Effects of oregano oil on growth performance of nursery pigs

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Summary

Objective: Two experiments were conducted to evaluate the effects on nursery pig growth performance of feeding a diet containing oregano oil (ORG), an in-feed antimicrobial, or no additive.

Materials and methods: In Experiment One, a total of 224 nursery pigs were used in a 28-day trial. Dietary treatments included a control (without ORG or antimicrobial), the control diet containing neomycin and oxytetracycline (154 mg per kg of each; NT), ORG, or both NT and ORG. In Experiment Two, the five dietary treatments included the control, control diet plus NT, and control diet with ORG at 25, 50, and 100 g per tonne for 28 days. Pigs and feed were weighed to determine ADG, average daily feed intake (ADFI), and feed efficiency (gain:feed; G:F).

Results: There was no differences in ADG, ADFI, or G:F in either experiment whether pigs were fed diets with or without ORG ($P > .05$). In Experiment One, Days 0 to 28, ADG, ADFI, G:F, and final weights were better in pigs fed diets containing NT than in pigs not fed NT ($P < .05$). In Experiment Two, ADG and ADFI were greater in pigs fed NT than in pigs fed the control or ORG diets ($P < .01$).

Implication: Under the conditions of this experiment, addition of in-feed antimicrobials enhanced growth performance of nursery pigs, but addition of oregano at a range of dosages did not.

Keywords: swine, oregano oil, neomycin, oxytetracycline, feed antimicrobial

Received: November 28, 2006
Accepted: February 23, 2006

Resumen – Efectos del aceite de orégano en el desempeño del crecimiento de cerdos de destete

Objetivo: Se realizaron dos experimentos para evaluar los efectos en el desempeño del crecimiento en cerdos de destete alimentados con una dieta que contenía aceite de orégano (ORG por sus siglas en inglés), un antimicrobiano en alimento, o sin aditivo.

Materiales y métodos: En el Experimento Uno, se utilizaron un total de 224 cerdos de destete en una prueba de 28 días. Los tratamientos dietéticos incluyeron un control (sin ORG o antimicrobiano), la dieta de control contenía neomicina y oxitetraciclina (154 mg por kg de cada uno; NT), ORG, o ambos NT y ORG. En el Experimento Dos, los cinco tratamientos dietéticos incluyeron el control, dieta control más NT, y dieta control con ORG a 25, 50, y 100 g por tonelada por 28 días. Se pesaron los cerdos y el alimento para determinar la GDP, el consumo de alimento diario promedio (CDA), y la eficiencia de alimento (ganancia:alimento; G:A).

Resultados: No hubo diferencia en GDP, CDA, o G:A en ninguno de los experimentos, sin importar si los cerdos fueran alimentados con dietas con o sin ORG ($P > .05$). En el Experimento Uno, los Días 0 a 28, la GDP, CDA, G:A, y los pesos finales fueron mejores en cerdos alimentados con dietas que contenían NT que en los cerdos que no recibieron la dieta con NT ($P < .05$). En el Experimento Dos, la GDP y CDA fueron mayores en cerdos alimentados con NT que en cerdos alimentados con la dieta control o con ORG ($P < .01$).

Implicación: Bajo las condiciones de este experimento, la adición de antimicrobiano en alimento mejoró el desempeño del crecimiento en cerdos de destete, pero la adición de orégano en un rango de dosis no lo mejoró.

Résumé – Effets de l'huile d'origan sur les performances de croissance des porcelets en pouponnière

Objectif: Évaluer au cours de deux expériences les effets sur les performances de croissance de porcelets en pouponnière une alimentation contenant de l'huile d'origan (ORG), un supplément antimicrobien, ou aucun supplément.

Matériels et méthodes: Au cours de l'expérience 1 d'une durée de 28 jours, un total de 224 porcelets en pouponnière ont été utilisés. Les traitements alimentaires incluaient un témoin négatif (sans ORG ou agent antimicrobien), une diète témoin contenant de la néomycine et de l'oxytétracycline (154 mg par kg de chaque; NT), ORG, ou NT et ORG. Lors de la deuxième expérience d'une durée de 28 jours, les cinq traitements alimentaires incluaient le témoin négatif, la diète témoin plus NT, et la diète témoin avec de l'ORG à des dosages de 25, 50, et 100 g par tonne. Les porcs et la nourriture ont

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Contribution no. 06–124-J of the Kansas Agricultural Experimental Station.

This article is available online at http://www.aasv.org/shap.html.

Neill CR, Nelssen JL, Tokach MD, et al. Effects of oregano oil on growth performance of nursery pigs. *J Swine Health Prod.* 2006;14(6):312–316.

été pesés pour déterminer le gain journalier quotidien moyen (ADG), la consommation de nourriture quotidienne moyenne (ADFI), et l'efficacité alimentaire (gain: nourriture; G:F).

Résultats: Aucune différence d'ADG, d'ADFI, ou de G:F ne fut noté au cours des deux expériences que les animaux soient nourris ou non avec une alimentation avec ou sans ORG ($P > .05$). Au cours de l'expérience 1, les données d'ADG, d'ADFI, de G:F et de poids aux Jours 0 et 28 étaient supérieures chez les porcs nourris avec une alimentation contenant NT comparativement à ceux ne recevant pas de NT ($P < .05$). Lors de l'expérience 2, les valeurs pour l'ADG et l'ADFI étaient supérieures chez les porcs nourris avec une alimentation contenant NT comparativement aux porcs nourris avec la diète témoin ou la diète avec ORG ($P < .01$).

Implication: Dans les conditions expérimentales décrites, l'ajout d'antimicrobiens dans la nourriture a augmenté les performances de croissance de porcelets en pouponnière alors que l'ajout d'origan à diverses concentrations n'a eu aucun effet.

Several ingredients have been proposed to partly or fully replace antibiotics as growth-promoting agents in swine diets. These include additives such as egg immunoglobulins, mannan oligosaccharide, probiotics, fructo-oligosaccharide, spices, botanicals, essential oils, and herbs.[1-3] Many human food products use oregano for seasoning, for example, pizza toppings. Oregano (*Origanum vulgare*) is a perennial herb grown in many countries, with oregano from the Mediterranean region, especially Turkey and Greece, reputed to be of the highest quality.[4] Oregano's unique odor and taste is attributable to the essential oil produced.[4] Oregano oil has antimicrobial-like activity,[5,6] making it a natural feed additive with the potential to enhance palatability of feed as well as ADG and feed efficiency (gain:feed; G:F) in pigs. Therefore, the objective of this trial was to compare the effects of oregano oil (ORG) and the in-feed antimicrobial combination of neomycin and oxytetracycline (NT) on growth performance in nursery pigs.

Materials and methods

Animals

A total of 434 pigs (PIC L327 × L42) were housed at the Kansas State University Swine Teaching and Research Center in an environmentally controlled nursery in pens (1.17 m × 1.52 m) with woven wire flooring. One self feeder and one nipple waterer in each pen allowed ad libitum access to feed and water. Pigs were observed daily for signs of diarrhea. All experimental protocols used in this study were approved by the Kansas State University Institutional Animal Care and Use Committee.

Experimental design

Two 28-day experiments were conducted, using a total of 224 pigs in Experiment One (initial mean body weight 5.9 kg) and a total of 210 pigs in Experiment Two (initial mean body weight 5.4 kg). Pigs were blocked by weight at weaning (Day 0; 21 ± 2 days of age) and randomly assigned to dietary treatment within weight block. Pigs were housed seven per pen, with eight pens per treatment in Experiment One and six pens per treatment in Experiment Two. Either four barrows and three gilts or three barrows and four gilts were included in each pen. The numbers of barrows and gilts per pen was constant within a weight block, with equal numbers of blocks including each gender ratio in each experiment. In both experiments, pigs were weighed on Days 0, 7, 14, 21, and 28 to determine ADG, ADFI, and G:F.

Experiment One. The four dietary treatments were arranged in a 2 × 2 factorial. Pigs were fed the control diet, the control diet with NT, the control diet with ORG, or the control diet with both ORG and NT. Oregano premix was added at 1 kg per tonne to Phase 1 diets (Days 0 to 14) and at 0.5 kg per tonne to Phase 2 diets (Days 15 to 28) to provide ORG at a rate of 50 g per tonne in Phase 1 and 25 g per tonne in Phase 2.

Experiment Two. The five dietary treatments were the control diet, the control diet plus NT, and the control diet plus oregano oil at 25, 50, and 100 g per tonne of the diet. Oregano oil concentration remained constant for the 28-day trial.

Dietary treatments

The control diets, provided in a meal form, were based on corn-soybean meal and fed

Table 1: As-fed composition of Phase 1 and Phase 2 nursery base diets in a study on effects of in-feed oregano and antimicrobials in nursery pigs

Variable	Phase 1	Phase 2
Ingredient (%)		
Corn	48.10	59.97
Soybean meal (46.5% CP)	29.00	34.98
Spray-dried whey	15.00	0
Select menhaden fish meal	3.75	0
Monocalcium phosphate (21% P)	1.15	1.60
Limestone	0.70	1.10
Salt	0.33	0.35
Vitamin premix with phytase	0.25	0.25
Trace mineral premix	0.15	0.15
L-threonine	0.13	0.15
L-lysine HCl	0.30	0.30
DL-methionine	0.15	0.15
Corn starch*	1.00	1.00
Calculated analysis		
Lysine (%)	1.55	1.45
Metabolizable energy (kcal/kg)	3.25	3.31
Crude protein (%)	26.40	21.40

* Dietary treatments were provided by substituting oregano premix or neomycin and oxytetracycline at the expense of corn starch in the base diet. Phase 1 diets were fed Days 0 to 14 after pigs were weaned (21 ± 2 days of age), and Phase 2 diets were fed Days 15 to 28.

in two phases (Table 1). The Phase 1 diet was formulated to contain 1.55% lysine and included 15% dried whey and 3.75% fish meal. The Phase 2 diet was formulated to contain 1.45% lysine with no specialty protein sources. The control diet for each phase, excluding the corn starch, was mixed in one batch and divided into four aliquots for Experiment One and five aliquots for Experiment Two. Premixes for each diet were then made with corn starch and the appropriate additive, and each premix was then mixed into an aliquot of the control diet. Diets were analyzed for crude protein content and were correct within normal expected analytic variation.

The oregano premix was a commercially available product (Regano 500; Ralco-mix Products, Marshall, Minnesota) consisting of 5% oregano oil and 95% inert carrier. Information provided by the premix provider indicated that the oregano oil used in the product contained from 75.0% to 84.0% carvacrol and 0.7% to 4.0% thymol.[4] According to company literature, the oregano used in these two experiments was cultivated in Greece and harvested from June to July when the plants are mature and expected to produce the most oil.[4]

The NT in-feed antimicrobial was provided as a premix containing neomycin sulfate (22 mg per kg) and oxytetracycline (22 mg per kg) (Neo-Oxy 10/10; Penfield Animal Health, Omaha, Nebraska). The premix was substituted at the expense of corn starch to provide 154 mg per kg neomycin sulfate and 154 mg per kg oxytetracycline in the complete feed in Phase 1 and 2.

Statistical analysis

Each experiment was analyzed as a randomized complete block design with pen as the experimental unit and pigs blocked on the basis of weaning weight. Analysis of variance was performed using the Mixed procedure of SAS (SAS Institute Inc, Cary, North Carolina) with block as a random effect and treatment as a fixed effect. In Experiment One, the effects of treatment were partitioned into the main effects of ORG, NT, and their interaction. In Experiment Two, preplanned contrasts were used to evaluate the effects of control versus NT, control versus ORG, and NT versus ORG, and linear and quadratic polynomial contrasts to determine the effects of increasing ORG dose. In all analyses, a P value of < .05 was considered significant.

Table 2: Mean body weights and growth parameters in nursery pigs fed a base diet (control) or the same diet supplemented with oregano oil (ORG) or neomycin and oxytetracycline (NT) (Experiment One)*

Variable	Treatment					*P*		
	Control	ORG	NT	ORG + NT	SE	ORG	NT	ORG × NT
Body weight (kg)								
Day 0	5.8	5.9	5.9	5.8	0.06	.80	.89	.57
Day 28	15.7	16.2	17.7	17.5	0.36	.65	< .001	.22
Growth parameters Days 0 to 14								
ADG (g)	225	237	284	280	13	.67	< .001	.40
ADFI (g)	267	274	305	301	14	.87	< .01	.61
G:F	0.84	0.87	0.93	0.93	0.026	.49	< .001	.37
Growth parameters Days 0 to 28								
ADG (g)	354	369	423	417	13	.61	< .001	.25
ADFI (g)	478	485	545	538	16	.98	< .001	.54
G:F	0.74	0.76	0.78	0.77	0.011	.24	< .01	.15

* A total of 224 nursery pigs (initial weight 5.9 kg and 21 ± 2 days of age) were used, with eight replications (pens) per treatment and seven pigs per pen (total of 32 pens). Dietary treatments were provided in a 2 × 2 factorial arrangement with ORG at a rate of 50 g/tonne in Phase 1 (Days 0 to 14) and 25 g/tonne in Phase 2 (Days 15 to 28), and NT at a rate of 154 g/tonne neomycin sulfate and 154 g/tonne oxytetracycline. Phase 1 and Phase 2 control diets (Table 1) contained neither ORG nor NT. Analysis of variance was performed with block as a random effect and treatment as a fixed effect with the effects of treatment partitioned into the main effects of ORG, NT, and their interaction (ORG × NT).

Results

In Experiment One, no ORG by NT interactions were observed (P > .05; Table 2). All growth parameters measured Day 0 to 28 were better (P < .01) for pigs fed NT compared to those fed all other treatments: ADG was 420 g for pigs fed NT and 361 g for pigs not fed NT (SE 12.2 g); ADFI was 542 g for pigs fed NT and 481 g for pigs not fed NT (SE 18.4 g); and G:F was 0.78 for pigs fed NT and 0.75 for pigs not fed NT (SE 0.007). Growth parameters measured Days 0 to 28 for pigs fed diets with or without ORG did not differ (P > .05): ADG was 393 g for pigs fed ORG and 388 g for pigs not fed ORG (SE 12.2 g); ADFI was 512 g for pigs fed ORG and 511 g for pigs not fed ORG (SE 18.4 g); and F:G for pigs fed ORG was 0.77 and 0.76 (SE 0.007) for pigs not fed ORG.

In Experiment Two, ADG and ADFI were greater for pigs fed NT at all data points and for Days 0 to 14, G:F was greater for pigs fed NT than for pigs fed the control or ORG diets (Table 3). For Days 0 to 28, G:F was better for pigs fed NT and these pigs were heavier than those fed ORG (Table 3). The ADG, ADFI, G:F, and 28-day weights of pigs fed ORG (25, 50, or 100 g per tonne) were similar to those of pigs fed the control diet (P > . 05), and there was no effect on growth parameters of increasing dose of ORG (linear ORG, P > .05; quadratic ORG, P > .05).

Discussion

Antibiotics are commonly added to swine diets to increase growth rate and feed efficiency and for disease prevention.[7] The response to feeding antibiotics is greater in nursery pigs than in finishing pigs and in unhygienic environments than in hygienic environments.[7] With widespread use of antibiotics, health officials are concerned about antimicrobial resistance when humans consume meat from livestock that have been fed antibiotics.[8] The use of antimicrobials in livestock feed is being debated as a public health issue.[8] Therefore, there is a need for in-feed antimicrobial substitutes. Many studies have evaluated various feed additives to replace antimicrobials. However, no results have demonstrated the same growth performance and feed efficiency responses to these "substitutes" compared to in-feed antimicrobials.

Table 3: Effects of three levels of oregano oil (ORG) or neomycin and oxytetracycline (NT) in the feed on growth performance of nursery pigs (Experiment Two)*

Variable	ORG (g/tonne)					SE	*P*	
	Control	NT	25	50	100		Control vs NT	NT vs ORG
Body weight (kg)								
Day 0	5.4	5.4	5.4	5.4	5.4	0.57	.98	.99
Day 28	15.4	17.0	15.4	15.3	15.4	0.99	.09	.04
Growth parameters Days 0 to 14								
ADG (g)	235	310	225	228	235	16	< .001	< .001
ADFI (g)	262	322	250	268	272	17	< .01	< .001
G:F	0.90	0.97	0.90	0.85	0.86	0.027	.01	< .001
Growth parameters Days 0 to 28								
ADG (g)	357	418	356	354	358	17	< .001	< .001
ADFI (g)	450	520	455	459	461	23	< .001	< .001
G:F	0.79	0.81	0.78	0.77	0.78	0.013	.35	.01

* A total of 210 pigs were used (initial mean weight 5.4 kg and 21 ± 2 days of age), with six replicates (pens) per treatment and seven pigs per pen (total of 30 pens). Dietary treatments were fed in two phases (Table 1) and included a base diet (control) and the base diet with NT at a rate of 154 g/tonne neomycin sulfate and 154 g/tonne oxytetracycline or with 25, 50, or 100 g/tonne ORG. Analysis of variance was performed with block as a random effect and treatment as a fixed effect. Preplanned contrasts were used to evaluate the effects of control versus NT, control versus ORG, and NT versus ORG, and linear and quadratic polynomial contrasts to determine the effects of increasing ORG dose.

Natural oregano oil has many components. Two of these, carvacrol and thymol, have been shown to have the strongest antimicrobial activity.[4] In their evaluation of 50 essential oils, Deans and Ritchie[5] placed thymol among the 10 with the greatest antimicrobial activity. A research trial conducted by Baratta et al[6] examined the antimicrobial activity of laurel, sage, rosemary, oregano, and coriander oils. Microbial growth inhibition of the microorganisms tested was greatest for oregano oil.

In a study by Gunter and Bossow,[9] in which weaned pigs were fed a diet containing oregano premix (5% etheric oil and 95% carrier) at 500 g per tonne, ADG and F:G were better in pigs fed the diet containing the oregano premix than in pigs fed the same diet without oregano. No antibiotics were fed in this study.

Oregano also has been reported to enhance sow reproductive performance. Amrik and Bilkei[10] reported enhancements in mortality rate, sow culling rate, farrowing rate, and number of liveborn pigs when sows were fed gestation and lactation rations containing oregano premix at 1000 g per tonne. In this study, each kg of oregano premix contained 500 g oregano oils (60 g carvacrol and 55 g thymol per kg), mixed with dried leaf and flower of *Origanum vulgare* up to 1 kg. Khajarern and Khajarern[11] also reported an increase in daily feed intake in lactating sows when origanum essential oil was added to the diet at 250 g per tonne, and in addition, daily weight gain was higher in pre-weaned pigs from these sows than in litters from sows not fed oregano oil.

Utiyama et al[12] evaluated growth performance in weanling pigs (21 days of age) fed a diet containing a combination of herbal extracts of garlic, clove, cinnamon, pepper, and thyme at 500 g per tonne. No enhanced growth performance was observed when the herbal extracts were fed. Cloves and spices have been used for many years as food preservatives because of their antimicrobial activity. Main et al[13] evaluated cloves as a substitute for antimicrobials in nursery pig diets in two experiments. Results were inconsistent, with ADG better in pigs fed the lowest concentration of cloves only during Days 0 to 21 in the first experiment and no growth enhancement in the second experiment. Iowa State University has published numerous reports evaluating several botanicals: echinacea,[14,15] garlic,[16,17] goldenseal,[18] and peppermint.[19,20] Growth performance of nursery pigs was assessed when diets contained either increasing levels of one of the botanicals or an in-feed antibiotic. Results of these trials showed either no growth-performance enhancement or inconsistent results among experiments. Turner et al[2] reviewed studies evaluating the effects of probiotics, oligosaccharides, spices, and plant extracts on growth performance of swine, as well as effects on gut function and health. Results were inconsistent and no true substitute for antimicrobials was identified. These reports, together with the results of our current studies, suggest that no herbal or plant-based substance tested is an effective substitute for nursery feed antimicrobials.

Implication

- Under the conditions of this experiment, addition of in-feed antimicrobials enhanced growth performance of nursery pigs, but addition of oregano at a range of dosages did not.

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