Agronomy Research **9** (Special Issue II), 389–394, 2011

The Influence of Organic Acid Additive, Phytoadditive and Complex of Organic Acid Additive Phytoadditive on Pig Productivity, Meat Quality

I. Jansons, A. Jemeljanovs, I. H. Konosonoka, V. Sterna, B. Lujane

Research Institute of Biotechnology and Veterinary Medicine “Sigra” of Latvia University of Agriculture, Instituta 1, Sigulda, Latvia, LV-2150; e-mail: sigra@lis.lv

Abstract. A study was conducted to determine the efficiency of organic acids, phytoadditives and an organic acids and phytoadditive complex on pigs' growth processes and meat quality. Control group pigs (group 1) were fed with a complete ration (basic feed); the trial group pigs additionally received an organic acid additive (group 2), a phytoadditive (group 3), an organic acids and phytoadditive complex (group 4). The highest impact of 12% on the live weight gain of pigs was exercised by inclusion of the newly developed phytoadditive in the feed ration compared with the control group. The feed conversion ratio for pigs having received organic acid additives was by 4.2% higher, for animals having received the phytoadditive – by 8.1% and for animals having received a complex of both – by 7.45% higher than for the control group pigs where feed consumption was 3.09. The phytoadditive and the organic acids and phytoadditive complex as a pig feed supplement ensures a higher protein quality in muscle tissue, i.e., a higher nutritive value. The highest impact on the cholesterol level reduction in muscle tissue was exercised by the phytoadditive by 51.1 mg kg^{-1} in comparison with the control group.

Key words: meat quality, organic acid additive, phytoadditive, pigs

INTRODUCTION

The productivity level of pigs is largely determined by the functional activity of the digestive system and the microbiological background of the gastro-intestinal tract.

Results of numerous research studies demonstrate the anti-microbial and anti-fungicidal properties of organic acids. Addition of the organic acid additives to pig feed ensures its protection against mould and other micro-organisms; nutrients are better preserved in such feed and the additional formation of mycotoxins is prevented. Nutrition of animals with feed containing organic acids results in reduction of the average pH level in the intestines, activation of pepsin, change in the background of microflora and better digestion of the nutrients contained in the feed. These improvements, in turn, reduce the probability of diarrhoea, for the acids prevent growth and multiplication of pathogenic bacteria in the gastro-intestinal tract, resulting in increase of the animal's biomass. The most important benefit of the above developments is less need for other therapeutic products targeted at improvement of resistance and growth intensity. It underpins the digestibility nutrients found in feed, the feed conversion ratio and reduces the amount of feed utilised for production of a product unit (Franco et al., 2005).

The scientific data published indicate that pigs receiving the additive of medicative herbs on top of their diet (30 g per 1 kg of feed) containing nettle *(Urtica dioica)*, rosemary *(Rosmarinus oficionalis)*, thyme *(Thymus vulgaris, Thymus serpyllum)*, and juniper *(Juniperus communis)* berries achieve higher live weight gains than the control group (Gerla et al., 2003). Pigs which received the additive of thyme in combination with sage, coriander and common yarrow achieved 7% higher weight gain and 3% higher feed conversion in comparison with the control group which was fed only the complete ration (Wagner, 2003).

Similar data were also found in the studies of other authors. In the studies concerning feeder pigs, it was demonstrated that organically active substances of plant origin in combination with an organic acid additive improved live weight gain of pigs by 10% and feed conversion by 8% (Peris, 2002; Piglet Nutrition, 2003).

The studies *in vitro* indicate that phytoadditives containing thyme, consequently its active components, volatile oils and thymol provides also anti-fungal activity (Paster et al., 1995). Both volatile oils and thymol possess antibacterial properties, as well. Data in scientific sources also indicate that adding phytoadditives to pig feed reduced the back fat layer by 8.4% and increased the cross cut area of *m. longissimus lumborum* by 15.1% and the amount of muscle tissue in the carcass by 6.7% (Juven et al., 1993).

The objectives of the study were development of a novel composition feed additive of herbal origin appropriate for local conditions, and evaluation of its impact on the productivity level and product quality of feeder pigs in a complex with an organic acid additive. The application of the above additive of herbal origin in pig feeding provides a favourable influence, promotes productivity of the feeder pigs and improves the quality of the final product.

Consequently, this work provides an assessment of the comparative efficiency of additives in the diet of pigs: the newly developed additive of herbal origin, or that of organic acid origin, or their combination.

MATERIALS AND METHODS

The trial was carried out at the pig barn of agricultural holding *Pakalni*, Krāslava district. The impact of organic acid additives, phytoadditives, as well as a complex of the two were evaluated pursuant to the set target by forming 4 analogous trial groups of feeder pigs. Every group included Landrase breed pigs of weaning age (42 days) until finishing, i.e., 170 days old. The gender distribution was sows 50%, male pigs 50%. Males were castrated at 7 days old. The control group pigs were fed a complete ration. The trial group pigs additionally received the organic acid additive, phytoadditive or their complex accordingly (Table 1).

A new composition phytoadditive was developed containing ingredients of locally grown medicative herbs: leaves of thyme *(Thymus vulgaris L.)*, leaves of nettle *(Urtica dioica L.)*, oak *(Quercus robur L.)* bark, and leaves of balm *(Melissa officinalis L.)*. The additive was developed assessing the biologically active plant substances, that its action in pig's body was bactericidal, antifungal, antioxidant, anti-stress and antidiarrhoeal, as well as stimulating feed intake, improving feed efficiency and improving immunity. The dried herb parts were milled and mixed in a powder–form phytoadditive**.** The organic acid additive contained formic acid, acetic acid, citric acid, phosphoric acid and calcium.

The productivity of the feeder pigs was evaluated in relation to the technological process by weighing every pig individually at the start of the trial, at weaning age (42 days) and at 78, 114 and 170 days.

Table 1. Trial scheme.

Group No. and title	Number of animals within a group	Feeding program in different age periods		
		42–78 days	78–114 days	114–170 days
Control group 1	15	Complete ration without additives (CR)	CR	CR
Trial Group 2	15	CR + 0.6% organic acid additive	CR + 0.4% organic acid additive	CR + 0.3% organic acid additive
Trial Group 3	15	CR + 1% phytoadditive	CR + 0.5% phytoadditive	CR + 0.5% phytoadditive
Trial Group 4	15	CR + 1% phytoadditive + 0.6 % organic acid additive	CR + 0.5% phytoadditive + 0.4% organic acid additive	CR + 0.5% phytoadditive + 0.3% organic acid additive

Average daily live weight gain per pig, feed consumption and conversion on average per pig were calculated and compared.

The quality of the muscle tissue in *m. longissimus lumborum* was evaluated by: chemical composition (dry matter, crude protein, amino acids – oxyproline, tryptophan and proportions thereof, crude fat, phosphorous, and cholesterol).

The biochemical tests were performed in the biochemistry and microbiology research laboratory of the Research Institute of Biotechnology and Veterinary Medicine *Sigra* and tests were performed in accordance with duly accredited ISO standards. The statistical processing of the obtained data was performed with the Microsoft Excel software package. The data were subjected to the descriptive analyses. The t test was used to ascertain the existence of significant differences between the groups.

RESULTS AND DISCUSSION

Highest impact achieved on the live weight daily gain was for younger animals from 42 to 78 days of age (Table 2). On the whole, it can be concluded that the most serious impact on the daily gain and consequently also on the growth of pigs was exercised by inclusion of the newly developed phytoadditive in the feed ration: the achieved average weight gain was 0.777 kg that is by 0.113 kg, or 12% more than for the control group ($P < 0.05$).

The feed consumption for 1 kg live weight gain or the feed conversion ratio for animals having received organic acid additives was 2.96 or by 4.2% higher, for animals having received the phytoadditive – 2.48 or by 8.1% and for animals having received a complex of both – 2.86 or by 7.45% higher than for the control group where feed consumption was 3.09. Better feed conversion ratio was demonstrated by groups receiving either a phytoadditive or the complex of both on top of their complete feed ration.

Table 2. Impact of the additives on the daily gain of pigs.

Indicators	Control group 1	Trial group 2	Trial group 3	Trail group 4
	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$	$\bar{x} \pm s_{\bar{x}}$
	n = 15	n = 15	n = 15	n = 15
Feed additives	Complete ration (basic feed) (CR)	CR + organic acid additive	CR + phytoadditive	CR + complex of organic acid +phytoadditive
From 42 to 78 days of age, kg	0.490 ± 0.018	0.540 ± 0.034	0.657 ± 0.024*	0.568 ± 0.029*
From 78 to 114 days of age, kg	0.673 ± 0.021	0.708 ± 0.024	0.751 ± 0.020*	0.747 ± 0.021*
From114 to 170 days of age, kg	0.869 ± 0.021	0.915 ± 0.034*	0.904 ± 0.017	0.940 ± 0.018*
From 42 to 170 days of age, kg	0.694 ± 0.009	0.737 ± 0.011*	0.777 ± 0.009*	0.767 ± 0.010*

* $P < 0.05$

Judging by the contents of dry matter, crude fat and phosphorous, applied additives did not largely impact the biochemical composition of the pig muscle tissue. However there were significant differences between the crude protein content of group 1 with groups 3 and 4, as well as between group 2 with groups 3 and 4 ($P < 0.05$) (Table 3).

Table 3. Biochemical composition of *m. Longissimus lumborum.*

Groups	Trait	Dry matter, %	Crude protein, %	Crude fat, %	Phosphorus, %
Control group 1	$\bar{x} \pm s_{\bar{x}}$	24.52 ± 0.31	20.90 ± 0.42	2.38 ± 0.18	0.19 ± 0.01
Trial group 2	$\bar{x} \pm s_{\bar{x}}$	24.54 ± 0.36	21.20 ± 0.29	2.18 ± 0.19	0.19 ± 0.01
Trial group 3	$\bar{x} \pm s_{\bar{x}}$	25.30 ± 0.47	22.27 ± 0.27*	2.07 ± 0.16	0.19 ± 0.01
Trial group 4	$\bar{x} \pm s_{\bar{x}}$	25.20 ± 0.24	21.94 ± 0.16*	2.02 ± 0.07	0.18 ± 0.01

* $P < 0.05$

The protein composition and nutritive value of the muscle tissue is characterized by the quantitative relation of two amino acids – tryptophan and oxyproline. In this correlation tryptophan characterizes the protein composition of complete amino acids while oxyproline describes the contents of the incomplete proteins, mainly connective tissue. There were significant changes observed between the oxyproline content for group 1 and group 3, as well as for group 1 and group 4 ($P < 0.05$; Table 4).

On average, the correlation of tryptophan and oxyproline content stayed within the limits of 3.53–4.48. Substantial differences in the tryptophan-oxyproline relation were found between group 1 and group 3–12.2%, as well as between group 1 and group 4–12.7% ($P < 0.05$).

Table 4. Tryptophan, oxyproline, tryptophan, oxyproline proportions and cholesterol in *m. Longissimus lumborum.*

Group	Trait	Tryptophan, g kg^{-1}	Oxyproline, g kg^{-1}	Tryptophan oxyproline relation	Cholesterol, mg kg^{-1}
Control group 1	$\bar{x} \pm s_{\bar{x}}$	3.02 ± 0.09	0.88 ± 0.04	3.53 ± 0.23	558.6 ± 22.3*
Trial group 2	$\bar{x} \pm s_{\bar{x}}$	2.99 ± 0.13	0.78 ± 0.07	4.13 ± 0.42	516.3 ± 24.6*
Trial group 3	$\bar{x} \pm s_{\bar{x}}$	3.05 ± 0.05	0.73 ± 0.04*	4.31 ± 0.21	507.4 ± 26.4*
Trial group 4	$\bar{x} \pm s_{\bar{x}}$	3.02 ± 0.08	0.69 ± 0.04*	4.48 ± 0.22	520.2 ± 23.2*

* $P < 0.05$

Consequently, both the phytoadditive alone and the complex of organic acids and phytoadditive as a pig feed supplement ensures a higher protein quality in muscle tissue, i.e., a higher nutritive value.

The intramuscular (crude) fat content in the muscle tissue average stayed within the limits of 2.02–2.38%, thus the additives applied had failed to substantially impact the amount of intramuscular fat in muscular tissue; i.e., the differences were not significant ($P < 0.05$).

An intramuscular fat level above 2% improves the meat taste quality (Devol et al., 1988). Comparing our data with data from scientific sources, the feed additives we used had not influenced the meat taste quality, for the intramuscular fat content was at optimum level.

The highest impact on the cholesterol level reduction in muscle tissue was exercised by the newly developed phytoadditive by 51.1 mg kg^{-1} or 9.2% in comparison with the control group ($P < 0.05$). A lower cholesterol level in muscle tissue could be due to reduced levels of intramuscular fat or changed composition of the fat, for instance in the relation between polar and non-polar fat. It is stated by the authors that “the phytoadditive had reduced the cholesterol synthesis in the system, thus decreasing the depositing of cholesterol in muscle tissue.” A lower cholesterol can be the result of decreased synthesis (Mukherjee, 2003), but also increased degradation and secretion in the form of bile acids (Chiang, 2009).

Evaluating all quality indicators tested, we can conclude on the whole that application of both the newly developed phytoadditives and complex of the latter with organic acids promoted acquisition of high quality pig meat.

CONCLUSIONS

1.The application of the phytoadditive, organic acid additive and complex of both in feeding of pigs increased their productivity:

- Improved the daily live weight gain, by 12.0%, 5.8% and 1.5% accordingly ($P < 0.05$);
- Improved the feed conversion ratio: by 8.1%, 4.0% and 0.6% accordingly.

2. The applied feed additives improved the quality of the meat:

- the phytoadditive alone and the complex of organic acids and phytoadditive ensures a higher protein quality in muscle tissue, i.e., a higher nutritive value;
- the cholesterol level in muscle tissue was decreased with the phytoadditive by 9.2%, with organic acid additive by 8.2% and with the complex of both – by 6.9% ($P < 0.05$).

REFERENCES

Chiang, J. Y. L. 2009. *Journal Lipid Res.* **50**., 1955–1966.

Devol, D. L, McKeith, F., Kbectel P. J. & Novakofski, J. 1988. Variation in composition and palatability traits and relationships between muscle characteristics and palatability in arandom sample of pork carcasses. *Journal of Anim. Sci*, **66**., 385–395.

Franco, L. D., Fondevila, M., Lobera, M. B. & Castrillo, C. 2005. Effect of combinations of organic acids in weaned pig diets on microbial species of digestive tract contents and their response on digestibility. *Journal of Anim. Phys. and Anim. Nutr.*, **89**, 88–93.

Grela, E. R., Czech, A. & Krukowski, H. 2003. Influence of dietary supplementation of herbs on perfomance and blood parameters in piglets. *Medycyna Weterynaryja*. **59**, 410–412.

Juven, B. J., Kanner, J., Schved, F. & Weisslovicz, H. 1994. Factors that can interact with the antibacterial action of thyme essential oil and its active constituents. *The Journal of Applied Bacteriology*. **76**(6), 626–631.

Mukherjee, P. K. 2003. Plant products with hypocholesterolemic potentials, *Adv. Food. Nutr. Res*, 47: 277–338.

Paster, N., Menasherow, M., Ravid, U. & Juven, B. 1995. Antifungal activity of oregano and thyme essential oil applied as fumigants fungi attacking. stored grain. *Journal of Food Protection*. **58**, 81–85.

Peris, S. & Asensio, J. J. 2002. Organic acids plus botanicals. *Feed International.*, **102**, 17–19. Piglet Nutrition. 2003. Early with probiotics. *Pig International.* **33**(10), 27–29.

Wagner, F. 2003. Legumes and phytogen feed additives. *Muhle + Mischfutter*, **140**(13), 398–400.