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Effect of Dietary Inclusion of Betaine in Finishing Pigs

Efecto de la Inclusión Alimenticia de Betaína en Cerdos en Fase de Finalización

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Abstract

The pork consumer demands a quality product with a lower fat content, requiring the nutritionist to look for new alternatives in the feeding of pigs. The objective of this study was to evaluate the effect of dietary betaine. The performance and dressing proportion were evaluated, a total of 30 finishing barrows (Landrace × Yorkshire) were fed a control diet or with the experimental diet added with 0.1 % betaine for 29 days. The average daily feed intake (CDPA) was similar in both groups (P>0.05). The average daily weight gain (GDP), feed conversion (CA) and dressing proportion (RC) in betaine group was significantly higher (p<0.05) compared to the non-supplemented diet. Backfat thickness (EGD) was lower in the experimental group (p<0.05). The dietary betaine inclusion of 0.1 % in barrows improves daily weight gain, feed conversion and reduces carcass fat content.
Keywords: betaine, pigs, fat, dressing proportion, nutrition.

Resumen

El consumidor de carne porcina demanda de un producto de calidad y con menor contenido de grasa, exigiendo que el nutricionista busque nuevas alternativas en la alimentación del cerdo. El objetivo de este estudio fue evaluar el efecto de la inclusión dietaria de betaína. Los parámetros productivos y rendimiento a la canal fueron evaluados, un total de 30 de cerdos machos castrados en fase de finalización (Landrace × Yorkshire) fueron alimentadas con una dieta control o con la dieta experimental adicionada con 0.1 % de betaína durante 29 días. El consumo diario promedio de alimento (CDPA) fue similar en ambos grupos (P>0.05). La ganancia diaria promedio de peso (GDP), conversión alimenticia (CA) y rendimiento a la canal (RC) para los cerdos alimentados con la dieta de betaína fue significativamente mayor (p<0.05) en comparación con la dieta no suplementada. El espesor de grasa dorsal (EGD) fue menor en el grupo experimental (p<0.05). La inclusión alimenticia de betaína al 0.1 % en fase de finalización mejora la ganancia diaria de peso, conversión alimenticia y disminuye el contenido de grasa de la canal
Palabras clave: betaína, cerdos, grasa, canal, nutrición.

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1 Introduction

Betaine, also known as trimethylglycine, is a derivative of the amino acid glycine that is normally found in a wide variety of plants and animals (Saarinen *et al.*, 2001). Its main function is to act as a methyl group donor (Craig, 2004), favors the synthesis of creatine and carnitine and decreases the requirements of other methyl donor molecules such as methionine and choline (Eklund *et al.*, 2005; Ratriyanto *et al.*, 2009; Simon, 1999). It has been shown its role as osmo-protector (Kidd, Ferket y Garlich, 1997) in a special way in environments of high osmolarity in some microorganisms (Boch, Kempf y Bremer, 1994) and cell cultures (Horio *et al.*, 2001). It has a low cost and a lot of safety in its nutritional use (Day y Kempson, 2016).

In recent years it has been discovered that Betaine participates in the regulation of transport genes and oxidation of fatty acids (Cai *et al.*, 2016), as well as genes for lipid and cholesterol synthesis (Albuquerque *et al.*, 2017). There is evidence of an energy-saving role of betaine in the metabolism of growing pigs, especially under specific conditions such as limiting food intake and energy in the diet (Siljander-Rasi *et al.*, 2003; Wray-Cahen *et al.*, 2004), proving that supplementation with betaine affects the energy partition (Fernández-Fígares *et al.*, 2002) and could improve the energy value of diets (Schrama *et al.*, 2003).

It is important to mention that the first results in the use of betaine in the feeding of pigs in finishing phase has been inconsistent, reporting an absence of effect or minimal effect on growth, food consumption, daily weight gain and deposit of adipose tissue (Matthews *et al.*, 1998; Overland, Rørvik y Skrede, 1999).

However, in other studies it has been determined that the inclusion of betaine in pigs in finishing phase favors productive performance (Yang *et al.*, 2009) decreases the fat content in the carcass (Huang *et al.*, 2006; Nakev *et al.*, 2009; Sales, 2011) and the thickness of dorsal fat, benefiting the pork industry (Feng *et al.*, 2006; Lawrence *et al.*, 2002; Ribeiro *et al.*, 2011).

Similarly, it has been found that the inclusion of betaine favors the formation of saturated fatty acids by using DDGs (30%) in the feeding of pigs, reducing the proportion of unsaturated fatty acids (Wang *et al.*, 2015) and improving the color of the meat (Su *et al.*, 2013). It has also been shown that betaine reduces total body heat production (Schrama *et al.*, 2003) and favors reproductive performance in hot times (Cabezón *et al.*, 2016; Lugar *et al.*, 2018; van Wettere, Herde y Hughes, 2012).

With the foregoing, the objective of this study was to evaluate the effect of dietary inclusion of 1 mg/kg of betaine on productive parameters, carcass yield and thickness of dorsal fat in pigs, when they were offered food ad libitum between 66 to 100 kg of the live weight.

2 Materials and methods

This work was developed in the pork farm "La Maresca", located in Cayambe, Pichincha-Ecuador. A total of 30 males castrated pigs F1 (Landrace X Yorkshire) were used with an initial average weight of 66 ± 4 kg and 110 days of age distributed randomly in two groups: control and experimental (0.1% of betaine), 15 pigs per treatment. Pigs were housed in individual paddocks (3.75 m^2) considering each pig as an experimental unit, food and water were ad libitum. Diets were prepared from maize and soybeans to meet the nutritional requirements of the National Research Council (2012). The composition of the ingredients and the nutritional content of the diets used in the experiment are shown in Table 1.

The experiment lasted 29 days, and 24 hours before slaughter the food was removed; however, pigs had access to drinking water until slaughter (139 days old). The evaluated variables were: average daily food intake (CDPA), daily weight gain (GDP), food conversion (CA), carcass yields (CR) and dorsal fat thickness (EGD). Carcass yield was calculated as the carcass weight as a percentage of live weight before slaughter. The dorsal fat thickness was measured with a manual calibrator in the last rib once the carcass was divided in half.

Tabla 1. Composition and nutritional content of diets

Ingredient	Control	Experimental
Corn (%)	77,86	77,76
Soy pasta (%)	19	19
Calcium carbonate (%)	1,1	1,1
Soy oild (%)	1	1
Salt (%)	0,3	0,3
Dicalcium phosphate (%)	0,23	0,23
L-Lisine HCl (%)	0,01	0,01
Mineral-vitamin pre-mix[a] (%)	0,5	0,5
Betaine[b] (%)	-	0,1
Diet composition		
Metabolizable energy (kcal/kg)	3300	3300
Crude protein (%)	14,5	14,5
Total calcium (%)	0,5	0,5
Total phosphorus (%)	0,45	0,45
Total lysine (%)	0,8	0,8

[a]The pre-mix contributes to the following amount of micronutrients per kilogram of diet: Vitamin A, 7600 IU; Vitamin D, 1 500 IU; Vitamin E, 10 mg; Vitamin K3, 2.0 mg; Vitamin B1, 1.0 mg; Vitamin B6, 1.0 mg; Vitamin B2, 3.0 mg; Vitamin B12, 12 µg; Pantothenic acid, 7 mg; Niacin, 12 mg; Zn, 105 mg; Fe, 100 mg; Cu, 20 mg; Mn, 45 mg; I, 0.3 mg; Se, 0.3 mg.
[b]Commercial product with a minimum of 96% betaine and a minimum of 1% calcium stearate

3 Statistical analysis

A completely randomized design (DCA) was used for the experiment, in which each pig was considered an experimental unit. For the means difference the T student's test was used for independent samples, with a significance level of 0.05.

4 Results and discussion

4.1 Daily Food Average Consumption (CDPA)

There was no significant difference (P>0.05) (Table 2) being the consumption of 2.64 ± 0.001 kg for the control and 2.63 ± 0.004 kg for the experimental group. The information obtained is consistent with the results found by Feng *et al*. (2006) in which the group receiving betaine (1.25 mg/kg) presented a consumption of 2.39 vs. 2.34 the control group (P>0.05). Similar to these results were those found by Wang *et al*. (2015) in which pigs fed with DDGs at 30% and received betaine (0.1%) showed a consumption of 2.65 vs. 2.71 kg/day of the control group (without DDGs or betaine).

They also coincide with those found in the study carried out by Schrama *et al*. (2003) in which was assessed the inclusion of betaine at a level of 1.29 g/kg of food (0.129%) with no significant difference (P>0.10) 1.548 kg vs. 1.558 kg for the control and experimental group, respectively, over a three-week period of experimentation, although this study was carried out in pigs between 35 to 46 kg of live weight. However, these results do not agree to those obtained by Yang *et al*. (2009) in which there was a significant (P<0.05) lower food intake in pigs that received betaine at an inclusion level of 0.2%, compared to the control group and to the levels of 0.4 and 0.6% of betaine.

Tabla 2. Dietary inclusion effect of betaine (0.1 %) in pigs in finishing phase

Variable	Control	Experimental
Final weight (kg)	94,75 ± 1,01 a	103,99 ± 1,78 b
Daily weight gain (kg/d)	0,99 ± 0,02 a	1,31 ± 0,03 b
Daily food intake (kg/d)	2,64 ± 0,001 a	2,63 ± 0,004 a
Food conversion	2,68 ± 0,04 a	2,02 ± 0,04 b
Carcass yield (%)	80,9 ± 0,38 a	82,07 ± 0,27 b
Thickness of the dorsal fat (mm)	17,27 ± 0,21 a	13,93 ± 0,37 b

The values presented are the mean ± standard error. The averages within the same row with different letters differ significantly (P<0.05).

4.2 Daily Weight Gain (GDP)

The statistical analysis found a significant difference (P<0.05) with higher gain in the experimental group 1.31 ± 0.03 kg/d compared to the control group 0.99 ± 0.02 kg/d. These observations are in agreement with those found in the study carried out by Yang *et al*. (2009) in which pigs between 65-100 kg fed with betaine at 0.2; 0.4 and 0.6 % differ significantly (P<0.05) from the control group, 0.94; 1.16; 1.07 and 0.91 kg/d respectively. Likewise, in the study carried out by Ribeiro *et al*. (2011) it was found that the group receiving betaine at 0.2 % presented the highest GDP (1.055 kg/d) compared to the control group (0.967 kg/d). However, these data differ from those obtained in pigs between 62.5 to 92.5 kg of live weight, in which there was no significant difference (P>0.05) 0.715 kg/d and 0.748 kg/d for the control group and betaine (1.25 mg/kg), respectively (Feng *et al*., 2006). Similarly, in the study carried out by Wang *et al*. (2015) in pigs between 58 to 94 kg there was no significant difference (P>0.05) between the group receiving betaine (0.1 %) and the control 0.85 vs. 0.87, respectively. A similar trend to the studies of Feng *et al*. (2006); Wang *et al*. (2015) was found when betaine was used at an inclusion level of 0.129 % in pigs between 35 to 46 kg, being the GDP of 0.651 for the experimental group and 0.648 for the control group (Schrama *et al*., 2003).

4.3 Food Conversion (CA)

Significant difference (P<0.05) was found between the two experimental treatments 2.02 ± 0.04, while the control group was 2.67 ± 0.04. This information is consistent with what was found by Yang et al. (2015), in which pigs receiving betaine at 0.2, 0.4 and 0.6 % showed lower food conversion (P<0.05) compared to the control group 3, 2.8, 3.01 and 3.45, respectively. This was also stated by Ribeiro *et al*. (2011) in which the CA was lower in the group receiving betaine at 0.2 % (3.038) when compared to the control group (3.470).

However, these results do not agree to those found by Feng *et al*. (2006) in which there was no significant difference (P>0.05) 3.27 for the control group and 3.22 for pigs receiving betaine (1.25 mg/kg). Likewise, no significant difference was found in the study carried out by Wang *et al*. (2015), in which a similar food conversion of 3.11 was obtained for both the control and betaine groups (0.1 %). Also, in pigs between 35 to 46 kg no significant difference was found (P>0.10) presenting both groups a CA of 2.39 Wang *et al*. (2015)(Schrama *et al*., 2003).

4.4 Carcass yield

The results obtained for the control group were 80.90 ± 0.38 % and for the experimental group 82.07 ± 0.27 %, with a significant difference (P<0.05) in favor of the experimental group. These results do not match to the reported by Feng *et al*. (2006), in which no significant difference was found (P>0.05) in pigs slaughtered at 92.5 kg of live weight and consuming betaine (1.25 mg/kg) compared to the control group. No significant difference was found in the study carried out by Wang *et al*. (2015), in which the yield was 77.05 % for the control group and 75.64 % for the betaine group in pigs slaughtered at 94 kg.

4.5 Thickness of the dorsal fat

Significant difference was found (P<0.05) being higher the fat deposit in the control group 17.27 ± 0.21 mm vs the experimental group 13.93 ± 0.37 mm.

The data agreed with those found by Feng *et al*. (2006), even though the measurement was performed at the tenth rib level 24.9 mm vs. 22.7 mm, obtaining a reduction of 8.84% ($P<0.05$) in favor of the group that consumed betaine (0.125%). It was also found that in pigs slaughtered at 150 days of age, those who received betaine at the level of 0.2% showed a lower thickness of dorsal fat 14.7 mm vs. the control group 15.4 mm (Ribeiro *et al*., 2011). In addition, in an experiment carried out by Schrama *et al*. (2003) in which Betaine was included at 0.129%, a higher protein deposit was favored 3 weeks after the experiment was initiated. However, these results do not agree with those reported by Wang *et al*. (2015) in which no significant difference ($P >0.05$) was found among the pigs in the control group 28 mm vs. pigs from the group that received betaine 27 mm.

5 Conclusions and recommendations

The food inclusion of betaine at 0.1% in the diet of pigs in finishing phase improves productive parameters, daily weight gain and food conversion. In addition, it favors carcass yield and decreases the dorsal fat deposit. More studies are recommended in which higher levels of betaine inclusion are assessed and pigs with lower energy levels are included.

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