Elaboration of restructured product with rabbit meat added from rosemary
*(Rosmarinus officinalis)*

Elaboração de produto reestruturado com carne de coelho adicionado de alecrim *(Rosmarinus officinalis)*

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ABSTRACT
The consumer profile was completely changed due to the need to work, these changes in habits demanded adaptations from the meat products industry, for the development of ready-made and easily prepared products, including restructured ones. The aim of this study was to develop a product restructured with rabbit meat added rosemary in different concentrations and perform the physical-chemical, microbiological and sensory analysis. The experimental design was completely randomized. The samples were divided into four treatments with five repetitions. The treatments were: 0; 0.15; 0.30 and 0.45% addition of rosemary in the product formulation. The microbiological analysis showed results within the standards established by legislation, indicating that the prepared samples were suitable for consumption. All treatments responded to the current legislation regarding the physical and chemical characteristics. The results presented for sensory analysis show better acceptance and preference for judges treatments with 0% and 0.15%. Therefore, it is concluded that the results of this study confirm the technological potential of rabbit meat for preparing meat products, in particular the type restructured with the addition of 0.15% of rosemary, and viability of production and marketing for human consumption.

Keywords: Acceptability, Condiment, Nuggets, Rosmanol, Spice.

RESUMO
O perfil do consumidor foi completamente mudado devido à necessidade de trabalhar, essas mudanças de hábitos exigiram adaptações da indústria de produtos cárneos para o desenvolvimento de produtos prontos e de fácil preparo, inclusive os reestruturados. O objetivo deste estudo foi desenvolver um produto reestruturado com carne de coelho adicionada de alecrim em diferentes concentrações e realizar as análises físico-químicas, microbiológicas e sensoriais. O delineamento experimental foi inteiramente casualizado. As amostras foram divididas em quatro tratamentos com cinco repetições. Os tratamentos foram: 0; 0,15 0,30 e 0,45% de alecrim na formulação do produto. As análises microbiológicas apresentaram resultados dentro dos padrões estabelecidos pela legislação, indicando que as amostras preparadas eram adequadas para o consumo. Todas as formulações atenderam à legislação vigente quanto às características físicas e químicas. Os resultados
apresentados da análise sensorial mostraram melhor aceitação e preferência para as concentrações 0% e 0,15%. Portanto, conclui-se que os resultados deste estudo confirmam o potencial tecnológico da carne de coelho para o preparo de produtos cárneos, em especial do tipo reestruturada com adição de 0,15% de alecrim, e a viabilidade de produção e comercialização para consumo humano.

Palavras-chave: Aceitabilidade, Condimento, Nuggets, Rosmanol, Especiaria.

1 INTRODUCTION

With the reduction of time dedicated to preparing food, the profile of the consumer has changed in recent years due to the need to work outside (CONTINI et al., 2016; RISCHKE et al., 2015). These changes in habits demanded adaptations from the meat products industry, for the development of ready-made and easily prepared products, including restructured ones (CONTINI et al., 2016; RYAN et al., 2002). The acceptance of these products has been growing for the consumers, since it presents itself, odor and taste highly appreciated (OZEN; SINGH, 2020; TAMSEN; SHEKARCHIZADEH; SOLTANIZADEH, 2018). Besides that, they allow adding value and convenience, thus serving the interests of both slaughterhouses and consumers (BARBUT, 2012).

Elaborating a restructured product with rabbit meat would be an alternative to stimulate the production of the rabbit meat production chain and the development of new products. Rabbit meat has a low amount of cholesterol, with 50 mg/100g, is characterized as a great source of nutritional value, being recommended in the diet, in view of its level of digestibility, and for not presenting interstitial fat it is considered a lean meat, not raising the blood cholesterol rate (DALLE ZOTTE; SZENDRO, 2011). Consequently, rabbit meat production has been increasing in recent years (WANG et al., 2020).

However, due to its characteristics, we can say that rabbit meat is an important food source, presenting an excellent potential for the production of meat derivatives. In addition to these characteristics, it also has a high biological value, because it contains essential amino acids, in addition to having high levels of potassium, phosphorus and magnesium being recommended for children, the elderly, convalescents and people seeking a healthy diet (DALLE ZOTTE; SZENDRO, 2011; WANG et al., 2020). Meat consumption in Brazil is inexpressive due to low production, making it a vicious circle, the production chain of rabbit farming is, in general, poorly organized, only a few local initiatives, which include producers, slaughterhouses, feed factories, distribution and use of by-products (DARMAWAN, 2016).

The organization of the links of the productive chain in Brazil, as well as the dialogue and collaboration between them, would be fundamental for sectorial growth, and it would also be essential that the academic sector works together with the productive sector, seeking improvements applicable
to problems and challenges from Camp (CULLERE; DALLE ZOTTE, 2018). *Rosmarinus officinalis*, among the spices with antioxidant activity, has been the subject of several studies and has sensory characteristics desired by the consumer. It is classified by the Council of Europe (1981) as a natural flavoring, the main antioxidant components of rosemary are carnosol phenolic terpenes and carnosic acid (KARADAĞ et al., 2019; SILVA; 2008).

Rosemary has a bittersweet taste, being used in breads, meat-containing preparations and to decorate salads, it is also used in French fries, green broths, desserts, cookies, jams, fruit salads, marmalades and hot wines, in some countries it is used in meat, poultry, fish and sausages, as well as added to butter and other foods to increase the shelf life of products (BARBIERI et al., 2020; KARADAĞ et al., 2019). It has culinary, medicinal, pharmaceutical and cosmetic uses, provides one of the most refreshing and least expensive aromas, being one of the most important herbs today (SAAD et al., 2021).

In this context, rosemary is ideal for insertion into a product formulation restructured with rabbit meat, however, the restructured products have a longer shelf-life, compared to raw meat, this is achieved mainly by the delay of oxidation and consequent appearance of rancidity, since the formulations of the restructured products intervene with a series of non-meat ingredients, whose addition is made for purely technological reasons, to improve the sensory characteristics of the product. Therefore, this study aimed to develop a restructured product using rabbit meat as the main raw material, added with rosemary in different concentrations, 0; 0.15; 0.30 and 0.45% and evaluate their chemical, microbiological and sensorial analysis.

2 MATERIAL AND METHODS

2.1 REAGENTS

The reagents 30% sodium hydroxide, 1% methyl red, potassium sulfate, 0.05 M sulfuric acid, were obtained from Sigma-Aldrich Chemical, SA (Hamburg, Germany), and hydrochloric acid (HCl) (37% w/w), absolute ethyl alcohol were purchased from Neon (São Paulo, Brazil). All chemical reagents used in the experiments were of analytical grade.

2.2 RESTRUCTURED PRODUCT PROCESSING

The product was elaborate in the Product Development and Sensory Analysis Laboratory, in the Federal University of Paraíba, Campus III Bananeiras - PB. The appropriate formulation was established by adding rosemary in different levels, referring to the four treatments presented in Table 1. The following procedures were carried: weighing of the raw material, grinding, mixing, molding, breading, pre-frying and freezing. 12 kg of rabbit meat purchased in the cuniculture laboratory of the
Federal University of Paraíba. The grinding was realized out in a meat grinder (G. Paniz, model MCR 10), and the mixing was done out manually for seven minutes.

After mixing, cooling was applied at -14 °C for two hours, obtaining firm mass for the molding process. Molding was also realized manually forming non-standard sizes. After molding, pre-flouring or pre-dust was realized, which is the first layer of the covering system using wheat flour. After pre-flouring, ingredients were mixed with starch and corn flour in ice water, known as batter. After realized the batter step, the next was breading, which is the third and last covering step, using only cornflour. Pre-frying was carried out in vegetable oil at a temperature of 180 °C for 28 seconds. The temperature of the oil was checked by a thermometer, so that the breaded presented uniformity in the visual aspect. After pre-frying, the breaded were frozen in a freezer at –18° (BOLZAN, 2010).

Table 1. Formulation of products breaded with rabbit meat

| Ingredients               | Quantity |
|---------------------------|----------|
| Rabbit meat               | 12 Kg    |
| Water                     | 676 ml   |
| salt                      | 100 g    |
| Rosemary                  | 15 g     |
| Soy protein               | 100 g    |
| Sodium Tripolyphosphate   | 35 g     |
| Powdered onion            | 10 g     |
| Garlic powder             | 5 g      |
| White pepper              | 1 g      |
| Sugar                     | 10 g     |
| Sodium erythorbate        | 13 g     |
| Coriander and chives      | 23 g     |

2.3 PHYSICOCHEMICAL ANALYSIS

The following physical-chemical analyzes were realized: proteins, lipids, ash and humidity. They were executed in triplicate, chemical and physical methods for food analysis were in accordance with the analytical standards of the Adolfo Lutz Institute (INSTITUTO ADOLFO LUTZ, 2008). The analyzes were executed in the physical-chemical laboratory of UFPB.

2.4 MICROBIOLOGICAL ANALYSIS

The formulations were submitted to the following microbiological analyzes: Coagulase positive staphylococci, total and thermotolerant coliforms, Salmonella sp. and viable mesophiles,
according to RDC No. 12 of January 2, 2001, from the National Health Vigilance Agency ANVISA (BRASIL, 2001). The American Public Health Association methodology was used (AMERICAN PUBLIC HEALTH ASSOCIATION, 2001).

2.5 SENSORY ANALYSIS

An acceptance test was carried out by applying a nine-point affective scale, varying from 1 (really liked it) to 9 (really liked it), through the attributes: flavor, color, aroma, texture, and overall quality. A purchase intention test was realized out on the four formulations of the restructured rabbit meat product, using a 5-point hedonic scale, ranging from 1 (certainly not buy) to 5 (certainly buy). To verify this analysis, 100 untrained consumers were gathered, from the staff of teachers, students and employees of different ages, from the Federal University of Paraíba, who evaluated the procedures of the restructured product. Between tasting each sample, the tasters took warm water to remove the residual flavor. They were served in a plastic cup, identified with three-digit numbers.

2.6 STATISTICAL ANALYSIS

The experimental design used was completely randomized. The samples were distributed in four formulations with five replications. The formulations were: 0; 0.15; 0.30 and 0.45% of the addition of rosemary in the preparation of the product. The results were evaluated by means of regression analysis, using the Statistical Analysis System SAS 9.4 (Statistical Analysis System), licensed for the Center of Social and Agrarian Human Sciences - CCHSA.

3 RESULTS

3.1 PHYSICOCHEMICAL ANALYSIS

The physical-chemical composition of the product restructured with rabbit meat and their respective regression equations and their coefficients of determinations are presented in Table 2.

| Parameters (%) | Rosemary addition levels (%) | Equation ($r^2$) | SEM |
|----------------|-------------------------------|------------------|-----|
|                | 0    | 0.15 | 0.30 | 0.45 |                    |                  |
| Humidity       | 35.06 | 36.30 | 32.33 | 31.12 | $Y = 34.6 + 1.48x - 0.61x^2$ ($r^2 = 0.81$) | 2.79 |
| Ashes          | 2.98  | 3.29  | 3.49  | 3.57  | $Y = 2.96 + 0.08x$ ($r^2 = 0.94$) | 0.199 |
| Lipids         | 11.77 | 12.18 | 13.05 | 13.23 | $Y = 11.7 + 3.50x$ ($r^2 = 0.95$) | 1.087 |
It is observed the lipid content elevation with increase in the percentage of rosemary in the formulation, with a linear effect being significant. There was no effect of adding rosemary the protein and carbohydrate parameters. For the ash value, there was a linear effect with the increase in percentages of rosemary, increasing the content of mineral matter. We can observe there was a significant quadratic effect for the humidity parameter, reducing with the inclusion different levels of rosemary.

The increase in the lipid content, as can be seen in Table 2, in relation to the increase in the percentage of rosemary in the formulation, occurs due to the active compounds present, as they are removed from the leaves and form the chemical composition of the essential oil, which is studied for feeding (EBRAHIMI et al., 2020). However, fresh rosemary contains essential oil in its composition, the amount of this oil depends on the extraction method (MOCZKOWSKA et al., 2020), however, the use of fresh form justifies this increase from 11.77% to 13.23%, when analyzing the product composition restructured. The means present in Table 2 are within the standards required by Normative Instruction n. 6 of February 15, 2001 - Annex III of the Ministry of Agriculture and Supply, which establishes a maximum value of 30% for carbohydrates and a minimum value of 10% for proteins (“Ministério da Agricultura Pecuária e Abastecimento”, 2001).

Protein values below 10% are related to the loss of protein content, caused by a washing process during the elaboration of restructured products. It is possible to observe higher protein values of the restructured product of rabbit meat, whose maximum value was 32.93%, in relation to other raw materials such as goat meat 20.24% and chicken meat with 23.82% (GADEKAR et al., 2014; TAMSEN; SHEKARCHIZADEH; SOLTANIZADEH, 2018). what may justify the high protein value, in comparison to other restructured products, may be related to the addition of 100g of soy protein in the formulation. what may justify the high protein value, in comparison to other restructured products, may be related to the addition 100g of soy protein the formulation.

The reduction in humidity, as can be seen in Table 2, occurs due to the ability of dry and crushed rosemary to retain humidity. That is, the higher the concentration in the formulation, the lower the values for humidity from 35.6% to 31.12%. It is important to remember that humidity values outside the technical recommendations, result in great losses in chemical stability, in microbiological deterioration and in the general quality of food (RIBEIRO et al., 2019). However, the expressed values of moisture Table are low when compared with the values found in the rabbit meat itself, of
76% humidity (DARMAWAN, 2016). High values compromise the useful life of a food. In Table 3, the absence of *Salmonella* sp. and the low count of positive coagulase Staphylococcus confirmed that sanitary hygienic procedures were correctly followed in all stages of processing.

### 3.2 MICROBIOLOGICAL ANALYSIS

The results of the microbiological analysis for *Salmonella* sp., Coliforms at 45 °C, coagulase positive staphylococci and viable aerobic mesophiles, of the restructured product are presented in Table 3.

| Parameters               | Rosemary addition levels (%) |
|--------------------------|------------------------------|
|                          | 0                 | 0.15            | 0.30            | 0.45            |
| *Salmonella* sp.         | Absence           | Absence         | Absence         | Absence         |
| Coliforms at 45°C        | 3 MPN             | 3 MPN           | 3 MPN           | 3 MPN           |
| Staphylococci            | 4x10^1 CFU/g      | 1.8x10^1 CFU/g  | 1.6x10^1 CFU/g  | 1.2x10^2 CFU/g  |
| Viable mesophiles        | 2.0x10^2 CFU/g    | 9x10^1 CFU/g    | 1.1x10^1 CFU/g  | 5.3x10^1 CFU/g  |

CFU - Colony forming unit, MPN - most probable number.

The results of the microbiological analyzes evaluated in the four formulations of the restructured product of rabbit meat, were within the standards of the legislation according to the resolution number 12 of January 2, 2001, and from the National Health Vigilance Agency ANVISA, indicating that the formulations prepared are own for consumption. The current legislation establishes for raw, chilled or frozen meat products the limit of 5x10^3 CFU/g of coliforms tolerant to 45 °C/g, 5x10^3 MPN of coagulase positive Staphylococci, 3x10^3 of viable mesophiles and absence of *Salmonella* sp. in 25g of meat. The dice presented in Table 3, confirm the absence of Salmonella and the low count of positive coagulase Staphylococcus, indicating that sanitary hygienic procedures were correctly followed in all stages of processing.

Studies claim that Salmonella sp. and the Estaphylococos, are responsible for approximately 45% of the toxinfections in humans in the world, and is one of the most common pathogens responsible for food-borne outbreaks, being normally transmitted to food by manipulators (BRASIL, 2001; DA SILVA; DA SILVA, 2019). The rosemary present in the formulation, in addition to having active substances with antioxidant properties, has antimicrobial activity, this, due to the presence of compounds such as rosmanol, diterpenes rosmaridifenol and rosmaquinone, being an alternative for use in the food industry (BILSKA et al., 2019; DE; SOUZA; POZZA, 2020).
3.3 SENSORY ANALYSIS

The results of the sensory analysis of the product restructured with rabbit meat and its unique regression equations and their determination coefficients are presented in Table 4.

Table 4. Means, coefficients of determinations \((r^2)\) and regression equation for color, softness, flavor, overall impression, purchase intention, depending on the rosemary levels added in the formulations

| Parameters         | Rosemary addition levels (%) | Equation \((r^2)\) | SEM  |
|--------------------|-----------------------------|-------------------|------|
|                    | 0     | 0.15 | 0.30 | 0.45 |                |                   |
| Color              | 7.48  | 7.22 | 6.64 | 6.97 | \(Y=7.6-0.21x\) \((r^2=0.60)\) | 1.470 |
| Aroma              | 7.37  | 7.34 | 6.94 | 7.17 | \(Y=7.20\)     | 1.460 |
| Softness           | 7.28  | 6.92 | 6.61 | 7.04 | \(Y=8.2-1.09x+0.19x^2\) \((r^2=0.90)\) | 1.600 |
| Flavor             | 7.72  | 7.24 | 6.12 | 6.44 | \(Y=8.12-0.5x\) \((r^2=0.78)\) | 1.740 |
| Global impression  | 7.44  | 6.98 | 6.34 | 6.80 | \(Y=8.68-1.4x+0.23x^2\) \((r^2=0.87)\) | 1.700 |
| Purchase intention | 4.22  | 3.80 | 3.04 | 3.35 | \(Y=5.35-1.2x+0.18x^2\) \((r^2=0.87)\) | 1.154 |

\(r^2\) - coefficient of determinations, SEM - standard error of the mean.

There was a linear effect for color parameter, the notes attributed by the tasters were reduced in relation to the increase in percentage of rosemary in the formulation. The treatment without the addition of rosemary, and what comprised 0.15% in the formulation, presented in Table 4, indicating that the evaluators liked it moderately. The treatment with 0.45% showed a lower average, indicating that the judges liked it slightly. There was no effect of adding rosemary for the aroma parameter, only the treatment with 0.30% showed an acceptance range indicating that they liked it slightly. According to the equation adjusted for the global impression attribute, there was a quadratic effect, stating that the treatment with 0% was the one that obtained the best notes, indicating that the evaluators liked it moderately. There was a quadratic effect for the intention to buy parameter, indicating that maybe bought, maybe didn't, with the addition of rosemary levels.

Because it is widely used in Brazilian cuisine, rosemary is characterized by its marked and irresistible odor of camphor, which justifies the good grades (Table4) attributed to the odor in the product restructured with rabbit meat, indicating that they liked it moderately (BILSKA et al., 2019). Rosemary is a spice widely accepted by consumers because it is an important source of phenolic compounds and diterpenes and its extracts or oils are commonly used to prepare different foods including meat products (TU et al., 2013; URBANCIC et al., 2014). The averages presented in Table
4 indicate that the different levels influenced the aspect of the product's softness, that is, when increasing the levels in the formulation, the scores given by the judges were low.

There is still no work in the literature regarding the influence of the use of rosemary on the aspect of meat softness, which is an objective for future research. When observing this parameter with the restructured product, there was a linear effect according to the equation, indicating that, with the increase in rosemary, the assigned grades were decreasing, therefore, the strong flavor characteristic of this condiment influenced negatively in one of the main parameters of the product restructured with rabbit meat. The very strong flavor, however, is one of the main characteristics that makes dishes more tasty, especially in meat products (ESTEVEZ-ARECO et al., 2018).

On the hedonic scale, the category “neither liked nor disliked”, which gives a value of 5 and is considered as a region of indifference of the analyzed product. When looking at all the averages in Table 4 for all attributes, there were no averages equal to 5, being within the range of acceptance of the scale, which varies from 6 to 9.

Therefore, there was an acceptance of the analyzed product for the four formulations, where only the treatments with 0% and 0.15% obtained the best grades. Regarding the purchase intention, only the control formulation without the addition of rosemary received the note indicating that it would possibly buy, if the product were available on the market. This quadratic effect between the formulations studied (0% and 0.45%) possibly occurred because they were untrained judges, that is, they did not verify the similarities between the samples offered to them.

4 CONCLUSION

The addition up to 0.15% of rosemary to the restructured product based on rabbit meat, did not affect its physical-chemical and sensory composition. Therefore, the results this study confirm the technological potential of rabbit meat for the preparation meat products, in particular of the restructured type, and its viability production and comercialization human consumption.

PATENTS

The formulation and the process of making breaded with rabbit meat added with rosemary, has been patented, the registration number is: BR 10 2018 005041 9. The patent was granted by the National Institute of Industrial Property (INPI).

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