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Effect of probiotics and *Yucca schidigera* extract supplementation on broiler meat quality

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ABSTRACT. The current study investigated the effect of dietary supplementation with probiotics and *Yucca schidigera* extract on physicochemical parameters, proximate composition, mineral content and fatty acid profile of broiler breast and thigh muscles. In total, 240 one-day old broilers were randomly allocated into two dietary treatments groups: 1) Control (basal diet), 2) experimental (basal diet with two probiotics *Pediococcus acidilactici* and *Saccharomyces cerevisiae* and *Yucca schidigera* extract). The results showed that the pH value was higher in the experimental group than in the control group ($p < 0.05$). However, drip, cook and thaw losses were not influenced by dietary treatment ($p > 0.05$). A significant increase in protein, Fe, Zn, Na, P and a significant decrease in lipid, Cu and Cr contents was exhibited in experimental group relative to control group ($p < 0.05$). The proportion of stearic acid and saturated fatty acids was significantly ($p < 0.05$) reduced, whereas linoleic acid and polyunsaturated fatty acids contents were significantly ($p < 0.05$) increased in breast and thigh muscles of fed the experimental diet. We concluded that additive supplementation of the diet with probiotics and *Yucca schidigera* extract could improve meat quality.

Keywords: breast; meat quality; *Pediococcus acidilactici*; *Saccharomyces cerevisiae*; thigh.

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Introduction

The repeated use of some antibiotics in curative and /or preventive treatments in poultry farming leads several pathogenic bacteria to develop a resistance to these antibiotics (Yassin et al., 2017). As a result, over the past decade, there has been an increasing interest in several alternative strategies to eliminate or reduce antibiotics use in poultry. The use of probiotics (Gaggìa, Mattarelli, & Biavati, 2010) and plant extracts (Kheirabadi et al., 2014) is particularly interesting.

It is well documented that feeding poultry with diet supplemented with probiotics, consisted of bacteria (*Pediococcus spp.*) or yeasts (*Saccharomyces cerevisiae*), leads to a significant improvement in animal performance, immune response and meat quality (Bai et al., 2013; Saleh, Hayashi, & Ohtsuka, 2013). Probiotics have a beneficial effect on the host animal by improving its intestinal microbial balance (Fuller, 1989).

Moreover, several studies on the plant extract, named *Yucca schidigera,* which is an important source of steroidal saponins and polyphenols, have shown that the use of this plant as feed supplement in poultry improves performance and litter quality (Sahoo, Kaur, Sethi, Sharma, & Chandra, 2015; Sun, Shi, Tong, & Yan, 2018), reduce production costs (Sariozkan et al., 2015), and control coccidian risk in broiler chickens (Djezzar, Benamirouche, Baazize-Ammi, Mohamed-Said, & Guetarni, 2014). However, to the best of our knowledge, little data are currently available on the effect of *Yucca schidigera* as feed supplement on broiler meat quality.

In previous work (Djezzar et al., 2012), we have demonstrated that feeding poultry with the probiotic *P. acidilactici* feed supplement versus control diet improves performance, but its effectiveness was limited due to the development coccidiosis. This intestinal disease caused by protozoans of the genus *Eimeria* is considered the most economical important disease affecting poultry worldwide (Chapman et al., 2013). Thus, in our other work (Djezzar et al., 2014), we have showed that the feed supplementation with a

combination of the probiotic *P. acidilactici* and the anticoccidial based on *Yucca schidigera* extract improves performance and control coccidian risk in broilers.

In this context, the objective of the study was to test the hypothesis that feeding a diet supplemented with probiotics (*P. acidilactici* and *S. cerevisiae*) and *Yucca schidigera* extract can have a positive impact on the meat quality. For this purpose, we analyzed the physicochemical parameters, proximate composition, mineral content and fatty acid profile of breast and thigh broiler muscles.

Material and methods

Animals and diets

The study was carried out on 240 unsexed one-day old cobb 500 broiler chicks with an average body weight of 38 ± 1.5 g, purchased from a commercial hatchery. The chicks were randomly assigned into two treatment groups (control group and experimental group) with four replicates for 50 days experimental period. Chicks of the control group were fed a basal diet. Ingredient and nutrient compositions of basal diet are given in the Table 1. Chicks of the experimental group were fed with the same basal diet supplemented plus two probiotics: *Pediococcus acidilactici* MA18/5M in a concentration of 10^9 cfu kg^{-1} and *Saccharomyces cerevisiae* type *boulardii* CNCM I-1077 in a concentration of 10^9 cfu kg^{-1}. Norponin XO® (Nor-Feed, France) based on naturel extract of *Yucca schidigera* was supplemented to drinking water of experimental group at a dose of 1 liter per 1000 liters of drink water.

Chickens diets were formulated taking into account the three breeding phases (starter, grower and finisher) (Table 1). Chicks of the two treatment groups were vaccinated on day 6 against Newcastle disease (UNI L CEVA®), the vaccination was repeated on day15 and day19 against Gumboro disease (IBD L CEVA®).

Table 1. Ingredients and nutrient composition of the basal diet (% of dry-matter basis).

Ingredients, %	Starter diet	Grower diet	Finisher diet
Corn	61.00	62.00	67.00
Soybean meal	29.70	26.00	18.00
Calcium carbonate	6.00	8.50	12.00
Salt	0.60	0.90	1.00
Calcium dibasic phosphate	1.70	1.60	1.00
Vitamin and mineral premix[1]	1.00	1.00	1.00
Calculated analysis,			
ME, kcal kg^{-1}	3200	3300	3300
Crude protein %	22.00	19.80	18.00
Ether extract %	2.90	3.00	3.00
Crude ash %	5.90	7.30	6.50
P %	0.42	0.42	0.38
Calcium %	1.00	1.00	0.90

[1]Composition kg^{-1} of product. Starter: vitamin A: 1200 UI; vitamin D3: 300 UI; vitamin E: 3600UI; vitamin K3: 360 mg; vitamin B1: 240 mg; vitamin B2: 720 mg; vitamin B3: 1440 mg; vitamin B5:3600 mg, vitamin B6: 360 mg; vitamin B9: 96 mg; vitamin B12: 3.0 mg; biotin: 15.0 mg; choline chloride: 65 mg; Fe: 4.4 mg; Zn: 8.8 mg; Cu: 1.65 mg; Mn: 9.9 mg; I: 138 mg; Se: 39 mg; Na: 0.02 g, Cl: 1.06 g; antioxidant: 200 mg. Grower and Finisher: vitamin A: 1000 UI; vitamin D3: 250 UI; vitamin E: 3000UI; vitamin K3: 300 mg; vitamin B1: 200 mg; vitamin B2: 600 mg; vitamin B3: 1200 mg; vitamin B5:3000 mg, vitamin B6: 300 mg; vitamin B9: 80 mg; vitamin B12: 2.5 mg; biotin: 12.5 mg; choline chloride: 50 mg; Fe: 4 mg; Zn: 8 mg; Cu: 1.5 mg; Mn: 9 mg; I: 125 mg; Se: 35 mg; Na: 0.02 g, Cl: 1.06 g; antioxidant: 200mg.

Sampling procedures

At the end of experiment, four birds from each replicate representing the average body weight (control group ≈ 2150±45 g; experimental group ≈ 2600±35 g) were slaughtered. After skinning, evisceration and splitting in respect of hygienic rules, representative samples (≈ 100 g) of breast and thigh muscles were collected and after put in a tray filmed and stored at + 4°C until physicochemical analysis of breast muscle and moreover also cut into small pieces and then put in identified plastic bags and frozen at - 80°C until chemical, mineral and fatty acid composition analysis of both muscles.

Physicochemical analysis

The pH of breast muscle was determined at 24 hours *post mortem* according to the method of Mehdipour, Afsharmanesh, and Sami (2013). Dripping and cooking losses were measured according to Honikel (1991) and thawing loss was measured according to Molette, Rémignon, and Babilé (2003).

Proximate composition

Moisture and ash contents were determined according to the method of the Association Official Analytical Chemist (AOAC, 2005). Total protein content was estimated by the Kjeldahl method and total lipid content was determined by Folch, Lees, and Sloane-Stanley (1957).

Mineral content

The content of copper, iron, zinc, potassium, sodium, magnesium and chromium in samples of breast and thigh muscles were determined using an Agilent 240FS AA Fast Sequential atomic absorption spectrometer (F-AAS) (Agilent Technologies, Waldbronn, Germany). Microwave digestion system (Milestone Ethos MicroSYNTH) was used for sample preparation. Samples of muscles were ground into a fine and homogenous powder, and then approximately 0.5 g was added into the digestion vessel with a mixture of nitric acid (HNO_3) and hydrogen peroxide (H_2O_2). Then, the samples were digested using a two-step temperature program. During the first step, the temperature was linearly increased to 200°C over 10 min; the maximum power of the rotating magnetron was 1000 W. During the second step, the temperature was maintained at 200°C for 10 min. After digestion and cooling at room temperature, the volume of each vessel was collected in a volumetric flask and adjusted to 20 ml with ultrapure water. For each mineral, a 5-point calibration curve was designed from pure standards. Solutions containing various concentrations were obtained by further diluting the stock standard solutions (1000 mg L^{-1}) in a nitric acid solution (1% v/v). The phosphorus content in muscle samples was measured after mineralization of 1 g of muscle with a mixture of nitric acid (HNO_3) and perchloric acid ($HClO_4$) by the Vanado-Molybdate method using a Specord spectrophotometer (Analytik Jena, Jena, Germany) at 470 nm. The mineral content of muscle samples was expressed in mg per 100 g of muscle.

Fatty acid profile

The methyl esters were prepared according to the method of Hossain and Yang (2014); approximately 1 g of homogenized samples of breast and thigh muscles were dissolved into 12 mL of Folch solution and homogenized at 8000 rpm for 1 min. The mixture was flushed under a flow of nitrogen gas, filtered and stored at 4.5°C until separated into two layers. After phase separation, the upper layer was collected and added to 2.4 ml of the 0.9% NaCl solution. The mixture was centrifuged at 3000 rpm during 15 min and the bottom layer was recovered. Next, each sample was dried under a flow of nitrogen and re-suspended by the addition of 3 ml of 5% sulfuric acid methanol solution. The sealed ampoules were heated in a water bath at 95°C for 45 min and cooled. After breaking, 3 ml of 5% Na_2CO_3 solution was added and vortexed. The fatty acid methyl ester was extracted three times with 3 ml of petroleum ether and dissolved in 100 µL of petroleum ether and filtered for injection into gas chromatography (GC/MS).

The fatty acid methyl esters were performed with a gas chromatograph (Agilent 6890) equipped with a flame-ionization detector and a capillary column (30 m × 0.25 mm, 0.25 µm film thickness) with helium as a the carrier gas running at a constant flow of 1 mL min^{-1}. The injector was set at 250°C, and operates in split mode 1:50. The detector temperature was set at 270°C. The temperature profile was programmed as follows: the initial oven temperature was set at 130°C, increased at a rate of 2°C min^{-1} to 180°C, then increased at a rate of 4° Cb min^{-1} to 225°C; the final temperature was held for 7 min. The identification of the fatty acids was performed according to the mass spectral library NIST 2.0 (The National Institute of Standards and Technology, Gaithersburg, MD, USA).

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 21 software (IMB Corp, 2012). Comparison of means between diets (control *vs.* experimental) and muscles (breast *vs.* thigh) and their interaction were tested by two-way ANOVA model, excepted for comparison of means between diets regarding physicochemical analysis of breast muscle whose programmed by one-way ANOVA. Statistical significance was set at $p < 0.05$. Values were presented as the mean ± standard deviation (SD).

Results and discussion

Physicochemical parameters

The physicochemical parameters of breast muscle are shown in the Table 2. The experimental diet increases the pH of breast muscle when compared to the control diet ($p < 0.05$). The pH and water holding

capacity of the meat are important quality attributes; high pH broiler breast meat has a higher water retention capacity than lower pH meat, resulting in increased tenderness (Barbut, 1993). Our result is in agreement with data reported by Aksu, Karaoğlu, Esenbuğa, Kaya, and Macit (2005); which show an increase in breast muscle pH in feeding a diet supplemented with the probiotics *Saccharomyces cerevesiae* compared to those fed unsupplemented diet. The study of Begum, Hossain, and Kim (2015) reported no significant difference in the pH of breast broiler meat fed a diet supplemented with of *Yucca schidigera* extract and caprylic acid compared to the control group. No differences ($p > 0.05$) were observed in drip, cooking and thaw losses on breast muscle between diets. Sarker et al. (2017) showed that the use of probiotic as an alternative to antibiotics does not affect water losses during cooking in broilers. The rise in temperature during cooking causes a total destruction of the cell wall of muscle tissue, which in turn causes a release of very large amounts of liquids. A high loss leads to a hardness of product during the tasting. In addition, Abdulla et al. (2017) showed that the use of probiotic *Bacillus subtilis* in the diet had a significant effect on drip and cooking losses. High water losses have a direct effect on the water-soluble nutrients that will be lost.

Table 2. Physicochemical parameters of chicken breast muscles of chickens fed diets without or with *Pediococcus acidilactici, Saccharomyces cerevisiae* and *Yucca schidigera* extract.

Item	Control	Experimental	P values
pH value	5.78±0.05	6.02±0.06	<0.0001
Drip loss 24h (%)	12.1±1.74	12.3±1.57	0.894
Drip loss 7 days (%)	21.25±2.15	21.4±2.27	0.920
Cooking loss (%)	25.3±0.70	24.7±0.55	0.166
Thaw loss (%)	13.7±0.99	11.8±0.61	0.305

The values are the mean ± standard deviation.

Proximate composition

The chemical composition of breast and thigh muscles is shown in Table 3. The experimental diet had no effect on moisture and ash contents of both breast and thigh muscles ($p < 0.05$). However, experimental diet led to a significantly ($p < 0.05$) increase protein content compared with control diet (23.6 *vs.* 22.3% for breast and 23.9 *vs.* 23.0% for thigh samples). On the contrary, total lipid content decreased significantly ($p < 0.05$) (3.18 *vs.* 5.63 % for breast and 4.78 *vs.* 7.40 % for thigh samples). In a data with probiotics, Sarker, Park, Kim, and Yang (2010) obtained similar results. However, Paryad and Mahmoudi (2008) using *S. cerevisiae* as a probiotic, showed a decrease in protein content and no change in the water and lipid composition of broiler muscles. These effects could be explained by the ability of probiotic strains to product proteins and lipid metabolism in chickens. With regard to *Yucca schidigera*, Begum et al. (2015) revealed no significant difference in serum protein content of broilers. It is well reported in the literature that *Yucca* saponins, whose cannot be absorbed through the epithelial membrane of the digestive tract, can influence the digestion of nutrients in the lumen of the digestive tract by their surfactant properties. In fact, *Yucca schidigera* slow down the lipid metabolism and decreases blood glucose levels (Kucukkurt & Dundar, 2013). *Yucca schidigera* saponins influence lipid absorption through the formation of micelles with bile salts and cholesterol in the gut (Cheeke, 2000). The beneficial effects attributed to the use of probiotics and plant extracts in combination and in fermented plant extracts on the health and meat composition of chickens have recently been reported (Bostami, Sarker, & Yang, 2017).

Muscle effect was observed in meat samples; total ash and protein contents of breast muscle were significantly ($p < 0.05$) higher than that of thigh muscle in both diet groups. In contrast, total lipid contents was significantly ($p < 0.05$) higher in thigh muscle than in breast muscle. Similar results were reported by Cortinas et al. (2004), these differences could result from different functions of particular muscle tissues.

Table 3. Chemical composition of chicken breast and thigh muscles of chickens fed diets without or with *Pediococcus acidilactici, Saccharomyces cerevisiae* and *Yucca schidigera* extract

Item	Control		Experimental		P values		
	Breast	Thigh	Breast	Thigh	Diet	muscle	Diet*Muscle
Moisture	73.9±4.51	73.7±1.96	73.5±1.66	74.7±1.52	0.760	0.575	0.476
Ash	1.12±0.19	1.12±0.03	1.17±0.09	1.02±0.04	0.539	0.037	0.724
Protein	19.5±0.76	17.8±0.35	22.2±0.37	19.4±0.41	<0.0001	<0.0001	0.049
Lipids	5.63±0.75	7.40±1.37	3.18±1.45	4.78±1.25	<0.0001	<0.0001	0.513

The values are the mean ± standard deviation.

Mineral content

The content of minerals of breast and thigh muscles is summarized in Table 4. Diet supplemented with probiotics and *Yucca schidigera* extract increases significantly ($p < 0.05$) the contents of Fe (7.48 *vs.* 6.30 mg/100 g; 7.06 *vs.* 6.45 mg 100 g^{-1}) and Zn (3.40 *vs.* 3.06 mg 100 g^{-1}; 8.45 *vs.* 5.63 mg 100 g^{-1}) and decreases significantly ($p < 0.05$) the contents of Cu (0.10 *vs.* 0.13 mg 100 g^{-1}; 0.12 *vs.* 0.14 mg 100 g^{-1}) and Cr (0.20 *vs.* 0.27 mg 100 g^{-1}; 0.13 *vs.* 0.24 mg 100 g^{-1}) in breast and thigh muscles respectively, compared with control diet. However, the amount of Na and P in meat of experimental group was lower ($p < 0.05$) in thigh (285 *vs.* 290 mg 100 g^{-1}; 275 *vs.* 284 mg 100 g^{-1}, respectively) and higher ($p < 0.05$) in breast muscles (242 *vs.* 240 mg 100 g^{-1}; 314 *vs.* 226 mg 100 g^{-1} respectively) than those observed in control. The increase in mineral content could not be attributed to the effect of *Yucca schidigera* extract since it was reported that the saponins, as one of the major composite of the plant extract could influence the absorption of minerals; *in vitro*, West, Greger, White, and Nonnamaker (1978) reported that alfalfa saponins unite with Fe and Zn. Also, Southon, Johnson, Gee, and Price (1988) found that gypsophila saponins reduce iron absorption in rats. According to Milgate and Roberts (1995), this mal-absorption is the consequence of the formation of an insoluble saponin-mineral complex, with Fe, Zn and Ca. Al-yasiri, Kiczorowska, and Samolińska (2017) reported that plant extracts decrease the concentration of Fe, Zn and Cu in broiler muscle. One hypothesis is the influence of probiotics on minerals composition of meat. In fact, Podolian (2017) reported the high influence of the probiotic on the minerals composition of broiler chicken meat. This effect could be explained by the metabolites of the probiotics whose minerals, in fact, *S. cerevisiae* is a natural source of Fe, Zn, Mn and Cu. However, it cannot exclude a synergistic effect of probiotics and *Yucca schidigera* extract on the mineral content of chicken meat.

Analysis of mineral composition in samples showed difference between muscles. In fact, in thigh compared to breast samples, the amounts of Fe, Zn and Na were higher and those of K and Mg were lower, exempt for Fe content in the experimental diet which was reduced in thigh compared with breast muscles. The mean values found are in general agreement with those reported by Hamm, Searcy, and Klose (1980) in broiler meat from two strains and three regions of production. In addition, a reduction in Cu levels was recorded in the order of 25% and 16% in breast and thigh samples, respectively, despite this reduction, no deterioration in chicken health was observed. The Cr content of the meat samples in our study ranged from 1.30 to 2.70 μg g^{-1}. Sadeghi et al. (2015) reported that in chicken samples in Iran feeding, Cr contents were in the range of 2.27 ± 1.07 μg g^{-1}.

Table 4. Mineral composition (mg/100 g of meat) of chicken breast and thigh muscles of chickens fed diets without or with *Pediococcus acidilactici, Saccharomyces cerevisiae* and *Yucca schidigera* extract.

Mineral	Control		Experimental		P values		
	Breast	Thigh	Breast	Thigh	Diet	Muscle	Diet*Muscle
Cu	0.13±0.01	0.14±0.09	0.10±0.01	0.12±0.02	0.003	0.592	0.250
Fe	6.30±0.46	6.45±0.60	7.48±0.26	7.06±0.54	0.001	<0.0001	0.005
Zn	3.06±0.24	5.63±0.68	3.40±0.18	8.45±1.26	0.006	0.021	0.587
K	1190±35	1136±34	1132±22	1112±14	0.153	<0.0001	0.927
Na	240±36.3	290±10.6	242±23.6	285±31.7	0.011	0.020	0.235
Mg	103±0.33	87.8±2.58	100±5.79	85.5±0.95	0.917	0.005	0.794
P	226±23.8	284±19.3	314±17.9	275±10.3	0.001	0.313	0.000
Cr	0.27±0.05	0.24±0.05	0.20±0.02	0.13±0.03	0.001	0.027	0.210

The values are the mean ± standard deviation

Fatty acid profile

The fatty acid composition of breast and thigh muscle is presented in Table 5. The experimental diet has significantly ($p < 0.05$) decreased the percentage of stearic acid (19.77 *vs.* 21.35 for breast and 19.12 *vs.* 20.30 for thigh samples) and total saturated fatty acids (SFA) (42.06 *vs.* 44.69 for breast and 40.38 *vs.* 42.35 for thigh samples) compared with control diet. Conversely, the proportion of linoleic acid (19.92 *vs.* 17.33 for breast and 18.86 *vs.* 18.07 for thigh samples) and total polyunsaturated fatty acids (PUFA) (26.85 *vs.* 22.90 for breast and 27.06 *vs.* 25.04 for thigh samples) were significantly ($p < 0.05$) increased in meat samples from experimental group than in control. Further, the experimental diet had no significant ($p > 0.05$) influence on palmitoleic acid, oleic acid and total monounsaturated fatty acids (MUFA) percent in both breast and thigh muscles. This can be explained by the antioxidant effects of probiotics and active compounds of *Yucca*

schidigera (saponins and polyphenols) which can prevent the oxidation of PUFA and a positive effect on the intestinal flora. Zhang et al. (2005) showed the antioxidant effect of probiotic strains, such as *S. cerevisiae*. The addition of this yeast with *A. awamori* in the diet of chickens improves the fatty acids profile of meat, mainly the amount of PUFA [18:1 (n-9), 18:2 (n-6) and 18:3 (n-3)] (Saleh et al., 2013). Our results also corroborate with those of Endo and Nakano (1999), who reported that the addition of probiotics increased the linolenic acid content and the PUFA/SFA ratio of broiler meat due to a positive effect on the intestinal flora. Indeed, dietary supplementation with *Yucca schidigera* extract of broiler chickens improves antioxidant capacity (Sun et al., 2018). In laying hens, Alagawany, El-Hack, and El-Kholy (2016) reported that *Yucca schidigera* supplementation improved the antioxidant status of serum, while egg yolk fatty acids were modified by the addition of *karaya* saponins to the diet (Afrose, Hossain, Salma, Miah, & Tsujii, 2010). The extract of *Yucca schidigera* contains phenolic compounds. It is well known that, owing to their redox potential, phenolics compounds positively affect antioxidant activity (Gümüş & Imik, 2016) and therefore the fatty acid profile.

The content of fatty acids in meat samples is influenced by muscle type, myristic acid, palmitic acid and SFA were significantly ($p < 0.05$) increased in breast compared with thigh muscles, while the opposite was observed with myristic acid in experimental diet. However, palmitoleic acid, linolenic acid and MUFA were significantly ($p < 0.05$) decreased in breast in relation with thigh muscles. These results are in general agreement with those reported by Puerto, Cabrera, and Saadoun (2017).

Table 5. Fatty acids profile (%) of chicken breast and thigh muscles of chickens fed diets without or with *Pediococcus acidilactici, Saccharomyces cerevisiae* and *Yucca schidigera* extract

	Control		Experimental		P values		
	Breast	Thigh	Breast	Thigh	Diet	Muscle	Diet*Muscle
C14	2.05±0.35	1.94±0.53	1.24±0.16	2.43±0.45	0.569	0.041	0.026
C16	21.36±1.22	20.11±1.47	21.04±1.12	18.83±0.52	0.257	0.030	0.487
C16:1	8.72±0.78	11.53±0.91	8.68±1.26	11.58±1.82	0.996	0.004	0.954
C18	21.35±0.69	20.30±1.06	19.77±0.68	19.12±0.24	0.012	0.081	0.668
C18:1	22.01±1.36	21.07±1.52	22.40±1.54	20.65±0.96	0.989	0.127	0.622
C18: 2n-6	17.33±0.94	18.07±0.29	19.92±0.69	18.86±0.13	0.001	0.646	0.034
C18:3n-3	2.15±0.53	3.07±0.65	2.75±0.75	3.88±0.51	0.064	0.023	0.733
C20: 4n-6	3.42±0.57	3.98±1.73	4.18±0.77	4.31±0.54	0.380	0.571	0.724
SFA	44.69±2.26	42.35±3.06	42.06±0.29	40.38±1.21	0.024	0.042	0.700
MUFA	30.73±2.15	32.60±2.44	31.09±0.55	32.23±2.78	0.988	0.013	0.465
PUFA	22.90±2.00	25.04±2.67	26.85±0.80	27.06±1.19	0.012	0.249	0.320
MUFA/SFA	0.69±0.01	0.77±0.03	0.74±0.01	0.80±0.04	0.004	0.085	0.244
PUFA/SFA	0.51±0.04	0.59±0.09	0.64±0.02	0.67±0.04	0.485	<0.0001	0.002

SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids. The values are the mean ± standard deviation.

Conclusion

The results of this study suggest that dietary supplementation with two probiotics (*P. acidilactici* and *S. cerevisiae*) and *Yucca schidigera* extract to control coccidian risk could improve meat quality. It can therefore be concluded that the use of probiotics and *Yucca schidigera* extract could be a viable alternative to antibiotic in production, with the ability not only to preserve animal health and performance but also to improve meat quality.

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