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Effect of yeast (Saccharomyces cerevisiae) associated or not to micro minerals in chemical composition, tissue composition, lipid oxidation and quality of meat of feedlot lambs

Efeitos da levedura (Saccharomyces cerevisiae) associada ou não a micro minerais na composição química e tecidual, oxidação lipídica e qualidade da carne de cordeiros confinados

Efectos de la levadura (Saccharomyces cerevisiae) asociada o no con micro minerales sobre la composición química y tisular, la oxidación de lípidos y la calidad de la carne de corderos confinados

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Abstract

Growth promoters are increasingly restricted in ruminants' diet. By the need to find safer alternatives for the environment and meat consumers the yeast in probiotics being an alternative. Chemical and tissue composition, lipid oxidation and sensorial quality of meat lambs supplemented with yeast (Saccharomyces cerevisiae), associated or not with the micro minerals, finished in feedlot was evaluated. 24 male lambs, Texel breed lambs divided into three experimental groups (n = 8 lambs / group) CON (without addition of yeast (Saccharomyces cerevisiae)), PB (constituted by yeast Saccharomyces cerevisiae) and PBM (constituted by yeast Saccharomyces cerevisiae + selenium and chrome). After slaughter of the lambs (mean live weight of 55.1 kg), the carcasses were refrigerated for 24 hours, sectioned in the medium for analysis of the Longissimus lumborum muscle. No significant values (P>0.05) were observed for the most qualitative analyzes, except for fat (%) in the proximate composition, with highest values for PBM (5.62%) when compared to CON and PB (P <0.05). The supplementation with yeasts containing or not the micro minerals, did not alter the parameters analyzed, indicating good acceptance and quality of the meat.

Keywords: Probiotic; Proximate composition; Sensory analysis; Sheep.

Resumo

Promotores de crescimento são cada vez mais restrito na nutrição de ruminantes, havendo a necessidade da busca por alternativas seguras para o meio ambiente e os consumidores de carne, sendo as leveduras dos probioticos uma alternativa. Neste estudo investigou-se a

composição química e tecidual, oxidação lipídica e qualidade sensorial da carne de cordeiros suplementados com levedura (Saccharomyces cerevisiae) associada ou não a micro minerais, terminados em confinamento. Foram utilizados 24 cordeiros machos, da raça Texel, divididos em 3 tratamentos (n = 8 cordeiros/tratamento) sendo eles CON (sem a adição da levedura), PB (com adição da levedura Saccharomyces cerevisiae) e PBM (com adição da levedura com micro minerais (selênio e cromo). Após o abate (peso médio de abate 55.1 kg), as carcaças foram refrigeradas por 24 horas, sendo cortadas ao meio para as análises no musculo Longissimus lumborum. Não houve efeito significativo (P>0.05) para a maioria das análises qualitativas, exceto para a gordura na composição centesimal, com maiores valores para o tratamento PBM (5.62%) quando comparado aos tratamentos CON e PB (<0.05). A suplementação com levedura associada ou não a micro minerais não altera os parâmetros analisados, indicando uma boa aceitação e qualidade da carne.
Palavras-chave: Análise sensorial; Composição centesimal; Ovino; Probiotico.

Resumen

Los promotores del crecimiento están cada vez más restringidos en la nutrición de los rumiantes, con la necesidad de buscar alternativas seguras para el medio ambiente y los consumidores de carne, siendo las levaduras probióticas una alternativa. Este estudio investigó la composición química y tisular, la oxidación lipídica y la calidad sensorial de la carne de cordero suplementada con levadura (Saccharomyces cerevisiae) asociada o no a microminerales, terminada en confinamiento. Se utilizaron veinticuatro corderos Texel machos, divididos en 3 tratamientos (n = 8 corderos / tratamiento) siendo CON (sin la adición de levadura), PB (con la levadura Saccharomyces cerevisiae) y PBM (con la adición de levadura con microminerales (selenio y cromo). Después del sacrificio (peso medio de sacrificio 55,1 kg), las canales se refrigeraron durante 24 horas, y se cortaron por la mitad para su análisis en el músculo Longissimus lumborum. No hubo efecto significativo (P> 0,05) para la mayoría de los análisis cualitativos, a excepción de la grasa en la composición próxima, con valores más altos para el tratamiento PBM (5,62%) en comparación con los tratamientos CON y PB (<0,05). La suplementación con levadura asociada o no a microminerales no altera los parámetros analizados que indican buena aceptación y calidad de la carne.
Palabras clave: Análisis sensorial; Oveja; Perfil nutricional de la carne; Probióticas.

1. Introduction

World sheep herd is growing and according to FAO (2018) the world has 1,209,467,079 sheep heads. In Brazil, sheep meat importation has increase 5.5% (CNA 2017), and Brazilian sheep production has showing a solid and linear increase by the increase in demand for sheep meat. It is estimated that in Brazil has 511758 farm sheep, with a total, proximately, 18947352 sheep (IBGE, 2018).

Growth promoters, mostly antibiotics, are increasingly restricted in ruminants' diet. By the need to find safer alternatives for the environment and meat consumers, probiotics have been used in ruminants diet as an alternative additive that improves the nutrient use by ruminants, improve the population establishment of desirable microorganisms in the intestinal flora, preventing colonization by enteropathogens (Uyeno et al., 2015).

Probiotics are live strains of microorganisms living when administered in adequate amounts, confer a benefit to the health of the host (Markowiak; Ślizewka, 2018). Probiotics work in the maintenance of intestinal flora balance, in harmony with digestive functions and animal health, improving the animal production (Pinheiro et al., 2007).

Advances in animal nutrition studies, especially in the micro minerals area, have shown greater response in ruminant productivity. Selenium acts in the immunologic system, decreases health disorders, protects against oxidative stress (Quin et al., 2007), and improve carcass quality (Domínguez-Varaa et al., 2009).

Meanwhile, chrome acts directly on insulin cells sensitivity and glucose metabolism (NRC, 2007), therefore improving nutrients digestion in animals' feedlot. Therefore, the aim of this study was to evaluate the effect of yeast (Saccharomyces cerevisiae) supplementation in addition or not to micro minerals (chrome and selenium) on proximate composition, tissue composition, lipid stability, fresh quality parameters, and sensory of lamb meat.

2. Methodology

Experimental area and Ethics Committee

The study was carried out in the Animal Science Center at the University of Oeste Paulista located in Presidente Prudente, SP, Brazil. All experimental procedures were conducted in accordance with the current law of the country and were approved by the Ethics Committee of Animal Experimentation (no. 4217).

Animals, diets, and sample collection

Twenty-four Texel ram lambs, with approximately 120 days of age and 29.20 ± 2.44 kg of body weight were randomly assigned to 1 of 3 dietary treatment (n=8 per treatment). Diets were formulated to attend the nutritional requirements according to NRC (2007) for lambs and potential daily gain of 250 g, with Coast cross hay and commercial diet® (base control diet) offered in a concentrate: roughage ratio of 80:20 (Table 1). Animals were fed ad libitum, three times a day (7 AM, 12 AM and 4 PM), and refusals were allowed at 5% of offered feed.

Dietary treatments consisted in Control (CON): base control diet; Probiotic (PB): control + 5 grams yeast/animal/day (Saccharomyces cerevisiae, Yea Sacc® cepa 1026, 1x108 CFU/g); Probiotic Mineral (PBM): control + 3 grams yeast/animal/day (Saccharomyces cerevisiae, Beef Sacc® strain 1026, 5x106 CFU/g) + selenium organic (500 mg/kg) + chromium (300 mg/kg).

The techniques described by Mizubuti et al. (2009) were used to determine the chemical composition of the diet (Table 1). The content of total digestible nutrients (TDN) was estimated according to Cappelle et al. (2001).

Table 1. Chemical composition of ingredients (% of dry matter) an total diet in feedlot of lambs, supplemented with yeasts (*Saccharomyces cerevisiae*) associated or not to micro minerals in chemical composition.

	Ingredients (%)		
	Hay	**Concentrate**	**Total diet (Hay + Concentrate)**
Dry Matter	89.07	92.04	91.44
Mineral Matter (MM)	3.87	16.97	14.35
Crude Protein (CP)	8.32	18.7	16.62
Ether Extract (EE)	1.57	3.41	3.04
Raw Fiber (RF)	34.10	5.8	11.46
Acid Detergent Fiber (ADF)	43.89	65.85	61.85
Total Digestible Nutrients (TDN)[1]	55.5	73.00	69,5

1 Estimated accordin to Capelle et al 2001. Source: Elaborated by the authors.

As can be observed in the Table 1, before been given for the animals the hay, concentrade and total diet (hay+concentrade) was analyzed according to AOAC (1995).

Feeding times were 8h00 and 17h00. Leftover feed was weighed daily, and the amount provided was adjusted according to the previous day's intake to allow there to be leftovers of 15% of the total DM offered. The animals had unrestricted access to water.

Animals were fed for 120 days and were slaughtered with an average body weight of 55,1 kg ± 2,40 and seven months old. After slaughtered, carcasses were chilled, and the M. Longissimus thoracis et lumborum was excised from loins 24 h post-mortem (Osório; Osório, 2005).

pH, proximate and tissue composition, loin eye area and marbling

The muscle used was Longissimus lumborum (2.54 cm) and then the pH was assessed by using a Hanna® pH meter. Proximate composition (moisture, ash, protein (N x 6.25) and fat content were determined according AOAC (2005) Silva and Queiroz (2002).

Tissue composition according methodology described by Osório et al. (1998), in which 24 loins which had been previously stored and were then gradually thawed while being kept at a temperature of approximately 4 oC for 24 hours, were dissected, and calculated on natural-matter basis.

Loin-eye area (LEA) was measured on the Longissimus dorsi muscle from the left half of the carcass, by making a transverse section between the 12th and 13th ribs and outlining it on tracing paper. The area was then determined as square centimeters of the image using AUTOCAD® software (Costa et al., 2012). Degree of marbling was subjectively assessed using photographic standards (1 - traces of marbling and 10 - abundant marbling) (AMSA, 2001).

Cooking loss and shear force

Cooking for shear force and sensory analysis was performed by thawing the lamb chops for 24 h at 4 °C and grilling to 71 °C (AMSA 2016). After being removed from the grill, chops rested for 30 min prior to final weighing. For shear force, chops were cooled for 24 h at 4 °C and 6 cores (1.27 cm in diameter) were removed from each sample with a drill press parallel to muscle fiber orientation. Cores were sheared with a C3 Texture Analyzer Brookfield® (Brookfield Engineering, Middleboro, MA), with a Warner-Bratzler blade.

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For cooking loss (CKL), these samples were previously weighed and roasted in a pre-heated gas oven at 170°C until a temperature of 71°C was reached at the geometric center; measurements were taken using a digital thermometer. After cooking, the samples were cooled at room temperature (25–30°C) and weighed again. The weight loss by cooking was calculated by the difference between the weight of the refrigerated and roasted meat, expressed as a percentage of the initial weight (AMSA, 2015).

Instrumental color and lipid oxidation

Objective color (L*, a*, b*) was recorded by using a CR-10 Konica Minolta® color reader after 30 minutes of blooming, according to the methodology described by Houben et al. (2000). For lipid oxidation, was used the Thiobarbituric Acid Assay (TBA) according the methodology described by Pikul et al. (1989). Lipid oxidation (TBA values) was expressed as malonaldehyde concentration (mg of MDA / kg of meat) and the quantification was realized comparing samples to standards absorbance.

Sensory analysis

For sensory analysis, a total of 8 trained panelists evaluate a scale of intensity and characterization according ABNT (1993) guidelines, and to be eligible for participation, consumers had to be regular or occasional lamb consumers. A total of 8 chops were served in 3 sessions. Chops were randomly assigned to each panelist according to dietary treatment. Chops were cooked, trimmed of subcutaneous fat cover, and 8 cubes (2.54 cm × 1.27 cm × 1.27 cm) from each chop were served to the eight-member panel. Samples were served to panelists individually and unsalted crackers and water were available to the panelists to cleanse their palates between samples. Panelists evaluated juiciness from 1 = extremely dry to 7 = extremely juicy; tenderness from 1 = extremely tough to 7 = extremely tender; off-flavor intensity from 1 = extremely mild to 5 = extremely intense; and overall acceptability from 1 = extremely liked to 9 = extremely disliked.

Statistical analysis

Data were analyzed as a complete randomized design, with 3 treatments (control, probiotic, and probiotic mineral) and 8 experimental units per treatment. The homogeneity of the variances was tested by the Bartlett's test (P>0.05) and the normality of the residuals was verified by the Shapiro-Wilk test. The data were submitted to analysis of variance at 5% significance level, using the statistical software SAS. For sensory evaluation, the G-test was used, whereas panelist was the random effect.

3. Results

Table 2 has the results for pH, moisture, ash, tissue composition, loin eye area, marbling score and fat.

Table 2. pH, proximate composition, tissue composition, loin eye area (LEA), and marbling score of *Longissimus lumborum* from lambs in feedlot, supplemented with yeasts (*Saccharomyces cerevisiae*) associated or not to micro minerals in chemical composition.

Variables	Dietary Treatments			P Value
	CON	**PB**	**PBM**	
pH	5.52	5.48	5.49	0.874
Moisture (%)	71.88	74.87	73.44	0.509
Protein (%)	21.07	19.71	19.76	0.693
Fat (%)	4.52^{b}	4.61^{b}	5.62^{a}	0.017
Ash (%)	1.03	0.99	0.98	0.826
Fat %	29.97	25.81	29.66	0.476
Bone %	12.77	13.00	11.71	0.872
Muscle %	57.26	61.19	58.63	0.502
LEA (cm^2)	17.66	19.60	16.90	0.812
Marbling (1-10)	1.87	1.75	1.63	0.484

Source: Elaborated by the authors.

Addition of yeast associated or not with micro minerals in lambs diets did not affect as variables (P>0.05) pH, moisture, protein, ash, tissue composition, loin eye area and marbling score (Table 2). Fat percentage in the lean was significant higher (P<0.05) from animals fed PBM when compared to animals fed PB, whereas values were similar for animals fed CON.

Qualitative characteristic evaluated in the muscle Longissimus lumborum from the lambs, can be observed in Table 3. No dietary effects (P>0.05) were observed for instrumental color, lipid oxidation, cooking loss, and shear force (Table 3).

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Table 3. Instrumental color, lipid oxidation, cooking loss, and shear force of *Longissimus lumborum* from lambs in feedlot, supplemented with yeasts (*Saccharomyces cerevisiae*) associated or not to micro minerals in chemical composition.

	Dietary Treatments			P Value
	CON	**PB**	**PBM**	
L*	39.91	38.94	38.49	0.567
a*	19.35	18.30	18.62	0.682
b*	14.33	13.48	13.47	0.352
TBA (MDA mg/kg)	0.685	0.793	0.514	0.207
CKL %	25.43	23.47	21.32	0.197
WBSF kgf/cm^2	3.46	3.57	3.60	0.813

Source: Elaborated by the authors.

The values for the variables L *, a *, b* was higher than the literature, and TBA, CKL obtained showed coherent averages for animals of this species (Sañudo et al., 2000, Rego et al 2019).

Evaluation parameters on meat (Table 4) for sensory attributes did not have dietary effects (P>0,05).

Table 4. Sensory attributes of *Longissimus lumborum* from lambs in feedlot, supplemented with yeasts (*Saccharomyces cerevisiae*) associated or not to micro minerals in chemical composition.

	Dietary Treatments			P Value
	CON	**PB**	**PBM**	
Flavor intensity	2.63	2.63	2.75	0.950
Tenderness	5.62	6.00	5.75	0.539
Juiciness	3.13	2.63	3.00	0.796
Overall Acceptability	6.00	5.38	6.00	0.840

Source: Elaborated by the authors.

Average values for flavor intensity, tenderness, juiceinss e overall accepatbility was 2.7, 5.8; 2,95 e 5.8 respectively. The results a similar to founded for Grandis et al. (2016) and Ferrão et al. (2009).

4. Discussion

Chung et al. (2011) and Silberberg et al. (2013) found that supplementation live yeasts (saccharomyces cerevisiae), in grain-based diets for ruminants stabilize the ruminal pH of the animals, reducing drastic changes in pH, which results in greater stability of the rumen environment along the day, so improving the ruminal environment and favoring the production of energy for the animal as a whole.

However, in this research, no significant differences (p>0,05) observed to none of the variables, but worth emphasizing that variable studies that are in accordance with good quality carcasses for the consumer market. The final pH results observed in this study was 5,49, and the values are in accordance to literature for ovine specie (Sobrinho et al., 2005), indicating a proper resolution of the *rigor mortis*.

The pH found is consistent with several researches with the Texel breed in confinement, with lambs slaughtered between 30 and 45 kg, with variations between 5.4 to 5.8 (Lima et al., 2013; Rego et al., 2017; Rego et al., 2019); and the meat protein values are in accordance to Texel lambs slaughtered with an average of 35 kg (Rego et al., 2017; Rego et al., 2019).

Addition of probiotic in sheep diets contributes to increased weight gain because probiotic alter rumen microbial community making it more efficient digestion of plant material (Schofield et al., 2018) also the yeast (*Saccharomyces cerevisiae*) can increased the population of protozoa and stabilized the rumen pH on diets rich in rapidly fermentable starch (Jouany et al., 1998) and according to Signorini et al. (2012) the use of probiotics can improve the composition of products of animal origin, such as fat content for example.

Use micro mineral chromium can reduce de fat tissue in the carcass or the marbling in meat (Bhattacharya, et al. 2006; Arvizu et al., 2011; Kneeskern et al., 2016) and selenium can reduce or did not effect in the fat deposition in carcass or meat (Medeiros et al., 2012; Silva et al., 2020; Soldá et al., 2020) contrary to our results how show an increase in fat % proximate composition in PBM treatment compare to CON and PB treatment.

Increase in fat % isn't a desirable quality for the consumer, how prefer lean meat, but even with the highest fat % in PBM group did not affect the sensory analysis where the trained panelists did not differ the treatments.

For tissue composition results, muscle represents the most percent of the tissue, with average 59,02%, the fat stayed in second place with 28,48% and bone, in the last place, with 12,49%. For market and consumer this composition is important because have relationship with the economic value. Most percent of muscle, lower percent of bone and the appropriate fat percentage is the intended (Luchiari Filho, 2000).

According to Luchiari Filho (2000) LEA is an important predictor of commercial cuts yield. For LEA values from all treatments showed satisfactory muscle deposition for Texel lambs.

Marbling average was 1.73. Low values were expected as fat is the last tissue to be deposited (Rosa et al., 2002), so, young animals have lowest values for marbling, and, as well, castrated male lambs when compared to female and uncastrated animals.

CKL didn’t have difference between the treatments with 23,40%. This results are in according with the pH, because pH has direct influence on the water retention, color and tenderness (Bonacina et al., 2011).

The shear force average value was 3.54 kgf/cm² and the meat was classified as very soft according to Boleman et al. (1997) and Bickerstaffe et al. (1997). This result is also in accordance with studies from Gularte et al. (2000) and Santos et al. (2015) with Texel lambs.

Shear force been a variable with distinct results in the researches, with variations around 50% of magnitude.

Datas from three differents articles, with texel lamb breed, slaughtered before 6 months of age and feeded with highest concentrate diet (more than 60%), with the analysis did in the same machine, has variation for shear force in 3.1 to 7.9 kgf/cm² (Lima et al., 2013; Rego et al., 2019; Rego et al., 2017)

For sheep meat, color values are reported as L* 31.36 to 38.0, for a* 12.27 to 18.01 and for b* 3.34 to 5.65 (Bressan et al., 2001). In this study, meat average values of L* (39.11), a* (18.75) and b* (13.76) higher than the literature. The higher L* can be result the slaughter age as noted Souza et al. (2004). In this study with different slaughter lambs age noticed that youngest animals had higher L* when compared with oldest animals and the youngest animals had more water and lass fat in the muscle resulting in a higher L*, being that study the animal age slaughter was 7 months, namely, young animals.

The diet can also be responsible for the highest a* value as the most concentrate ratio has in the diet higher the a* value it will be (Coutinho et al., 2013). For the b* the highest value observed may be related to the ingestion of carotenoids contained in the roughage

(Fernandes et al., 2008) and also to bigger concentration of lipid intra and intermuscular (Costa et al., 2011).

The lipid degradation that occurs in meat cooking results in flavor compounds, which determine the different odors of meat of different species (Mottran 1998). Diets high in concentration result in higher concentration of branched chain fatty acids (Grandis et al., 2016). The odor felt by the light to moderate intensity tasters may be related to the higher concentrate diet.

Meat can be juicier if intramuscular fat content since the amount of intramuscular fat (marbling) from meat is one of the determining factors of juiciness (Osório et al., 2009). A result obtained in the sensory analysis of juiciness is directly related to the marbling of meat (Table 2) which is traces of marbling. The overall acceptability is affected by the consumer as stated by Osório et al. (2009) that, in order to achieve the "highest possible customer satisfaction", not only must the desired characteristics be sought in food; but the consumer needs to be educated to better appreciate these characteristics.

Storage meat can promote a linear increase in TBA values (Fernandes et al., 2012), reducing the shelf life, but, TBA values below the 1.59 mg/kg of malonaldehyde concentration are considered acceptable because are imperceptible in sensory analysis (Torres;Okani 1997; Terra et al. 2006). In this study the TBA is 0.793 mg/kg, that is to say, it's acceptable and no have sensory losses to consumer.

5. Conclusion

Yeast supplementation with or without the addition of micro minerals in lambs diet did not affect meat quality parameters evaluate in this study, but Yeast supplementation with micro minerals increase fat % in proximate composition. However, new studies are necessary to evaluate the yeast with micro minerals effects in fat.

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