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Evaluation of diets containing probiotic and antibiotic as additives in growing pigs

Evaluación de dietas conteniendo probiótico y antibiótico como aditivos en cerdos en fase de desarrollo

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ABSTRACT

The objective of the study was to compare the effect of a probiotic and an antibiotic as additives in the productive behavior of pigs in the growth phase. 20 pigs were used, male and female, Landrace-Belgian, Pietrain, Yorkshire and Duroc-Jersey crossbreed, 60 days old, distributed in two experimental groups. The probiotic Lacto-Sacc® and the antibiotic Avoporcin were used. The group that was given the Lacto-Sacc® probiotic was the one that obtained the highest final live weight, the best total and daily weight gain, the best feed conversion, and the benefit-cost ratio. It is concluded that probiotic additives improve the productive and sanitary behavior of pigs in the growth phase.

Keywords: probiotic; antibiotic; diets; growth promoter

RESUMEN **RESUMEN**

El objetivo del estudio fue comparar el efecto de un probiótico y un antibiótico como aditivos en el comportamiento productivo de cerdos en la fase de crecimiento. Se utilizaron 20 cerdos, machos y hembras, mestizos Landrace-Belga, Pietrain, Yorkshire y Duroc-Jersey, de 60 días de edad, distribuidos en dos grupos experimentales. Se utilizó el probiótico Lacto-Sacc® y antibiótico Avoporcina. El grupo que se le suministró el probiótico Lacto-Sacc® fue el que obtuvo mayor peso vivo final, mejor ganancia de peso total y diaria, mejor conversión alimenticia y relación beneficio-costo. Se concluye que los aditivos probióticos mejoran el comportamiento productivo y sanitario de los cerdos en la fase de crecimiento.

Palabras clave: probiótico; antibiótico; dietas; promotor de crecimiento

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Palabras clave: probiótico; antibiótico; dietas; promotor de crecimiento

INTRODUCTION

Due to the need to improve livestock enterprises, reduce production costs and maximize productivity, it is necessary to use antibiotics as growth promoters at sub-therapeutic levels to reduce the incidence of certain diseases and improve nutrient utilization.

In recent decades, much research has focused on the development of alternative antibiotics to maintain pig health and performance. The main alternatives studied include the use of probiotics.

APC Antibiotic Growth Promoters are one of the most widely used additives in animal feed:

> According to a study by the European Federation for Animal Health, 4,700 tons of antibiotics were consumed by farm animals in the European Union in 1999, representing 35% of all antibiotics used. APCs cause modifications of the digestive and metabolic processes of animals, which result in increases in feed utilization efficiency and significant improvements in weight gain. Some metabolic processes modified by APCs are nitrogen excretion, efficiency of phosphorylation reactions in cells and protein synthesis. (Carro, Ranilla, 2002, pp. 1-6)

Based on the comments of Corrasa, Lopes, Bellaver (2012), feed additives allow improving animal response by modifying the metabolism or digestive process, increasing the efficiency of nutrient utilization (pp. 467-476).

Thus Manzano, Estupiñán, Poveda (2012), have described that probiotics can regulate the immune response of animals and humans not only at the intestinal mucosal level but also at the systemic level (p. 99).

Antimicrobials "have been used for many years as growth promoters in swine diets to decrease the incidence of diarrhea and improve animal performance" (Corasa et al., 2012, pp. 467-476).

Moreover, according to Bosscher, Breynaert, Pieters, and Hermans (2009), the intestinal flora can be considered as an organ of the body that can adapt to metabolism and renew itself rapidly (p. 5).

Likewise, according to Santos et al. (2005), the indiscriminate use of antibiotics has produced resistance to antibiotics, so recent research analyzes the modulation of the normal intestinal microbiota through the application of probiotics in food, which do not generate resistance (pp. 1-15).

An alternative to the use of antibiotics is "the use of live microorganisms with probiotic characteristics in the diet" (Jurado Gámez, Ramírez, Martínez, 2013, pp.3648-3657).

García Curbelo, García, López, Boucourt, (2005), points out the difference between the term probiotic[for life] the effect is not immediate, but for a longer period, the antibiotic means against life, and its action on microorganisms is immediate.

In the suppression of pathogenic microorganisms:

> Probiotic bacteria produce a number of antimicrobial substances, including hydrogen peroxide, diacetyl, reuterin, organic acids such as lactic and acetic acids and substances of a protein nature, known as bacteriocins. (García et al., 2005, p. 131).

Prats, Boucourt, Rodriguez (2005), the use of probiotics is a way to combat diseases without introducing foreign bodies into the body.

Probiotics are:

> Those that modulate the immune response at local and systemic level; they are food supplements composed of live microorganisms such as microencapsulated lactic acid bacteria, Streptococcus faecium and Lactobacillus acidophilus, which benefit the health of the host through the balance of intestinal macrobiotics (García Hernández, Pérez, Boucourt, Balcázar, Nicoli, Moreira Silva, Rodríguez, Fuertes, Nuñez, Albelo, Halaihel, 2007, pp. 125-132).

Probiotics, "their use in production animals is intended to improve feed conversion, promote growth and inhibit the development of pathogenic bacteria" (Blajman, Zbrun, Astesana, Berisvil, Scharpen, Fusan, Soto, Signorini, Rosmini, Frizzo, 2015, 360-367).

Of equal importance in what Garcia, Boucourt, Acosta, Albelo, Nuñez (2007) points out, the mode of action of probiotics is related to the inhibition of pathogenic microorganisms, the effect of lowering hypocholesterolemic action, changes of microorganisms and host metabolism and stimulation of the immune response (p. 71).

In order to reduce the indiscriminate use of antibiotics in animal production, the use of various alternatives has been explored, among which are:

> Probiotics, prebiotics and synbiotics, which represent a potentially significant and safe therapeutic advance, are live microorganisms that, when added as a dietary supplement, promote digestion and help maintain the balance of the microbial flora in the intestine. These products when fed directly to animals improve their metabolism, health and production. Among the probiotics are yeasts that induce positive effects in terms of productive performance in monogastric species, but they cannot colonize the digestive tract. (Castro, Rodríguez, 2005, pp. 26-38).

For Fuller, R. (in Journal of Applied Bacteriology, January 1989, pp. 365-378) probiotics are "... a live microbial supplement, which beneficially affects the host animal by improving the intestinal microbial balance".

Probiotics are "additives that improve the digestive process by maintaining a healthy intestinal environment as they modify the composition or activity of the intestinal microflora" (Reyes, Figueroa, Cobos, Sánchez Torres, Zamora and Cordero, 2012, p. 90).

For Rafael Villanueva (in Probiotics: an alternative for the food industry, January - December, 2015, pp. 265-275) "...probiotics are defined by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) as living organisms, which when administered to a host in adequate amounts provide health benefits."

Accordingly, Gupta, Garg (2009), indicates that microorganisms used in probiotic preparations should have the properties of being generally safe, resistant to bile, hydrochloric

acid and pancreatic juice, having anticancer activity and stimulating the immune system, reducing intestinal permeability, producing lactic acid and being able to survive either in the acidic conditions of the stomach or the alkaline conditions of the duodenum (p. 205).

It is stated that the components of probiotics according to Fotiadis, Stoidis, Spyropoulos, Zografos (2008), most probiotics are members of the two lactic acid bacteria (LAB), Lactobacillus and Bifidobacterium, but yeasts and enterococci are also used (p. 6453).
Based on research conducted by Cáceres and Gotteland (2010), he points out that probiotics are mainly lactic acid bacteria belonging to the genera Lactobacillus or Bifidobacteriu (pp. 97-109).
Also in the research on Probiotics in pigs, it is indicated that "among the strains of greater use as probiotics are mainly Gram-positive bacteria such as Lactobacillus, Enterococcus, Bacillus, Bifidobacterium and Saccharomyces" (Giraldo-Carmona, Narváez Solarte, Díaz-López, 2015, pp. 81-90).
In relation to Lactobacillus acidophilus and Lactobacillus casei James, M., Velastegui, E., Cruz, M. (2017) states that these Lactobacillus are lactic acid bacteria that act as probiotics and are generally used to formulate functional foods and grow in similar culture conditions. Both lactic acid bacteria metabolize specific sugars (p. 235).
Based on the results of Garcia et al. (2007), it can be inferred that the constant presence of Lactobacillus and Lactobacillus rhamnosus in the diet is necessary to achieve the hypocholesterolemic effect. The mechanism of action proposed to achieve this response of the lactobacilli explains the need for their persistence in the gastrointestinal tract to exert their effects.
Corresponding to the comments of Ng, Hart, Kamm, Stagg, Knight (2009), the intestinal flora plays a fundamental role in the maintenance of immune homeostasis (p. 300).
Based on the preliminary in vitro identification of probiotic properties in S. cerevisiae strains, it is indicated that "probiotics are made from microbial cultures whose function is to stimulate the gastrointestinal flora in animals and humans" (Rubio, Hernández, Aguirre and Poutou, 2008, pp. 1157-1169).
With reference to yeasts, Moslehi, Lindegaard, Jespersen (2010), mentions, besides being very important in food and beverage fermentation, yeasts also show many beneficial effects on human health. Among them, the probiotic effect is the most well-known health effect, including the prevention and treatment of intestinal diseases and immune regulation. Other beneficial functions of yeast are increasing mineral bioavailability through hydrolysis of phytic acid, biopotentiation of folic acid, and detoxification of mycotoxins due to surface binding of yeast cell walls (p. 449).
In general, yeasts have been little used as probiotics:

> Saccharomyces cerevisiae has been reported as a supplement in the diet of monogastric animals, in which its probiotic action reduces the presence of enteropathogens, produces favorable changes in the intestinal mucosa and improves productive behavior. It has also been recognized for its ability to promote growth, increase vitamin B production, help weight gain, improve digestion of some feeds, stimulate the immune system, improve nutrient assimilation and correct the balance of the microbial population (Rubio et al., 2008). (Rubio et al., 2008, pp. 1157-1169).

The yeast S. cerevisiae "would stimulate the activity of beneficial microorganisms in the gastrointestinal tract, thus increasing nutrient digestibility and production potential of animals" (Dos Santos, Pereira, Ferreira, Penna, Rosa, Drummond, Neves, Nicoli, 2005, pp. 1-15).

Based on Biricik and Turkmen (2001), in high diets, live yeast culture of Saccharomyces cerevisiae can improve the digestibility of dry matter, organic matter and neutral detergent fiber, NDF (p. 32).

The importance of modulating the intestinal microbiota of animals is widely recognized due to its vital role in animal health:

> There are complex communities of microbiota that colonize the gastrointestinal tract. The gut microbiota supports animal health and the development of the host's immune system. Probiotics are commonly used dietary additives in which they provide the host with many beneficial functions, such as modulating intestinal homeostasis and promoting intestinal health. These beneficial effects of probiotics can be derived from inhibiting the growth of pathogenic bacteria and promoting the growth of beneficial flora in the gastrointestinal tract. (Shenghan, Li, & Zongyong, 2017, pp. 382-387)

However, gaps remain in the exact role probiotics play in modulating the gut microbiota and immune response:

> The roles of probiotic Lactobacillus plantarum strain JDFM LP11 in modulating intestinal microbiota and immune response in weaned piglets, L. plantarum JDFM LP11 increased the population of lactic acid bacteria in feces and enhanced villi development in the small intestine. (Donghyun et al., 2019, pp. 1-23)

Towards rational selection criteria for probiotic selection in pigs:

> The expected probiotic effect depends on the age of the animal and disease prevention in young animals may require different probiotic strains compared to growth promotion in older animals. With appropriate selection criteria, the inclusion of probiotics in feed supplementation is a promising way to exert positive effects in sows, neonates, weanlings and finishing pigs as they promote feed digestion and improve growth performance. (Wang and Ganzle, 2019, pp. 83-112)

According to Reyes, Figueroa, Cobos, Sánchez-Torres, Zamora, Cordero (2012), the addition of the standard low-protein probiotic Streptococcus faecium to the soybean and sorghum meal diet will not affect pig production variables, body characteristics and plasma urea concentration of the pig during the initial, growth and finishing processes. Reducing dietary protein will not adversely affect production response or carcass characteristics (p. 597).

The beneficial functions of probiotics, demonstrated that "the importance of probiotics in swine production is widely recognized as crucial" (Donghyun, Yong, Bogere, Won, Jae-Young, Yeon-Jae, Hak, Hur, Byung-Yong, Younghoom, & Jaeyoung, 2019, p. 1-23).

Probiotics used in the intensive rearing of farm animals could totally replace antibiotics as growth promoting additives, due to the beneficial effects they produce in the host. The objective of this work was to compare the effect of a probiotic and an antibiotic as additives on the productive behavior of pigs in the growth phase.

On the other hand, Miranda Yuquilema et al. (2018) argue that, at all stages of research, the use of probiotic preparations can improve production parameters and reduce diarrhea and mortality (p. 27).

According to the latest research by Vega Cañizares et al. (2018) on lactic acid bacteria as probiotics in swine farms shows that they constitute a possible substitute for antibiotics (p. 2).

However Giraldo Carmona, Narváez Solarte, Díaz López (2015) another factor to consider when conducting such research is to determine the health of the animals used as experimental units and the load of environmental microorganisms on each farm, which can change the complex ecosystem in the gastrointestinal tract (p. 89).

Coppola, Gil (2004), Abércio da Silva, Bridi, Castro-Gómez, Hernán, Benítez da Silva, Gual Menegucci, Bueno de Carvalho (2007), Ayala, Bocourt, Martínez, Castro, Hernández, (2008), Castillo, Cárdenas, Cepero, Silveira, (2010), Ferreira, Barbosa, Larissa, Silva, Henrique, Figueira (2011), Nagae, Westphal, Santi (2014), Abreu-Abreu (2018) study on probiotics, in all cases the researchers agree that probiotics were better in reducing diarrhea, improve zootechnical performance by reducing microbial contamination or regulate the immune response of the animal.

Boucourt, Savón, Díaz, Brizuela, Serrano, Prats, Elías, (2004), Dos Santos et al, (2005), Gil de los Santos, Gil-Turnes, (2005), Pérez, Milián, Galindo, Domínguez, Pérez, Portilla, Rondón (2015), Flores-Mancheno, García-Hernández, Usca, Caicedo, (2016), Cano, Carcelén, Ara, Quevedo, Alvarado, Jiménez, (2016), probiotics have been introduced as a promising alternative solution, in all cases researchers agree that it has a positive impact on the physiological indicators of pigs, improving production.

While it is true that the use of probiotics decreased the mortality percentage of pigs, it determined that there were differences in weight gain, feed conversion, this does not relate at all with the experimental results of other investigations (confront Chiquieri et al., 2006).

MATERIALS AND METHODS

The research was carried out at the Double A Swine Farm, located in Guayaquil, Guayas province, Ecuador. Twenty pigs were used in each group of 60 days of age, with crossbreeding of Landrace-Belga, Pietrain, Yorkshire and Duroc-Jersey breeds, weights were adjusted at 92, 120 and 149 days, the initial weight in the control group was 29.0 ±4.49 kg, the C.V. of 15.47% and in the experimental group the initial weight was 21.04 ±8.42 kg, the C.V. of 16.91%. The animals were housed in a cement shed, with hopper feeders and automatic waterers. The experiment lasted 58 days.

The research design was experimental, with descriptive scope. The animals were distributed in two groups: the experimental group received a diet with the addition of three biological components; microencapsulated bacteria (*Streptococcus faecium*, *Lactobacillus acidophilus*), enzymes (protease, amylase and cellulases) and yeast culture (*Sacharomyses cerevisiae* strain 1026), without antibiotic, while the control group received the diet containing the antibiotic avoparcin as growth promoter.

The composition and nutrient description of the feed rations (Table 1 and 2) were formulated according to the nutritional requirements (McDonald, 1975). Growth promoters were added according to the manufacturer's specifications (0.75 kg/Ton. of probiotic and 200 g of Avoporcine). Water and feed rations were supplied ad Livitum. Pig weight and feed consumption were monitored at the beginning and end of the phase,

Data were analyzed by Student's t-test with related samples, using SPSS version 26. The price of the diets in each group was also calculated and the benefit-cost ratio was estimated.

Table 1

Composition of feed rations supplied during the growth phase

Ingredients	Formula (%)	
	Lacto-Sacc	Avotan
Corn	34.63	34.63
Extruded soybean paste	10.4	10.4
P. export	8.75	8.75

Palm oil	1	1
Cookie	26.27	26.27
Wheat bran	17.15	17.15
Dicalcium phosphate	0.72	0.72
Carbonate #40	0.35	0.35
Salt	0.4	0.4
Lacto-Sacc	0.08	
Avotan		0.02
Premix pigs	0.15	0.15
Methionine 99%.	0.1	0.1
Antioxidant BHT	0.01	0.01
Total	100.0	100.0

Table 2

Description of nutrients of the feed rations supplied during the growth phase

Description of nutrients	Lacto-Sacc	Avotan
Protein	18.01	18.02
ME kcal/kg	3264.62	3266.49
Calcium	0.8	0.8
Assimilable phosphorus	0.6	0.6
Methionine 99%.	0.48	0.48
Methionine + Cystine	0.61	0.61
lysine	0.96	0.96
Fiber	4.49	4.49
Total salt	0.49	0.49
Grease	6.27	6.28
Calcium/Phosphorus	1.34	1.34
Total		

RESULTS

The effect of the addition of Probiotic (Table 3) on productive parameters was observed (p≤0.05). Feed conversion was better for the group with probiotic: 2.33 kg of feed to gain 1 kg of weight. On the other hand, the benefit-cost analysis is higher for the probiotic group, so it should be considered economically viable and profitable.

Table 3

Initial and final weight, ration consumption per day per animal, daily weight gain and feed conversion of growing pigs on a probiotic and antibiotic diet.

Parameters	Diets	
	With probiotic	With antibiotic
Initial weight, kg	21.04 ± 3.56	29.0 ± 4.49
Final weight, kg	46.54 ± 8.42	56.28 ± 11.51
Daily weight gain, kg	0.54	0.48
Ration consumption per day, kg/Animal	2.365	2.32
Feed conversion	2.33	2.59

Table 4

Benefit-Cost Ratio Determination

Groups	Consumption/ Bag 40 kg/pig	Cost/Bag 40 kg	Weight gain/kg	Price - kg/ft - $	Expenditure - $	Income - $	Benefit-Cost Ratio
Experimental	2.36	28.00	30.84	2.55	66.21	78.64	1.19
Control	2.32	28.00	27.27	2.55	65.08	69.54	1.07

The study demonstrated the feasibility of using probiotics as additives, since it was possible to improve the productive response, achieving a better development and utilization of the feed. The results are in agreement with the findings of other authors (Alltech, 1996; Biricik and Türkmen, 2001; Swientek, 2003; Boucourt et al., 2004; Ayala *et al*., 2008; Manzano et al., 2012), Jurado Gámez et al., 2013). However, Chiquieri et al., (2006) working with mixed-breed, castrated male pigs, adding probiotic and prebiotic in the diet, reported contradictory results on weight gain and feed conversion with the use of probiotics.

CONCLUSIONS

The use of additives such as probiotic containing microencapsulated lactic acid bacteria (LAB) (*Streptococcus faecium* and *Lactobacillus acidophilus*), enzymes (protease, amylase and cellulase), and yeast culture (*Sacharomyses cerevisiae* 1026), in the diet at a dose of 0.75 kg/t of feed, improves weight gain, feed conversion ratio and benefit-cost ratio, in the growth phase of pigs.

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