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Short communication

Effect of Brazilian red pepper (*Schinus terebinthifolius* Raddi) essential oil on performance, diarrhea and gut health of weanling pigs

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ABSTRACT

This study aimed to evaluate the effects of dietary Brazilian red pepper (*Schinus terebinthifolius* Raddi) essential oil and an antimicrobial agent on weanling pig growth performance, diarrhea occurrence, pH of the digestive content, small intestine histology, and intestine microbial counts. Ninety weanling castrated male pigs (5.6 ± 0.78 kg BW and 21-d old) were used in a randomized complete block design experiment with five treatments, six replications per treatment, and three animals per experimental unit (pen). The treatments were a basal diet supplemented with 0 (negative control), 500, 1000, and 1500 mg/kg Brazilian red pepper essential oil vs with 120 mg/kg chlorohydroxyquinoline (antibiotic treatment). At the end of the experimental period one animal from each pen was slaughtered to record the pH of digestive contents, small intestine histology, and intestine microbial counts. Treatments had no effect ($P > 0.05$) on growth performance, diarrhea occurrence, pH of the digestive content, villus height, crypt depth, and intestinal microbial counts of weanling pigs. However, pigs fed the diet containing 500 mg/kg essential oil had greater villi density ($P < 0.05$) than those fed diets containing the antibiotic or 1000 and 1500 mg/kg essential oil. Thus, both Brazilian red pepper essential oil and the antibiotic are of limited benefit for enhancing the growth of weanling pigs. However, the effectiveness of growth enhancer additives may be reduced in low challenging situations as demonstrated by the current study.

1. Introduction

The use of natural additives for food preservation and disease control in humans, animals, and plants are of scientific and industrial interest. Continued advances in modern technology are facilitating the isolation and characterization of active components present in plants, along with improving our understanding about their potential actions and, hence, human-interest applications (Costa et al., 2013).

Traditionally, antibiotic growth promoters were used to enhance piglet performance during weaning period; however, possible bacterial cross-resistance has limited the use of the antibiotics as growth promoters (Brenes and Roura, 2010). Thus, the potential application of plant extracts, essential oils, oleoresins, and their purified compounds is being investigated as alternative feed strategies to enhance weanling pig performance during this critical period (Hashemi and Davoodi, 2011).

Brazilian red pepper (*Schinus terebinthifolius* Raddi, Anacardiaceae) exhibits antimicrobial activity in vitro (Lima et al., 2006) and also has various medicinal properties, including antioxidant (Bendaoud et al., 2010), antitumoral (Matsuo et al., 2011) and antifungal (Johann et al., 2010) properties. However, there is in the literature, one study with Brazilian red pepper in broiler feed. Silva et al. (2010) found an increase on weight gain and final body weight when broiler chickens were fed dietary red pepper essential oil (4000 mg/kg). Therefore, it has been hypothesized that red pepper could replace performance-enhancing antibiotics also in weanling pig diets. To our knowledge there are not studies that evaluated Brazilian red pepper in swine feed.

This study aimed to evaluate the effects of dietary Brazilian red

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pepper (*S. terebinthifolius* Raddi) essential oil and an antimicrobial agent on the growth performance, diarrhea occurrence, pH of digestive content, small intestine histology, and intestine microbial counts of weanling pigs.

2. Material and methods

2.1. Essential oil composition of Brazilian red pepper (S. terebinthifolius Raddi) fruit

The composition of the essential oil from pepper tree fruit was determined by using a gas chromatograph (6890N, Agilent Technologies, Santa Clara, USA) with a mass detector (5973, Agilent Technologies), equipped with a DB-5MS silica column (60 m × 0.32 mm × 1.0 μm). Identification was confirmed using standard compounds that were available in the chosen library (Givaudan Ltda., São Paulo, SP, Brazil). The essential oil from pepper tree fruit contained δ-3-carene 41.01%, α-phellandrene 14.40%, limonene 12.36%, α-pinene 10.36%, and other compounds 21.87%.

2.2. Animals, facilities, and experimental design

All procedures using animals were approved by the "Committee of Ethics for the Use of Animals (CEUA) of the State University of Santa Cruz (Ilhéus, Bahia, Brazil)" (Protocol 024/2011). Ninety weanling castrated male pigs (female DanBred – DB90 × male PIC-AGPIC337) (5.6 ± 0.78 kg BW and 21-d of age) were used in a randomized complete block design experiment with five treatments, six replications per treatment, and three animals per experimental unit (pen).

2.3. Experimental diets

The dietary treatments were a basal diet supplemented with 0 (negative control), 500, 1000, and 1500 mg/kg of red pepper essential oil (AgroRosa Ltda, São Mateus, ES, Brazil) vs 120 mg/kg of chlorohydroxyquinoline (antibiotic treatment) (Indukern Ltda, São Paulo, SP, Brazil). The red pepper essential oil was microencapsulated to stabilize the molecule and minimize its sharp flavor. The microcapsules contained 15% of the red pepper essential oil and the carrier.

Basal diets (Table 1) were formulated according to the nutrient requirements of pigs (Rostagno et al., 2011). A two-phase feeding program was adopted: pre-starter (days 1–14 of the experiment) and starter (days 14–35 of the experiment).

2.4. Experimental procedure

During the trial period, the animals were provided water and feed ad libitum.

The performance variables (average daily feed intake, average daily gain, and feed:gain ratio) were calculated by using animal BW and feed disappearance data. The presence or absence of diarrhea (liquid feces on the floor and/or soiling in the anal area) was checked twice a day to calculate the percentage of days with diarrhea.

At the end of the experiment one animal with BW closest to the average BW of each pen (with six animals per treatment) was slaughtered according to humanitarian approved methods by electrical stunning followed by exsanguination. The pH of the stomach, jejunum, and cecum contents was immediately measured by inserting a unipolar electrode, following the methods of Manzanilla et al. (2004).

To measure the histology of the small intestine (villus height and crypt depths), 3-cm samples of duodenum (resected at 15 cm from the pylorus sphincter) and jejunum (resected at 150 cm from the ileocecal junction) were cut, washed with saline solution (0.9% NaCl), and fixed in buffered formalin solution as described by Gao

Table 1
Basal diet composition (as-fed basis) fed to piglets throughout the 35-day experimental period[a].

Ingredients (%)	Pre-starter diet (1–14 days)	Starter diet (14–35 days)
Soybean meal (46%)	31.02	33.71
Corn	16.11	43.63
Gelatinized corn	15.00	–
Biscuit meal	20.00	6.00
Milk product[b]	5.00	4.00
Milk product[c]	3.16	1.50
Dextrin	4.10	2.20
Sugar	0.21	2.60
Soybean oil	–	1.27
Dicalcium phosphate	1.88	1.59
Limestone	–	0.42
Salt	0.40	0.40
$NaHCO_3$	0.25	0.20
L-lysine.HCl (78%)	0.55	0.40
DL-Methionine (99%)	0.31	0.23
L-Threonine (98.5%)	0.20	0.11
L-Tryptophan (98%)	0.02	–
Choline chloride (60%)	0.10	0.04
Vitamin and mineral premix[d]	0.20	0.20
Inert and/or feed additive	1.50	1.50
Calculated values (%)		
Metabolizable energy (MJ/kg)	14.57	14.15
Crude protein	20.23	20.63
Calcium	0.85	0.83
Total phosphorus	0.71	0.66
Available phosphorus	0.51	0.45
Digestible lysine	1.46	1.37
Digestible met+cys	0.83	0.79
Digestible tryptophan	0.88	0.82
Digestible threonine	0.25	0.24

[a] Commercial diet-Master Nutrição Animal® (Minas Gerais, Brazil).
[b] Start-pro 20 (40.5% lactose)-Auster Nutrição Animal Ltda. (São Paulo, Brazil).
[c] Prius L72 (71.5% lactose)-Auster Nutrição Animal Ltda. (São Paulo, Brazil).
[d] Quantities per kg of feed: 50 mg of manganese; 160 mg of zinc; 246 mg of iron; 14 mg of copper; 1.5 mg of iodine; 15000 IU of vitamin A; 3000 IU of vitamin D3; 110 IU of vitamin E; 5.5 mg of vitamin K3; 4.4 mg thiamine; 9.2 mg of riboflavin; 6.6 mg Pyridoxine; 38 μg of vitamin B12; 1.6 mg of folic acid; 27 mg of Pantothenic acid; 44 mg of niacin; 0.14 mg of biotin; 0.36 mg of selenium.

Table 2
Effects of dietary Brazilian red pepper essential oil and an antimicrobial agent on the body weight (BW), average daily feed intake (ADFI), average daily gain (ADG), feed:gain ration (F:G), diarrhea occurrence (DF) (n=18/group), and villi density (VD) in the duodenum and jejunum (n=6/group) of weanling piglets during the 35-day post-weaning period.

Variables	Treatments[a]					SEM[b]	*P*-value
	ANT	0	500	1000	1500		
Performance:							
Initial BW (kg)	5.64	5.65	5.66	5.65	5.65	–	–
Final BW (kg)	14.85	16.99	16.30	14.84	16.66	0.078	0.10
ADFI (g)	497.82	557.29	543.14	478.88	538.84	103.9	0.14
ADG (g)	321.23	311.56	345.53	308.65	323.79	34.88	0.36
F:G	1.71	1.80	1.72	1.61	1.90	0.001	0.16
DF (%)	36.00	37.50	37.83	38.17	28.00	2.692	0.25
VD duodenum[c]	25.44c	33.75ab	39.56a	18.29c	26.56bc	0.81	0.00
VD jejunum	32.75	32.22	28.89	27.00	37.50	2.55	0.31

[a] ANT=Antibiotic (120 mg/kg chlorohydroxyquinoline); 0; 500; 1000; or 1500 mg/kg of red pepper essential oil.
[b] Standard Error of the Mean.
[c] Different letters in the row indicate a significant difference between the values by the Tukey test (5%).