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EFFECT OF DIETS CONTAINING *SACCHAROMYCES CEREVISIAE* FERMENTATION PRODUCTS ON BROILER PERFORMANCE AND MEAT QUALITY

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Abstract: This work aimed to evaluate the effect of adding *Saccharomyces cerevisiae* fermentation products (SCFP) to broiler diets on performance, carcass yield, and meat quality. One-day-old male Cobb chicks (n = 624), randomised into four treatment groups with six replicates of 26 birds per experimental unit, were reared for 42 days. Treatments consisted in the inclusion of SCFP at different concentrations (0.000, 0.625, 1.250, and 2.500 kg/ton of feed). At 43 days of age, three broilers from each experimental unit were slaughtered, totalling 18 birds per treatment. Feed intake, weight gain, feed conversion, and carcass yield and meat quality were analysed. Breast fillets were submitted to colour (L*, a*, and b*), pH, water holding capacity (WHC), cooking loss (CL), shear force, and lipid oxidation analyses. Data were analysed using polynomial regression. SCFP supplementation not affected ($P > 0.05$) broiler performance, carcass and breast yields, pH, colour, WHC, and CL. The fillets of broilers that received the highest concentration of SCFP had shear force values approximately 10% lower ($P < 0.05$) than those of control fillets. Lipid oxidation was lower in fillets of chickens fed the highest SCFP concentration, although this difference was not statistically significant ($P = 0.092$). It is concluded that the addition of SCFP to broiler's diet does not interfere with broiler performance, though improves meat quality, mainly its tenderness, and might reduce lipid oxidation.
Keywords: Animal nutrition. Lipid oxidation. Prebiotic. Shear force.

INTRODUCTION

Animal protein production in Brazil has grown considerably in recent years and will likely continue to expand (EMBRAPA 2021). To meet the increasing demand and quality standards of poultry meat, professionals in the field employ principles of continuous improvement in production systems, such as adequate management of aviary systems, genetic improvement, integrated production, and advances in nutrition (Brasil 2021).

A current strategy to improve the performance of broiler chickens is the use of *Saccharomyces cerevisiae* fermentation products (SCFP) for dietary supplementation. SCFP are composed of intracellular and cell wall components (β-glucans and mannan oligosaccharides) and extracellular metabolites (vitamins, flavonoids, proteins, peptides, amino acids, nucleotides, lipids, organic acids, esters, and alcohols) (Jensen *et al.* 2008).

Studies have shown that fermentation products improves the immune system of broiler chickens (Gao *et al.* 2009; Silva *et al.* 2009; Osweiler *et al.* 2010; McIntyre *et al.* 2013; Hofacre *et al.* 2017), performance, meat quality (Zhang *et al.* 2005; Gao *et al.* 2008; Gao *et al.* 2009; McIntyre *et al.* 2013) and growth promoter (Ignacio, 1995). Afsharmanesh et al. (2010) evaluated the effects of SCFP added in wheat-based diets on blood, gastrointestinal parameters, and broiler performance. The results showed that the addition of SCFP increased feed intake and performance of the broiler chickens.

Oxidative changes are the main non-microbial causes of quality loss in chicken meat. Lipid oxidation in muscle tissues can occur as a result of several internal and/or external factors, producing undesirable odours and flavours (Soares *et al.* 2009). Research has been carried out with the aim of inhibiting or retarding meat oxidation (Silva *et al.* 2009). In humans, studies have shown that SCFP consumption inhibits the formation of reactive oxygen species (Jensen *et al.* 2007). As reactive oxygen species can increase lipid oxidation in meat (Soares *et al.* 2009), the inclusion of SCFP in broiler diet might be an alternative to reduce oxidative alterations.

The aim of this work was to evaluate the different levels of SCFP in the diet of broiler chickens on performance, carcass characteristics and meat quality.

MATERIAL AND METHODS

Experimental procedures were carried out at the poultry nutrition testing unit of the Londrina State University, Paraná, Brazil, and were approved by the Ethics Committee on the Use of Animals (protocol no. 24603.2016.29).

A total of 624 one-day-old male Cobb 500 chicks were obtained for this study and raised to 42 days of age. Four treatments were employed, with six replicates of 26 chicks per experimental unit. Chicks received diets (Table 1) that met the minimum requirements recommended by Rostagno *et al.* (2011).

Treatments consisted of isoenergetic and isonutrient feeds based on corn and soybean meal containing different SCFP concentrations (0.000, 0.625, 1.250, and 2.500 kg/ton of feed). Chicks received different diets at the pre-starter (1 to 7 days old), starter (8 to 21 days old), grower (22 to 35 days old), and finisher phases (36 to 42 days old).

The animals were kept in boxes (1.45 m × 1.45 m) at a density of approximately 12 birds/m^2. At 43 days of age, chickens were slaughtered using commercial slaughtering practices, including eight-hour pre-slaughter fasting, electrical stunning, bleeding, scalding, defeathering, and evisceration. Animal performance, carcass yield, and meat quality analyses were carried out.

ANIMAL PERFORMANCE

Feed intake, weight gain, and feed conversion at 1–42 days was evaluated.

CARCASS AND BREAST YIELDS

Three chicks were selected per experimental unit, representing the average weight of the experimental unit. Animals were fasted for 8 h, weighed individually, and sent to slaughter. The chickens were electrically stunned at 42 V and 800 Hz in a water bath (FX 2.0 Fluxo, Chapecó, Brazil) for 10 s and subsequently submitted to bleeding, scalding, defeathering, evisceration, and cutting.

Carcass yield (%) was determined as the ratio of cold carcass weight (without feet, head, neck, and viscera) to weight at slaughter. Breast yield (%) was determined as the ratio of breast weight to cold carcass weight.

MEAT QUALITY

Breast fillets (pectoralis major muscle) were harvested, packed in sealed plastic bags, chilled in a tank containing water and ice, and stored at 4°C for 24 h. Subsequently, the pH, colour, water holding capacity (WHC), cooking loss (CL), shear force (SF), and lipid oxidation of breast fillets were determined.

pH was measured, in duplicate, by inserting an electrode into the ventral part of the cranial side of the fillet using a pH meter (Testo 205 AG, Lenzkirch, Germany). CIELab colour parameters L* (lightness), a* (redness), and b* (yellowness) were determined at three regions equidistant from the ventral surface of the pectoralis major muscle using illuminant D65 and an observation angle of 10° (Konica Minolta, Colour reader CR10, Mahwah, USA).

WHC was determined in duplicate following the procedures described by Hamm (1960). Samples (2.0 ± 0.10 g cubes) were collected from the cranial side of the fillet, arranged between two filter papers enclosed by two acrylic plates, and placed under a 10 kg weight for 5 min and were weighed again. WHC was calculated by weights difference.

CL was determined, in duplicate, according to the method proposed by Honikel (1998). Samples were weighed, placed in hermetically sealed plastic bags, and boiled in a water bath (MA 127/BO, Brazil) at 80°C until reaching an

Ingredients (%)	Pre-starter phase (1–7 days)	Starter phase (8–21 days)	Grower phase (22–35 days)	Finisher phase (36–42 days)
Corn	55.25	58.28	61.33	65.89
Soybean meal	35.37	31.71	27.89	22.62
Meat and bone meal	5.00	5.00	5.00	5.00
Salt	0.28	0.24	0.21	0.16
Sodium bicarbonate	0.20	0.25	0.25	0.30
Calcitic limestone	0.28	0.29	0.29	0.18
Dicalcium phosphate	0.45	0.17	–	–
Soybean oil	1.84	2.82	3.81	4.56
DL-Methionine	0.37	0.33	0.29	0.31
L-Lysine	0.26	0.24	0.24	0.31
L-Threonine	0.13	0.11	0.15	0.12
Choline chloride	0.06	0.05	0.04	0.04
Nicarbazin	0.05	0.05	–	–
Salinomycin	–	–	0.05	0.05
Vitamin premix	0.10	0.10	0.10	0.10
Mineral premix	0.10	0.10	0.10	0.10
Enramycin	0.01	0.01	–	–
Virginiamycin	–	–	0.003	0.003
Kaolin[A]	0.25	0.25	0.25	0.25
Nutrient specification				
Metabolizable energy (Kcal/kg)	3,000.00	3,100.00	3,200.00	3,300.00
Crude protein (%)	23.500	22.000	20.500	18.500
Digestible lysine (%)	1.324	1.217	1.131	1.06
Digestible Total methionine (%)	0.680	0.625	0.571	0.563
Digestible met+cist (%)	0.970	0.900	0.830	0.800
Digestible threonine (%)	0.861	0.791	0.780	0.689
Sodium (%)	0.220	0.210	0.200	0.195
Calcium (%)	0.920	0.850	0.800	0.750
Available phosphorus (%)	0.480	0.420	0.380	0.370
Nicarbazin (ppm)	125	125	–	–
Enramycin (ppm)	10	10	–	–
Salinomycin (ppm)	–	–	66	66
Virginiamycin (ppm)	–	–	16.5	16.5

Table 1. Composition (%) and nutrient specification of broiler diets containing *Saccharomyces cerevisiae* fermentation products

Kaolin was partially or completely replaced by *Saccharomyces cerevisiae* fermentation products (SCFP), depending on the treatment (0.000, 0.625, 1.250, or 2.250 kg of SCFP/ton of feed).

internal temperature of 75°C. Subsequently, the exudated water was discarded, samples were cooled to room temperature (approximately 27°C) and reweighed. CL was calculated by weights difference.

The samples used for CL analysis were also used for SF analysis. Experiments were performed with at least five replicates per sample. Meat samples were cut parallel to the muscle fibres, measuring 1 cm in height, 1 cm in width, and 2 cm in length, and subjected to shear test. A Warner–Bratzler blade coupled to a texturometer (TAXT-2i, Surrey, UK) was used at 5.0 mm/s to perform cross-sectional cuts, as described by Pinto *et al.* (2010). Results are expressed in newton (N) and correspond to the minimum force required to cut the meat.

Lipid oxidation was determined in triplicate. Breast fillets were stored at −20°C for 30 days, according to the method described by Tarladgis *et al.* (1962). Results are expressed in mg MDA/kg (milligrams of malonaldehyde per kg of sample).

STATISTICAL ANALYSIS

Data were submitted to polynomial regression analysis using Minitab version 18.

RESULTS AND DISCUSSION

SCFP supplementation influenced the performance of broilers in the pre-starter phase only (Table 2). The results show that the different levels of SCFP inclusion in the diet of broiler chickens did not influence feed consumption, weight gain and feed conversion. This was due to the fact that SCFP is rich in nucleotides, which under be hydrolysed before absorption (Sauer *et al.* 2011).

Carcass and breast yields were not influenced ($P > 0.05$) by the different concentrations of SCFP in broiler diets (Table 3). These results were expected, as there was no difference in broiler performance between groups at the end of the growth period. Similar results were reported by Karaoglu and Durdag (2005), Chumpawadee *et al.* (2008), and Nihei *et al.* (2017), who did not find differences in carcass yield of broilers fed diets containing SCFP. Conversely, Fathi *et al.* (2012) reported an increase in carcass yield of broilers fed 1.5 g SCFP/kg of feed.

Breast fillet quality parameters (pH, L*, a*, b*, WHC, and CL) (Table 4) were not influenced ($P > 0.05$) by SCFP supplementation. However, fillets of chickens fed diets with the highest SCFP concentration (2.500 kg/ton of feed) had a shear force approximately 10% lower ($P < 0.05$) than that of control fillets, which indicates an increase in meat tenderness.

As meat tenderness greatly influences consumer's perceptions of meat quality and purchase intention (Brewer and Novakofski

Variable	SCFP concentration (kg/ton of feed)				CV (%)	*P*-value	Effect
	0.000	0.625	1.250	2.500			
	1–42 days of age						
FI (g)	4.283	4.408	4.280	4.320	6.49	0.981	–
WG (g)	2.696	2.699	2.708	2.689	7.63	0.989	–
FCR	1.591	1.633	1.572	1.611	2.67	0.978	–

Table 2. Feed intake (FI), weight gain (WG), and feed conversion ratio (FCR) of broilers fed diets containing different levels of *Saccharomyces cerevisiae* fermentation products (SCFP)

Yield (%)	SCFP concentration (kg/ton of feed)				CV (%)	*P*-value	Effect
	0.000	0.625	1.250	2.500			
Carcass	74.26	74.18	73.94	73.59	1.77	0.36	–
Breast	42.57	42.78	43.20	42.24	5.20	0.57	–

Table 3. Carcass and broiler carcass yield of broilers, fed with different levels of inclusion of the nutritional metabolites of the *Saccharomyces cerevisiae* fermentation products (SCFP)

Variable	SCFP concentration (kg/ton of feed)				CV (%)	*P*-value	Effect
	0.000	0.625	1.250	2.500			
pH	5.90	5.85	5.83	5.83	1.80	0.162	–
L*	54.63	54.33	53.99	55.84	4.76	0.154	–
a*	4.94	4.85	4.64	4.10	34.04	0.277	–
b*	10.02	10.48	9.48	9.49	17.13	0.433	–
WHC (%)	0.66	0.68	0.69	0.68	11.77	0.532	–
CL (%)	42.19	43.80	42.85	41.65	16.10	0.769	–
SF (N)	35.04	35.37	36.81	31.38	38.11	0.011[A]	Quadratic
Lipid oxidation	0.10	0.05	0.06	0.06	30.82	0.092	–

Table 4. pH, colour (L*, a*, and b*), water holding capacity (WHC), cooking loss (CL), shear force (SF), and lipid oxidation of fillets from broilers fed diets with different concentrations of *Saccharomyces cerevisiae* fermentation products (SCFP)

[A]Regression equation: SF = 34.74 + 3.69 Treat – 2.00 Treat × Treat

L* (lightness); a* (redness); b* (yellowness); WHC (Water Holding Capacity); CL (Cooking Loss); SF (Shear Force)

2008), SCFP supplementation can contribute to greater acceptance of broiler fillets. Zhang *et al.* (2005) evaluated meat quality characteristics of Ross broilers fed diets containing 0 or 0.5 kg of SCFP/ton of feed for five weeks. The authors observed that thigh and breast cuts of birds fed SCFP-containing diets had lower shear force, that is, greater tenderness. The authors also reported that SCFP supplementation resulted in meats with reduced lipid oxidation.

In the present study, we found similar results to those of Zhang *et al.* (2005); lipid oxidation tended to be lower (P = 0.092) in fillets of broilers fed SCFP. Probably, this reduction is associated with the antioxidant and anti-inflammatory effects of SCFP components, such as phenolic compounds and vitamin E. Phenolic compounds are primary antioxidants and act in the initiation stage of lipid oxidation, whereas vitamin E exerts its antioxidant function in the propagation and termination stages (Coneglian *et al.* 2011). Avila *et al.* (2013) showed that the addition of 10 or 100 ppm of vitamin E to broiler diets reduces lipid oxidation in meat.

Under mild handling, transportation, and slaughter conditions, birds suffer minimal

stress, and SCFP might have less pronounced effects on meat quality, as observed in this study. However, if broilers are exposed to more stressful situations, such as thermal stress, homeostasis is significantly affected. Stress conditions can increase free radical production, resulting in cell membrane damage, lipid oxidation, and severe alterations in meat quality parameters (Han *et al.* 2010). In these cases, the effect of antioxidant substances, such as those present in SCFP, becomes more evident, as the effects of stressors is attenuated by antioxidants and meat quality is improved.

CONCLUSIONS

Addition of SCFP to broiler diets does not interfere with animal performance. SCFP supplementation at 2.500 kg/ton of feed contributes to meat quality by improving tenderness and might reduce lipid oxidation.

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