Scientific Paper

Effect of non-conventional diets with native microorganisms on pig rearing

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Abstract

A total of 134 animals of the pig categories piglets, pre-fattening, initial fattening and finishing, were used, distributed in a completely randomized design, in order to evaluate the effect of non-conventional diets with microorganisms on the live weight gain, under production conditions. The treatments were: I: with native microorganisms, and II: control. The animals received the same feeding in the two treatments based on a broth elaborated with cattle slaughter residues, besides bran, which was supplied in two parts: in the morning and in the afternoon, plus the dose of microorganisms. The difference among the live weight ranges on each sampling date was compared through a non-parametric test for independent means (Mann-Whitney U test). The same was done for the mean daily gain in each experimental group and animal category. The live weight gains were 92 *vs.* 62; 319 *vs.* 216; 769 *vs.* 496 and 534 *vs.* 454 g animal^{-1} day^{-1} for the categories piglet, pre-fattening, initial fattening and finishing, in treatments I and II, respectively. According to the results, it is concluded that native microorganisms in the non-conventional feedstuff that was used allowed an increase of the mean daily gain and of the live weight in the animals of all categories, the decrease of the fattening period and an increase of the economic incomes for the enterprise of $ 11 307,16 CUP.

Keywords: feed additives, pig, weight gain.

Introduction

The industrial production of monogastric animals has as premises the incorporation of growth stimulators, the use of antibiotics and the mixture of minerals in the diet; according to Davies (2011) more than 70 % of those additives are included in the feedstuffs. This practice brings about secondary effects, such as the presence of residues which are noxious for the environment and the consumers, resistance to antibiotics and decrease of the efficacy of drugs to treat diseases, which conspires against human and animal health (Abreu and Barreto, 2014).

This originated that the European Union (EU) Council decreed the suspension of this practice partially in 1999, and with absolute character in January, 2006. Although this regulation exists, producers maintain inadequate practices, such as the incorporation of copper sulfate in the concentrate feeds, which causes crossed resistance to different antimicrobial drugs (Badillo, 2016).

In the purpose of intensifying pig production efficiently and safely for the consumer and the environment, prebiotics and probiotics constitute one of the most widely used and innocuous proposals (Brown, 2011). Nevertheless, this practice is subject to the external supply of the products at the moment they are required.

The so-called efficient microorganisms are an additional alternative which offers the same benefits as the above-mentioned products, and, also, they allow a broader application spectrum in animal husbandry. Due to these reasons, the objective of this research was to evaluate the effect of non-conventional diets with the utilization of native microorganisms (NM) on the live weight gain of pigs under production conditions.

Materials and Methods

Location. The study was conducted in a self-supply pig production unit (non-specialized) of the Animal Husbandry Enterprise Macún, in the Sagua la Grande municipality –Villa Clara province, Cuba.

Preparation of the mixture of native microorganisms. The mother solution of NM (which contains fungi, yeasts, lactobacilli, and phototrophic bacteria), which spontaneously grow on a non-disturbed soil of the Sagua la Grande municipality, was propagated and activated in a 200-liter plastic tank, with lid, where 10 kg of NM, 5 liters of milk serum and five liters of sugarcane molasses were mixed. After their homogenization, chlorine-free water was added until leaving a small free chamber (approximately 5 cm from the rim) and it was covered. The tank was maintained in afresh place, at room temperature, away from sun rays; and every day gas release was allowed. At two weeks a product of bittersweet smell, typical from lactic fermentations, with pH lower than 3,5, was achieved.

Animals, treatments and design. The NM were included in the diet of the pigs, which were distributed in a completely randomized design with two treatments: I (with native microorganisms), and II (control, without microorganisms). A total of 134 animals were used, belonging to different groups in each category, distributed as shown in table 1.

Table 1. Animals used in the study, according to the zootechnical management of the unit.

Category	Total	Treatment I	Treatment II
Lactating piglet	35	16	19
Pre-fattening	38	18	20
Initial fattening	30	16	14
Finishing	31	15	16
Total	134	65	69

Feeding. The diet in both systems consisted in the following feedstuffs: milk and yogurt whey, broth elaborated with slaughter waste of cattle from the enterprise (bones, tissue fragments, ears, hooves, rumen content, abdominal and thoracic viscera), and corn bran. An approximation of the nutritional contribution of the main components of the diet is shown in table 2.

The ingredients of the diets were mixed and supplied twice per day (in the morning and in the evening). The bran and the microorganisms were added in the doses that are detailed, per category (table 3).

Live weight and mean daily gain. 100 % of the animals were fortnightly weighed using a dynamometer of 100 kg ± 50 g. The mean daily gain in the evaluation period was calculated.

Statistical analysis. The difference among the live weight ranges on each sampling date was compared through a non-parametric test for independent means (Mann-Whitney U test), because the variance normality and homogeneity assumptions (Kolmogorov-Smirnov and Levene, respectively) were not fulfilled. The same was done for the mean daily gain in each experimental group and animal category, a value of $p < 0,05$ was considered significant.

Results and Discussion

The increase of live weight every 14 days in the lactating pigs showed, since the third weighing, differences between the two studied groups (fig. 1A). The beneficial effect of using microorganisms on the weight gain, which exceeded in 42,3 % that of the control treatment, was proven.

The live weight in the piglets when microorganism was offered in the diet was similar to that obtained by Díaz-Gutiérrez and Hernández-Cruz (2010), who reported 7,1 kg at weaning, although these authors used a higher energy diet than the one in this study. The latter was not balanced, because it was constituted by cattle slaughter wastes.

Table 2. Nutritional contribution of the main diet components (%).

Feedstuff	DM	Moisture	Ash	CP	EE	CF	Reference
Corn bran	88,7	NR	5,8	11,9	4,6	12,3	Heuzé *et al*. (2016)
Acid whey	NR	4,4	12,0	9,4	0,9	NR	Blas *et al*. (2010)
Rumen content	NR	85,0	27,1	9,6	NR	2,8	Uicab-Brito and Sandoval- Castro (2003)

DM: dry matter, CP: crude protein, EE: ethereal extract, CF: crude fiber, NR: not reported by the author.

Table 3. Offer of bran and native microorganisms, during the 70 days of experimentation.

Animal category	Corn bran (kg day^{-1})	NM doses♦
Lactating piglet	0,5	3 mL animal^{-1} three days after birth and 25 mL
Pre-fattening	1,0-1,5	50 mL animal^{-1} day^{-1}
Initial fattening	2,0-2,5	50 mL animal^{-1} day^{-1}
Finishing	3,0	50 mL animal^{-1} day^{-1}

♦ The doses that were used respond to an initial test with NM in their inclusion in the diets.

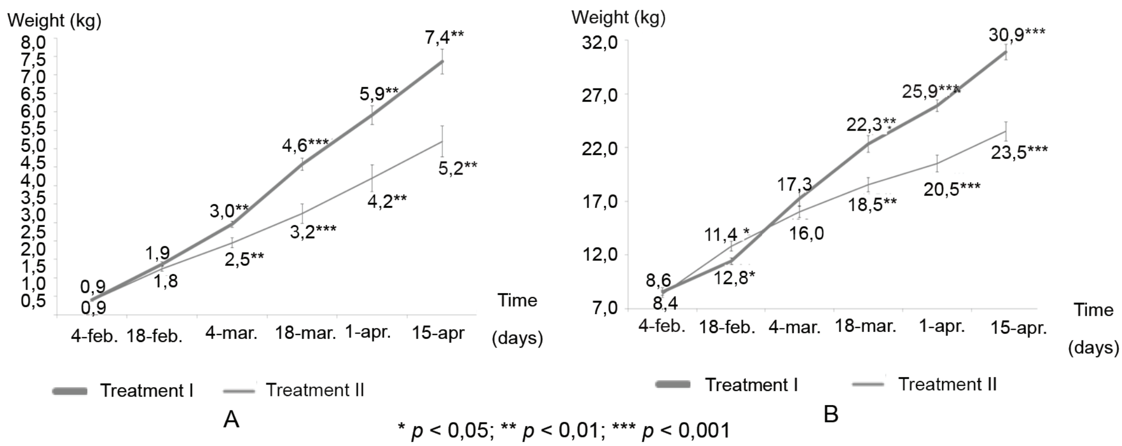

Figure 1. Increase of the live weight. A: lactating pigs, B: pre-fattening pigs..

The weight difference of 2,2 kg between the group that consumed microorganisms and the one which did not, was similar to the one reported by Rodríguez *et al.* (2013), which was 2,5 kg with regards to the control. The animals that received NM achieved 7 kg of live weight at weaning at 70 days. These values are similar to the reports in literature, but were reached in a longer time period than the one established for weaning, according to López *et al.* (2008), who obtained between 6 and 7 kg in the interval between 26 and 33 days after being born. Nevertheless, in the treatment without NM (control) the animals only reached 5,2 kg at 70 days. From this it is inferred that in the unit there are feeding and zootechnical management problems which affect the productive performance of the piglets at weaning.

The mean live weight gain of the piglets was low in both treatments, but significant difference ($p < 0,05$) was found between them (table 4), because the diet was constituted by feedstuffs of low nutritional quality compared with the requirements of pigs in this category (Liu *et al.*, 2014).

The animals in pre-fattening differed ($p < 0,001$) in favor of the ones that consumed microorganisms, which gained more than 7 kg of live weight (figure 1B), representing an increase of 31,4 %. The daily live weight gain in that treatment exceeded that of the control in 103 g (table 4).

In the initial fattening (fig. 2A) the animals that received the microorganisms were the heaviest ($p < 0,001$) and exceeded in 20 kg of live weight the ones which did not receive it, in spite of feeding with equal ration. This increase of 31,1 % with regards to the control was similar to the one obtained in the previous category.

The mean daily gain in the category initial fattening (table 4) showed significant differences between treatments ($p < 0,05$), and the group with NM obtained 273 g more than the control (769 *vs.* 496 g animal^{-1} day^{-1}).

In this category, Contino-Esquijerosa *et al.* (2008) reported gains of 636 g animal^{-1} day^{-1} with diets based on concentrate feeds for pigs, which were lower than the ones found in this work with the use of microorganisms and a non-conventional diet.

Quintero and Huerta (1996) reviewed several studies with probiotics for the nutrition of pigs of different ages, whose daily weight gains for the

Table 4. Mean daily gain (MDG) of weight (g) in each category.

Category	MDG with microorganisms	MDG without microorganisms	± SE	*P*
Lactating piglet	92,2	61,4	6,82	0,012
Pre-fattening	318,6	216,2	28,78	0,071
Initial fattening	769,2	496,4	63,25	0,019
Finishing	534,4	453,6	63,84	0,559

SE: Standard error

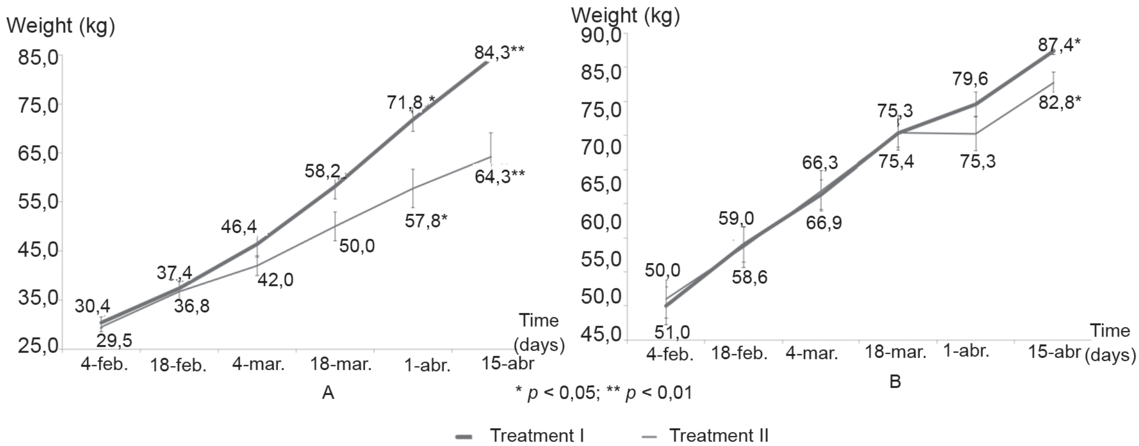

Figure 2. Live weight increase in pigs. A: initial fattening, B: finishing.

category initial fattening were lower than the ones in this research in the treatment with NM (table 4). The same occurred in the experiment conducted by Piloto *et al.* (2013), who obtained 748 g animal^{-1} day^{-1} with a diet of corn and soybean with 0 % of wheat bran and 611 g with 30 % of bran.

The results reached in initial fattening (fig. 2A) concerning the live weight increase (up to 84,3 kg) in the animals that received treatment I (with native microorganisms) at the end of this stage, allowed that the minimum slaughter weight (90 kg) was practically achieved. In that sense, taking as calculation basis the MDG of the animals, in economic terms it would mean saving non-conventional feed due to the shortening of this stage in 44 days with regards to the control.

The animals in finishing (fig. 2B) had lower live weight gain than in initial fattening, because the diet lacked the necessary energy levels to obtain a higher gain than 600 g animal^{-1} day^{-1}.

Heuzé *et al.* (2016) stated that the variable quantities of starch, fiber and fat of the corn bran affect its energy and digestibility value in growing pigs. Although the live weight differed between treatments ($p < 0,05$), the difference was low (4,6 kg); while the gain was 534 and 454 g animal^{-1} day^{-1} for the animals of treatments I and II, respectively. This represented a weight increase of 5,5 %.

These gains were lower than the ones reported by García *et al.* (2004), who obtained 677 g animal^{-1} day^{-1} when using a concentrate feed based on soybean, wheat meal and torula yeast with 16 % of protein, value higher than that of corn bran used in this work.

The best gains and the live weight increase found in this study are a response to the inclusion of microorganisms in the diet of pigs, which reaffirms the probiotic action of this product, similarly to the report by Abd (2014) in poultry.

In a sample of soil microorganisms, prepared similarly to the ones used in this work, nine strains of acid lactic bacteria were isolated and two strains of lactobacilli with probiotic activity were identified (Delgadillo-Valdés *et al.*, 2015).

With the consumption of probiotics scientifically established benefits are obtained: a) increase of the nutrient absorption capacity, b) stimulation in enzyme production at enterocyte level, c) inhibition of intestinal pathogens, d) production of substances with bioactive effects for the host, among others (Corcionivoschi *et al.*, 2010). The yeasts and acid lactic bacteria present in the microbial mixture are considered to be probiotics (Zakaria *et al.*, 2010), which has been confirmed in the experiments relative to the application of this technology in poultry and pigs.

According to the reports by Blas *et al.* (2013), the mean daily gain was lower in all the categories for both treatments. This occurred because the offered diet did not cover the requirements of pigs for the studied categories. In addition, bran was included in the feeding, which limited the productive results.

In studies conducted by Núñez-Escoto and Yance-Angulo (2015), when including 30 % of bran in the diet, the weight gain in the pigs was lower. Nevertheless, the best gains were obtained using microorganisms.

During the fermentation process, during which microorganisms grow, organic acids (lactic, acetic), vitamins, minerals, enzymes, aminoacids, are produced, among other products of their metabolism, which contribute to incorporate enzymatic cofactors that improve the functioning of the digestive system of the animals which consume them, with a better assimilation of the nutrients present in the diet, according to the criterion expressed by Escalante *et al*. (2016).

In this sense, in the evaluated diet the protein was contributed by unicellular organisms, which allowed its total incorporation to the digestive process. Because of this there was a weight increase of the animals with regards to the control, as well as a decrease in the excreta volume. This explains why in this work, with lower quantity of protein but of higher biological value, the animals showed a better productive response.

Figueroa (1995) reported that when the protein of the diet is contributed practically completely by a protein source of high concentration, good balance and adequate availability of essential aminoacids, such as soybean, it is possible to satisfy the requirement of pigs with a lower contribution of crude protein, according to NRC (2012). Almaguel *et al.* (2010) confirmed it in their work, by achieving an average daily intake of 313 g of protein per animal, which is a moderate protein level with regards to the recommendations made by the NRC (2012) for growing-fattening pigs (380 g day^{-1}).

The inclusion of beneficial native microorganisms in the non-conventional diet improved the live weight gain of all the animal categories; and according to the economic analysis an increase of $ 11 307,16 CUP (table 5) was appreciated, according to the prices regulated by GRUPOR (Vecino-Rondan *et al.,* 2015).

The weight difference observed with the incorporation of NM and the economic implication of that increase, according to the price for each category, is shown in table 5.

According to the results it is concluded that native microorganisms in the non-conventional feedstuff used allowed an increase of the MDG and the live weight in the animals of all categories, the decrease of the fattening period and an increase of the economic incomes for the enterprise.

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Table 5. Economic benefit for the utilization of soil microorganisms.

Category	Quantity of animals	Difference with regards to the control (kg)	Price ($/kg)	Profit ($)
Lactating piglet	16	2,2	11,80	415,36
Pre-fattening	18	7,4	11,67	1 554,44
Initial fattening	16	20,0	22,40	7 168,00
Finishing	15	4,6	31,44	2 169,36
Total	65			11 307,16

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