Indian Journal of Animal Sciences **85** (9): 1017–1020, September 2015/Article

Effects of essential oil and yeast culture supplements on growth performance, nutrient digestibility and blood characteristics in weaning pigs

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Received: 22 April 2014; Accepted: 24 March 2015

ABSTRACT

The present study was undertaken to assess the effects of essential oil (EO) and yeast culture (YC) on growth performance, nutrient digestibility and blood profiles in weaning pigs. Pigs were randomly assigned to basal diet, basal diet with 0.05% EO, and basal diet with 0.2%, 0.3% or 0.4% YC in 2 phases. During the first phase, feed efficiency though not significant was numerically higher in YC 0.3 and EO treatment compared with control whereas ADG was numerically higher in pigs with EO treatment. During 0–14 days, dry matter, nutrient and energy digestibility was significantly higher in YC0.3, EO and YC0.2 treatment and lymphocyte concentration tended to be higher in YC and EO compared with control. In conclusion, administration of EO or YC (0.2% to 0.3%) partially had positive effect on the growth performance and nutrient digestibility suggesting that the use of EO or YC may exert beneficial effects in weaning pigs.

Key words*:* Essential oils, Weaning pig, Yeast culture

The ban on antibiotics as growth promoter has prompted the scientific investigation of several feed additives (Yang *et al*. 2012).Yeast culture, essential oils, organic acids, etc. are some of the feed additives that are used in the replacement of antibiotics. Previous reports indicated that essential oil (EO) and yeast culture (YC) have a stimulating effect on appetite and secretion of digestive enzymes (Huang *et al*. 2010, Yan *et al*. 2012) and maintaining a favorable intestinal environment (Van Heungten *et al*. 2003). The present study was conducted to assess the effects of dietary supplementation of EO and YC on the growth performance, nutrient digestibility and blood profiles of weanling piglets.

MATERIALS AND METHODS

Weaning pigs [(Yorkshire × Landrace) × Duroc; 150] were randomly allotted to 1 of 5 experimental diets. There were 6 replicate pens / treatment with 5 pigs per pen. The experiment consisted of 2 phases; phase 1 (0–14 d) and phase 2 (15–35 d). Dietary treatments were: (1) CON, basal diet; (2), EO 0.05, basal diet + essential oil 0.05%; (3) YC 0.2, basal diet + yeast culture 0.2%; (4) YC0.3, basal diet + yeast culture 0.3%; and (5) YC0.4, basal diet + yeast culture 0.4%. All nutrients in diets were formulated to meet or exceed the recommendation of NRC (1998) for weaning pigs and fed in a mash form (Table 1).

Animals in all treatment groups were assessed for growth performance, nutrient digestibility and blood characteristics. The BW and feed intake of individual pigs were recorded on day 1 to 14 and day 15 to 35 to calculate average daily gain (ADG), average daily feed intake (ADFI), and feed efficiency (G:F). All pigs were fed diets mixed with 0.20% chromium oxide (Cr_2O_3) as an indigestible marker four days prior to sample collection (i.e. during day 10 to 14 and day 31 to 35) and feed and feces samples were analyzed according to procedure mentioned by Fenton and Fenton (1979). The procedures utilized for the determination of dry matter (DM), nitrogen (N) and gross energy (E) digestibility were conducted in accordance with the methods established by the AOAC (1995). Nitrogen was measured using an analyzer. Gross energy was determined using a oxygen bomb calorimeter. The amino acid profiles in the feed were analyzed by amino acid analyser after acid hydrolysis for 24 h in 6M HCl. Methionine was analyzed after cold performic acid oxidation overnight before hydrolysis.

For the blood profiles, blood samples were collected from 2 pigs per pen via anterior vena cava puncture into K_3EDTA vacuum tubes on day 14 (first phase) and day 35 (second phase). The white blood cells (WBC), red blood cells (RBC), lymphocyte counts in the whole blood were determined using an automatic blood analyzer.

All data were subjected to the statistical analysis as a randomized complete block design using the GLM procedures of SAS, and the pen was used as the experimental unit. Differences among treatment means were determined using the Duncan's multiple range test with a

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Table 1. Composition of diet as fed basis

Ingredients	Phase 1 (d0-d14)					Phase 2 (d14-d35)				
	CON	0.05 EO	0.2 YC	0.3 YC	0.4 YC	CON	0.05 EO	0.2 YC	0.3 YC	0.4 YC
Corn	42.8	42.75	42.61	42.52	42.43	58.85	58.8	58.66	58.57	58.49
Soybean meal, 44%	17.7	17.7	17.69	17.68	17.67	27.8	27.8	27.79	27.78	27.76
Fermented soybean meal	5.0	5.0	5.0	5.0	5.0	2.5	2.5	2.5	2.5	2.5
Fish meal (Menhaden)	3.5	3.5	3.5	3.5	3.5	0	0	0	0	0
Soybean oil	3.29	3.29	3.29	3.29	3.29	2.20	2.20	2.20	2.20	2.20
Limestone	0.70	0.70	0.70	0.70	0.70	0.88	0.88	0.88	0.88	0.88
DCP	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19	1.19
Salt	0.20	0.20	0.20	0.20	0.20	0.25	0.25	0.25	0.25	0.25
Sugar	3	3	3	3	3	0	0	0	0	0
Whey dried	10	10	10	10	10	5	5	5	5	5
Lactose	8.3	8.3	8.3	8.3	8.3	0	0	0	0	0
Spray animal plasma	3	3	3	3	3	0	0	0	0	0
DL-methionine	0.3	0.3	0.3	0.3	0.3	0.24	0.24	0.24	0.24	0.24
L-lysine	0.39	0.39	0.39	0.39	0.39	0.46	0.46	0.46	0.46	0.46
L-threonine	0.19	0.19	0.19	0.19	0.19	0.2	0.2	0.2	0.2	0.2
Choline	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vit Mix[1]	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Min Mix[2]	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Saccharine	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
EO (essential oil)	0.0	0.05	0.0	0.0	0.0	0.0	0.05	0.0	0.0	0.0
YC (yeast culture)	0.0	0.0	0.2	0.3	0.4	0.0	0.0	0.2	0.3	0.4
Analyzed composition,%										
CP	20.60	20.60	20.60	20.60	20.60	19.10	19.10	19.10	19.10	19.10
Lys	1.50	1.50	1.50	1.50	1.50	1.41	1.41	1.41	1.41	1.41
Met	0.51	0.51	0.51	0.51	0.51	0.43	0.43	0.43	0.43	0.43
Cys	0.38	0.38	0.38	0.38	0.38	0.34	0.34	0.34	0.34	0.34
M+C	0.89	0.89	0.89	0.89	0.89	0.77	0.77	0.77	0.77	0.77

[1]Provided per kg of complete diet: vitamin A, 11,025 IU; vitamin D_3, 1,103 IU; vitamin E, 44 IU; vitamin K, 4.4 mg; riboflavin, 8.3 mg; niacin, 50 mg; thiamine, 4 mg; d-pantothenic, 29 mg; choline, 166 mg; and vitamin B_{12}, 33 µg. [2]Provided per kg of complete diet: Cu (as $CuSO_4 \bullet 5H_2O$), 12 mg; Zn (as $ZnSO_4$), 85 mg; Mn (as MnO_2), 8 mg; I (as KI), 0.28 mg; and Se (as $Na_2SeO_3 \bullet 5H_2O$), 0.15 mg.

P<0.05 indicating a significance and P= 0.1 as a tendency.

RESULTS AND DISCUSSION

The effects of experimental diets during 2 phases of experiment are shown in Table 2. In the current study, EO supplementation numerically increased the ADG overall and in the first phase. Overall, feed intake tended to increase in EO compared with control. Our previous report (Yan *et al*. 2010) also suggested that supplementation of essential oils led to improved ADG throughout the experimental phase. Likewise, Ao *et al*. (2011) and Czech *et al.* (2009) also indicated that herbs or herbal by-products could be used in pig production industry to stimulate the growth performance. The partial beneficial effects of EO in the current study could be due to improved digestive secretion, improved beneficial microflora in gastrointestinal tract and immune stimulation. There was numerical increase in ADG in YC 0.3 in overall as well as in the first and second phase of the experiment compared with control. Moreover, ADFI tended to increase in YC 0.3 compared with control in overall and the second phase of experiment. Likewise, Shen *et al*. (2009) reported that ADG improved after supplementing the feed with yeast culture. Gao *et al*. (2008) also reported that in the broiler chicken the ADG and feed efficiency was improved with YC supplementation in the diet. Possible reason of improved ADG could be due to improved nutrient digestibility. However, growth performance with YC supplementation has shown to be variable by some investigators.

The effects of experimental feed on the nutrient digestibility in weaned pigs are shown in Table 3. During day 0–14, dry matter, nitrogen and gross energy digestibility was greater (P < 0.05) in YC 0.3, EO and YC 0.2 treatment but in the second phase, dry matter and nitrogen digestibility was lower in YC 0.2 and EO treatment compared with control. Dry matter and nitrogen digestibility was significantly higher in EO treatment compared with control during the first phase which is in agreement to the finding by Yan *et al*.(2010). Similarly, YC supplementation led to increased digestibility of DM, E and N in our experiments.

Table 2. Effect of EO and YC supplementation on growth performance in weaning pigs

Items	CON[1]	EO 0.05[1]	YC 0.2[1]	YC 0.3[1]	YC 0.4[1]	SE[2]	P -value
BW Initial, kg	5.7	5.7	5.7	5.7	5.7	-	-
BW Final. kg	19.72	20.05	19.54	20.16	18.64	0.48	0.26
Phase 1 (0~14d)							
ADG, g	272.6	285.4	261.8	274.6	241.4	16.8	0.44
ADFI, g	396.4	386.4	366	373.2	362.6	16.3	0.56
Gain:Feed	0.684	0.737	0.717	0.731	0.658	0.03	0.23
Phase 2 (15~35d)							
ADG, g	486	493	484	495	458	19.4	0.66
ADFI, g	756^{ab}	799^{ab}	818^{a}	736^{ab}	698^{b}	36.1	0.16
Gain:Feed	0.643	0.617	0.592	0.673	0.656	0.03	0.42
Overall (0~35d)							
ADG, g	400.8	409.8	395.4	407.2	371.2	16.1	0.32
ADFI, g	612^{ab}	634^{a}	637^{a}	591^{ab}	564^{b}	22.2	0.10
Gain:Feed	0.654	0.652	0.620	0.692	0.658	0.03	0.45

[1] Abbreviations: CON, basal diet; EO0.05, basal diet + essential oil 0.05%; YC0.2, basal diet + yeast culture 0.2%; YC 0.3, basal diet + yeast culture 0.3%; YC 0.4, basal diet + yeast culture 0.4%; [2] Pooled standard error; BW, Body weight; ADG, average daily gain; ADFI, average daily feed intake.

Table 3. Effect of EO and YC supplementation on nutrient digestibility in weaning pigs

Items	CON[1]	EO 0.05[1]	YC 0.2[1]	YC 0.3[1]	YC 0.4[1]	SE[2]	P -value
Phase 1 (0~14d)							
Dry matter	79.01^{d}	83.96^{b}	80.52^{c}	86.37^{a}	82.75^{c}	0.39	<0.0001
Nitrogen	76.03^{d}	82.33^{b}	80.69^{c}	84.99^{a}	81.90^{bc}	0.45	0.002
Gross energy	79.05^{c}	84.01^{b}	80.02^{c}	86.62^{a}	83.69^{b}	0.4	0.001
Phase 2 (15~35d)							
Dry matter	89.35^{ab}	88.30^{bc}	87.60^{c}	89.25^{ab}	90.04^{a}	0.43	0.0001
Nitrogen	88.69^{ab}	87.28^{cd}	86.29^{d}	88.28^{bc}	89.70^{a}	0.46	0.24
Gross energy	89.66	89.23	88.08	89.98	90.32	0.39	0.75

[1] Abbreviations: CON, basal diet; EO0.05, basal diet + essential oil 0.05%; YC0.2, basal diet + yeast culture 0.2%; YC 0.3, basal diet + yeast culture 0.3%; YC 0.4, basal diet + yeast culture 0.4%; [2] Pooled standard errors; [a,b,c,d]Means in the same row with different superscripts differ (P<0.05).

Table 4. Effect of EO and YC supplementation on blood profiles in weaning pigs

Items	CON[1]	EO 0.05[1]	YC 0.2[1]	YC 0.3[1]	YC 0.4[1]	SE[2]	P -value
Phase 1 (0~14d)							
WBC, 10^3/ul	15.5	13.6	12.6	15.2	14.3	1.14	0.77
RBC, 10^6/ul	6.1	5.9	5.6	5.9	5.8	0.22	0.39
Lymphocyte,%	45.8	49.9	54.2	54.4	51.8	3.76	0.07
Phase 2 (15~35d)							
WBC, 10^3/ul	20	16.8	17.7	18.5	16.3	1.84	0.53
RBC, 10^6/ul	6.5	6.3	6.2	5.8	6.4	0.23	0.65
Lymphocyte,%	44.5	45.2	48.8	46.5	52.1	4.85	0.56

[1] Abbreviations: CON, basal diet; EO0.05, basal diet + essential oil 0.05%; YC0.2, basal diet + yeast culture 0.2%; YC 0.3, basal diet + yeast culture 0.3%; YC 0.4, basal diet + yeast culture 0.4%; [2] Pooled standard error.

Shen *et al.* (2009) also reported that YC supplementation improved the digestibility of pig due to increased villus height and increased villus: crypt ratio in jejunum. On the contrary, van der Peet-Schwering *et al*. (2007) did not observe improved digestibility with YC supplementation

The effects of experimental feed on blood characteristics are shown in Table 4. There were no differences in the WBC, RBC concentration in both phases but lymphocyte concentration tended to be higher in all treatments compared with control in the first phase. The tendency of improved

lymphocyte in pig fed EO and YC diet is in agreement with the findings by Czech *et al.* (2009), Yan *et al.* (2011b) who indicated that herb supplement increased lymphocyte concentration in growing pigs. The improvement in lymphocyte concentration could be due to the fact that EO or YC might have exerted antimicrobial or antiseptic property thereby stimulating immune function to some extent.

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