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Effect of Consumption of a Liquid Apple Yeast Additive on Growing-Finishing Pigs

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Abstract

A liquid apple yeast additive (ALL) was evaluated on the productive behavior of pigs in the growth-completion stage. Four levels of ALL kg−1 of food from the diet were tested: 0 mL kg−1 (T1: control), 50 mL kg−1 (T2), 100 mL kg−1 (T3) and 150 mL kg−1 (T4). A total of 24 pigs with an average age of 30 days and a Average starting weight of 28,170 ± 3.6 kg. The variables evaluated were: live weight (BW), daily feed intake (CAD), daily weight gain (GDP), feed conversion (CAT), carcass yield (CR), rib eye area (COC), back fat thickness (EGD), meat and fat color (L, a, b*) and blood count (BH). A univariate analysis was performed to detect statistical differences between treatments using a confidence level of α = 0.05. T3 was better (P < 0.05) for PV, GDP, CDA, and CA. (P < 0.01) for AOC, EGD and BH. It is concluded that the addition of 100 mL of ALL per kg of feed in the growth-completion diet of pigs improves their productive response and the health of the animals.*

Keywords: *Food, fattening, yeasts, apple, meat, blood county.*

INTRODUCTION

Pig farming in Mexico is one of the main livestock economic activities, which is why pork consumption ranks third in production nationwide after chicken and beef. The domestic pig (Sus scrofa domesticus) is one of the most exploited species in animal production, and its production has provided access to resources for smallholder families in Mexico (Hernández-Antonio et al. 2021). Pork production in Mexico is estimated at 1.7 million tons per year and is influenced by quality standards such as animal health, food safety, environmental sustainability, and animal welfare (SADER 2019), aspects that are increasingly valued by consumers. In addition, pork is the most widely consumed meat worldwide and the most economical source of animal protein for humans (Liao et al. 2015). On the other hand, yeast additives obtained from the fermentation of apple bagasse

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are known to be an alternative to improve pig production, as they provide active and beneficial yeasts that improve nutrient utilization (Díaz-Plascencia et al. 2011).

Probiotics have been used as a natural additive to improve intestinal function and reduce stress, so it is advisable to use them in pig feed. The importance of the consumption of live yeast cultures lies in the production of enzymes, vitamin B complexes, minerals, mannan oligosaccharides (MOS) of the cell wall and different types of amino acids (Pereira et al. 2021). This stimulates nutrient absorption, improves the gut microbiota environment, and promotes immune system response (Duarte & Kim 2021). In addition, it is recommended that yeast supplements be rich in trace elements, especially zinc, copper, and manganese. This is because they are essential for the proper functioning of practically all biochemical processes in the body (López-Alonso 2012). Therefore, the aim of this study was to evaluate the effects of different concentrations of liquid apple yeast additive (ALL) on the performance and production parameters of growing pigs in order to determine the optimal level of addition.

MATERIALS AND METHODS

Localization

The experiment was carried out from January to June in the pig metabolic unit of the Faculty of Zootechnics and Ecology (FZyE) of the Autonomous University of Chihuahua (UACH), located near the city of Chihuahua, Mexico. The unit is located between parallels 28° 38' LN and 106° 04' LO, at an altitude of 1,440 meters above sea level. The average annual temperature is 18.6 °C with an average annual rainfall between 200 and 600 mm (INEGI 2017).

Number of animals used

A total of 24 weaned and castrated pigs with an average age of 30 days from the York x Landrace cross, with a live weight (BW) of 28,170 ± 3.6 kg, were used. Prior to random assignment to treatment, the animals were weighed, identified with plastic earrings, dewormed and vitaminized (1.0 mL per 33 kg of BW). The animals were housed in individual cages in groups of six, each with a space of 2.18 m2 (0.95 x 2.30 m) provided with a slat floor, stainless steel feeder and pacifier drinker. The animals had access to water and food ad libitum and had an adaptation period of 15 days.

Ethical aspects

The study was carried out in accordance with the internal code of bioethics and taking into account both the animal welfare regulations of the FZyE of the UACH and the regulations of the Official Mexican Standard on animal care published by the Ministry of Agriculture and Rural Development (SAGARPA 1999).

Obtaining the liquid yeast additive (ALL)

The ALL contained a mixture of the yeasts Kluyveromyces lactis, Issatchenkia orientalis and Saccharomyces cerevisiae that was obtained from the fermentation of apple bagasse with a concentration of 1.8 x109 CFU mL−1 of the Lebas® brand

Treatments

Four treatments, with six replications (n = 6), were evaluated under a completely randomized experimental design. In treatment 1 (T1: control), a basal diet with ground sorghum and 46% soybean paste was offered, considering its nutritional contribution according to the nutritional requirements of the productive stage (NRC 1998, Table 1). In treatment 2 (T2), T1 was evaluated: control plus 50 mL of ALL per kilogram of feed (ALL kg−1). In treatment 3 (T3), T1 was assessed: control plus 100 mL of ALL kg−1. Treatment 4 (T4) consisted of T1: a control with 150 mL of ALL kg−1.

Table 1. Experimental diets for pigs in the growth and completion stage on a dry basis.

Ingredients (kg)	**Initiator***	**Growth***	**Fattening***
Sorghum (milled)	688.0	719.0	754.0
Soybean paste 46%	265.0	240.0	215.0
Soybean oil	20.0	15.0	5.0
Lysine	2.0	1.0	1.0
1Premix V & M	25.0	25.0	25.0
Total	1,000	1,000	1,000
Price per (kg)	6.08	5.32	5.06
Calculated Nutrient Analysis			
E. M. Mcal $^{kg-1}$	3.293	3.265	3.210
E.D. Mcal $^{kg-1}$	3.404	3.367	3.303
E.N. Mcal $^{kg-1}$	2.426	2.408	2.364
TDN %	76.88	76.18	74.79
Total Protein %	18.00	17.00	16.00
Digestible Protein %	16.39	15.48	14.68
Crude Fiber %	2.44	2.44	2.46
Crude Fat %	4.04	3.60	2.67
Lysine %	1.112	0.965	0.896
Methionine %	0.275	0.263	0.251
Calcium %	0.756	0.666	0.628
Phosphorus %	0.665	0.553	0.505

*The animals of each treatment received the same diet by physiological stage, the difference was the addition of liquid yeast additive (ALL) at the time of offering the feed in the trough, T1: control (0 mL kg-1), T2 (50 mL kg-1), T3 (100 mL kg-1) and T4 (150 mL kg-1); 1Pork SV starter: Ca 15%, P 3.20%, Na 4.62%, Cl 6.30%, Cr 20.00 mg kg-1, Cu 390.00 mg kg-1, Zn 3,900.00 mg kg-1, Mn 400.14 mg kg-1, Fe 3,800.00 mg kg-1, Se 11.00 mg kg-1, I 20.00 mg kg-1, Vitamin A 450,000 IU kg-1, Vitamin D 81,000 IU kg-1, Vitamin E 900 IU kg-1; 1Pork growth: Ca 19.00%, P 3.15%, Na 5.90%, Cl 3.95%, Cr 24.00 mg kg-1, Cu 380.00 mg kg-1, Zn 3,850.00 mg kg-1, Mn 420.10 mg kg-1, Fe 3,850.00 mg kg-1, Se 12.00 mg kg-1, I 19.80 mg kg-1, Vitamin A 400,000 IU kg-1, Vitamin D 60,000 IU kg-1, Vitamin E 600 IU kg-1; 1Pork completion 7.5: Ca 19.80%, P 1.70%, Na 3.95%, Cl 5.95%, Cr 355.00 mg kg-1, Cu 32.40 mg kg-1, Zn 3,522.00 mg kg-1, Mn 406.00 mg kg-1, Fe 3,520.00 mg kg-1, Se 12.80 mg kg-1, I 19.85 mg kg-1, Vitamin A 432,000 IU kg-1, Vitamin D 72,000 IU kg-1, Vitamin E 720 IU kg-1.

Productive Variables Under Evaluation

The pigs were weighed at the beginning (day 0) of the experiment and at 15 days of the adaptation period with the support of a REVUELTA digital scale with a capacity of 1 500 kg. Subsequently, they were weighed at 24, 48 and 72 days after the start of the test, to evaluate in each period the average body weight (BW) and the daily weight gain (GDP). The feed offered to each pig and at the end of each period (24, 48 and 72 days) was recorded to determine the daily feed intake (CDA). Finally, feed conversion (CA) was calculated with the average of the CDA parameter and the GDP. For the variables carcass yield (CR), rib eye area (COC), a tenth-of-inch grid template was used to measure these variables, which was placed on the surface of the loin at the height of the 12th and 13th ribs to expose the Longissimus Dorsi muscle. The thickness of back fat (EGD) was determined in the same slice as the AOC, at an angle of 45° to the axis of the muscle and the measurement was recorded in millimeters. Flesh and fat color (L, a*, b*) was determined at 72 h using a Minolta® Sensing, Inc. colorimeter; Osaka, Japan, with the methodology used by Garrido et al., (1994). For blood count (BH) analysis, the blood sample was collected in a vacutainer® tube on days 15, 24, 48 and 72. The BH samples were sent to a clinical laboratory for analysis.

Statistical analysis

For the variables PV, GDP, CDA and CA, a repeated univariate analysis (ANOVA) was performed for each period, using the SAS statistical package (2004). Initial weight was considered as covariate and the experimental design was completely randomized. All analyses were performed with a confidence level of 95% or $\alpha = 0.05$. When the ANOVA showed statistical differences between treatments, the Dunnett test was used to establish statistical differences between the treatments and the control (Rubio and Jiménez 2012).

The analysis of the variables AOC, EGD and meat and fat color was performed using the GLM procedure of the SAS package (2004) using a completely randomized design with factorial arrangement that included four levels. For the analysis of BH, the data were analyzed using the MIXED procedure of the SAS package (2004), where a completely randomized design with a two-by-two factorial arrangement with means repeated over time was used.

RESULTS AND DISCUSSION

Live Weight (PV)

The ANOVA detected statistical differences for the PV variable in the three study periods ($P < 0.05$). Table 2 shows that pigs in T3 (100 mL of ALL kg^{-1} of feed) showed the highest BW with 56,717 kg in the period 1 to 24 days, 78,033 kg in a period of 24 to 48 days and 104,383 kg in the period of 48 to 72 days. The animals in T1 (control) obtained the lowest PV compared to the other treatments, but the PV of the T3 animals was notorious, which exceeded the weight of the other treatments in the three periods evaluated. These data show that pigs that received ALL in the diet were better than the T1 treatment (control), so it is suggested that ALL decreases the fattening time of pigs favoring PV to go to market. These results are consistent with a study where it was mentioned that adding a yeast additive to the diet of pigs at weaning significantly improved weight gain, feed intake, and decreased the incidence of diarrhea and death of piglets (Xu et al. 2018). While other authors mention that, by adding yeasts to the diet of pigs, the productive response in the growth phase was improved (Lee et al. 2018), as well as the immune system and intestinal health (Palma et al. 2015), indicating that yeast promotes feed digestibility (Li and Kim 2014). In this regard, it is suggested that the mechanism by which yeasts provide these benefits is due to the types of sugar that form cell walls, particularly β-D-glucans and α-D-mannans (Lee et al. 2021).

Table 2. Effect of the liquid yeast additive on the productive behavior of pigs in the growth and finishing stages.

Periods in days	Treatments T1	S2	S3	S4	P-Value
	Kg				
Live Weight					
1 to 24	48.850±0.86C	54.717±0.80AB	56.717±0.81A	53.217±0.79B	<0.0001
24 to 48	66.117±1.18c	74.433±1.10AB	78.033±1.12A	72.067±1.09B	<0.0001

48 to 72	84.883±1.62c	97.117±1.51B	104.383±1.53A	93.467±1.50B	<0.0001
Average	58.558±0.69c	66.092±0.64B	69.421±0.65A	64.067±0.64B	<0.0001
GDP					
1 to 24	0.603±0.03B	0.692±0.03AB	0.757±0.03A	0.654±0.03AB	<0.043
24 to 48	0.719±0.04B	0.822±0.04AB	0.888±0.04A	0.785±0.04AB	<0.048
48 to 72	0.782±0.06B	0.945±0.06ab	1.098±0.06A	0.892±0.06ab	<0.044
Average	0.701±0.02c	0.820±0.02b	0.914±0.02A	0.777±0.02BC	<0.001
CDA					
1 to 24	1.863±0.00A	1.838±0.00B	1.822±0.00c	1.850±0.00AB	<0.0001
24 to 48	2.599±0.02A	2.552±0.02AB	2.484±0.02BC	2.468±0.02c	<0.0001
48 to 72	2.958±0.02A	2.851±0.02b	2.729±0.02c	2.800±0.02b	<0.0001
Average	2.473±0.00A	2.414±0.00B	2.345±0.00C	2.373±0.00c	<0.0001
AC, kg $^{kg-1}$					
1 to 24	3.176±0.16A	2.675±0.15AB	2.423±0.15b	2.853±0.15ab	<0.019
24 to 48	3.785±0.20A	3.125±0.19AB	2.798±0.19b	3.143±0.19AB	<0.018
48 to 72	3.964±0.33A	3.189±0.31AB	2.491±0.31b	3.217±0.31AB	<0.043
Average	3.642±0.08A	2.996±0.08b	2.571±0.08c	3.071±0.08b	<0.001

abc Means ± standard error (n=6 per treatment) per row, between treatments and with different superscripts differ (P<0.05); GDP=Daily Weight Gain; CDA=Daily feed intake; CA=Feed conversion; T1: control; T2: control + 50 mL liquid yeast additive (ALL) kg-1 feed; T3: control + 100 mL of ALL kg-1 feed; T4: control + 150 mL of ALL kg-1 of feed.

Daily Weight Gain (GDP)

The ANOVA detected statistical differences between the treatments for the GDP variable in the three evaluation periods ($P < 0.05$). Pigs that received 100 mL of ALL kg−1 of feed had the highest levels with 0.757 kg−1 day−1 in the period from 1 to 24 days, 0.888 kg−1 day−1 in the period from 24 to 48 days and from 1,098 kg−1 day−1 in the period from 48 to 72 days. It is important to mention that according to the Dunnett test, all ALL treatments outperformed the T1 (control) treatment, indicating the advantage of using ALL. These results are consistent with previous studies that reported a positive effect on GDP in weaned pigs by adding probiotics to a corn-soybean base diet (Pan et al. 2017). While another study reports an increase in weight gain from supplementation with yeast cell wall products in weaned pigs (Lee et al. 2021). Other researchers observed an increase in GDP and CA in early weaned piglets supplemented with probiotics based on Saccharomyces cerevisiae (S. cerevisiae), compared to piglets fed only the basal diet (Xu et al. 2018). It has also been reported that pigs in the final phase of fattening and under caloric stress that were fed a sorghum-based diet, but supplemented with a live yeast additive of S. cerevisiae had a higher GDP compared to those fed only sorghum and even pigs fed a high-energy and high-protein diet (Galaz-Galaz et al. 2018). In another study, it was reported that piglets weaned early and fed with live yeast additives and/or lyophilized yeasts did not show any differences in GPD compared to control, however, feed conversion was better in piglets supplemented with live yeasts (Jiang et al. 2015). The positive effect of S. cerevisiae-based additives on GDP may be due to the establishment of a healthy gastrointestinal tract (Broadway et al. 2015). This is due to the fact that the β-

D-glucans present in the cell walls of yeasts stimulate the receptors of the innate immune system, which improves antimicrobial activity, thus reducing the susceptibility of animals to infectious diseases (Pizarro et al. 2014, Jiang et al. 2015, Lee et al. 2021). In addition, the environment of the microbiota of the gastrointestinal tract is improved, which increases nutrient absorption (Jiang et al. 2015, Lee et al. 2021). All of the above coincides with the results obtained in this study because it is very evident that live yeasts added to diets favor food acceptance, which may have increased intestinal villi for greater nutrient absorption, digestibility and improvement in the immune system, which was reflected in a higher GDP for the consumption of ALL in the diet compared to T1 (control), This potential for productive behavior from the use of yeasts has also been observed in other species (Keyser et al., 2007; Vieira et al., 2013; Plaza-Díaz et al., 2014).

Daily Feed Intake (CAD)

Table 2 shows that, for the first period (1 to 24 days), the highest consumption was in T1 (control) with 1,863 kg−1 day−1 while the lowest was in T3 with 1,822 kg−1 day−1. It was notorious that pigs in T1 (control) increased their consumption in the following two periods, being higher than the rest of the treatments. This indicates that the pigs in the control group increase the CDA and are less efficient in the response of GDP and CA, which has an impact on the final marketing weight and is reflected in the producer's economy. In this regard, Galaz-Galaz et al. (2018) documented that pigs that received a positive control (PT) diet increased CDA when compared to animals that received S. cerevisiae in feed. While Dávila-Ramírez et al. (2020) reported that the addition of 0.2 and 0.3% yeast culture in the pig diet increased GDP by 25.52 and 23.7%, CDA by 13.42 and 11.85% and final weight by 8.09 and 7.26%; but without a noticeable impact on AC when compared to the control group. On the other hand, in weaned piglets that were supplemented with yeast cell wall products, the CDA did not show differences with respect to the control, however, they had a lower incidence of diarrhea during the first two weeks after weaning, compared to the control (Lee et al. 2021). Under the hypothesis that probiotics optimize animal health, improve productive behavior, promote nutrient absorption and improve the modulation of the immune system (Van Der Aar et al. 2016) have also been reported to improve and stabilize the natural microbiota of pigs (Miranda-Yuquilema et al. 2018). The establishment of the beneficial gut microbiota improves the health of animals by reducing the risk of contracting diseases as it reduces the colonization and invasion of pathogenic bacteria (Robles-Huaynate et al. 2013, Zheng et al. 2021).

Feed Conversion (CA)

Table 2 shows that pigs in T1 (control) were less efficient when compared to the other treatments. On the contrary, it is observed that T3 (100 mL of ALL kg−1 of feed) favored the productive behavior of pigs. Therefore, the results coincide with those reported by Méndez-Palacios et al. (2018) who indicate that the addition of S. cerevisiae + Lactobacillus spp + Bacillus spp in the diet of pigs improved weight gain and AC in the 70 to 100 days, 100 to 125 days, and 125 to 150 days of trial. They also coincide with data obtained in other research, where it was observed that probiotic supplementation in weaned piglets had better AC than the control group that did not receive probiotics (Dong et al. 2013). It also agrees with Markowiak and Slizewska (2018) who mentioned that probiotics improve body weight and AC in production animals. This may be due to the fact that piglets treated with probiotics have greater nutrient assimilation, increase live weight, improve the production of vitamins and short-chain fatty acids, which improves nutrient digestibility (Jurado-Gámez et al. 2013). In a study, Jiang et al. (2015) reported that supplementation of S. cerevisiae in different forms (live yeast, dead yeast, or cell wall components) improves feed conversion, gut development, and stimulates the immune system of early weaned piglets.

Channel Performance (RC)

No effect was observed between treatments (P>0.05), all treatments were very similar (Table 3). In muscle production, it was observed that T3 pigs produced carcasses with a higher meat content (Table 3).

Table 3. Averages ± EE of the production and quality variables of meat in pigs in the growth and completion stages.

Variable		Treatments			
		T1 n=6	S2 n=6	S3 n=6	S4 n=6
CR (kg)*		82.63±0.67A	81.61±0.73A	83.78±0.73A	83.02±0.73A
AOC (inches)*		6.36±0.43C	6.82±0.40B	6.80±0.43B	6.94±0.43A
EGD (mm)*		2.38±0.25b	2.03±0.25c	2.70±0.27A	1.86±0.27D
Flesh Color	**L**	50.62±1.55A	45.36±1.55B	49.10±1.70A	49.64±1.70A
	to*	3.12±0.69A	2.19±0.69b	2.21±0.75b	0.84±0.75C
	b*	23.95±0.85A	13.33±0.85B	22.45±0.94A	23.33±0.94A
Grease Color	**L**	74.29±1.30A	68.59±1.30c	72.22±1.43B	73.26±1.43ab
	to*	-3.81±0.68B	-2.90±0.68C	-4.20±0.75A	-2.59±0.75D
	b*	37.16±1.56A	28.52±1.56b	35.84±1.71A	36.31±1.71A

abc Means ± standard error (n=6 per treatment) per row, between treatments and with different superscript (Tuckey, P<0.01)

AOC.- Rib eye area

EGD.- Thickness of Dorsal Fat

Rib eye area (COC)

For this variable, an effect was observed (P<0.001), presenting a greater effect at T4 and between treatments where ALL was used compared to T1 (control). It is possible that yeast acts on the metabolism of the animal, both energetically and proteinly, which increases the turnover time of intestinal cells, causing savings in the nutrients digested by the animal and making it possible for them to be used in the production of muscle mass (García et al., 2014). The values obtained in this study for this variable coincide with others previously reported by Beattie et al., 1999. Carcass weight and length were affected by slaughter weights, with higher values for these variables being observed as slaughter live weights increased. It is documented that the hardness of meats is directly affected by the diameter of muscle fibers and collagen Hiner et al., 1953; Tuma et al., 1962 e indirectly by the amount of intramuscular fat and juiciness Jeremiah et al., 1978; Ramsey et al.,1990; De la carne, 2009.

Thickness of back fat (EGD)

Table 3 showed an effect (P<0.001) in T4 pigs compared to the other treatments, which indicates that T4 pigs produced a greater amount of meat and a lower amount of back fat, which from the point of view of production benefits the production system and also human health since it has the advantage that the carcasses can reach the market. with a lower back fat content. The deposition of back fat is influenced by factors such as genetics, housing conditions, gender and diet among others (Pauly et al., 2008), however.

The effect of the yeast additive can be considered as a growth promoter as yeasts are included in the diet of different species, contributing to palatability and feed consumption, stimulating salivary secretion and improving enzyme activity which favors animal health (Windisch et al., 2008).

Flesh color and fat (L, a*, b*)

In relation to the sensory characteristics of the meat, it was observed that the fat color was brighter in the pigs of T1, T3 and T4 since the values recorded were higher than 72 points (Table 3). While in the case of pigs fed with 50 mL/kg−1 (T2) it only exceeded 68 points. In the color of the meat, the negative effect is again observed, since the pigs supplemented with 50 mL/kg−1 had darker meat compared to the other treatments, whose luminosity and red tendency values were similar.

This result may have been affected by the treatment since the color of meat can be influenced by intrinsic, biochemical, physicochemical and extrinsic factors (feeding, pre-slaughter stress) (Pérez, 2006). Formerly Judge et al., (1989) reported that the color of meat can be influenced by physicochemical aspects such as a decrease in pH since the color changes from the moment of slaughter generated by the transformation of glycogen into lactic acid, which can transform the properties of the meat, Torrescano et al., 2008. Castrillón et al. (2007) mentions that, for pork, pH values of 5.5 indicate, pale soft and oxidative meats (PSE); pH values of 6.0 are considered firm and dark tough meats (DFD), while pH values between 5.6 and 5.9 indicate normal meats due to the fact that microbial counts decrease due to the effect of pH, generating improvements on the color and texture characteristics of the meat, Braña et al, 2011; Archundia et al., 2023. However, it would be interesting to know if there is a relationship between the level of additive and physiological aspects of the animal, since the pigs were handled and slaughtered in a TIF slaughterhouse, so the differences found here could be more related to the level of additive supplemented and not to the ante- and post-mortem handling of the pigs.

Blood Biometry (BH)

Leukocyte levels in this variable were higher ($P<0.001$) at T1 (control) compared to treatments where the yeast additive was used, it is worth mentioning that leukocyte levels increase when diseases occur due to infections or in stress-related situations (Figure 1). When there is a stressful situation in animals, there is a release of glucocorticoids which have an influence on leukocytes, causing the mobilization of cells stored in the periphery, increasing the total count of leukocytes in the bloodstream. The parameters of blood count (BH) values are a fundamental diagnostic aid in the analysis and orientation of an animal's clinical condition, as this information is useful in cases of control, assessment of enzootic diseases and nutritional status (Mancillas, 2012). BH is the numerical and descriptive evaluation of the cellular elements of the blood such as red blood cells, white blood cells, and platelets (Barrio et al., 2003). The number of erythrocytes was different ($P<0.001$) between treatments, with the lowest values recorded at T3 (Table 4), and it was also observed that the concentration of erythrocytes increased in all treatments over time. Hoffman et al. (2008) mentioned that erythrocytes play an important role in gas exchange in tissues, transport hemoglobin, and give cellular signals under physiological conditions and in stressful situations (Harrison et al.,2003). However Mejía and Alzate (2015) published that erythrocytes are altered in their shape, size and texture due to the presence of diseases, because when red blood cells are elevated, it is a sign of the body that it is not oxygenating well for which two parameters are assessed: hematocrit which is the volume of red blood cells in the blood and hemoglobin which represents the protein inside the red blood cell. Likewise, when there are low levels of erythrocytes, it is associated with possible anemia, both high and low levels in erythrocytes can represent various health problems (López, 2021), however, the recorded value remained within normal parameters.

Table 4. Effect of liquid yeast additive on pig blood variables in the growth and finishing stages.

Variable	Day	Treatment T1 n=6	S2 n=6	S3 n=6	S4 n=6	Reference Values*
Erythrocytes (k/µL)	15	6.5±0.19A	6.4±0.20A	6.3±0.20A	6.3±0.20A	7.0-11.0
	24	7.6±0.19A	7.5±0.20 A	7.2±0.20 b	7.4±0.20 A	
	48	7.8±0.19A	7.6±0.20 A	7.4±0.20 B	7.8±0.20 A	
	72	7.9±0.19a	7.8±0.20 A	7.6±0.20 b	8.0±0.20 A	
Hemoglobin (g/µL)	15	11.5±0.41b	12.5±0.43A	11.4±0.46b	11.7±0.46b	10-16
	24	14.8±0.41b	15.1±0.43A	14.20.46b	14.4±0.46b	
	48	15.2±0.41A	15.6±0.43A	14.50.46b	14.6±0.46b	
	72	15.4±0.41A	15.7±0.43A	14.20.46b	15.4±0.46A	
Hematocrit (%)	15	39.6±1.09b	42.0±1.20A	38.6±1.20b	40.8±1.20A	32.0-50.0
	24	49.2±1.09b	49.8±1.20A	46.9±1.20c	48.4±1.20b	
	48	50.3±1.09A	49.1±1.20b	46.6±1.20c	49.6±1.20b	
	72	49.7±1.09A	50.9±1.20A	48.5±1.20b	51.9±1.20A	

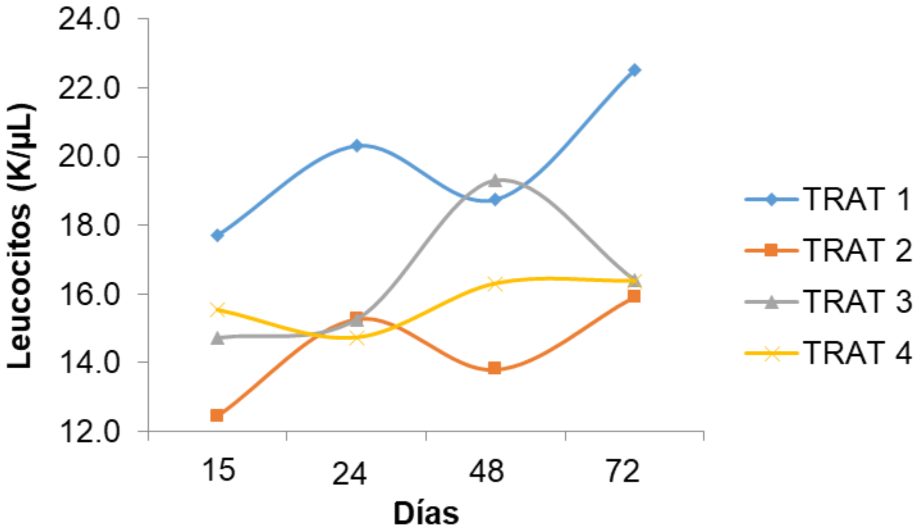

Figure 1. Effect of the day-by-treatment interaction of the amount of leukocytes present in the blood of pigs supplemented with a liquid yeast additive. In original Spanish language

The hemoglobin and hematocrit values observed were different ($P<0.001$) between treatments, with the highest values for T2 (Table 4). The hemoglobin and hematocrit values observed in this study are consistent with the normal values described for domestic pigs Merk (2018). A high hematocrit value implies an increase in blood viscosity and resistance to blood flow, causing a greater workload on the heart (Shlosberg et al., 1996). Because T2 and T3 animals had the best GDP, hematocrit and hemoglobin results can be related to faster metabolism and higher oxygen demand. Zhang and Reisen, (2000) mention that, under normal conditions of oxygen tension, a greater gain in body weight coincides with a greater increase in cardiac output. MFMER (2021) reported that if there is a low level of hematocrit it can indicate a supply of healthy red blood cells (anemia), a large number of white blood cells due to illness or infection, or recent or long-term blood loss; Likewise, a high hematocrit level represents dehydration or lung and/or heart disease.

CONCLUSIONS

By adding 100 mL of liquid apple yeast additive (ALL) per kilogram of the sorghum and soybean paste-based diet for pigs in the growth-finishing stage, live weight was increased, daily weight gain was improved, efficiency in daily feed consumption was improved, as well as feed conversion efficiency was favored. carcass characteristics and color, it also has a higher production of meat with less fat and larger AOC size.

It is recommended to develop further research at the different stages of fattening, to evaluate different levels of liquid yeast additive in the diet of pigs in confinement.

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