Individual and combined usage of enzyme preparation and heat-treated cereals in pig fattening

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ABSTRACT: In order to reach better production and financial results of pork production different technological ways of pig fattening are researched. The purpose of this paper is to show separate results of polyenzyme application and the results of the use of heat-treated cereals in pig fattening as well as the results of their combined application. Pigs fattened on a diet with polyenzyme preparation and heat-treated cereals, either separately or combined, were characterised by an insignificantly higher growth rate and their feed intake per kilogram of weight gain was low compared to pigs fed standard mixtures (control group). In statistical terms, the relative portion of muscle tissue in pork carcass was significantly lower in experimental group 3 fed the mixture with heat-treated cereals than in the other groups. The absolute portion of muscle tissue in pork carcass was statistically more important in experimental group 2 (45.15 kg) receiving the mixture of enzyme additive and heat-treated cereals, and the least important in experimental group 3 (40.92 kg) fed heat-treated cereals. During pig fattening the income for experimental groups was higher than for the control group because of better production results. Average values covering variable expenses show the increase only in the third experimental group in the second fattening period compared to the control group, but these differences were of no statistical importance.

Keywords: fattened pigs; polyenzyme preparation; heat-treated cereals

Aiming to reach better production and financial effects in pork production, different technological solutions are required. Various bio-stimulative substances (growth stimulants) such as enzymes and different procedures of feed heat treatment aiming to increase both the nutritive and energy value of feed ration are commonly used. In their application it is necessary to take into account the effects they have on pig productivity, economic advantage of their use as well as their influence on animals' health.

The heat treatment of cereals increases their digestibility and leads to better productivity of pigs (Aumaitre, 1976; Medel et al., 2002). Medel et al. (2004) also stated that the heat treatment of cereals increased their digestibility and weight gains of pigs but only within the first ten days after weaning. Some other researchers (Fernandez et al., 1975; Thacker, 1999; Zarkadas and Weiseman, 2002; Lawlor et al., 2003a,b) did not report any effects of heat-treated cereals in the pig fattening. The reasons for these contradictory results are not quite understandable. Aumaitre (1976) and Medel et al. (1999) pointed out the greater effect of heat-treated barley than that of maize.

This paper aims to indicate individual effects of enzyme application and the use of heat-treated cereals in pig fattening as well as effects of their combined application. Concerning the fact that the heat treatment of cereals increases accessibility of nutrients (especially of starch) to the digestive enzymes, we assumed that an addition of enzyme preparation into feeds (which increases the enzyme concentration in the digestive tract) combined with heat-treated cereals will lead to higher nutrient utilisation and, therefore, to higher productivity of pigs.

Supported by the Ministry of Science and Technology in Zagreb, Croatia (Project No. 0079050).

Table 1. Experimental design

Groups	1	2	3	4
Feed mixture	Enzyme in mixture	Enzyme and heat-treated cereal	Heat-treated cereal	Control (standard feed mixture)
Number of replications	2	2	2	2
Number of pigs per replication	10	10	10	10
Total number of pigs	20	20	20	20
Sex ratio	1:1	1:1	1:1	1:1

Table 2. Composition of polyenzyme preparation (per gram of product)*

Type and enzyme activity	Polizym-R
Amylase AU (amylase units)	150.000
Glycanase BGU (β glycanase units)	400
Protease PU (protease units)	140.000
Cellulase FPU (filter units)	50
Glycosidase BGU (β glycosidase units)	4

*minimal activity was declared in accordance with the declared expiry date

Table 3. Composition of feed mixture

Feeds (%)	Feed mixture ST1	Feed mixture ST2
Maize	26.80	33.00
Barley	40.00	40.00
Wheat meal	5.50	8.00
Lucerne meal	4.00	4.00
Soybean meal	10.50	8.00
Sunflower meal	4.00	–
Fish meal	3.50	2.00
Pork fat	2.00	1.00
Limestone	1.60	1.80
Phosphonal*	1.10	0.70
Salt (NaCl)	0.50	0.50
Premix**	0.50	0.50
Crude proteins	16.09	14.10
Crude fat	4.79	4.32
Crude fibre	5.68	5.70
Lysine	0.83	0.67
Methionine + Cystine	0.56	0.50
Tryptophan	0.18	0.15
Ca	0.90	0.90
P	0.65	0.53
Metabolizable energy (MJ/kg)	12.54	12.66

*phosphonal – (P 18%; water solvent 95%, Ca to 1%, humidity to 5%, crude protein equivalent (N × 6.25) to 62.5%)
**premix composition – 1 kg contains: vitamin A 1 000 000 I.U., vitamin D3 100 000 I.U., vitamin E 2 400 mg, vitamin K3 400 mg, vitamin B1 400 mg, vitamin B2 600 mg, vitamin B6 400 mg, nicotinic acid 3 000 mg, pantothenic acid 2 000 mg, vitamin B12 3 mg, choline chloride 100 000 mg, J 150 mg, Fe 16 000 mg, Cu 4 000 mg, Mn 8 000 mg, Zn 16 000 mg, Co 40 mg, Se 20 mg

MATERIAL AND METHODS

An investigation was conducted on 80 cross-bred pigs between Large White, Swedish Landrace and German Landrace. The initial body weight of pigs in all groups was 26 kg. The fattening in all groups lasted for 101 days: the first period lasted for 52 days and the second 49 days. The pigs were randomly divided into four groups according to a feeding schedule as it can be seen from the experimental design (Table 1).

The applied polyenzyme preparation "Polyzim –R" ("Krka", Novo Mesto, Slovenia) is a stable mixture of enzymes such as n-protease, alpha-amylose, beta-glucanase, cellulase, hemicellulase and beta-glucosidase. Table 2 show the composition of this polyenzyme preparation. The polyenzyme preparation was in a powdery form. For more uniform mixing of active ingredients, a pre-mixture with vitamin-mineral supplement was prepared in advance. The enzyme activity in the analyzed preparation is maintained for a year at storage in a dry and dark place at a temperature by 25°C. The stability of vitamin-mineral mixture and feed mixture does not change for at least two months. The activity loss at pelleting temperatures (80–90°C) is negligible. Optimal pH for the effect of the enzyme from the preparation is from 5 to 6.5. Optimal concentration of enzyme preparation in feed mixtures was used according to the manufacturer's recommendation. The polyenzyme preparation activity was checked

Table 4. Fattening traits of pigs

Traits	Statistical parameters	Groups			
		1	2	3	4
Daily gain (g)					
1st fattening period	$\bar{x}$	690	719	702	687
	sd	64	82	72	92
2nd fattening period	$\bar{x}$	791	816	809	785
	sd	75	59	87	68
Total (1st + 2nd)	$\bar{x}$	739	766	754	734
	sd	58	60	53	68
Feed conversion (kg/kg)					
1st fattening period	$\bar{x}$	3.07	2.89	2.92	3.08
2nd fattening period	$\bar{x}$	3.59	3.46	3.50	3.61
Total (1st + 2nd)	$\bar{x}$	3.33	3.18	3.22	3.34

$\bar{x}$ = mean; sd = standard deviation

according to the manufacturer's methodology prior to its use. The polyenzyme preparation was added into the feeds of experimental pig group 1 and 2 in 0.1% quantity. The enzyme preparation was added into the pre-mixture of experimental group 1 and 2 – damaging the wheat bran.

A micronizer Mocro Red 20 (Micronizing Company Ltd., UK) was used for maize and barley heat treatment. The feed micronization was done at 110°C and lasted for 60 seconds. The forage shares in the mixtures were uniform in all the groups. In the first fattening period ST-1 mixture was fed to pigs while in the second fattening period ST-2 mixture was applied. The mixture composition can be seen in Table 3.

Chemical composition and energy value of feeds were established numerically according to the tables of chemical composition and nutritive values of feeds (Grbeša, 2004.). Ten animals (5 males and 5 females) from each group were slaughtered at the end of the experimental fattening. Primarily processed pig carcasses were cooled for 24 hours at +4°C. Right sides of pork were dissected according to the Weniger et al. (1963) method. Less valuable parts (head and knuckles) were not dissected. The cost price of feed per kg was determined by the economic analysis per fattening groups and periods. Costs of both the enzymatic preparation and cereal heat treatment were included in the mixture price. According to Däumler and Graben (1985), Paller (1991) the analysis of production financial results was based on the coverage estimate of variable costs. Statistical analysis of data was performed by the computer program Statistica (StatSoft, Inc. 2001). The results were statistically evaluated using Duncan's multiple range test.

RESULTS AND DISCUSSION

The fattening period was characterized by daily gains (Table 4) higher in the experimental groups (1, 2 and 3) compared to control group 4, but not statistically significantly ($P > 0.05$). Significant progress of pig daily gains (5–5.6%) when an enzyme preparation was used during fattening was determined by Inborr (1990a,b,c) and Graham and Inborr (1991). Unlike them, Anderson and Ogle (1991) did not report any improvement of daily gains of fattened pigs when enzymes were applied. Similar to our investigation results Lawrence (1973a,b) reported daily gains higher by even 11% while using heat-treated cereals in pig fattening. While feeding pigs on micronized maize, Bekrić (1987) obtained a daily gain increase by 5%. In Thacker's (1999) researches the nutrient increase which was detected as a result of micronization did not effect the pig growth during the fattening period. The pigs fed micronized barley were growing by 10.3% more slowly than those fed non-micronized barley. In the post-weaning period of pigs, Zarkadas and Weiseman (2002) found out a significantly higher feed consumption for micronized barley application but they did not record a higher daily body weight increase. A significant difference concerning the

Table 5. Proportions of tissues in pig carcasses

Tissues	Proportions	Statistical parameters	Groups			
			1	2	3	4
Muscle	kg	$\bar{x}$	$42.86^{a,A}$	45.15^{B}	40.41^{C}	$40.92^{b,A,C}$
		sd	1.67	0.97	0.80	1.59
	%	$\bar{x}$	54.81^{A}	54.03^{A}	51.74^{B}	54.20^{A}
		sd	3.94	2.81	1.87	3.14
Fatty	kg	$\bar{x}$	21.13^{A}	$23.66^{a,B}$	$24.80^{b,B}$	21.38^{A}
		sd	1.80	1.19	1.04	1.97
	%	$\bar{x}$	27.02^{A}	28.32^{a}	$31.75^{b,B}$	$28.32^{a,C}$
		sd	4.50	3.85	2.24	4.43
Bones	kg	$\bar{x}$	7.74^{A}	$7.86^{a,A}$	7.32^{B}	7.49^{b}
		sd	0.31	0.40	0.15	0.35
	%	$\bar{x}$	9.90	9.41	9.37	9.92
		sd	0.82	1.05	0.45	1.19
Weight of cooled carcasses	kg	$\bar{x}$	78.20^{A}	83.55^{B}	78.10^{A}	75.50^{A}
		sd	2.86	3.21	2.18	4.72

$\bar{x}$ = mean; sd = standard deviation

^{a,b,A,B,C}means with different superscript letters differ significantly: small letters $P < 0.05$; capital letters $P < 0.01$

feed conversion for the body weight increase was also detected.

As for the feed conversion (kg/kg), the second group of pigs fed a mixture with enzyme addition and heat-treated cereals had the best feed utilization. The third group of pigs receiving a mixture with heat-treated cereals was somewhat worse compared to the second one, but still better by 3.6% than the fourth group (control one). Concerning all the groups of pigs, we cannot determine the differences in feed conversion between groups but it is clear that the thermal treatment of cereals can have a good influence on digestibility and nutrient utilization. In Thacker's (1999) researches the barley micronization caused an increase of jelly wheat in the barley based mixture, and that was followed by the improvement of dry matter digestibility, crude proteins and energy. This report is in accordance with the investigations conducted by Lawrence (1973a,b) and Voncken and Rensink (1988). In Thacker's (1999) researches the pigs fed a mixture based on micronized barley had a decreased feed consumption by 14.3% but the feed conversion was

Table 6. Price per kg of feed mixture and price per kg of gain (EUR)

Groups		1	2	3	4
Price per kg of feed mixture					
1st fattening period	EUR	0.228	0.239	0.222	0.211
	Index	108.05	113.27	105.21	100.00
2nd fattening period	EUR	0.206	0.219	0.202	0.188
	Index	109.57	116.48	107.45	100.00
Price per kg of gain					
1st fattening period	EUR	0.702	0.691	0.648	0.650
	Index	108.00	106.31	99.69	100.00
2nd fattening period	EUR	0.739	0.759	0.707	0.678
	Index	108.99	111.94	104.27	100.00

Table 7. Financial account of pig fattening (EUR)

Indicators	Fattening period	Groups			
		1	2	3	4
Total income	1st	107.65	113.12	109.98	107.82
	2nd	141.08	147.44	157.44	138.82
Costs of feeds	1st	25.19	25.94	24.09	23.27
	2nd	28.72	28.84	28.02	24.92
Total costs	1st	75.26	79.04	78.21	73.77
	2nd	137.31	142.82	138.92	133.94
Coverage of variable costs	1st	32.40	34.07	31.75	34.06
	2nd	3.77	4.62	5.29	4.90

better by 4.7%. In the fattening period there were no significant effects of the enzyme preparation addition on the feed utilization in the first group of pigs, which was also quoted by Chamachenko and Borisenko (1976). Data on the slaughter quality of pig carcasses (Table 5) show that the average weights of carcasses from the pigs fattened 101 days were higher in all three experimental groups compared to the fourth – control one.

However, statistically significant differences ($P < 0.01$) were determined only between the second experimental group and the other groups of pigs. The highest absolute muscle tissue portion in the carcasses was reported in the second experimental group (45.15 kg) fed a mixture with added enzyme and heat-treated cereals and the lowest one in the third experimental group fed the ration with heat-treated cereals. The highest relative portion of muscle tissue was found out in the first experimental group of pigs (54.81%) fed the mixture with polyenzymatic preparation. A statistically lower relative portion of muscle tissue in carcass compared to the other groups was recorded in the third experimental group of pigs (51.47%). A higher proportion of fat and a lower proportion of muscle tissue in group 3 receiving the heat-treated cereal feeds could be explained by higher starch availability. From the above-mentioned findings it can be concluded that neither individual nor combined application of polyenzymatic preparation and heat-treated feeds affected the relative muscle tissue portion in pig carcasses significantly. In the course of fattening, Andersson and Ogle (1991) reported no effect of enzymes added to pig feed on pig carcass weight and meatiness. Data on the effect of heat-treated cereals on pig carcass meatiness could not be found in our available literature.

During the fattening, the price of mixture/kg was higher all three experimental groups compared to the control group (Table 6).

The price per one kilogram gain was also significantly higher in all experimental groups compared to that of the control group, which is the consequence of the less positive effect of enzyme and heat-treated cereals in fattening pigs. In the course of fattening, higher total yield obtained in the experimental groups compared to the control led to the better production results (Table 7). The average value of variable cost coverage indicates an increase compared to the control group only in the third experimental group (the second fattening period). However, these differences were not statistically significant.

CONCLUSION

The fattening of pigs on mixtures with polyenzymatic preparation and heat-treated cereals, applied individually or combined, was characterized by insignificantly higher gains and lower feed conversion compared to the pigs fed the standard composition mixture (control group). The relative muscle tissue portion in the carcasses was statistically significant lower in experimental group 3 fed the mixture with heat-treated cereals, compared to the other investigated groups. The absolute muscle tissue portion in the carcasses was statistically significantly higher in experimental group 2 (45.15 kg) fed the mixture with added enzyme and heat-treated cereals. However, it was lowest in experimental group 3 (40.92 kg) receiving the heat-treated cereal ration. The complete fattening period was characterized by the higher total yield reached in the experimental groups compared to the control one. The aforesaid brought about bet-

ter production results. The average values of variable cost coverage show an increase (compared to the control group) only in the third experimental group of the second period, but these differences were not statistically significant.

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Received: 2005–07–08
Accepted after corrections: 2005-12–01

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