BRIEF COMMUNICATION PEER REVIEWED

Effect of a phytogenic feed additive on weaning-to-estrus interval and farrowing rate in sows

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Summary

Primiparous and multiparous sows were supplemented during lactation and until the first standing estrus with oregano, chlortetracycline, or no supplement. Weaning-to-estrus interval was shorter in sows supplemented with oregano compared to other treatments, and farrowing rate was greater in sows supplemented with either chlortetracycline or oregano compared to untreated sows.

Key words: swine, oregano, weaning-to-estrus interval, farrowing rate, total born litter size

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Weaning-to-estrus interval (WEI) is a major contributor to sow nonproductive days.[1] Shortening WEI may be achieved by zootechnical methods (eg, feeding management, flushing, breeding management practices) or biotechnical methods (eg, use of exogenous gonadotropins).[2]

Oregano feed supplementation exerts positive effects against various gastrointestinal infectious or multifactorial diseases.[1,3–16] Khajarern and Khajarern[8] found that when essential oils of the plant *Origanum vulgare* (commonly called oregano) were fed to sows, there was a significant positive effect on live born litter weights, weaning weights, preweaning mortality, and sow feed intake during lactation. There have been no previously published reports on the effect on WEI, farrowing rate (FR), and subsequent total born litter size when oregano essential oils are fed to a large number of sows under field conditions.

Material and methods

Animals

This trial was conducted between April and August 2002, in a 1600-sow, indoor production unit in Alföld, Hungary. A total of 132 primiparous and 138 multiparous sows (Landrace × Duroc, F_1 generation) were used in the study. The herd was of high health status, with minimal signs of respiratory disease in finishing pigs. Sows were vaccinated against erysipelas during the second trimester of pregnancy, and against pseudorabies, leptospirosis, and *Escherichia coli* (with a commercial killed *E coli* vaccine to prevent diarrhea in neonatal piglets) during the third trimester.

Study groups and study design

Sows were assigned at parturition to one of three treatment groups, with 44 primiparous and 46 multiparous animals in each. The animals were identified with ear tags of different colors for each treatment group. During lactation, and from weaning to first standing estrus, Group 1 received supplementation with oregano in the feed, Group 2 received no feed supplementation or treatment (controls), and Group 3 were treated with in-feed chlortetracycline (subtherapeutic dose). A body condition (BC) score,[1] as defined in Table 1, was determined for all sows at parturition and at weaning. The degree of fat cover was estimated visually and by palpation over the ischium, ribs, vertebrae, and tailhead. Weight loss and loss of back fat during lactation were not recorded.

During lactation, sows were housed in identical large farrowing barns, each with 30 identical individual farrowing crates. Assignment of sows to crates was randomized so that sows in the same treatment group were not necessarily housed next to each other. Caretakers were not blinded to the treatments. Piglets were cross-fostered within 24 hours of birth to provide an even litter size of 10 piglets. Litters were weaned at 22.1 ± 2.1 (SD) days of lactation.

At weaning, all sows were transferred to a single breeding area in an adjacent barn, consisting of 20 identical breeding subcomplexes, where they were housed in identical crates arranged so that they had continuous nose-to-nose contact with boars and sows in adjacent crates.[1] Sows were checked twice daily for estrus, beginning on Day 3 postweaning. Because of individual variation in the time of ovulation, all sows were bred by artificial insemination at detection of estrus and again 24 hours later.[1] Artificial insemination was performed using commercial pooled semen with 3×10^9 spermatozoa per dose. Three weeks post insemination, sows were rehoused in groups of eight in large pens (14 m^2).

Feed

Sows in all treatment groups were fed the same commercial lactation diet (digestible energy [DE], 12.6 MJ per kg; crude protein, 180 g per kg; lysine, 12 g per kg; calcium, 8.5 g per kg; and phosphorus, 6.5 g per kg). During the last 4 days prior to farrowing, sows were fed 2 to 3 kg of this ration daily. Feed was withdrawn on the day of farrowing. Beginning the day after parturition and continuing until the day of weaning, the lactation ration was provided ad libitum. In the period between weaning and standing heat, the lactation diet for all three groups was provided ad libitum and was top dressed with vitamin E, 300 IU per kg feed. For the first 12 days after insemination, the lactation ration was fed

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Table 1: Postweaning body condition scoring for primiparous and multiparous sows in a 1600-sow production unit in Hungary

Score	Pelvic bones	Loin	Ribs	Vertebra	Back fat[1] (mm)
1	Prominent, deep cavity around tail head	Narrow with sharp edge, hollow flank	Prominent	Prominent	<12
2	Slightly covered, some cavity around tail	Narrow, slightly covered	Prominent	Covered, can be felt	13-14
3	Covered	Spinal process covered	Visible only over the shoulder	Covered, can be felt	15-16
4	Felt with firm pressure	Felt with firm pressure	Felt with firm pressure	Not visible, felt with firm pressure	17-19
5	Impossible to feel	Impossible to feel	Impossible to feel	Impossible to feel	20-23
6	Impossible to feel, folds of fat surrounding tail	Thick fat cover	Thick fat cover	Thick fat cover	>23

[1] Back fat was estimated by observation and palpation, not measured.

at 2 kg per sow per day.[1] Between days 12 and 90 of gestation, sows in all treatment groups were fed, according to their body condition, 2 to 2.5 kg daily of a commercial gestation diet[1] (DE, 12.2 MJ per kg; crude protein, 125 g per kg; lysine, 6.5 g per kg; calcium, 8.5 g per kg; and phosphorus, 4 g per kg).

The lactation diet for Group 1 was supplemented with Oregpig (Feed Additives, Pecs, Hungary), 1000 mg per kg of feed. Oregpig contains the dried leaf and flower of *Origanum vulgare*, enriched with 500 g per kg cold-pressed essential oils of the leaf and flower of *Origanum vulgare*, and also contains 60 mg per kg carvacrol and 55 mg per kg thymol. The lactation diet for Group 3 contained 100 mg chlortetracycline per kg. The lactation diet for Group 2 contained no supplement.

The amounts of lactation diet required for Groups 1 and 3 for the entire trial were mixed in the same mixer at the beginning of the study. The feed mixer was flushed between rations to ensure that there was no residue in the next feed mixed. The diets for the three treatment groups were stored in bags of different colors.

In each farrowing crate, a plastic container with a capacity of 50 kg delivered feed into a deep trough (depth 30 cm). Average daily feed disappearance was interpreted as average daily feed intake. Feed disappearance for each sow was calculated during lactation by weighing the feed given to the sow and the unconsumed feed. Because of the depth of the trough, no feed wastage was expected, and feed wastage was not recorded.

Estrus detection

Signs regarded as indicative of impending estrus included sow activity, vocalization, nibbling and nosing with the boar and sows standing in adjacent crates, and reddening and swelling of the vulva (not always present in older sows).[2] A positive "riding test" and slight sticky discharge (positive thumb test) were considered final confirmation of estrus.[2]

Calculations and statistical analysis

Statistical analyses were performed using the GLM procedures of SAS (SAS Institute, Cary, North Carolina) to derive least squares means and SE. Differences between calculated parameters of the groups (average voluntary daily feed intake, WEI, and subsequent total born litter size) were compared. When marked deviations from normality were present (verified by Levene's test significance), data were transformed to homogenize such variations. Covariate included in the model was parity, and the dependent variables were WEI and subsequent total born litter size. The month of weaning was found significant ($P = .04$) and was therefore included as a covariate. Full lactation length, full litter size suckled, number of piglets removed, and number of piglets remaining with the sow had no significant effects on WEI or subsequent total born litter size and were not included as covariates. Only sows detected as estrous by 18 days after weaning were included in the analyses. For the purposes of this study, the remaining sows were designated as "anestrus." Farrowing rates were compared by χ^2 analysis. Body condition score and number of anestrous sows in each treatment group were not statistically analyzed.

Results

All sows remained healthy, without excessive post-mating or postparturient discharges. Average BC score was 3.3 ± 0.2 at parturition and 3.0 ± 0.2 at weaning for primiparous sows, and 3.2 ± 0.2 at parturition and 3.0 ± 0.3 at weaning for multiparous sows.

Among primiparous sows, one sow in each of Groups 1 and 3 (2.8%), and two sows in Group 2 (4.5%) failed to exhibit estrus by 18 days after weaning. Among multiparous sows, one sow in Group 1 (2.2%), two in Group 2 (4.3%), and three in Group 3 (6.5%) were anestrous.

Feed wastage was not observed. Primiparous sows had an average voluntary daily feed intake of 5.6 ± 0.84 kg, with 5.5 ± 0.81 kg in Group 1, 5.5 ± 0.89 kg in Group 2, and 5.7 ± 0.17 kg in Group 3. Daily feed intake of primiparous sows did not differ among treatment groups ($P > .05$).

Multiparous sows had an average voluntary daily feed intake of 7.2 ± 0.63 kg, with 7.5 ± 0.11 kg in Group 1, 7.0 ± 0.39 kg in Group 2, and 7.2 ± 0.14 kg in Group 3. Mean feed intake of multiparous sows was greater in Group 1 than in Group 2 ($P = .05$), but did not differ between Groups 1 and 3 and Groups 2 and 3 ($P > .05$).

Effects on WEI and FR of treatment with oregano (Group 1) or chlortetracycline (Group 3) compared to no treatment

Table 2: Effect of *Origanum vulgare* (oregano) or chlortetracycline on weaning-to-estrus interval (WEI), subsequent farrowing rate, and subsequent total born litter size of primiparous and multiparous sows[1]

Treatment (Group)	No. of anestrous sows / total no. of sows (%)	WEI (days)	Farrowing rate[2] (%)	Total born litter size
Primiparous sows (n=44 in each treatment group)				
Oregano (1)	1/44 (2.8)	5.1 ± 0.3[a]	38/43 (88.4)[c]	10.1 ± 0.4
No treatment (2)	2/44 (4.5)	6.2 ± 0.7[b]	34/42 (81.0)[d]	10.1 ± 0.5
Chlortetracycline (3)	1/44 (2.8)	6.1 ± 0.5[b]	37/43 (86.0)[e]	10.2 ± 0.6
Multiparous sows (n=46 in each treatment group)				
Oregano (1)	1/46 (2.2)	4.5 ± 0.4[A]	38/45 (84.4)[f]	10.8 ± 0.5
No treatment (2)	2/46 (4.3)	5.5 ± 0.6[B]	34/44 (77.3)[g]	10.7 ± 0.6
Chlortetracycline (3)	3/46 (6.5)	5.3 ± 0.8[B]	37/43 (86.0)[e]	10.8 ± 0.4

[1] Sows were assigned to one of three groups. Beginning the day after parturition, feed for Group 1 sows included an oregano supplement at 1000 mg/kg feed, provided in a commercial oregano premix that contained 500 mg/kg essential oils of *Origanum vulgare*, 60 mg/kg carvacrol, and 55 mg/kg thymol; feed for Group 2 sows contained no supplements; and feed for Group 3 sows included chlortetracycline, 100 mg/kg feed.

[2] Farrowing rate = total no. of sows that farrowed ÷ (total no. of sows – no. of anestrus sows).

[a,b] Within a column, values with different superscripts differ, $P = .04$ (linear regression analysis)

[A,B] Within a column, values with different superscripts differ, $P = .01$ (linear regression analysis)

[c,d; f:g] Within a column, values with different superscripts differ, $P = .02$ (χ^2 test).

[d,e] Within a column, values with different superscripts differ, $P = .03$ (χ^2 test).

[c,e] Within a column, values with different superscripts differ, $P = .05$ (χ^2 test).

(Group 2) are shown in Table 2. The mean WEI of primiparous sows (5.8 ± 0.2 days) was greater ($P = .03$) than that of multiparous sows (5.1 ± 0.2 days). In both primiparous and multiparous sows, WEI was shorter in Group 1 compared to Groups 2 and 3 (Table 2). Farrowing rates were higher in Groups 1 and 3 compared to Group 2, both for primiparous and multiparous sows (Table 2).

Subsequent total born litter size did not differ among treatment groups ($P > .05$). Mean total born litter size for primiparous sows was 10.1± 0.4 in Group 1, 10.1 ± 0.5 in Group 2, and 10.2 ± 0.6 in Group 3. Mean total born litter size for multiparous sows was 10.8 ± 0.5 in Group 1, 10.7 ± 0.6 in Group 2, and 10.8 ± 0.4 in Group 3.

Discussion

Especially in Europe, social pressure for less antimicrobial usage in pig production is forcing researchers to identify environmentally friendly natural alternatives that exert therapeutic effects similar to in-feed antimicrobials.[1,3–16] In this study, chlortetracycline did not influence anestrus, but WEI and FR were significantly better for sows treated with in-feed chlortetracycline compared to the untreated controls. The subtherapeutic dose of chlortetracycline might have exerted a protein-sparing effect and resulted in acceleration of milk production and uterine involution.[1]

Phytogenic feed additives are not new in veterinary medicine. Studies have shown that essential oils derived from the plant *Origanum vulgare* have in vitro antimicrobial activities against various bacteria[7–16] and, in addition, have antioxidant properties.[3] Effectiveness of origanum oils has been reported for postweaning diarrhea caused by *Escherichia coli,*[6,7,14] growth retardation of growing pigs,[5] and porcine proliferative enteropathy.[6] It has been reported that *Origanum vulgare* stimulates organic and microbiotic digestion.[7,13] Oregano supports digestion and absorption of nutrients and regulation of gastrointestinal metabolism, and exerts antibacterial properties in the digestive tract of the pig by hindering dysbiotic processes.[7,11–16] It was reported that supplementation of pigs with oregano at 1000 ppm in the feed during the postweaning period significantly improved weight gain and health.[7] In a recently published study, Khajarern and Khajarern[8] reported a significant ($P < .05$) positive effect of oregano essential oils on total litter birth weights, total litter weaning weights, preweaning mortality, and sow feed intake during lactation, stating that *Origanum vulgare* essential oils in sow feed stimulated appetite and digestion. In contrast, average voluntary feed intake in this study was not significantly greater in primiparous sows treated with oregano, but was significantly greater in multiparous sows treated with oregano, compared to the control animals.

Khajarern and Khajarern[8] concluded that carvacrol and thymol accelerate renewal rate of mature enterocytes on intestinal villi, and that *Origanum* essential oils not only act as alternative antibacterial performance promoters, digestion aids, and appetite enhancers in sows, but also enhance growth and reproductive performance.

The effect of oregano on sow fertility may only be speculated. If *Origanum vulgare* stabilizes gut microflora,[13] decreases populations of undesirable microorganisms,[10–15] and increases the digestibility of the feed,[13] the sows' general health may be improved, and postparturient immune system activation might be positively influenced (ie, the delayed immune response and reduced leukocyte activity of the postparturient uterus may be diminished).[1] Such an effect may improve uterine involution and protect the sow from postpartum urogenital infections.

In this study, improved WEI and FR might have been the result of an additive effect between *Origanum vulgare* and Vitamin E, which plays a role in normal leukocyte function.[17]

The results of this study show that feeding oregano to lactating and postweaning sows does improve some reproductive parameters. Oregano is a feed additive of natural origin that may be preferred because it is perceived as more consumer and environmentally friendly. Where it is available in Europe, it is more cost effective than antibiotics. It is important to note that the natural origin of a feed additive does not make it better or safer than other additives. Many antibiotics are of natural origin, originating from molds. There is no evidence that oregano is more user friendly to producers and safer for consumers than antibiotics, particularly if it exerts antimicrobial effects. Therefore, basic research is needed both to describe the precise effects of essential oils of *Origanum vulgare* on the gastrointestinal, immune, and urogenital systems, and to discover possible problems with residues in meat.

Implication

- Supplementation with *Origanum vulgare* in the feed during the first 22 days of lactation, and from weaning to mating, may improve the reproductive performance of sows fed ad libitum.

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