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**Research Article**

# Effect of Bijao Leaf (*Calathea lutea*) on the Softening of Beef Muscle

[1]P. Conto Sandra, [1]S. Rodríguez Danellys, [2]Aguas Yelitza, [1]Olivero, E. Rafael, [1]Torres Ramiro
[1]Departamento de Ingeniería Agroindustrial, Universidad del Atlántico, Km 7 Antigua vía Puerto Colombia (Barranquilla), Colombia
[2]Universidad de Sucre, Departamento de Ingeniería Agroindustrial, Cra 28 # 5-267 Barrio Puerta Roja (Sincelejo), Colombia

**Abstract:** The aim of study was to evaluate the effect of bijao leaf (C*alathea lutea*) on the softening of beef, using a cut of *Bíceps femoris* muscle. A 3×2 factorial experimental design was used, evaluating the covering of three shapes (bijao leaf, self-adhesive transparent film and a sample not covered) during two periods of refrigeration (72 and 96 h). Rheological and physicochemical properties such as water and pH retention were analyzed. A sensory analysis was developed on 30 panelists where an organization test was used to know the degree of acceptance according to the hardness of the samples. The results of the texture profile and tenderness test showed that the cuts of *Bíceps femoris* muscle covered with *Calathea lutea* show less shear force and more softening than the other treatments. On the other hand, the results show more water retention capacity than the samples not covered with the treatment. Likewise, the sensory panel showed the preference of covered meat for presenting less hardness. We can conclude that the covering with *Calathea lutea* confers more properties to achieve a softer cut from the muscle. Becoming an option to replace commercial meat tenderizers.

**Keywords:** Beef, exogenous enzymes, tenderness, texture profile

## INTRODUCTION

Meat is considered of great alimentary value, with a great content of water and proteins; in less proportion lipids, carbohydrates, mineral salts, ashes (Santrich Vacca, 2006). Bovine meat has high consumption worldwide in industrialized countries and in lesser proportions in developing countries (FAO, 2014). Its appearance, texture, smell and taste are aspects that help determine its quality and acceptance (Cury *et al*., 2011). Nevertheless, its tenderness is considered the most important upon the perception of meat quality for consumers (Huffman *et al*., 1996). For the determination of these textural characteristics rheological analysis are made, among which are the texture profile, which consists of the application of a compression force two times successive in the samples in order to simulate human chewing. From this analysis seven parameters are obtained: fracturability, hardness, adhesiveness, cohesiveness, gumminess and chewiness (Isaza Rengifo *et al*., 2010). To determine the tenderness, this being meat quality to be cut and chewed with greater or lesser facility before swallowing, the Warner Bratzler method which consists of measuring the resistance of the meat to be cut is used (Bratzler, 1932; Sullivan and Calkins, 2010).

Some parts of the canal don´t have high preference for the consumer due to its high tenacity. To increase the degree of tenderness and the demand of the consumer, different physical and chemical methods have been studied (Pietrasik and Shand, 2011). Nowadays exogenous enzymes of vegetable origin with a high degree of activity on the myofibrillar and collagen proteins capable of providing good organoleptic and textural characteristics to the meat, being able to replace commercial products are being used (Ashie *et al*., 2002 Istrati *et al*., 2011; Sullivan and Calkins, 2010). In this context is found C*alathea lutea*, which grows in humid, temperate and warm places in The Antilles, Central America, Panamá, Venezuela and Colombia belonging to the *marantáceas* family (Sepulveda, 2009). Its leaves are green on the front and whitish on the back and are leathery, strong and of large size. They are useful in the domestic economy to wrap traditional foods of each region. C*alathea lutea* used as a wrapping, allows you to preserve fresh food without deterioration and confers organoleptic characteristics when traditional foods are cooked (Sosa Rodríguez, 2013). It has been established that the wrapping allows a well-timed softening due to the existence of enzymatic reactions between the food and the leaf (Salvador Badui, 2006).

**Corresponding Author:** Aguas Yelitza, Universidad de Sucre, Departamento de Ingeniería Agroindustrial, Cra 28 # 5-267 Barrio Puerta Roja (Sincelejo), Colombia

The softening ability of *Calathea lutea* on meat has not been studied much, so in this investigation the effect of *Calathea lutea* on beef softening was evaluated, taking advantage of the characteristics, it gave and the oganoleptic properties it confers. With the purpose of giving an added value to the meat and having an option to replace commercial meat tenderers.

## MATERIALS AND METHODS

**Design of experiments:** A factorial design was used, (type of covering, maturation time, respectively) to determine the softening of meat cut *Bíceps femori.* Used coverings:

- C*alathea lutea* (CL)
- Self-adhesive Transparent Film (STF)
- Without covering (C)

Were treated during 72 and 96 h. The constant refrigeration temperature of 5°C was monitored with a wireless thermos-hygrometer (wireless thermo-hygrometer TM005-X) five repetitions were performed for a total of fifteen experimental units. Cuts of 2×2 cm were made to apply the pH, WRC, TPA and tenderness tests, the sensory evaluation was performed by 30 panelists.

**Preparation of the samples:** The conditioning of *Calathea lutea* starts with the selection of the leaves with the higher degree of freshness removing the impurities. The disinfection was done by immersing it in sodium hypochlorite 20 ppm for 2 min and then rinsing it to remove the disinfectant and finally they were dried naturally.

The cuts of meat coming from a certified retailer were kept in a refrigeration temperature of 5.0°C before their processing. For the cleaning, the bones and fat were removed with the help of a scalpel. The washing of the meat was done with a water spray and the immersion in a small concentration of acetic acid, to remove unwanted smells. For the characterization of the sample and the evaluation of its properties it proceeded to a size reduction with cuts of 2 $cm^3$. For the determination of pH, the official method established in the manual of analytical methods of the AOAC (1995) was used.

**Water Retention Capacity (WRC):** It was determined through the compression method. Inside a filter paper for quantitative analysis of 110 mm of diameter ~3.0 g of the sample of meat were placed, then it was put under pressure between two plates for 5.0 min. The water retention capacity was calculated as percentage of expedited water (Braña Varela *et al*., 2011).

**Tenderness test:** The tenderness test was done with the Warner-Bretzler shear force method, it was developed at the 72 and 96 h of refrigeration with samples of raw meat and 5 repetitions. The shear force was measured in cuts of 2 $cm^3$ for three or four days. The sample was cut in a perpendicular direction to the muscular fibre with a Warner-Bratzler (WBSF) razor, in a speed of 10.0 mm/s until all the samples were cut. The maximum cutting force was taken to evaluate the hardness of the meat.

**Texture Profile Analysis (TPA):** In the analysis of texture profile a texturometer TA. XTPlus was used. For this was used the meat cut in cubes of 2×2 cm with a thermic treatment of 70 $cm^3$ in the thermic center for about 10.0 min. The samples were put through a uniaxial compression, using as an accessory a compression plate of 75 mm with a speed of 600 mm/min until the 50% of the initial height, with a waiting time between compressions of 5s. From the curve time-force obtained the textural parameters were determined: hardness, adhesiveness, cohesiveness, elasticity, gumminess and chewiness (Isaza Rengifo *et al*., 2010).

The rheological analysis was performed in the laboratories of the investigation group GIPAVE in the University of Córdoba, Berástegui.

**Sensory evaluation:** It was developed by members of the community, forming the sensory panel with thirty people of both genders, of ages between 18-99 years old. The panelists were given 3 portions of each of the evaluated samples (CL, STF and C) the sensory analysis was made in the same way at 72 and 96 h of refrigeration, having a total of 6 analyzed samples. In the organization test, the panelists compared the "hardness" and this way, they allowed to know the most enjoyable sample according to the sensory evaluation, the obtained results were analyzed with the test of multiple ranks in the program SPSS Statistics.20, to determine if there are or not significative differences statistically en each one of the results.

**Statistical analysis:** A variance analysis with 95% of trust was carried out to determine the incidence of covering type and maturation time upon meat hardness, the physicochemical and textural properties of raw and cooked meat. Afterwards, the comparison test of ways of Tukey treatment was made. The statistical analysis and processing of the data was executed in the statistic software SPSS Statistics. 20 (SPSS version 20, SPSS 2010).

## RESULTS AND DISCUSSION

**pH determination:** The meat obtained of *Bíceps femori*s muscle presented for the treatment C (pH = 4.98±0.02) STF treatment (pH = 4.97±0.03) and CL treatment (pH = 4.98±0.02) According to Braña

Table 1: Percentage of retained juice (WRC) for samples

| Sample | WRC (Water/g meat) | S.D. |
|---|---|---|
| CL | 0.686 | ±0.064 |
| STF | 0.668 | ±0.060 |
| C | 0.670 | ±0.061 |

S.D.: Standard deviation

Table 2: Tenderness analysis with the Warner Bratzler test

| Parameter | | CL | STF | C |
|---|---|---|---|---|
| Firmness | Average | 8240.132 | 13508.147 | 13498.166 |
| | SD | 1510.088 | 2405,841 | 4464.621 |
| | Coef. Var | 18.326 | 17.81 | 33,076 |
| Tenacity | Average | 13647.028 | 19272.593 | 19639.451 |
| | SD | 2272.257 | 2623.65 | 5937.91 |
| | Coef. Var | 16.65 | 13.613 | 30.235 |

Table 3: Sample of meat coated with CL treatment

| Parameter | | 72 hours | 96 hours |
|---|---|---|---|
| Hardness | Average: | 6510.387 | 4588.021 |
| | SD. | 3751.018 | 570.742 |
| | Coef. Var: | 57.616 | 12.44 |
| Adhesivenes | Average: | -1.318 | -0.933 |
| | SD. | 0.862 | 0.647 |
| | Coef. Var: | -65.384 | -69.326 |
| Elasticity | Average: | 0.766 | 0.736 |
| | SD. | 0.058 | 0.044 |
| | Coef. Var: | 7.535 | 5.924 |
| Cohesiveness | Average: | 0.717 | 0.671 |
| | SD. | 0.04 | 0.045 |
| | Coef. Var: | 5.597 | 6.759 |
| Gomosidad | Average: | 4694.734 | 3080.601 |
| | SD. | 2760.388 | 458.197 |
| | Coef. Var: | 58,798 | 14,874 |
| Chewiness | Average: | 3504,632 | 2260,422 |
| | SD. | 2037,51 | 304,741 |
| | Coef. Var: | 58,138 | 13,482 |

Varela *et al.* (2011), the pH of a normal meat (fresh) is in the ranks 5.4 and 5.9. Nevertheless, pH variations can generate different types of meat. The studied meat is PSE type (pale, soft, exudative) which happens when the pH decreases to under 5.5 in the post mortem phase (Braña Varela *et al*., 2011). In the variance analysis the pH did not present any type of reaction to hardness.

**Water retention capacity:** The result shows in the data Table 1, where it is noted that the Water Retention Capacity (WRC) of *Bíceps femori*s muscle for the CL treatment is of 0.686, that means a 68.6% of water is present in every g of meat. For the STF treatment it is of 0.668, meaning a 66.8% and for the C treatment it is of 0.670 which is a 67.0%. The performed treatments do not influence the WRC of the meat directly due to not finding significant differences in the WRC results.

**Tenderness test:** In the data Table 2, the average value can be observed. The standard deviation and the coefficient of variation analysis of meat tenderness is evaluated. The sample covered in *Calathea lutea* (CL) showed an average firmness and tenacity lower regarding the samples of the Self-adhesive Transparent Film (STF) and without covering (C). The sample covered in the CL treatment showed a significant improvement in comparison to the STF and C treatments, resulting in less shear force, matching with the reported when enzymes are used for different cuts of meat (Ashie *et al*., 2002; Istrati *et al*., 2011; Sullivan and Calkins, 2010).

**Textural profile analysis:** The variance analysis showed that there is no significant difference (significant of the 5%) in the treatments applied to the meat, about none of the textural parameters (hardness, elasticity, cohesiveness, gumminess and chewiness) evaluated at 72 h of treatment. This shows that maturation time is not enough to observe structural changes of the meat evidenced by the textural parameters. Meanwhile in the evaluated treatment at 96 h there is a significant difference (significant of 5%) showing that maturation time is enough to observe a structural change evidenced by the textural parameters being a useful indicator in meat processing. The elasticity and cohesiveness parameters did not show a significant difference (Table 3).

The CL treatment at 96 h showed a significant improvement in the hardness and chewiness regarding the other treatments. Presenting less value regarding the other treatment. There are significant differences between the samples of CL and C; being the CL sample the less hard one out of all the studied samples. It is evidenced that treatment time influences significantly the results. Also, *Calathea lutea* gives better textural properties to the meat the longer it is observed that the sample is elastic, softer and of good chewiness. These results match with treatments done with different enzymes in cuts of meat. (Ashie *et al*., 2002; Istrati *et al*., 2011; Pietrasik and Shand, 2011; Sullivan and Calkins, 2010).

**Sensory evaluation:** In Fig. 1 and 2 the order of a rank of 1-3 is taken as reference, being 1 the softer sample, 2 the one with mild hardness and hardest sample. It is observed that for the organization test performed on samples with 72 h of treatment (Fig. 1) 24 panelists (80%) indicated that the sample 4822 belonging to the CL treatment was the softest one out of all the evaluated samples.

On the same way for the samples 1438 with 96 h of treatment (Fig. 2) 22 panelists (72%) indicated the

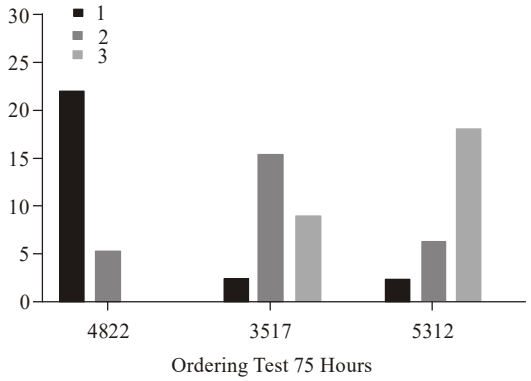


Fig. 1: Sensory analysis at 72 hours of treatment

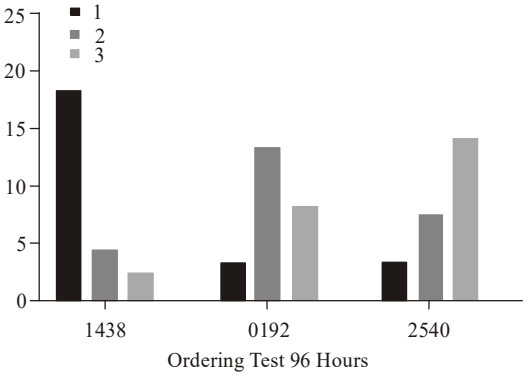


Fig. 2: Sensory analysis at 96 hours of treatment

same for the sample with CL treatment. Out of the obtained results it can also be noted that the hardest sample in both study times was the one without covering, codified as 2540 and 5321 at 72 and 96 hours respectively.

## CONCLUSION

The sample that showed the best softening effect in the cut of *Bíceps femori* muscle according to the values obtained in the Textural Profile Analysis (TPA) and tenderness analysis, was the CL treatment covered with C*alathea lutea*. It has more chewiness and more elasticity, according to the firmness values it can be considered that this sample requires less shear force. These results are corroborated in the sensory analysis with the organization test, where the 80% of the panelists indicate that the sample covered in C*alathea lutea* is softer.

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