



The effects of aromatic oils on growth performance and physiological parameters in the intestine of weaned pigs

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ABSTRACT

The influence of aromatic oils from aromatic and spicy plants on the basic production parameters and on the incidence of intestinal disorders of weaned pigs (weaning at the age of 30-32 days) was compared in a trial. The trial was performed with three experimental and one control ($n = 12$) group in the commercial pig fattening farm (Michalovce, Slovak Republic). Aromatic oils isolated from Cinnamon (*Cinnamomum zeylanicum* Ness, Lauraceae; the compounds according to gas chromatography analyse: eugenol 77 % \pm 3) Clove (*Syzygium aromaticum* L., Myrtaceae; eugenol 85 % \pm 3) and Oregano (*Origanum vulgare* L., Lamiaceae; carvacrol 65 % \pm 3) were added to feed mixtures of the 1st (20 ml 100 kg⁻¹), 2nd (22 ml 100 kg⁻¹) or 3rd experimental group (17 ml 100 kg⁻¹) from 35th to 66th day of age. The daily average weight gains of experimental groups increased in the trial by 66,67 g day⁻¹ (1st), by 43,79 g day⁻¹ (2nd) and by 32,15 g day⁻¹ (3rd) compared with control. A decrease of the incidence of diarrhoeal diseases was observed in the experimental groups of the trial as follows: by 60.84 % (1st exp. group), by 24.70 % (2nd exp. group) and by 27.71 % (3rd exp. group) in comparison with the control group. A significant decrease of Enterobacteriaceae was observed by colony forming unit (CFU) 118.41 ± 38.6 ($p < 0,01$), 261.59 ± 96.25 ($p < 0,01$) and 645.3 ± 147.72 ($p < 0,01$) 106 . g⁻¹ 100% DM of faeces in the particular experimental groups as a result of antibacterial activity of aromatic oils on 21st day of experiment. In the case of quantification of Enterococcus spp. the differences were insignificant. A significant decrease of amylolytic activity was observed after intake of aromatic oils from Cinnamon (26.33 m kat.l⁻¹ \pm 9.62, $p < 0,01$) and Clove (30.99 m kat.l⁻¹ \pm 7.28, $p < 0,01$) but increase after intake of aromatic oil from Oregano ($49,40$ m kat.l⁻¹ \pm 21.24) in the faeces in comparison with the control group.

Keywords: aromatic oils, cinnamon, clove, oregano, weaned pigs

INTRODUCTION

In the plant kingdom 24 families are reported to contain more than one essential oil producing genus and further 40 families contain only one genus. The biological activity of essential oil-plants has been known and utilized since ancient times (e.g. in food seasoning, ethnomedicine, etc.) (Máthé, 1996).

Their biological characteristics are associated with the development of analytical techniques, chemical characterization, and their evaluation of biological activities (Biavati et al., 1996). Characteristics of essential oils are derived from their compounds terpenoids (mono- and sesqui-), fenols, glycosides and alkaloids. However, essential oils are important commercial items, especially with a main area of utilization in the food industry (55 %).

Their market share is rather limited and amounts to only 5 % (Máthé, 1996).

Physiological effects of essential oils can be divided into several categories: a) intensification of the impulses sent by the taste- and smelling-nerves in the nasal cavity area towards the central nervous system, b) increasing the secretion of digestive juices, e.g. saliva, gastric juice, gall, pancreas and intestinal secretion, c) intensification of the activity of digestive enzymes in the gastro-intestinal area, d) increasing nutrient absorption by activating the transport mechanisms, e) inhibition of oxidation processes of intermediary metabolism, e.g. amino acids, f) inhibition of the growth of bacteria and fungi in the alimentary tract and stabilization of the microbial flora, g) inhibition of mould growth on feed-stuffs (fungicide effect) (Gunther, 1990).

The aim of this study was to compare the influence of aromatic oils isolated from Cinnamon, Clove and Oregano added to feed mixtures in a feeding trial on basic production parameters, on the incidence of intestinal

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disorders of weaned pigs and physiological parameters in the intestine (i.e. the occurrence of Enterobacteriaceae and Enterococcus spp. as well as amylolytic activity in faeces).

MATERIAL AND METHODS

The experiment was conducted in the experimental facilities of commercial pig fattening farm (Michalovce, Slovak Republic) to test the effect of plant aromatic oils on the production, physiological and health parameters of weaned pigs (Slovak White Meaty pigs x Landrace). The weaning was performed at the age of 30 days. The observations included 24 gilts and 24 hogs. The experiment started at the age of 35 days and ended 31 days later.

The plant aromatic oils, isolated by steam distillation from leafs of Cinnamon (*Cinnamomum zeylanicum* Ness, Lauraceae, from flowers of Clove (*Syzygium aromaticum* L., Myrtaceae and from tops of Oregano (*Origanum vulgare* L., Lamiaceae in Calendula joint-stock company (Nová Eubovňa a.s., Slovak Republic), were added into the feed mixture for three experimental groups (Table 1). The isolated products were tested by gas chromatography. The control group was fed with an identical ration without aromatic oils.

The dosage of aromatic oils was defined according to the results of previous chemical, microbiological and palatability tests (Marcin et al., 2003, Marcin et al., 2006).

Table 1: Plant aromatic oils added into the feed mixture of weaned pigs (35th-66th day of age)

Group of animals	n	Aromatic oil (100% v/v)	Dosage (ml 100kg ⁻¹)
Control	12	absent	0
1st experimental	12	Cinnamon	20
2nd experimental	12	Clove	22
3rd experimental	12	Oregano	17

The content of nutrients in the feed mixtures used in the trial were analysed (Table 2).

The following parameters were recorded during the trial on the starting day and on 10 days intervals: number of pigs entering the experimental feeding unit, starting live weights, daily weight gains, incidence of diarrhoeal diseases, health status and mortality.

To examine the physiological parameters in the intestine the monitor of the occurrence of Enterobacteriaceae and Enterococcus spp. as well as the amylolytic activity in the faeces of pigs samples was performed on 21st day of experiment.

The samples were subsequently transported to the microbiological laboratory and their cultivation was immediately performed without multiplication by a quantitative method. The samples were inoculated directly onto the surface of MacConkey agar (Imuna Pharm joint-stock company, Slovak Republic) and Slanetz-Bartley agar (Imuna Pharm joint-stock company, Slovak Republic). The bacterial isolates were identified morphologically and biochemically.

The amylolytic activity was determined in faeces of pigs with the method by Lever (1977) on 21st day of experiment.

Table 2: Content of nutrients in the feed mixtures

Nutrient	Day of age	
	35th-53rd	54th-66th
Dry matter (g . kg ⁻¹)	905.3	907.8
Crude protein (N x 6.25) (g . kg ⁻¹)	164.5	173.3
Crude fibre (g . kg ⁻¹)	21.6	11.9
MEp (MJ. kg ⁻¹)	12.5	12.5

SD – standard deviation

There were performed a qualitative detection of pathogenic bacteria in the rectal smears of diarrhoeic pigs. The chemical and microbiological analyses of drinking water used for experimental animals were made as well.

Data in the present paper are expressed as means \pm standard deviation (SD) of a single values (SAS, Version 8.2, 1999). Means of results from treatment were compared by one-way analysis of variance. Treatment means were statistically compared by Turkey-Kramer multiple comparison test. Significance was declared at $p < 0.05$ (*) and $p < 0.01$ (**).

RESULTS AND DISCUSSION

The percentage ranges of the main components of the aromatic oils utilized in the trial are reported in Table 3.

Table 3: Gas chromatography analysis of aromatic oils

Aromatic oil (100 % v/v) from	Compound	Content (%) (mean \pm SD)
Cinnamon	Eugenol	77 \pm 3
Clove	Eugenol	85 \pm 3
Oregano	Carvacrol	65 \pm 3

SD – standard deviation

The average daily weight gain was always higher in all three experimental groups of pigs for the whole

duration of experiment (Table 4). In particular groups this increase was 17.18 - 30.08 % compared to the control group. The higher daily gain of pigs was also reflected in the higher final weight – by 10.71 – 18.02% or by 1.55 – 2.84 kg in comparison with the control.

A non-statistically significant decrease of the diarrhoea score was noticed in the 1st, 2nd and 3rd experimental group in comparison with the control group by 10.10, 4.10 and 4.6 day pcs-1, respectively. The reason of mortality in all experimental groups was the higher incidence of the respiratory diseases in the 8th week of age. The effect of mortality in the experimental groups was considered in the statistical analysis.

According to performed bacteriological examination a significant decrease of Enterobacteriaceae was observed (Table 5) by colony forming unit (CFU) 118.41 ± 38.6 ($p < 0,01$), 261.59 ± 96.25 ($p < 0,01$) and 645.3 ± 147.72 ($p < 0,01$) $106 \cdot g^{-1}$ 100% DM of faeces, respectively, after intake of aromatic oils from Cinnamon, Clove or Oregano in comparison with the control group.

On the contrary, in the case of quantification of Enterococcus spp. in faeces (Table 6), there were not observed statistically significant differences between the experimental groups and the control group.

At the end of the third week of experiment the significant decrease of amylolytic activity (Table 7) was observed in the faeces of pigs after intake of aromatic oils from Cinnamon ($26.33 \text{ m kat.l-1} \pm 9.62$, $p < 0,01$) and Clove ($30.99 \text{ m kat.l-1} \pm 7.28$, $p < 0,01$) on one hand and on the other hand increase after intake of aromatic oil from Oregano ($49,40 \text{ m kat.l-1} \pm 21.24$) in comparison with the control group.

There were detected E. coli (K antigen negative, haemolyt, Citrobacter spp. and coliform microflora in the rectal smears of diarrhoeic pigs after bacteriological analyse.

Mesophilic bacteria (87 CFU ml-1), coli bacteria (25 CFU 100 ml-1), Enterococcus sp. (48 CFU 100 ml-1), psychrophilic bacteria (106 CFU ml-1) and iron (43.75 mg ml-1) were detected in drinking water.

Table 4: Effect of applied aromatic oils isolated from Cinnamon, Clove and Oregano on weight gains and incidence of diarrhoeal diseases of the weaned pigs (35th – 66th day of age)

Parameter	Group of animals (mean \pm SD)			
	Control	1st experim.	2nd experim.	3rd experim.
Pigs (35th day)	12	12	12	12
Pigs (66th day)	12	10	11	11
Initial weight (kg)	8.26 ± 1.073	7.87 ± 1.111	9.923 ± 1.114	8.717 ± 1.296
Final weight (kg)	12.92 ± 3.084	14.47 ± 1.904	15.76 ± 2.666	14.52 ± 3.074
Daily weight (g.day ⁻¹) gain	155.0 ± 92.379	221.67 ± 47.662	198.79 ± 55.419	187.15 ± 64.736
Diarrhoea (day 10 pig-1) score	16.6	6.5	12.5	12
Mortality (%)	0	16.66	8.33	8.33

SD - standard deviation

Table 5: Enterobacteriaceae in faeces of pigs after 21 days intake of aromatic oils

Group of animals	n	CFU (106 g-1 100 % DM) (mean \pm SEM)
Control	12	$1599.0 \pm 86.829c$
1st experimental	12	$118.41 \pm 38.60a$
2nd experimental	12	$261.59 \pm 96,25a$
3rd experimental	12	$645.3 \pm 147.72b$

Values in the same column with different superscript (a,b,c) differ at $p < 0,01$, CFU – colony forming unit, DM – dry matter, SEM – standard error minor

Table 6: Enterococcus spp. in faeces of pigs after 21 days intake of aromatic oils

Group of animals	n	CFU (10 ⁶ g ⁻¹ 100 % DM) (mean ± SEM) ¹
Control	12	418.42 ± 67.705
1st experimental	12	502.88 ± 110.21
2nd experimental	12	356.01 ± 109.09
3rd experimental	12	664.36 ± 143.66

CFU – colony forming unit, SEM – standard error minor, DM – dry matter

Table 7: Amylolytic activity in faeces of pigs after 21 days intake of aromatic oils

Group of animals	n	Activity (m kat.l ⁻¹) (mean ± SD)
Control	12	47.39 ± 7.31c
1st experimental	12	26.33 ± 9.62a
2nd experimental	12	30.99 ± 7.28b
3rd experimental	12	49.40 ± 21.24

Values in the same column with different superscript (a,b,c) differ at p < 0,01, CFU – colony forming unit, SD – standard deviation

The use of antibiotics in pig feed as an acceptable means for promoting growth and well being of pigs is currently under intense revision by many authorities world-wide. Antibiotics are now banned in many European countries because of a potential risk for human health since the January 2006. The search for safe alternatives of antibiotics in livestock production has been the focus of a lot of scientists over many years.

Phytogenic flavours (essential plant extracts or oils) are the group of compounds that has been Plant products whose use is connected with a positive effect on livestock performance can be called “phytobiotics“.

Some products in this group are used specifically as natural substances with quasi performance- enhancing properties and thus have a not unimportant additional benefit beyond their appetite-stimulating effect (Pape, 2004).

Recent studies have shown that essential oils from Oregano (*O. vulgare*), Thyme (*Thymus vulgaris*), Bay (*Pimenta racemosa*) and Clove (*Eugenia caryophyllata* synonym: *Syzygium aromaticum*) has the highest antibacterial activity against strains of *E. coli* (Smith-Palmer et al., 1998; Hammer et al., 1999; Dorman and Deans, 2000). An important characteristic of essential oils and their components is their hydrophobicity, which enables them to partition in the lipids of the bacterial cell membrane and mitochondria, disturbing the structures and rendering them more permeable (Sikkema et al., 1994).

The results obtained in this research are in partial agreement with the literature.

Wheeler (1995) showed that the application of a complex herbal feed ingredient Livol (Indian Herbs, USA) to pig diet resulted in increased daily weight gain by 85 g pig⁻¹ day⁻¹ (11.94%) and decreased mortality by 15.82% in comparison with the negative control group. However, Kovac and Bilkei (2003) examined sows in a large commercial herd where alternate farrowing groups were given diets containing 1,000 ppm Oregano in the lactation diet. The Oregano treated groups showed a lower sow mortality rate, a lower sow culling rate during lactation, an increased farrowing rate, more liveborn piglets and less stillbirth piglets per litter compared with untreated females.

In conclusion, the growth performances and the incidence of diarrhoeal diseases of the experimental weaned pigs were positively influenced by the intake aromatic oils isolated from Cinnamon, Clove and Oregano. The incidence of diarrhoeal diseases of the weaned pigs was partially negatively affected by bacteriologically objectionable quality of drinking water in the feeding trial. The aromatic oils can perhaps be a more environment friendly perspective in improving production efficiency and protection of animal health.

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