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Antioxidant activity in dorsal fat and *Longissimus dorsi* muscle of post-weaned Pelon piglets fed with arboreal leaves meal

Actividad antioxidante en la grasa dorsal y en el músculo *Longissimus dorsi* de lechones Pelones post-destetados alimentados con hojas de arbóreas

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ABSTRACT

The objective of this study was to compare the effect of a 10% inclusión of leaf meal from the arboreal species *Morus alba* (Mulberry), *Moringa oleifera* (Moringa), and *Cnidoscolus aconitifolius* (Chaya) in a conventional maize-soy bean meal diet on the antioxidant activity (DPPH, ABTS assays, and total polyphenols) in dorsal fat (DF) and *Longissimus dorsi* (LD) of post-weaned Pelon (hairless) piglets. A total of 28 piglets, 24 days old at weaning, were divided in to four experimental groups, each consisting of seven piglets homogenized by sex and weight. After a seven-day adaptation to the experimental cages and diet, the pigs were fed ad *libitum* for 28 days and were slaughtered at 59 days of age, with a final weight of 6.8 ± 0.3 kg. A statistical model under a completely randomized block design was employed to determine if there were differences between the means of the analyzed variables. Correlations, regressions and a principal component analysis were performed to group the results obtained from the variables in each treatment. The diet with Chaya meal exhibited the highest antioxidant activity measured in the DPPH, ABTS assays, and total polyphenols in both DF and LD. It was also demonstrated that the antioxidant activity in DF (dorsal fat) and LD, as well as the ether extract (EE) in LD, was greater ($P<0.0001$) in piglets fed with Chaya and Moringa. The statistical correlations and regressions showed that increased consumption of antioxidants correlates with a higher percentage of EE in LD; and that greater antioxidant activity in both GD and LD corresponds to a higher percentage of EE in LD. The 10% inclusion of Moringa and Chaya meal in the conventional maize-soybean meal diet enhances antioxidant activity in both DF and LD of post-weaned Pelon piglets.

Key words: Phenolic compounds; forage plants; pelón pigs

RESUMEN

El presente estudio tuvo como objetivo comparar el efecto de la inclusión al 10% de las harinas de hojas de las arbóreas *Morus alba* (Morera), *Moringa oleifera* (Moringa) y *Cnidoscolus aconitifolius* (Chaya), en la dieta convencional maíz – pasta de soya, sobre la actividad antioxidante (ensayos de DPPH, ABTS y polifenoles totales) en grasa dorsal (GD) y en LD del lechón post destetado de raza Pelón. Para el experimento se utilizaron 28 lechones, con una edad de 24 días de nacidos en etapa post-destete, los cuales se dividieron en cuatro grupos experimentales, cada uno con siete lechones homogenizados por sexo y peso. Después de siete días de adaptación a las jaulas experimentales y a la dieta, los cerdos fueron alimentados ad *libitum* durante 28 días y se sacrificaron con una edad de 59 días con un peso final de 6,8 ± 0,3 kg. Se empleó un modelo estadístico bajo un diseño de bloques completamente al azar, para determinar si existían diferencias entre las medias de las variables analizadas. Se realizaron correlaciones, regresiones y un análisis de componentes principales para agrupar las variables en cada tratamiento. La dieta con harina de Chaya presentó la mayor actividad antioxidante medida en los ensayos de DPPH, ABTS y polifenoles totales en GD y en LD. También se demostró que la actividad antioxidante en GD y en LD, así como el EE en LD fue mayor ($P<0,0001$) en los lechones alimentados con Chaya y Moringa. Las correlaciones y regresiones estadísticas demostraron que a mayor consumo de antioxidantes, incrementa el porcentaje de EE en el LD; y a mayor actividad antioxidante en GD y en LD, mayor es el porcentaje de EE en LD. La inclusión al 10 % de la harina de Moringa y Chaya en la dieta convencional Maíz – pasta de Soya eleva la actividad antioxidante en GD y en LD del lechón Pelón post-destetado.

Palabras clave: Compuestos fenólicos; plantas forrajeras; cerdos pelones

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INTRODUCTION

Swine (*Sus scrofa domesticus*) a highly nutritions food but is susceptible to lipid oxidation and microbial contamination, compromising its quality and safety [1]. Some authors, such as Hadidi *et al*. [2], report that synthetic preservatives like butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and tert-butylhydroquinone (TBHQ) reduce the oxidation of fats and proteins in meat but pose health risks such as food poisoning, liver damage, carcinogenesis, and mutagenesis.

To improve the quality of pork, extend its shelf life, and provide consumers with health hire meat products and by-products, it is necessary to enhance its antioxidant profile through feeding. Antioxidants significantly reduce the development of spoilage and pathogenic microorganisms, prevent lipid oxidation and rancidity, preserve or reduce the loss of sensory attributes such as color, odor, flavor, and texture, and increase shelf life [3].

Serra *et al*. [4] report numerous publications demonstrating that consuming a variety of antioxidant compounds presenting natural plant-based foods can decrease the risk of serious health disorders due to their antioxidant activities. Additionally, these compounds may reduce lipid oxidation, potentially decreasing the need for synthetic antioxidants, as consumers have expressed a preference for natural alternatives.

Some authors [5, 6, 7], have studied the use of natural antioxidants to reduce lipid oxidation in pork and demonstrated that utilizing forage tree species in the diets of these animals could be considered an alternative to modify their antioxidant profile through their feeding, given that pigs are omnivores.

The authors [8, 9] note that various methods can be used to evaluate the antioxidant capacity of a compound or diet, based on quantifying the reaction product between an unstable chemical species and the antioxidant in question. Among the free radical scavenging assays are the DPPH method (1,1-diphenyl-2-picrylhydrazyl), the ABTS decolorization assay (2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)), and total polyphenols using the Folin-Ciocalteureagent. The percentages of inhibition determined by the aforementioned assays are generally converted to equivalents of caffeic acid, gallicacid, or trolox [10].

Various researchers affirm that certain arboreal species, such as *Morus alba* (Mulberry), *Moringa oleifera* (Moringa), and *Cnidoscolus aconitifolius* (Chaya), could be valued as alternatives to meet the nutritional needs of Pelon pigs. Besides being rich in proteins, minerals, and vitamins, albeit with a high fiber content, these plants contain bioactive phytochemical components like flavonoids and carotenoids, which can enhance the quality of pork regarding its antioxidant profile [11, 12, 13].

This study was conducted to demonstrate that incorporating 10% leaf meal from the arboreal species Morera, Moringa, and Chaya as an ingredient in the conventional maize-soybean meal diet for post-weaned Pelon piglets increases antioxidant activity (DPPH, ABTS, and total polyphenols) in dorsal fat and *Longissimus dorsi muscle.*

MATERIALS AND METHODS

Location

The animal rearing was carried out at the pig farm of the Laboratory of Nutritional Physiology and Experimental Surgery, located at the Academic Unit of Agriculture of the Autonomous University of Nayarit (21º 26' N, 104º 54' W).

The lipid and antioxidant analyses of the dorsal fat and Longissimus dorsi muscle of post-weaning Pelon (hairless) piglets were conducted at the Instrumental-Analytical Laboratory Unit of the Higher Technological Institute of Calkiní, Campeche, Mexico (20º 20' N, 90º 2' W).

Animals

Twenty-eight post-weaning piglets, 24 days old (d), with a weaning weight of 5 ± 0.3 kg were used . They were divided into four experimental groups, each consisting of seven Pelón piglets, homogenized by sex and weight (scale digital Advance, Model I-PCA (±1 g)). After a seven-d adaptation period to the experimental cages and diet, the pigs were fed ad libitum for 28 d. The piglets were housed in individual pens following the recommendations of the Mexican Official Standards (NOM-051-ZOO-1995) [14]. Transportation was carried out according to NOM-062-ZOO-1999 [15] for technical specifications in the production, care, and use of laboratory animals. The animals were slaughtered following the guidelines of the Mexican Official Standard NOM-033-SAG/ZOO-2014 [16], methods for the slaughter of domestic and wild animals. This project was registered by the Graduate Committee of the Autonomous University of Nayarit under identification SIP 21-106-2023.

Experimental desing

The four experimental groups were:

Treatment 1 (Control): Base diet of corn-soybean meal, ad libitum.

Treatment 2 (Mulberry): Base diet of corn-soybean meal, ad libitum, plus the inclusion of 10% Mulberry leaf meal.

Treatment 3 (Moringa): Base diet of corn-soybean meal, ad libitum, plus the inclusion of 10% Moringa leaf meal.

Treatment 4 (Chaya): Base diet of corn-soybean meal, ad libitum, plus the inclusion of 10% Chaya leaf meal.

The diet composition (TABLE I) was balanced according to the nutritional requirements of post-weaning piglets, using the Brazilian tables for poultry and swine as a reference [17]. The nutritional content of the diets was calculated based on the nutritional values of the ingredients, and metabolizable energy was calculated using McDowell *et al*. [18] methodology. The arboreal leaves were dried in shaded mesh screens and ground in a mill to produce the leaf meal. The diets were formulated with the ingredients and pelleted (PELLET MACHINE, model KL150B/C, made in China), with pellet sizes of 2 cm.

TABLE I
Nutritional composition of balanced diets and nutritional content

Ingredients (%)	Control	Morera	Moringa	Chaya
Inclusion level	0	10	10	10
Ground corn	63.20	59.70	59.00	58.30
Soybean meal	31.70	25.00	25.90	26.40
L –Lysine	0.60	0.60	0.60	0.60
Calcium carbonate / orthophosphate 1:1	2.00	2.00	2.00	2.00
Vitamin and mineral premix	0.20	0.20	0.20	0.20
Canola Oil	2.30	2.30	2.30	2.30
Calculated analysis				
Crude protein (CP)	20.03	20.05	20.04	20.04
Metabolizable energy (Mcal)	3.38	3.35	3.37	3.38
Lysine	1.55	1.50	1.51	1.54
Lysine/ME Ratio	4.57	4.47	4.49	4.54
Crude Fiber	3.22	3.63	3.45	3.72

ME: Metabolizable Energy; CP: Crude Protein

Measured variables

Sample collection

At the time of slaughter, 50 g samples of the Longissimus dorsi and 20 g of dorsal fat (DF) were collected from each animal. These samples were vacuum-packed and stored at -20°C in a Torrey horizontal freezer, model CHTC -145 D made in Mexico, until analyzed (DPPH, ABTS, and total polyphenols assays).

Determination of antioxidant activity in dorsal fat and Longissimus dorsi muscle:

For the preparation of extracts, 1 g of freeze-dried meat was mixed with 10 mL of distilled water and placed in an ultrasonic bath for 20 minutes (min). The resulting extract was centrifuged (Centrifugue Eppendorf, model 5702 R, Germany) at 35,000 x g for 15 min at 4°C and filtered using Whatman No. 42 paper. The filtrate was stored at -20°C Torrey horizontal freezer, model CHTC -145 D, Mexico) until analysis. DPPH and ABTS radical scavenging activity and the antioxidant activity of polyphenols were determined using a spectrophotometer (Lambda 25, UV/VIS Spectrometer).

The DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity was determined using the method of Brand-Williams *et al*. [19]. The stock solution was prepared by mixing 2.5 mg of DPPH radical with 100 mL of methanol, and the mixture was left to stand at room temperature for 30 min. The absorbance reduction was measured at 515 nm using spectrophotometry (UV/VIS, model Lambda 25, CompanyPerkin Elmer, USA). The calibration curve was prepared using different concentrations of Trolox, and the results were expressed as Trolox equivalents in µM per 100 g of dry weight.

The ABTS (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)) radical scavenging activity was carried out according to the methodology of Miller *et al*. [20]. The ABTS+ cation was generated through the interaction of 19.2 mg of ABTS dissolved in 5 mL of HPLC-grade water and 88 µL of potassium persulfate 0.0378 g/mL (K2S2O8). The cation was incubated in the dark at room temperature for 16 hours. The activated ABTS radical was diluted with ethanol to obtain an absorbance of 0.70 ± 0.02 at 734 nm. After adding 30 µL of antioxidant extract plus 2970 µL of diluted ABTS solution, the absorbances were recorded 6 min after the reaction. The calibration curve was prepared using different concentrations of Trolox, and the results were expressed as Trolox equivalents in µM per 100 g of dry weight.

For the determination of total phenol content, 50 µL of each extract was mixed with 3 mL of water, 250 µL of Folin-Ciocalteu reagent (1 N). After 8 min of rest, 750 µL of 20% Na2CO3 and 950 µL of water were added to the extracts; after incubation for 30 min at room temperature, the absorbance was read at 765 nm using a spectrophotometer. The concentration of total soluble phenolic compounds was calculated using a standard curve of aqueous gallic acid solutions (0-10 ppm) and expressed as mg gallic acid equivalents (GAE) per 100 g of fresh weight (Moo-Huchin *et al*. [21]).

Ether Extract of the Longissimus dorsi Muscle:

For the ether extract analysis of the *Longissimus dorsi* muscle, 5 g samples from each piglet were analyzed according to AOAC methods [22].

Statistical analysis

For the statistical analysis of the variables associated with antioxidant activity (DPPH, ABTS, and total polyphenols), a completely randomized block design statistical model was employed to determine if there were statistical differences between the least squares means of the analyzed parameters.

$Y = \mu + T + B + e$

The statistical model comprises the variable µ which is the overall mean; T: treatments according to the different diets, B: indicates the blocks, and e: experimental error which were related to the birth litter. Correlations and regressions were also performed using the MINITAB15 program to evaluate the effect of antioxidant consumption on the percentage of ether extract in the Longissimus dorsi (LD), and a principal component analysis was conducted to group the analyzed variables for each treatment.

RESULTS AND DISCUSSION

TABLE II presents an analysis of the variables associated with antioxidant activity (DPPH, ABTS, and polyphenols) for each treatment, with the purpose of determining if there are differences between the diets (P<0.0001).

TABLE II
Variables Associated with antioxidant activity of each treatment

Parameters	Control	Morera	Moringa	Chaya	Se
DPPH (µM de trolox /g)	244.2^{d}	355.5^{c}	477.0^{b}	496.0^{a}	0.16*
ABTS (µM de trolox /g)	270.1^{d}	460.7^{c}	465.7^{b}	497.0^{a}	0.09*
Polyphenols (µg/g)	1641.4^{d}	2343.9^{c}	3465.7^{b}	3485.7^{a}	0.16*

***P<0.0001; se: standard error; ABTS: 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonate), DPPH: 2,2-diphenyl-1-picrylhydrazyl**

These results demonstrate that the antioxidant activity (DPPH, ABTS, and total polyphenols) of each treatment was different (P<0.0001), with the diet containing Chaya presenting the highest results compared to the other diets. This finding may be justified by the research results from Godínez-Santillán *et al*. [23], who identified and quantified 11 phenolic compounds in the species *Cnidoscolus aconitifolius* (Chaya): gallic acid, vanillic acid, vanillin, chlorogenic acid, caffeic acid, ferulic acid, rosmarinic acid, p-coumaric acid, resveratrol, luteolin, and apigenin, which enhance the content and antioxidant activity of this plant.

TABLE III presents an analysis of the variables associated with the percentage of ether extract and antioxidant activity (DPPH, ABTS, and polyphenols) of the dorsal fat (DF) and the Longissimus dorsi (LD) muscle of Pelon piglets fed with the treatments: Control, Mulberry, Moringa, and Chaya, to determine if there are differences (p<0.0001).

TABLE III
Variables associated with antioxidant activity and EE of *Longissimus dorsi*

Parameters	Control	Morera	Moringa	Chaya	Se
DPPH LD (µM de trolox /g)	220.43^{d}	453.47^{c}	464.09^{b}	478.36^{a}	2.14*
ABTS LD (µM de trolox /g)	266.77^{c}	453.11^{b}	455.36^{b}	478.35^{a}	0.48*
Polyphenols LD (µg/g)	1477.04^{d}	2189.73^{c}	3313.72^{b}	3495.65^{a}	0.55*
DPPH DF (µM de trolox /g)	235.00^{d}	344.74^{c}	468.47^{b}	483.69^{a}	0.62*
ABTS DF (µM de trolox /g)	269.39^{d}	456.02^{c}	460.71^{b}	490.61^{a}	0.53*
Polyphenols DF (µg/g)	1528.57^{d}	2276.58^{c}	3496.23^{b}	3547.69^{a}	0.52*
EE LD (%)	3.65^{c}	6.51^{b}	6.8^{a}	6.71^{a}	0.03*

***P<0.0001; se: standard error; EE: ether extract; DF: dorsal fat; LD: Longissimus dorsi; ABTS: 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonate), DPPH: 2,2-diphenyl-1-picrylhydrazyl**

The obtained results indicated that antioxidant activity (DPPH, ABTS, and polyphenols) in DF and LD was different for each treatment (P<0.0001), where piglets fed with Chaya and Moringa showed the highest values compared to those that consumed the Control and Mulberry treatments. This is related to what was reported by researchers Godínez-Santillán *et al*. [23], Moo Huchin *et al*. [24], Dzib-Cauich *et al*. [6] and Alcívar *et al*. [12] who demonstrated that the flours from these arboreal forrage present an antioxidant potential with a high phenolic content, influencing the high values of DPPH, ABTS, and total polyphenols, particularly highlighting Chaya and Moringa.

The highest percentage of ether extract (EE) in the *Longissimus dorsi* (LD) was different in the Control and Mulberry treatments, with their values being lower than those of Chaya and Moringa. This may be due to the EE content from the leaf meal these arboreal forrage, which contain oils that, when consumed by the animal, lead to an increase in the percentage of ether extract in the muscle tissue, in agreement with the findings of researchers Alcívar *et al*. [12], who showed that Chaya and Moringa leaf flours have a higher EE content than Mulberry.

TABLE IV presents a correlation analysis between the antioxidant activity (DPPH, ABTS, and polyphenols) of the dorsal fat (DF) and the Longissimus dorsi (LD) muscle and the percentage of ether extract (EE) in LD of post-weaning Pelón piglets.

TABLE IV
Correlations between antioxidant activity (LD and DF) and EE of LD

Parameters	EE LD
DPPH LD (µM de trolox /g)	2.14*
ABTS LD (µM de trolox /g)	0.48*
Polyphenols LD (µg/g)	0.55*
DPPH DF (µM de trolox /g)	0.62*
ABTS DF (µM de trolox /g)	0.53*
Polyphenols DF (µg/g)	0.52*

***P<0.0001; EE: ether extract; DF: dorsal fat; LD: Longissimus dorsi; g: grams; µm: micromole; ABTS: 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonate), DPPH: 2,2-diphenyl-1-picrylhydrazyl**

The analysis in TABLE IV demonstrates that there are high and significant correlations between the percentage of EE (%) in LD and the antioxidant activity (DPPH, ABTS, and polyphenols) in DF and LD, indicating that as antioxidant activity in LD and GD increases, the percentage of EE in LD also rises. Piglets supplemented with Chaya and Moringa presented higher EE values in LD and antioxidant activity in DF and LD compared to animals fed the Control and Mulberry treatments.

Several authors have reported that animals fed with grasses and green diets may exhibit higher antioxidant content and ether extract percentage in their meat. Furthermore, the fat percentage in meat is accompanied by a greater content and activity of antioxidants, which help delay the oxidative degradation of lipids [25, 26].

TABLE V presents a regression analysis between the percentage of ether extract (EE) in the *Longissimus dorsi* (LD) muscle and the consumption of antioxidants (flavonoids, carotenoids, and polyphenols) in post-weaning Pelón piglets, according to the results obtained in the DPPH, ABTS, and total polyphenol assays.

TABLE V
Regression of Variables Associated with antioxidant consumption according to DPPH, ABTS, and total polyphenols assays

Antioxidants	Model	R^2
DPPH (µM de trolox consumed)	y= 1.69 + 0.01 (x)	0.76*
ABTS (µM de trolox consumed)	y= -0.53 + 0.02 (x)	0.98*
Polifenoles (µg consumed)	y= 2.46 + 0.001 (x)	0.67*

***P<0.0001; x: antioxidant consumption; y: percent of ether extract in Longissimus dorsi; ABTS: 2,2'-azino-bis (3-ethylbenzothiazoline-6-sulfonate), DPPH: 2,2-diphenyl-1-picrylhydrazyl**

The previous analyses indicate significant differences (P<0.0001) between the consumption of antioxidants (flavonoids, carotenoids, and polyphenols) corresponding to the values obtained in the DPPH, ABTS, and total polyphenol assays and the percentage of EE (LD), where it is observed that higher antioxidant consumption (x) increases the percentage of EE in the *Longissimus dorsi*.

These results coincide with the search conducted by Benítez *et al.* [5], who noted that some scientists and the food industry are modifying the nutritional composition of feed intended for livestock, as it has been demonstrated that the diets with which pigs are fed can alter their fat content, antioxidants, and gene expression.

In FIG. 1, a principal component analysis was conducted, associating the percentage of ether extract (EE) in the Longissimus dorsi (LD) muscle and the antioxidant activity (DPPH, ABTS, and polyphenols) in the dorsal fat (DF) and in (LD) of post-weaning Pelon piglets fed with the treatments: Control, Mulberry, Moringa, and Chaya.

The principal component analysis reveals that Pelon (hairless) piglets fed the Chaya treatment exhibited the highest percentages of ether extract (EE) in LD and antioxidant activity (DPPH, ABTS, and total polyphenols) in both LD and DF, aligning with the data presented in TABLE II. This may be attributed to the high antioxidant content and percentage of EE found in this plant compared to Mulberry and Moringa.

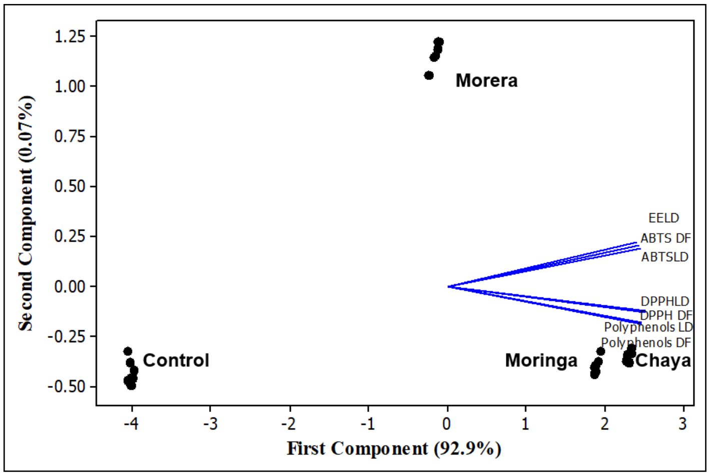

FIGURE 1. Principal Component analysis for each treatment. DF: dorsal fat; LD: *Longissimus dorsi*; ABTS: 2,2´- azino – bis – 3etil benzotiazolin – 6-sulfonato de amonio, DPPH: 2,2 –difenil– 1 – picrilhidracilo

Some researchers as Godínez-Santillán *et al*. [23], Us-Medina *et al*. [27], and Alcívar *et al*. [12] demonstrated through the same methods of antioxidant activity determination that Chaya leaves are rich in flavonones, dihydroflavonoids, carotenoids, and polyphenols, and they also exhibit higher EE compared to the other plants used to supplement Pelon piglets.

In FIGS. 2, 3, and 4, a principal component association analysis was conducted between antioxidant consumption based on the results of the ABTS, DPPH, and total polyphenol assays, and the average values of EE (%) in the Longissimus dorsi muscle of post-weaning piglets fed the Control, Mulberry, Moringa, and Chaya treatments.

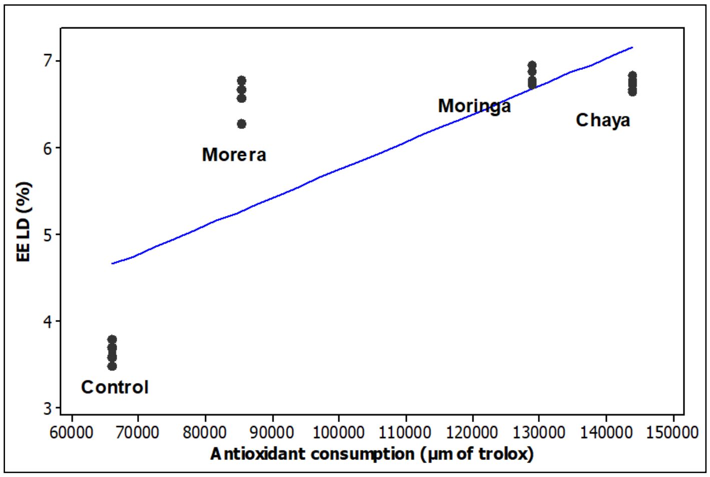

FIGURE 2. Association between the ether extract of Longissimus dorsi and antioxidant consumption reported by the DPPH assay for each treatment. EE: ether extract; LD: *Longissimus dorsi*, DPPH: 2,2 –difenil– 1 – picrilhidracilo

Post-weaning Pelon (hairless) piglets fed the Chaya and Moringa diets showed the highest antioxidant consumption and the greatest percentage of EE in LD, coinciding with the results in Table 4 and with researchers Vargas *et al*. [28] and Alcívar et al. [12], who demonstrated a high and significant correlation between the antioxidant content (LD and DF) and the percentage of EE in LD, indicating that higher antioxidant contents associated with a greater percentage of EE in LD. This may be due to the

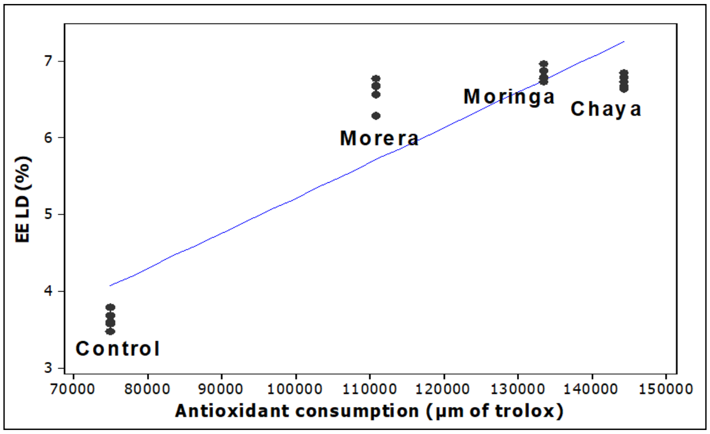

FIGURE 3. Association between the ether extract of Longissimus dorsi and antioxidant consumption reported by the ABTS assay for each treatment. EE: ether extract; LD: *Longissimus dorsi*; ABTS: 2,2'-azinobis (3-ethylbenzothiazoline-6-sulfonate)

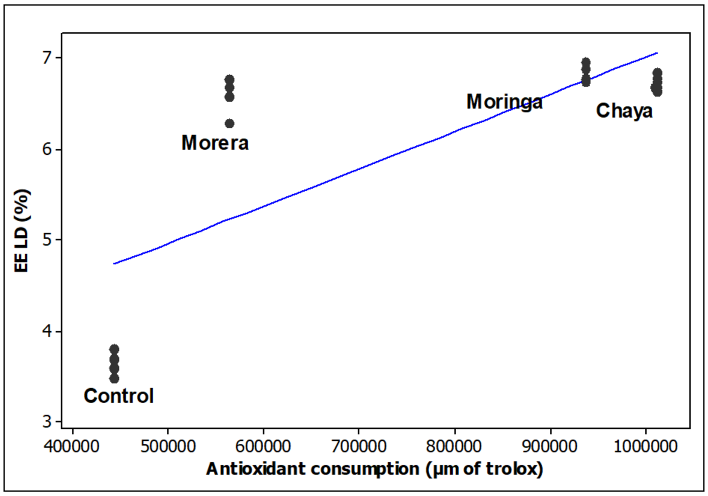

FIGURE 4. Association between the ether extract of *Longissimus dorsi* and antioxidant consumption reported in the total polyphenols count assay for each treatment. EE: ether extract; LD: *Longissimus dorsi*

organism's need to delay cellular stress processes.

According to the results obtained in this research work and those reported by Castellón *et al*. [29], the inclusion of leaf flours from these arboreal in the conventional corn-soybean meal diet could be valued as an alternative in pig feeding that satisfies the nutritional needs of these animals and, in turn, participates as free radical scavengers, increasing the antioxidant activity in DF and LD of pigs that consume these diets (DPPH, ABTS and total polyphenols), thus prolonging the storage period and quality of their meat. Related to the above, there are a series of investigations in which different extracts of natural plants with antioxidant properties have been tested in the ration of productive animals, including fattening pigs, where it is shown that the consumption of forage plants produces a low transfer of unpleasant odors and flavors to the meat, which indicates that the oxidation process of the meat is reduced (Ranucci *et al*. [30]).

CONCLUSION

The Chaya diet presented the highest antioxidant activity (DPPH, ABTS, and total polyphenols) compared to the Control, Mulberry, and Moringa treatments.

The Chaya and Moringa treatments increased antioxidant activity in both the dorsal fat (DF) and the *Longissimus dorsi* (LD) muscle of Pelón piglets compared to animals fed the Control and Mulberry diets.

The Chaya and Moringa diets elevated the percentage of ether extract (EE) in the *Longissimus dorsi* (LD) of the piglets that consumed them.

Higher consumption of antioxidants (flavonoids, carotenoids, and polyphenols) is associated with a greater percentage of ether extract (EE) in the *Longissimus dorsi* (LD); similarly, a higher antioxidant content in dorsal fat (DF) and in LD correlates with an increased percentage of EE in LD.

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Conflict of interest

The authors declare no conflict of interest

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