ELABORATION OF LOW-SODIUM RESTRUCTURED BEEF USING ALLIGATOR (*cayman crocodilus yacare*) MEAT

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Abstract –There is a requirement to develop new methods for the restructuring of low-value cuts and trimmings to improve its appearance and texture, and finally increasing the market value. With this ambition, Microbial Transglutaminase (MTGase) can be used in meat products in order to promote protein cross-linking. In addition, the growing call for healthier products has stimulated the development of nutritionally better products. In this context, the objective of this study was to instrumentally measure the cooking loss, texture and color of seven formulations of restructured beef using trimmings of alligator with two concentrations of MTGase (1% and 0.5%) and three different salt contents (NaCl, NaCl/KCl, NaCl/$MgCl_2$). A higher yield was observed for 1% NaCl and 0.5% NaCl + 0.5% KCl (both with 1% of MTGase), both differed significantly ($p<0.05$) from the control. Regarding texture when analyzing the raw samples, 1% MTGase/0.5% NaCl/0.5% KCl was the hardest, the control had the lowest elasticity and cohesiveness and 0.5%MTGase/0.50%NaCl/0.50% $MgCl_2$ showed the lowest resistance. The addition of 1% transglutaminase showed desirable results for the analyzed parameters for a restructured low-salt alligator beef.
Key-words – transglutaminase, Caiman crodocilus yacare, sensory.

I. INTRODUCTION

Higher food prices have stimulated industrial research and consequently promoted the processing of carcasses at its full potential. Thus, there is great potential in the conversion of less valuable cuts that would be considered by-products in new products with high biological value aiming human consumption (Ahamed et. al, 2007). With this ambition there is a requirement to develop new methods for the restructuring of low-value cuts and trimmings to improve its appearance and texture, and finally increasing the market value (Marques, Marostica & Pastore, 2010). Microbial Transglutaminase (MTGase) works exactly increasing the interaction of mussel's proteins. Therefore, this enzyme can be used in meat products in order to mimic the effects of salt, improving the water holding capacity, connection between particles, consistency, emulsification and texture (Chin; Gob & Xiong, 2009).

The growing call for healthier products has stimulated the development of nutritionally better products such as using raw materials of high biological value, product and technological processes rework (Trespalacios & Pla, 2007; Mark, Marostica & Pastore, 2010). Thus, alligator meat (*Caiman crocodillus yacare*) represents a great potential for human consumption due biological, nutritional and technological characteristics (Romanelli et al. 2002, Paulino et al. 2011).

On the other hand, the role of the sodium in the development of high blood pressure in susceptible individuals appears as a matter of interest, since the meat products generally have a high salt content in their formulations. The use of mixtures of minerals is a good alternative to low-sodium meat products (Hathwar et al., 2011). The food industry is challenged to develop low-sodium products with similar texture and flavor of regular products (Desmond, 2006).

In this context, the objective of this study was to instrumentally major the cooking loss and sensory trades of seven formulations of restructured beef using trimmings of alligator and different concentrations of NaCl, two types of salt substitutes (KCl and $MgCl_2$) and levels of TGMase.

II. MATERIALS AND METHODS

*Experimental Desing***.** There used 3 Kg of alligator carcass trimmings (tail, neck, legs and back), divided into seven formulations containing approximately 0.4 kg each, with two variables: sodium substitutes and transglutaminase level. Each treatment was represented by five medallions of 80g each, totaling 35 sampling units.

*Restructured beef production***.** The meat was bought from slaughterhouse-fridge with federal inspection, located in Amazon region, Brazil. The frozen meat arrived the Laboratory, where it was thawed under refrigeration (4±2 °C) for further processing. The recipes include sodium chloride (inform supplier), potassium chloride, magnesium chloride, sodium tripolyphosphate, garlic powder, onion powder, besides the MTGase (Active WM, Ajinomoto Co Inc, Kawasaki, Japan). As indicated by the supplier Active WM contains 99% (w/w) maltodextrin and 1% (w/w) of MTGase from *Streptoverticillium* sp with activity approximately 100 U/g (one unit is the amount of enzyme that catalyzes 1 µmol hydroxamic acid per minute at 37 °C). All formulations were performed with the same enzyme preparation.

The meat (3 kg) was thawed for about 18 h at 2±2 °C, weighed, ground using 10mm disk, manually mixed for five minutes with the common ingredients (0,4%sodium tripolyphosphate, 1% garlic, 1% onion powder and 1% water). Later the 3kg were divided into same portions on seven different trays, representing each formulation, where they were homogenized with the other specific ingredients (NaCl, KCl. $MgCl_2$ and MTGase).

Seven formulations were prepared: control (**C**) with addition of 1% NaCl; F1 1% MTGase and 1% NaCl; F2 0.5% MTGase and 1% NaCl; F3 1% MTGase, 0.5% NaCl and 0.5% KCl; F4 0.5% MTGase, 0.5% NaCl and 0.5% KCl; F5 1% MTGase, 0.5% NaCl and 0.5% $MgCl_2$; F6 0.5% MTGase, 0.5% NaCl and 0.5% $MgCl_2$. The alligator meat content varied accordingly with MTGase content (95.6% for control, 95.1% for those with 0.5%; and 94.6% for those with 1%) and no fat was added.

The enzyme was sprinkled on the batter according to manufacturer's specifications. The treatments were cast on polyvinylchloride (PVC) film, compressed in order to obtain the correct shape and size (7 cm diameter), then the film was punctured several times to remove the trapped air. The treatments were taken to refrigerator (5 ±2 °C) left there overnight. After this period the cylinders were cut into medallions 2cm height each, that were vacuum packaged and stored in a freezer (-18°±2 C).

Cooking loss. Two restructured steaks were weighed, wrapped in aluminium foil and cooked for 10 min in a forced air oven at 170±2 °C until the center of the product reached 70±2 °C. These conditions were determined beforehand by inserting thermocouples, connected to a temperature recorder. Steaks were tempered for 30 min at room temperature and weighed again to measure the cooking loss (CL) by difference. This was expressed as a percentage.

*Instrumental color analysis***.** The color parameters of L* (luminosity), a* (−a=green; +a=red) and b* (−b=blue; +b=yellow) were obtained using a portable Konica Minolta model CR 400 colorimeter (Konica Minolta Sensing, Inc., Osaka, Japan). For the reading, the samples were transversally cut (thickness of 1 cm) and maintained at room temperature for 30 min. The result was obtained from the mean of measurements made at two distinct regions of each sample.

*Instrumental texture analysis***.** The texture analysis was carried out through texture profile analysis (TPA) (Bourne, 1978) under the following conditions: samples cut into 2 cm^3 cubes held at temperature of 10±2 °C, instrument model TA XTplus texturometer (Stable Micro System, London, England) with a 75 mm diameter cylindrical metal probe (P/75), compression to 70% of the original height in two cycles, pre-test speed: 5 mm/s; test speed: 1 mm/s; and post-test speed: 5 mm/s, time between compressions: 2 s, and 5 g of force per area. The data were processed by Texture Expert for Windows (Stable Micro System), express the cohesiveness, hardness, springiness and resistance. Four repetitions were made for each group.

III. RESULTS AND DISCUSSION

Table 1. Variations of different parameters in all restructured beef treatments.

Parameters	Treatments						
	C	F1	F2	F3	F4	F5	F6
Cooking loss	74.05[b]	81.80[a]	75.30[ab]	76.98[ab]	75.05[b]	78.25[a]	71.43[b]
Raw							
L*	46.24[a]	43.98[a]	43.93[a]	44.43[a]	44.43[a]	43.77[a]	45.33[a]
a*	4.55[a]	3.90[a]	4.03[a]	4.14[a]	4.06[a]	4.43[a]	4.24[a]
b*	4.06[a]	3.37[a]	3.91[a]	3.99[a]	3.75[a]	4.03[a]	3.45[a]
Hardness	18.53[b]	32.61[b]	28.69[b]	53.13[a]	28.98[b]	34.21[b]	22.20[b]
Springiness	0.398[b]	0.704[a]	0.588[a]	0.721[a]	0.627[a]	0.654[a]	0.591[a]
Cohesiveness	0.308[b]	0.422[a]	0.406[a]	0.431[a]	0.366[ab]	0.357[ab]	0.321[b]
Resistance	0.079[bc]	0.114[ab]	0.087[bc]	0.128[a]	0.078[bc]	0.095[bc]	0.073[c]
Cooked							
L*	62.74[a]	62.17[a]	63.61[a]	64.15[a]	63.00[a]	61.33[a]	62.19[a]
a*	3.95[a]	3.45[b]	3.54[b]	3.50[b]	3.54[b]	3.65[b]	3.57[b]
b*	4.55[a]	4.99[a]	5.23[a]	5.18[a]	4.86[a]	4.95[a]	4.45[a]
Hardness	198.4[a]	147.7[a]	176.4[a]	166.1[a]	158.7[a]	159.6[a]	187.4[a]
Springiness	0.733[b]	0.859[a]	0.846[a]	0.863[a]	0.843[a]	0.829[ab]	0.846[a]
Cohesiveness	0.450[a]	0.503[a]	0.462[a]	0.501[a]	0.469[a]	0.502[a]	0.499[a]
Resistance	0.165[a]	0.161[a]	0.147[a]	0.159[a]	0.148[a]	0.157[a]	0.175[a]

Different letters in rows represent significantly different averages ($P \leq 0.05$).

Table 1 show a higher yield for F1 and F5 (both with 1% of MTGase), they both differed significantly ($p<0.05$) from the control. F3 resembled statistically similar to F1, F5 and C. However samples with 0.5% MTGase did not differ statistically ($p> 0.05$) from control and both demonstrated a lower yield than F1 and F5, at final product. The formulations with 1% transglutaminase obtained higher yield probably because of promotion of links between proteins, forming a three-dimensional network favoring a better gel formation and therefore providing lower loss of water during cooking (Llorente-Bousquets *et al.*, 2011).

In raw and cooked samples, colorimeter analysis there weren't observed significant difference ($p> 0.05$) between brightness (L*) and yellowness (b*), the only significant difference was observed in the red content (a*) of raw samples. Regarding this parameter, control has reached the highest value and was statistically different ($p <0.05$) from other treatments. The same behavior was observed in chicken meat (Trespalacios & Pla, 2007) .

It was observed statistical similarity among treatments in almost all parameters of texture in the analyzed cooked samples, except for the elasticity the treatments were different statistically from control which had the lowest value. On the other hand when analyzing the same parameters in raw samples, F3 was the hardest, differentiating statistically ($p <0.05$) from the other samples; this increase in hardness can be explained by increased crosslinking of proteins (Jong and Koppelman, 2002).

The control had the lowest elasticity and cohesiveness; the last one was statistically resembled only with F6, which showed the lowest resistance and significantly differentiated from F1 and F3 (both with 1% of transglutaminase). Some studies have also shown that the addition of transglutaminase increases the hardness, cohesiveness and elasticity with restructured beef (Pietrasik, 2003, Bousquets-Llorente et al, 2011). Furthermore, Pietrasik and Li-Chan (2002) reported that samples of meat gel with 0.5% transglutaminase had better texturial characteristics when compared with control (no enzyme), showing higher hardness and elasticity of the pork meat gel, but is wasn't reproducible in products with a low-sodium content. Tseng *et al*. (2000) found that gel strength of poultry meatballs with low salt content was increased with the addition of 1% transglutaminase.

IV. CONCLUSION

Restructured beef using alligator trimmings meat aiming a low-sodium product represents a promising alternative use of underutilized industrial meat, to develop a healthier product with high biological value, using less valuable cuts. Thus, the addition of 1% transglutaminase showed desirable results for the analyzed parameters.

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