EDIBLE GELATIN/GLYCEROL COATING WITH ADDED ROSEMARY ESSENTIAL OIL (*ROSMARINUS OFFICINALIS* L.) INCREASES PORK LOIN SHELF LIFE

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The use of plastic as packaging for food preservation has been questioned due to its great environmental impact. Thus, we seek new alternatives to reduce the use of non-biodegradable material and add value to packaged food. The use of edible coating is a very viable alternative, not only because it reduces the use of plastic, but also because it acts as an active packaging. Elements that improve the properties of the product can be added to this packaging, such as essential oils. This work aims to evaluate the effects of gelatin-based coating with added rosemary essential oil on pork loin, during a period of 8 days of cold storage The coated samples added with rosemary essential oil responded better to the pH, weight loss, firmness, lipid oxidation, and microbiological growth analyses, proving to be a great alternative for the conservation refrigerated meat. In sensory evaluation, no significant difference was observed between the control samples and the coated meat.

KEY-WORDS: *EDIBLE FILM; ROSMARINUS OFFICINALIS L.; PORK QUALITY; MEAT CONSERVATION; MEAT QUALITY.*

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1 INTRODUCTION

Food packaging is used to maintain food quality, providing hygienic and sanitary safety and extending the shelf life of perishable products that are easily contaminated by microorganisms and/or undergo oxidative deterioration (Ahmad, Benjakul, Prodpran, & Agustini, 2012). Food packaging is a subject on which researchers frequently set their sights, seeking to develop and/or improve many ofmany of the crucial traits for maintaining product quality.

Intelligent packaging, thus, seeks to provide a barrier against harmful contaminants and simultaneously contribute to the extension of shelf life (Holman, Kerry, & Hopkins, 2018).

The increased environmental impact due to the high consumption of conventional petroleum-based plastics has become a matter of utmost concern. Therefore, there is a growing interest in the development of environmentally friendly food (Ahmad et al., 2012; Atarés & Chiralt, 2016). For this reason, several polymers are being studied in search of alternative packaging materials. However, biodegradable films and coatings represent an attractive alternative for reducing the use of non-biodegradable plastic materials (Atarés & Chiralt, 2016). Edible coatings are defined as a thin layer of material formed on the surface of food, derived from natural sources to protect and prolong shelf life. They act as a barrier, inhibiting gas exchange, controlling the rate of respiration and preventing the growth of microorganisms that can cause product deterioration (Debeaufort, Quezada-Gallo, & Voilley, 1998; Tokatlı & Demirdöven, 2020; Yuan, Chen, & Li, 2016).

One of the biopolymers already known for their excellent film-forming ability is gelatin, a compound obtained from collagen hydrolysis or generated from animal slaughter and fish processing.

Among its main characteristics there is the ability to form a barrier against light and oxygen, which leads to protection against dehydration and lipid oxidation during storage (Ahmad et al., 2012). There are some recent studies which use gelatin in the Production of film coating for several kinds of meat, such as, such as beef (Battisti et al., 2017; Jridi et al., 2018), tilapia fillets (Zhao, Wu, Chen, & Yang, 2019), rainbow trout (Nowzari, Shábanpour, & Ojagh, 2013), golden pomfret fillet (Feng, Bansal, & Yang, 2016), shrimp (Alparslan et al., 2016; Farajzadeh, Motamedzadegan, Shahidi, & Hamzeh, 2016), grass carp fillets (Sun et al., 2019), salmon nigiri (Kulawik, Jamróz, Zając, Guzik, & Tkaczewska, 2019), pork (Kaewprachu et al., 2018) and brisket fillet (Moreno, Atarés, Chiralt, Cruz-Romero, & Kerry, 2018), which obtained quite satisfactory results in their research.

While thinking about sustainability and more environmentally friendly methodologies, reducing the use of chemical additives by industries is also a major goal in product development, as seen in the growing interest in the use of natural additives, e.g. essential oils (EO), which possess antioxidant and antimicrobial properties and no harmful effects to human health.However, there are major limitations in the use of EOs due to their application costs and intense aroma, which may negatively affect the sensory characteristics of the food.

In this sense, coatings are promising vessels for the incorporation of active ingredients, among them the OEs, which stand out due to their high biological activity, and also because many are classified as GRAS (Generally Recognized As Safe) by the FDA (Yuan et al., 2016). Another positive aspect of using EOs is that this material is very effective at very low concentrations (Sánchez-González, Vargas, González-Martínez, Chiralt, & Cháfer, 2011). Two factors have been bringing popularity to EO application in coating: its lipid nature, as it is believed that ithelps reduce permeability, enhancing the water barrier capacity; and its volatility, which facilitates the use of concentrations small enough to be safe for for consumption (Atarés & Chiralt, 2016; Yuan et al., 2016). In addition, EOs can add antioxidant and/or antimicrobial effects to the coating (Atarés & Chiralt, 2016).

The rosemary EO (*Rosmarinus officinalis*) is widely used in the industry as a flavoring, as well as in the production of fragrances and medication, among other applications. Several uses of this herb have been reported in traditional medicine for treating illnesses, as well as painkillers and tonics to improve memory dysfunction and extensive physical or mental work, in addition to being known as an insecticide and herbicide. Studies already conducted using this EO have shown antioxidant, antimicrobial, hepatoprotective, antitumor, and hypoglycemic-hypolipidemic activity (Arranz et al., 2015; Karadağ et al., 2019). The presence of phenolic compounds in rosemary composition, such as rosmarinic acid, carnosol, carnosic acid, α-pinene, bornylacetate and 1,8-sineol, may be the main cause of the biological activity of the extract (Arranz et al., 2015; Karadağ et al., 2019; Satyal et al., 2017).

This research aimed to evaluate the the effects of edible biodegradable gelatin coating, added with rosemary essential oil, on the shelf life of chilled pork loin, evaluated by its microbiological and physicochemical characteristics.

2 MATERIAL AND METHODS

2.1 MATERIALS AND METHODS

The gelatin used was a commerci1al type B gelatin (Bloom 250, Gelita do Brasil - Cotia, SP, Brazil) donated by the company Gelita do Brasil. The glycerol and pork loin were obtained from local commerce in the region (Rio Paranaíba, MG, Brazil) and sliced in approximately 20 mm thick pieces. The rosemary (*Rosmarinus officinales)* samples were acquired in the central market of Belo Horizonte – MG, Brazil.

2.1.1 Extraction of rosemary essential oil

The essential oil was extracted from the leaves by hydrodistillation for two hours, using a modified Clevenger apparatus coupled to a 6L round bottom flask. The hydrolact was separated by centrifugation in a horizontal crosshead centrifuge at 1100 g for 5 minutes. The essential oil was removed with the aid of a Pasteur pipette and transferred to a glass vial, which was wrapped in aluminum foil and stored under refrigeration (ANVISA, 2010).

2.1.2 Coating preparation and application

The coating solution was prepared by solubilizing gelatin and glycerol (10:1) in 500 mL of distilled water, heated to 70 °C and stirred for 10 minutes. The solution was cooled to 40 ºC for the addition of rosemary essential oi, two oil concentrations were used in two different samples, being 0.4 mg.L^{-1} and 0.8 mg.L^{-1}. The coating application was performed by immersing the pork loin in the solution for 5 seconds and suspending it on hooks for 30 minutes in a climatic chamber at 4 ºC for direct coating polymerization on the meat surface.

The coated loins were individually weighed, packaged in polypropylene trays, wrapped in polyvinyl chloride (PVC) oxygen permeable film and stored at a controlled temperature of 4 ± 0.5 °C. The obtained samples were designated as: T1: loin coated with gelatin/glycerol coating with 0.4 mg.L^{-1} of rosemary essential oil; T2: Loin coated with gelatin/glycerol coating with 0.8 mg.L^{-1} rosemary essential oil; T3: Loin coated with gelatin/glycerol only; and C: control loin sample.

The described analyses were performed with 0, 2, 4, 6 and 8 days of storage, except for the lipid and sensory oxidation analysis, performed with 0, 4 and 8 days of storage.

2.1.3 Physicochemical analysis on pork loin

2.1.3.1 Determination of weight loss

To monitor weight loss during the storage process, the pork loins were weighted in a semi-analytical scale, with the weight of the packaging deducted to obtain the real weight of the sample. The results were expressed as percentages of lost weight relative to the initial sample weight (day 0).

2.1.3.2 Determination of firmness

The firmness was analyzed by checking the force required for muscle tissue disruption using a manual firmness analyzer (model PTR-300, Instrutherm) with a 5 mm diameter tip.

2.1.3.3 Determination of pH

The pH was measured at different points of the samples using a digital pH meter (Model JK – PHM – 005) equipped with a puncture glass electrode.

2.1.3.4 Centesimal composition

To evaluate the samples' centesimal composition, moisture, ash and two of the main macronutrients (lipids, proteins), analyzes were performed using the Soxhlet and Kjeldahl method, respectively. The methodologies used are described in the Manual of Official Methods for Analysis of Animal Food (Brasil & Ministério da Agricultura Pecuária e Abastecimento, 2017).

2.1.4 Microbiological analysis on the pork loin

Populations of total coliform (TC), thermotolerant coliform (TTC), mold and yeast (MY) and psychrotrophic bacteria (BP) were monitored during storage, following the Official Analytical Methods for Microbiological Analysis for Control of Animal Products and Water (Brasil & Ministério da Agricultura Pecuária e Abastecimento, 2017). Triplicate samples of 5 g of each steak were obtained aseptically, 45 ml of 0.1% (w/v) sterile and homogenized peptone water were added, obtaining dilution 10-1, diluted in decimal series to 10-12 sown in the following conditions: TC and TTC analysis was divided into two procedures; in the first test, suspected colonies were inoculated into Broth Bright Green (BBG) 2% lactose and incubated (with inverted Durham tubes in the growth tubes) at 36 °C/24-48 h; in the second procedure, suspected colonies were inoculated into EC broth and incubated (with inverted Durham tubes in the growth tubes) at 45 °C/24-48 h. Positive results were verified by the presence of gas in the Durham tubes and expressed as NMP/g or mL. Meanwhile, MY levels were determined on dextrose potato agar (acidified with 10% tartaric acid) after incubation at 25 °C for 5 days. BP was plated by a Spread plate on plates with PCA (Plate Count Agar) agar and incubated for 10 days at 7 ºC. Results are reported as colony forming units per gram of food (CFU/g).

2.1.5 Lipid oxidation of pork loin

The peroxide value was the factor used to evaluate the lipid oxidation in the pork loin during storage. The methodology used was proposed by the National Agricultural Laboratory/Animal Products (MAPA/SDA/CGALI, 2014), in which the fat mass obtained was used in the storage. Eq. 1 used the calculation of the peroxide value.

Peroxide value (mEQ/kg) = ((V-B) x C x f x 1000)/m **Eq.1**

V = volume (mL) of sodium thiosulfate spent on titration; B = volume of sodium thiosulfate solution spent on blank titration (mL); C = Concentration of the sodium thiosulfate solution; f = sodium thiosulphate solution correction factor; m = sample mass in grams or sample mass in aliquot.

2.1.6 Consumer study

Sensory analysis was performed after approval by the Ethics Committee of the Federal University of Viçosa, Brazil, under protocol number 1.815.160. Fifty untrained participants of both sexes and over 18 years old from the Federal University of Viçosa, Brazil, evaluated the pork loins under the same retail conditions, in monadic order, presented randomly in a single test session. Participants evaluated the attributes appearance, color, overall impression and purchase intent using a 9-point hedonic scale (9 = extremely liked, 1 = extremely disliked) and 5 points (5 = certainly would buy, 1 = certainly would not buy), for the first three attributes and for global intent, respectively.

2.1.7 Statistical analysis

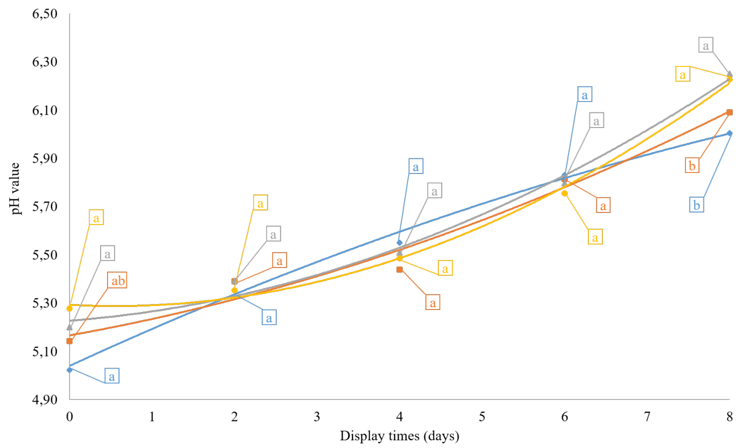
Statistical analysis was performed using Software R, version 3.2.2. Analytical data were reported as mean ± standard error of independent measurements and submitted to analysis of variance (ANOVA). Tukey's test was applied to compare the means in samples with a 5% variance probability level. For sensory evaluation, ANOVA was performed with taster and treatment as independent variables (random and fix1variables, respectively), and hedonic scores corresponding to an individual sensory attribute as the dependent variable. Tukey's test was again applied to compare the means.

3 RESULTS AND DISCUSSION

3.1 CHANGES IN PH AND MICROBIOLOGICAL ANALYSIS ON THE PORK LOIN

The interaction between coating type x storage time had significant effect for pH analysis. The increase in pH values is noticeable for all samples analyzed during the storage time (Figure 1). The increase in pH during the 8 days in refrigeration can be associated with the accumulation of ammonia and amines in the samples, possibly caused by microbial secretion of proteolytic enzymes (Lorenzo, Batlle, & Gómez, 2014; Wu et al., 2019), and the aerobic storage conditions may have favored the development of deteriorating microorganisms in porcine loins (Cardoso et al., 2019; Ntzimani, Paleologos, Savvaidis, & Kontominas, 2008).

FIGURE 1. PH PROFILE OF GELATIN-COATED PORK LOIN DURING 8 DAYS OF STORAGE.



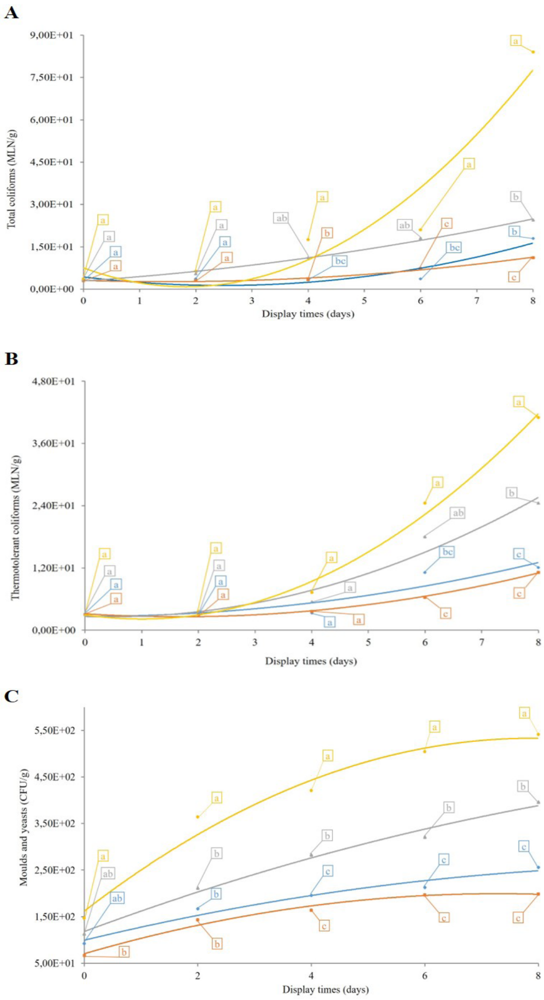
Values with different letters on the same day of storage showed significant difference ($p < 0.05$) by Tukey test. T1 (): Gelatin coated samples added w1ith 0.4 mg.L^{-1} rosemary essential oil; T2 (): Gelatin-coated samples added with 0.8 mg.L^{-1} rosemary essential oil; T3 (): Samples coated with gelatin only; and T4 (): Control.

There are several sources for contamination of pork loin samples, such as air pollution, manipulation, contaminated utensils and contamination already present on the meat surface. The availability of oxygen and nutrients may have facilitated the growth of bacteria, which possibly degraded proteins, releasing alkaline compounds, resulting in an increased pH value. (Feng et al., 2016; Ruan et al., 2019)

This behavior for pH analysis has been observed in other studies using fresh meat coatings (Cardoso et al., 2019; Jridi et al., 2018; Kaewprachu et al., 2018; Ruan et al., 2019). Therefore, the pH increase in the coated pork loin being lower than in uncoated samples may indicate less contamination.

The contamination of samples is confirmed after microbial evaluations (Figure 2). The TC, TTC, and MY and BP counts suggest there was a significant effect resulting from the interaction between coating type x storage time ($p < 0.05$). The TC count increased during storage, being higher in gelatin coated samples without rosemary essential oil and in the control samples (T3 and T4). For TTC counts, values from 1.21×10^1 to 4.1×10^1 CFU/g were obtained on the eighth day of storage, and the samples with the addition of rosemary essential oil (T1 and T2) with the lower count show that treatments were effective in inhibiting microbial growth.

FIGURE 2. MICROBIAL EVALUATION OF TC (A), TCC (B), AND MY (C) IN GELATIN COATED PORK LOIN.



Values with different letters on the same storage day show significant difference ($p < 0.05$) by Tukey's test. T1 (): Gelatin coated samples added with 0.4 $mg.L^{-1}$ rosemary essential oil; T2 (): Gelatin-coated samples added with 0.8 $mg.L^{-1}$ rosemary essential oil; T3 (): Samples coated with gelatin only; and T4 (): Control.

Presence of microorganisms of the coliform family are directly linked to the sanitary quality of slaughtering and food processing facilities, making their evaluation fundamental. Pork loin contamination was already expected due to the fact that meat is very favorable to contamination (Oliveira, et al. 2008). The profiles found in microbiological analyses are similar as there is no significant difference between the microorganism growth from the fourth day of evaluation, in which the samples containing the gelatin coating without the addition of essential oil and the control sample had higher contamination values. This shows that the coating with added rosemary essential oil is effective in controlling these microorganisms.

Rosemary essential oil has already been tested in other experiments on the development of TTC by Jiang, Liu, & Wang (2011), in which damage to the cell wall of the microorganism was observed, with extravasation of cell content and disturbance of the cell shape due to increased concentration of rosemary essential oil. It was also used in experiments on MY, by Santurio et al. (2011), using beef and poultry, which confirmed the rosemary essential oil antifungal action by evaluating the lack of multiplication of these microorganisms when applied to fresh samples. This characteristic can be explained by the presence of monoterpene compounds in rosemary essential oil, such as thymol and carvacrol, which are responsible for causing alterations in the microorganisms' cell membrane lipid bilayer, penetrating it and interacting at critical levels for microbiological activity (Dorman & Deans, 2008).

The growth of psychrotrophic bacteria presented a similar profile as the other microorganisms evaluated, with lower growth in samples with added rosemary essential oil, having in the last day of storage values of 1,33 × 10^{-5} and 3,05 × 10^{-5} CFU/g for samples with 0.8 mg.L^{-1} and 0.4 mg.L^{-1} of oil, respectively. This phenomenon shows better control of the growth of these microorganisms. In gelatin-coated samples without rosemary essential oil, growth control was observed only when compared to the control sample; however, the count was still high, with 1.21 × 10^{-7} CFU/g on the last day, not too far from control treatment, which was found at 2.09 × 10^{-7} CFU/g.

Therefore, the increased control of pH variation in coated samples during the 8 days of storage may be due to the protective activity of the gelatin coating against porcine loin decomposition, resulting in lower microbial growth than that observed in control samples. In addition, the efficiency of rosemary essential oil can be seen from the low results obtained from microbiological growth analyses. However, the storage temperature already influences microbiological development, increasing the latency phase of microorganisms and causing growth delay. Thus, the application of these methods to decrease microbial growth in fresh meat is very effective and promising, although it is still necessary to monitor the quality control inside the processing plant, ensuring the health and quality of the fresh meat.

3.2. PHYSICOCHEMICAL ANALYSES

3.2.1. Changes in weight loss and firmness value

Weight loss is a limiting indicator of the quality of fresh meat in cold storage, which may cause changes in color, taste, and texture. Moreover, it is related to profitability, which makes it highly relevant to industry and consumers. The weight loss was significantly affected by the coating type and storage time separately (Table 1). During the 8 days of storage, lower weight loss was observed in gelatin-coated pork loins with or without rosemary essential oil, differing only from those that were not coated.

TABLE 1. CENTESIMAL COMPOSITION OF GELATIN COATED PORK LOIN

	Moisture (g/100g)	Ash (g/100g)	Proteins (g/100g)	Lipids (g/100g)	Weight loss (%)	Firmness (N)
T1	73,32 ± 0,76 a	1,24 ± 0,35 *	14,29 ± 0,66 *	5,97 ± 0,82 *	2,43 ± 0,15 a	6,86 ± 0,61 a
T2	72,68 ± 1,22 a	1,31 ± 0,45 *	14,34 ± 0,43 *	5,90 ± 0,63 *	2,40 ± 0,12 a	6,71 ± 0,43 a
T3	72,75 ± 0,24 ab	1,26 ± 0,30 *	14,38 ± 0,27 *	5,78 ± 0,49 *	2,96 ± 0,24 a	6,96 ± 0,66 a
T4	71,73 ± 0,91 b	1,33 ± 0,21 *	14,19 ± 0,48 *	5,88 ± 0,66 *	3,67 ± 0,39 b	6,40 ± 0,56 b

Values with different letters in the same column show significant differences ($p < 0.05$) and (*) non-significant differences. T1: Gelatin coated samples added with 0.4 mg.L^{-1} rosemary essential oil; T2: Gelatin-coated samples added with 0.8 mg.L^{-1} rosemary essential oil; T3: Samples coated with gelatin only; and T4: Control.

The weight loss control of gelatin-coated samples was lower possibly due to gas and water permeability inherent in food coatings (Kaewprachu et al., 2018). In particular, the gelatin coating with added rosemary essential oil showed the best ability to control weight loss.

During storage, fresh meat tends to release exudate, which was not noted in the coated samples. The absence of exudate is very important for consumer evaluation for purchase, since the release of liquid inside the packaging makes the product less attractive. For that purpose, increasing gelatin concentration helps reduce water diffusion in biopolymers, and the high surface tension of the gelatin aids in repelling water (Antoniewski, Barringer, Knipe, & Zerby, 2007). This was confirmed by Cardoso et al. (2016) in their gelatin and chitosan coating experiments, where less weight loss was observed in steaks coated with higher gelatin concentrations.

As well as weight loss, pork firmness evaluated was affected by coating type and storage time separately (Table 1). Firmness decreased over the storage time for all samples, with the uncoated sample being the only one that significantly differed among the others, with greater cut softening at the end of storage.

Of all the attributes of meat, texture represents one of the most important to the consumer (Gerelt, Ikeuchi, Nishiumi, & Suzuki, 2002), and is directly related to the protein content of meat. Postmortem protein breakdown occurs as a result of endogenous proteolytic enzymes action causing a weakening of the myofibrils structure and associated proteins, resulting in meat softening (Kaewprachu et al., 2018). About 60-70% of total protein in meat is myofibrillar protein, whose primary role is structural, as most water in muscle fiber is stored between and within myofibrils (Y. Zhang & Ertbjerg, 2018). Regarding meat softening caused by the degradation of myofibrillar proteins, calpains are believed to be the most important enzymes (Y. Zhang & Ertbjerg, 2018). Its activity is directly related to the main attributes of meat quality (beef, sheep, and pork), such as sensitivity, juiciness, loss of cooking and color of cooked and fresh meat (Baur et al., 2015).

As evidenced by the evaluation of pH variation and microbial contamination, the pork loin samples were contaminated at the end of the storage time, a fact that may explain the meat softening. In general, the growth of bacteria resistant to refrigeration temperatures correlates with the production of extracellular enzymes, which can degrade muscle fibers, leading to softening (Baur et al., 2015). These enzymes are mainly excreted by fungi and bacteria (Ozturkoglu-Budak, Wiebenga, Bron, & de Vries, 2016), microorganisms that were present in the samples at the end of storage.

3.2.2 Centesimal composition value

Statistical evaluation was performed for each component analyzed to facilitate the perception of possible changes in the composition of pork loin during cold storage (7 ºC). There was no significant effect of the parameters evaluated for protein, lipid and ash analyses. Moisture was significantly affected by coating type (Table 1), i.e., different results were found for the coated samples when compared to the control sample.

3.3 CHANGES IN LIPID OXIDATION VALUES OF PORK LOIN

Lipid oxidation is a major cause of the loss of quality of meat and meat products. This parameter was evaluated from the peroxide value, which evaluates the primary fatty acid oxidation level, and was performed soon after film polymerization in the samples (T0) and later on the fourth (T4) and eighth (T8) storage days (Table 2). The peroxide value determines the number of hydroperoxides formed as primary products of self-oxidation that occur based on the meat storage conditions (Medić et al., 2018). That is, lower values for the peroxide index indicate that the sample underwent less oxidation during storage.

TABLE 2. PEROXIDE CONTENT IN GELATIN-COATED PORK LOIN

	Day 0	Day 4	Day 8
T1	1,17±0,04 a	1,97±0,39 a	2,71±0,12 b
T2	1,00±0,08 a	1,83±0,35 a	2,29±0,13 b
T3	1,51±0,14 a	3,37±0,23 a	5,15±0,08 a
T4	1,67±0,24 a	3,61±0,28 a	5,82±0,60 a

Values with different letters in the same column show significant differences ($p < 0.05$). Day 0 represents the first day the start of the experiment; Day 4 represents the fourth day; Day 8 represents the eighth day. T1: Gelatin coated samples added with 0.4 $mg.L^{-1}$ rosemary essential oil; T2: Gelatin-coated samples added with 0.8 $mg.L^{-1}$ rosemary essential oil; T3: Samples coated with gelatin only; and T4: Control.

At T0 and T4, the evaluated samples showed no significant differences, characterizing the oxidation rates as statistically equal. However, at T8 there was a significant difference between the gelatin coated samples added with rosemary essential oil, in both proportions, and the gelatin coated and uncoated samples. This means that the samples containing 0.8 $mg.L^{-1}$ and 0.4 $mg.L^{-1}$ had lower values of lipid oxida1tion and the other samples (gelatin coating only and no coating) presented higher values, indicating higher lipid oxidation. These results suggest that the use of rosemary essential oil promoted antioxidant effects, being effective in controlling the auto-oxidation of the samples during storage.

The literature regarding the determination of the oxidation degree and the value of fat peroxide in different types of meat is scarce and interpreted differently. Meat has natural endogenous antioxidants and prooxidants and living cells have several protection mechanisms against oxidation, i.e., the superoxide dismutase enzyme responsible for protection against damage caused by the superoxide anion radical, as well as the enzymes catalase and glutathione peroxidase, which are mainly responsible by removing the peroxide radical (Moreira, Oliveira, Silva, & Saraiva, 2019; J. Zhang et al., 2016).

3.4 CHANGES IN SENSORIAL ANALYSIS

The application of effective tests is equivalent to the subjective opinion of the judge about the food tested, demonstrating the degree of consumer satisfaction, either positive or negative. The results obtained from the application of these tests are difficult to interpret since personal judgements may have higher variability in the results. The visual presentation is usually the first user contact with the product, in order to evaluate color and appearance. When searching for a product, the consumer already envisions characteristics, such as appearance and color, which would make it desirable for consumption. This expectation is associated with personal reactions of rejection, indifference, and acceptance (Teixeira, Meinert, & Barbeta, 1987).

Sensory evaluation was performed according to acceptable visual attributes of meat quality for consumers. The results obtained from the visual evaluation for the attributes appearance, color, overall impression, and purchase intent are shown in Table 3. The statistical study of the answers obtained from the fifty participants was performed individually at each analysis time, having as factors treatment and participants; result is characterized as not significant for any of the attributes as well as purchase intent.

TABLE 3. SENSORY EVALUATION OF COLOR, APPEARANCE, OVERALL IMPRESSION AND PURCHASE INTENT ATTRIBUTES OF GELATIN-COATED PORK LOINS

	Attributes	Display times (days)		
		0	4	8
T1	Color	73,78 *	71,44 *	67,89 *
T2		74,11 *	71,11 *	70,89 *
T3		78,89 *	70,11 *	69,89 *
T4		80,44 *	72,22 *	69,67 *
T1	Appearance	73,56 *	74,56 *	66,56 *
T2		75,56 *	71,11 *	68,00*
T3		82,56 *	65,56 *	64,78 *
T4		78,33 *	74,56 *	63,44 *
T1	Overall impression	72,56 *	74,11 *	68,11 *
T2		74,11 *	70,11 *	68,56 *
T3		82,00 *	69,78 *	67,67 *
T4		77,78 *	74,56 *	67,22 *
T1	Purchase intent	77,60 *	76,20 *	66,60 *
T2		81,80 *	76,60 *	71,40 *
T3		81,00*	69,00 *	64,80 *
T4		81,80 *	70,40 *	63,80 *

(*) Not a significant difference according to the statistical test. T1: Gelatin coated samples added with 0.4 mg.L^{-1} rosemary essential oil; T2: Gelatin-coated samples added with 0.8 mg.L^{-1} rosemary essential oil; T3: Samples coated with gelatin only; and T4: Control.

The results show that on the first day of evaluation, the samples obtained values higher than 70%, showing a good acceptance by consumers. On the fourth day of storage, the values decrease, suggesting variation in the samples when sensorially perceived by the judges. And finally, on the last day of analysis, the values decreased even more, although there was no statistical difference, showing that the product acceptance decreased during the storage time. This result was expected, since meat when stored for long periods has some of its desirable characteristics lost. It was also evident that the coating, with or without essential oil, had no significant difference from the control sample. That is, the coating was not effective in maintaining the sensory characteristics evaluated by the acceptance test applied.

However, judges noticed a change in meat color, especially for the control treatment on the last day of storage (eighth day). Many of the judges reported loss of color and a slimy appearance. This can be explained by the microbiological development in meat, which had already been verified in the microbiological analysis of the loins. The production of a viscous film on meat occurs due to the high development of anaerobic yeasts. In addition, microbiological growth may result in increased acidity and production of various volatile organic compounds that directly influence meat odor and taste, as well as changes in color and toxin production (Moreira et al., 2019).

4 CONCLUSIONS

The application of the edible gelatin coating with added rosemary essential oil is a viable alternative for quality control of pork loin. The coating by itself would already bring major improvements in the characteristics of the meat, however, the use of rosemary essential oil in the composition of the coating further enhanced its beneficial effects for product conservation. Food packaging goes beyond the basic function of protecting the product and can be used to maintain and enhance its desirable traits. Packaging characteristics and packaging-related products influence consumers' intent and purchasing decisions. Thus, not only the hygienic-sanitary characteristics and physical-chemical stability need to be adequate, but the appearance and color are also important factors, and as pointed out by sensory evaluation, the coating does not influence these aspects, positively affirming its application.

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