.7, and 7% lower in, respectively, growing, finishing and the whole experimental period if compared with the control group of pigs fed the diet without enzymatic supplementation. 0.035% multienzyme composition supplementation of the diet for pigs in Group 2 did not result in any food consumption changes if compared with the control group in the growing period. However, in the finishing period, food consumption per kg gain for the pigs in Group 2 was 6.3% lower and during the whole experimental period – 2.5% lower than that of the pigs in the control group. In Trial 1, the highest food consumption was also determined for the pigs in Group 3 fed 0.05% multienzyme composition. The pigs in Group 3 consumed daily 8.8, 5.6 and 4.8% more feeds in, respectively, growing, finishing and whole experimental periods than the control pigs. When the triticale based diet was supplemented with 0.035% of multienzyme composition, the daily consumption of feeds was similar to that of the control group.

In Trial 2, in the growing period, the highest food consumption per kg was determined for Group 4 pigs fed 60–70% triticale diets supplemented with 0.125% multienzyme composition. Food consumption per kg gain for Group 4 was 6.7% higher in comparison with the control pigs. When the multienzyme composition doses in the diets were 0.075 and 0.1% for, respectively, Group 2 and 3, the pigs in these groups also consumed 2.7% more feeds per kg gain than the control pigs. In the finishing and the whole experimental periods, pig fed diets containing 0.075% multienzyme composition consumed almost the same amount of feeds per kg gain as the control pigs. Diet supplementation with 0.1% and 0.125% multienzyme composition resulted in, respectively, 3.1 and 5.1% lower food consumption per kg gain in the finishing period and 2.6 and 1.9% lower consumption in the whole experimental period. It can be seen from Table 10 that the lowest food consumption was in Groups 2 and 4 with, respectively, 0.075 and 0,125% of multienzyme composition supplementation. The daily food consumption of the pigs in Group 2 and 4 was, respectively, 4.3 and even 8.6% lower than that of the control pigs. The pigs in Group 3 fed the diet supplemented with 0.1% multienzyme composition consumed daily 5.4% more feeds than the control pigs. In the finishing and the whole experimental periods lower daily food intake was also determined in Group 2 fed 0.075% multienzyme composition. The pigs in this group consumed daily 4.9 and 5.5% less feed than the control pigs in, respectively, finishing and whole experimental periods. 0.1 and 0.125% supplementation of the diets with multienzyme composition resulted in respectively 1.6 and 2.6% higher food consumption in the finishing period. However, in the whole experimental period there were almost no differences for the food intake between the control and experimental pigs in Groups 3 and 4.

The both trials indicated that the best feed consumption per kg gain results were obtained when the triticale based diets were supplemented with 0.05% multienzyme composition.

Effect of multienzyme composition on nutrient digestibility. In Trial 1, supplementation of triticale based diet with 0.05% multienzyme composition, showed a tendency towards better digestibility of protein, fat and fibre. The pigs in Group 3 digested protein, fat and fibre, respectively, 2.3 (P>0.2), 8.4 (P>0.4), and 13.8% (P>0.2) better, but the differences were insignificant. There were almost no differences for the digestibility of dry matter, organic matter and nitrogen–free extracts between the pigs of Group 3 and the control (P>0.5). 0.035% multienzyme composition supplementation of the diet has improved fat digestibility 19.7% (P<0.05), but the digestibilities of the other nutrients were not much different from those in the control groups (P>0.4–0.5).

In Trial 2, 60–70% triticale diet supplementation with 0.1% multienzyme composition had almost no influence on the digestibilities of dry and organic matter, protein, fat, fibre and nitogen–free extracts in comparison with the control group. 0.125% multienzyme composition supplementation of the showed a tendency towards improved digestibilities of dry matter, protein and fibre by, respectively 2 (P>0.2), 5.8 (P>0.1), and 4.1% (P>0.2) in comparison with the control group. However, the differences were statistically insignificant. The digestibilities of organic matter, fat and nitogen–free extracts in Group 4 were similar to those in the control group.

In conclusion, supplementation of the triticale besed diets with multienzyme composition has improved nutritient digestibility.

Effect of multienzyme composition on carcass quality. Control slaughter results from Trial 1 are presented in Table 5.

Table 5. **Control slaughter data** (I trial)

Item	Groups		
	I (n=14)	II (n=14)	III (n=14)
	$\bar{x} \pm SE$	$\bar{x} \pm SE$	$\bar{x} \pm SE$
Dreesin percentage, %	77,4±0,51	78,5±0,49	78,5±0,41
Lean meat, %	50,6±1,41	52,7±0,90	52,0±1,08
Backfat thickness, mm			
At withers	41,1±2,11	36,5±2,40	35,1±1,82*
At 6 th–7th rib	28,6±1,60	24,3±2,01	26,6±1,86
At last rib	20,3±1,37	16,1±0,83**	18,9±1,33
Ham weight, kg	9,32±0,45	9,95±0,51	10,15±0,59
Loin lean area, cm^2	59,9±1,74	63,8±2,57	62,5±2,46
Compared with control group: *P<0.05; **P<0.025 – Stjudent‘s t–test.			

Triticale based diet supplementation with 0.035 and 0.05% multienzyme composition had almost no influence on the dressing percentage, length of carcass and bacon half, ham weight and lean meat content compared with the control group (P>0.2–0.5; Table 5). The use of the multienzyme composition in the diets has lowered the backfat thickness. Backfat thickness of the pigs in Group 2 (0.035% multienzyme composition) 4.2 mm (P<0.025) lower at the last rib compared with the control group. Moreover, a tendency towards thinner backfat at withers and 6–7 ribs has been observed. In this case, backfat thickness at withers and 6–7 ribs was, respectively, 4.6 mm (P>0.2), and 4.3 mm (P>0.1) lower though the differences were not statistically significant in comparison with the control group. The backfat thickness of the pigs fed the diet with 0.05% multienzyme composition was 6 mm (P<0.05) lower at withers but the thickness at the 6–7 and the last ribs was similar to that of the control pigs (1.4–2 mm; P>0.4–0.5). There was a tendency observed for by 2.6–3.9 cm^2 (P>0.2) greater lain lean area when the pigs were fed the diets supplemented with 0.035 and 0.05% multienzyme composition, but the differences were insignificant. According to the SEUROP classification system, the carcasses of the pigs fed triticale based diets supplemented with 0.035 and 0.05% multienzyme composition mostly corresponded to the U class requirements. The percentage of U class carcasses was 14.5 and 5.4% higher in, respectively, Group 2 and 3. In Groups 2 and 3, there were, respectively, 8.2 and even 17.3% more carcasses classified as corresponding to E class in comparison with the control group. Supplementation of the triticale based diets with the multienzyme composition reduced the percentage of R class carcasses by 22.7% in comparison with the control group.

Control slaughter data from Trial 2 are presented in Table 6. According to these data, there were no significant differences for the dressing percentage, the length of the carcass and bacon half, backfat thickness, ham weight and lain lean area between the control groups and Groups 2, 3 and 4 where the pigs were fed triticale 60–70% based diets supplemented with, respectively, 0.075, 0.1 and 0.125% multienzyme composition. The differences between the groups were statistically insignificant. The results from the trial indicated that supplementation of the diets with multienzyme composition had no significant influence on the lean meat percentage in the carcass. According to the SEUROP classification system, the carcasses of the pigs fed triticale based diets supplemented with 0.075 and 0.125% multienzyme composition mostly corresponded to U class requirements. The percentage of U class carcasses was 10 and even 30% (1.6 times) higher in, respectively, Group 2 and 4. In Group 3 (0.1% multienzyme composition), the percentage of U class carcasses was the same as in the control group, i.e.

50%. However, in Group 3 even 20% (twice) more carcasses corresponded to E class requirements compared with the control groups.

Table 6. **Control slaughter data** (II trial)

Item	Groups			
	I (n=10)	II (n=10)	III (n=10)	IV (n=10)
	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE
Dreesin percentage, %	77,1±0,31	77,0±0,59	77,8±0,34	76,6±0,37
Lean meat, %	54,9±1,63	55,3±0,98	55,8±1,44	53,7±0,62
Backfat thickness, mm:				
At withers	32,8±2,77	32,6±1,78	33,4±1,38	33,6±0,81
At 6 th–7th rib	22,4±2,93	21,3±1,45	22,2±1,62	20,9±1,36
At last rib	15,4±1,85	17,9±1,26	17,2±1,47	16,9±1,91
Ham weight, kg	11,00±0,17	10,90±0,22	10,94±0,32	10,82±0,21
Loin lean area cm^2	57,5±2,49	52,4±2,29	55,3±3,77	51,9±2,95

Hence, the carcasses of the pigs in Group 3 fed triticale based diets supplemented with 0.1% multienzyme composition were mostly classified as corresponding to E and U lean grading. When the triticale based diets for pigs were supplemented with the multienzyme composition, there were no carcasses, as opposed to the 10% carcasses in the control group, classified as R class carcasses.

To conclude, the results from the both trials indicate that supplementation of the triticale based diets with the multienzyme composition had no negative effect on the quality of the pig carcasses.

Effect of multienzyme composition on physicochemical indicators of meat and backfat. In Trial 1, there were no significant changes for the chemical composition of meat, pH–values, cooking losses, water holding capacity, colour intensity, backfat, melting temperature and hydrolysis number between the controlgroups and Groups 2 and 3 fed the diets supplemented, respectively, with 0.035 and 0.05% multienzyme composition (Table 7). Supplementation of the diet with the multienzyme composition had no negative effect on the biological value of meat. There were no significant changes for the contents of tryptophan and oxyproline in the meat of both control and experimental groups of pigs.

In Trial 1, 10 (C14:0–C20:0) and 11 (C14:0–C18:3) fatty acids in, respectively, intramuscular fat and backfat have been analysed. Intramuscular fat of the pigs in Groups 2 and 3 (0.035 and 0.05% multienzyme composition, respectively) contained 0.14% (P<0.01–0.05) more saturated miristic acid and 0.68–1.46% (P<0.025–0.05) more saturated

palmitic acid in comparison with the control group. The contents of the other fatty acids did not differ significantly in all groups. The data indicate that 0.05% multienzyme composition supplementation of the diet resulted in higher contents of saturated miristic (P<0.005) and monounsaturated palmitoleic acids (0.1>P>0.05) by, respectively, 0.18 and 0.54% in the backfat of pigs in comparison with the control group.

Table 7. **Physicochemical indicators for meat and fat** (I trial)

Item	Groups		
	I (n=3)	II (n=3)	III (n=3)
	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE
M. longissimus dorsi			
Dry matter, %	23,81±0,48	25,25±1,50	24,30±0,45
Crude protein, %	20,58±0,46	20,60±0,43	20,85±0,28
Crude fat, %	2,22±0,35	3,61±1,42	2,37±0,67
Crude ash, %	1,01±0,01	1,03±0,01	1,06±0,02[1]
Tryptophan:oxyprolin ratio	5,58	4,96	6,60
Meat pH	5,40±0,02	5,46±0,06	5,47±0,06
Water binding capacity, %	57,96±0,65	57,28±3,15	59,81±1,99
Cooking losses, %	43,62±0,42	43,77±1,31	41,92±0,82
Colour intensity, units	60,0±1,00	63,2±4,52	63,7±15,64
Fat			
Melting temperature, ^0C	37,50±1,32	35,49±2,50	41,08±1,24
Saponification number	17,92±0,23	18,16±0,07	18,10±0,13
Compared with control group: [1]P<0.05 – Mann–Whitney–Wilcoxon‘s criterion.			

In Trial 1, higher contents of the above mentioned acids (respectively 0.084 and 0.42%; P>0.1–0.2) were also observed in the backfat of the pigs in Group 2 fed the diets 0.035% multienzyme composition, however, the differences were statistically insignificant. The contents of the other backfat acids in Groups 2 and 3 did not differ significantly from those of the control group.

The data from Trial 2 indicated that 0.075% multienzyme composition supplementation of the triticale based diets did not change the contents of dry matter, protein and fat in the meat in comparison with the control group (Table 8). In Group 2, pH value of meat, cooking losses, backfat melting temperature and hydrolysis number did not differ significantly from those of the control group.

Table 8. **Physicochemical indicators for meat and fat** (II trial)

Item	Groups			
	I (n=3)	II (n=3)	III (n=3)	IV (n=3)
	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE	$\bar{x}$ ±SE
M. longissimus dorsi				
Dry matter, %	24,98±0,10	24,64±0,15	25,43±1,04	25,95±0,42
Crude protein, %	22,81±0,05	22,67±0,18	22,21±0,38′	23,01±0,57
Crude fat, %	1,13±0,14	0,81±0,18	2,16±0,73	1,69±0,48
Crude ash, %	1,01±0,01	1,05±0,01	1,06±0,02	1,06±0,02
Tryptphan:oxyprolin ratio	5,75	5,73	5,92	5,24
Meat pH	5,37±0,06	5,46±0,12	5,39±0,07	5,35±0,01
Water binding capacity ,%	62,89±0,22	59,07±2,18	57,97 ±0,38*****[1]	57,94 ±0,57*****[1]
Cooking losses, %	43,84±0,51	41,57±2,23	44,17±0,80	43,03±2,45
Colour intensity, units	80,7±6,50	61,5±5,27	68,0±6,54	60,3±1,64**[1]
Fat				
Melting temperature, ^{0}C	38,41±0,88	38,91±1,05	39,71±0,88	39,22±1,54
Saponification number	18,74±0,58	18,80±0,71	18,85±0,39	19,23±0,43

Compared with control group:
**P<0.025; *****P<0,001 – Stjudent‘s t–test;
[1]P<0.05 – Mann–Whitney–Wilcoxon‘s criterion.

However, there was a tendency observed that the ash content increased and water holding capacity and colour intensity of meat decreased when the pigs were fed 0.075% multienzyme composition with higher amount of triticale. In Group 2, the ash content was 0.04% (P>0.1) higher while water holding capacity and colour intensity were 3.82 (P>0.2) and 23.8% (P>0.1) lower, respectively, in comparison with the control group, but the differences between the groups were statistically insignificant. As regards Group 3 and 4 with respectively 0.1 and 0.125% multienzyme composition supplementation of triticale diets, water holding capacities were, respectively, 4.92 (P<0.001) and 4.95% (P<0.001) lower compared with the control group. In Group 3 and 4, colour intensity of meat was, respectively, 15.7 (P>0.2) and 25.3% (P<0.025) lower than that of the control group (differences insignificant for Group 3). 0.1 and 0.125% multienzyme composition supplementation of the diets also resulted in 0.56–1.03% (P>0.2) higher contents of fat and 0.05% (P>0.1) higher content of ash in

the meat of pigs compared with the control ones, but the differences were statistically insignificant. Other physicochemical indicators of meat and backfat of the pigs from Group 3 and 4 did not differ significantly from those of the control pigs. There were no significant differences for the contents of tripyophan and oxyprolin in the meat of pigs from all groups. Thus, it can be concluded that in Trial 2 supplementation of diets with the multienzyme composition did not affect the biological value of meat.

In Trial 2, 16 (C14:0 – C22:6) and 14 (C14:0 – C22:6) fatty acids in, respectively, intramuscular fat and backfat have been analysed. When 60–70% triticale based diets were supplemented with 0.075% multienzyme composition, the content of polyunsaturated docosahexaenoic acid in the intramuscular fat 0.34% (P<0.025) was higher in comparison with the control group. Besides, there was also a tendency observed for higher contents of saturated margaric and polyunsaturated linoleic and arachidonic acids in the intramuscular fat of the pigs in Group 2. The contents of the above mentioned acids in the intramuscular fat of Group 2 were, respectively, 0.08 (P>0.1), 2.01 (P>0.1) and 0.4% (P>0.1) higher compared with those in the control group, but the differences were statistically insignificant. There were no significant differences for the contents of other fatty acids in the intramuscular fat of the control and Group 2 pigs. The composition of fatty acids in the intramuscular fat the pigs fed triticale based diets supplemented with 0.1 and 0.125% multienzyme composition did not differ significantly from that of the control pigs.

In Trial 2, the analysis of the backfat composition indicates that backfat composition did not differ significantly when the pigs were offered 0.075 and 0.1% multienzyme composition. 0.125% multienzyme composition supplementation of the diet resulted in 2.49% (0.1>P>0.05) higher content of saturated srearic acid and 2.35% (P<0.025) and 0.26% (0.1>P>0.05) lower contents of, respectively, monounsaturated oleic and palmitoleic acids in the backfat of the pigs from Group 4 compared with the control ones. The contents of other saturated and unsaturated fatty acids in the backfat of the control and Group 4 pigs did not differ significantly.

In summary of the data from the both trials, it can be concluded that feeding of the pigs triticale based diets supplemented with the multienzyme composition did not have any significant influence on the unsaturated and saturated fatty acid ratio in the intramuscular fat and backfat. Thus, supplementation of the pig diets with the multienzyme composition did not worsen the biological value and physicochemical indicators of pig meat and backfat. Only 0.05% multienzyme composition supplementation of the pig diet was economically efficient in the trials.

Economic indicators. In Trial 1, supplemention of triticale based pig diets with 0.035% and 0.05% multienzyme composition result in, respectively, 0.03 LTL (16%) and 0.08 LTL (4.3%) lower cost of feeds per kg gain in composition with the control group. The cost of feeds per one pig growing was 1.17 LTL (0.87%) lower if compared with the control pigs when the diet for Group 3 pigs was supplemented with 0.05% multienzyme composition. However, 0.035% supplementation of the diets with the multienzyme composition increased the cost price per kg growing by 2.52 LTL (1.88%) if compared with the control group.

In Trial 2, when the triticale (60–70%) based diets were supplemented with 0.075%, 0.1% and 0.125% multienzyme composition, the cost of feeds per kg gain increased, respectively, by 0.03 (2.1%), 0.01 (0.7%) and 0.02 LTL (1.4%) in comparison with the control group. However, pig feeding with 0.075%, 0.1% and 0.125% multienzyme composition reduced the price of feeds, respectively, by 10.78 (8.8%), 5.34 (4.4) and 3.93 LTL (3.2%) in comparison with the control group of pigs.

Both trials indicated that the best economic indicators were reached when the triticale based diets were supplemented with 0.05% multienzyme composition.

CONCLUSIONS

The study of the effects of the multienzyme composition in triticale based (60–70%) diets on pig productivity and meat quality indicated:

1. 0.05% supplementation of the diets with multienzyme composition improved feed consumption, increased daily weight gains from 11 to 18% and by 3.4 – 7% decreased feed consumption per kg gain. Other different amounts of multienzyme composition had no significant influence.

2. 0.035% multienzyme composition supplementation of the diets improved fat digestibility by 19.7% while 0.05 and 0.125% supplementation of the diets had no significant influence on nutrient digestibility, except for insignificantly higher digestibility of protein, fat and fibre.

3. 0.035% supplementation of the diet with multienzyme composition lowered backfat thickness at the last rib by 4.2 mm, while 0.05% supplementation reduced backfat thickness at withers by 6 mm.

4. Supplementation of the triticale based diets by 0.1% multienzyme composition reduced water holding capacity of meat by 4.92%, while 0.125% supplementation reduced water holding capacity by 4.95% and colour intensity by 25.3%.

5. 0.035% supplementation of the diets with multienzyme composition increased the contents of miristic and palmitic acids by, respectively, 0.14 and 0.68%, while 0.05% supplementation of the diet increased the content of palmitic acid by 1.46%, and 0.075% supplementation with multienzyme composition increased the content of docosahexaenoic acid by 0.34%.

6. 0.05% multienzyme composition supplementation of the diets increased the content of miristic acid in the backfat by 0.018%, while 0.125% supplementation of the diets increased the content of stearic acid by 2.49% and reduced the contents of oleic and palmitoleic acids, respectively, by 2.35% and 0.26%.

7. 0.035 – 0.05% multienzyme composition supplementation of the diets reduced the cost of feeds per kg gain by 0.03– 0.08 LTL. Higher amounts (0.075, 0.1 and 0.125%) of multienzyme composition in the diets of pigs increased the cost of feeds per kg gain by, respectively, 0.03, 0.01 and 0.02 LTL.

8. 0.05% supplementation of triticale (60 –70%) based diets was found to be most suitable from the economic viewpoint as far as pig growth, feed conversion, carcass, meat and backfat quality were concerned.

SUGGESTION

In order to inprove pig growth and reduce feed consumption per kg gain, it is suggested from weaning till the end of fattening to supplement the diets of pigs based on 60 70% triticale with 0.05% of multienzyme composition composed of xylanase, 1800 U/g, β–glucanase, 700 U/g, α –amylase, 70 U/g, protease, 0.8 U/g and distinguished for its higher xylanase and glucanase activity.

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ĮVADAS

Plečiantis kvietrugių panaudojimo galimybėms Lietuvoje sparčiai didėja jų auginimo plotai. Juos kaip vertingą grūdinį pašarą galima šerti penimoms kiaulėms. Palyginti su kitomis varpinėmis kultūromis (miežiais, kviečiais, rugiais, avižomis), jie yra didesnės energetinės vertės (13,0–13,5 MJ/kg), turi daugiau baltymų (11,7–13%), mažiau ląstelienos (2,0–2,5%). Tačiau kvietrugių grūduose yra antimitybinių medžiagų (nekrakmolinių polisacharidų, karčiųjų gliukozidų ir kt.), kurios slopina virškinimo procesą bei maisto medžiagų įsisavinimą, dėl ko dažnai sumažėja kiaulių prieaugiai, gaunama blogesnė skerdena.

Darbo tikslas – ištirti multienziminės kompozicijos iš ksilanazės – 1800 U/g, β–gliukanazės – 700 U/g, α–amilazės – 70 U/g, proteazės – 0,8 U/g panaudojimo galimybes penimų kiaulių racionuose su didesniu kvietrugių kiekiu.

Siekiant šio tikslo, buvo iškelti tokie uždaviniai:

Ištirti skirtingų multienziminės kompozicijos kiekių įtaką:

1. kiaulių augimo intensyvumui ir pašarų sunaudojimui;
2. pašarų maisto medžiagų virškinamumui;
3. skerdenos kokybei;
4. mėsos kokybei;
5. mėsos riebalų kokybei;
6. lašinių kokybei;
7. ekonominiams rodikliams;
8. Nustatyti tinkamiausią tirtos multienziminės kompozicijos dozę kiaulių kombinuotuosiuose pašaruose su didesniu kvietrugių kiekiu

2004–2005 metais Lietuvos veterinarijos akademijos Gyvulininkystės instituto fiziologinių tyrimų tvarte atlikti du bandymai su Vokietijos ir Norvegijos landrasų veislių mišrūnais.

Ištyrus skirtingų multienziminės kompozicijos kiekių kombinuotuosiuose pašaruose su didesniu (60–70%) kvietrugių kiekiu įtaką kiaulių produktyvumui ir kiaulienos kokybei, nustatyta:

1. Multienziminės kompozicijos 0,05% priedas pagerino pašarų suvartojimą, 11–18% padidino prieaugius per parą ir 3,4–7% sumažino pašarų sąnaudas 1 kg priaugti. Kiti multienziminės kompozicijos kiekiai esminės įtakos neturėjo.

2. Multienziminės kompozicijos 0,035% priedas 19,7% pagerino riebalų virškinamumą, o 0,05 ir 0,125% priedai pašarų maisto medžiagų virškinamumui esminės įtakos neturėjo, tik nežymiai pagerino baltymų, riebalų ir ląstelienos virškinamumą.

3. Multienziminės kompozicijos 0,035% priedas 4,2 mm sumažino lašinių storį ties paskutiniuoju šonkauliu, o 0,05% priedas lašinių storį ties ketera sumažino 6 mm.

4. Multienziminės kompozicijos 0,1% priedas 4,92% sumažino mėsos vandens rišlumą, o 0,125% priedas 4,95% sumažino mėsos vandens rišlumą bei 25,3% – spalvos intensyvumą.

5. Multienziminės kompozicijos 0,035% priedas mėsos riebaluose 0,14% padidino miristino ir 0,68% – palmitino rūgščių kiekius; 0,05% priedas 1,46% padidino palmitino rūgšties kiekį, o 0,075% priedas 0,34% padidino dokozoheksaeno rūgšties kiekį.

6. Multienziminės kompozicijos 0,05% priedas lašiniuose 0,018% padidino miristino rūgšties kiekį, o 0,125% priedas 2,49% padidino stearino rūgšties bei atitinkamai 2,35% ir 0,26% sumažino oleino ir palmitoleino rūgščių kiekius.

7. Multienziminės kompozicijos 0,035–0,05% priedai 1 kg prieaugio sunaudotų pašarų kainą sumažino 0,03–0,08 Lt. Panaudoti didesni 0,075%, 0,1%, 0,125% multienziminės kompozicijos kiekiai pašarų, sunaudotų 1 kg prieaugiui gauti, kainą atitinkamai padidino 0,03 Lt, 0,01 Lt ir 0,02 Lt.

8. Kiaulių augimo, pašarų konversijos, skerdenos, mėsos ir lašinių kokybės bei ekonominių rodiklių požiūriu, pašaruose su didesniu (60–70%) kvietrugių kiekiu tinkamiausias yra 0,05% multienziminės kompozicijos priedas.

PASIŪLYMAS

Kiaulių augimui pagerinti ir pašarų sąnaudoms prieaugiui sumažinti siūloma į jų šėrimui nuo nujunkymo iki penėjimo pabaigos skirtus kombinuotuosius pašarus, turinčius 60–70% kvietrugių, įmaišyti 0,05% multienziminės kompozicijos, sudarytos iš: ksilanazės – 1800 U/g, β–gliukanazės – 700 U/g, α–amilazės – 70 U/g, proteazės – 0,8 U/g, kuri pasižymi stipresniu ksilanaziniu ir gliukanaziniu aktyvumu.

GYVENIMO APRAŠYMAS (CURRICULUM VITAE)

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