EFFECT OF ULTRASOUND INTENSITY AND TIME ON THE QUALITY OF COOKED HAMS WITH REDUCED SODIUM CONTENT

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Abstract –This study evaluated the effect of ultrasound intensity and time on the quality of cooked hams with reduced sodium content. Eleven different treatments were carried out with two independent variables (intensity and time of the ultrasound). The restructured product stability (RPS) and the color were evaluated. Effects were significant only in the time. As the time increases, the RPS increases. The time between 6 and 12 minutes presented the lowest values for L*; between 4 and 14 minutes, the highest values for a*; and between 6 and 18 minutes, lowest values for whiteness. The study showed that the ultrasound can help in the processing of this product with reduced sodium by influencing the stability of its restructure and its color.

Key Words – Cavitation, pork, surface response, color.

I. INTRODUCTION

Ultrasound is an innovative technology that has potential application in food processing and analysis methodologies. In recent years, many studies have shown the effects of ultrasound and its benefits in meat and meat products [1] [2]. Ultrasound can be a complementary technology in the processing of low-sodium meat products. Sodium chloride, the highest sodium source ingredient in these products helps with product stability [3]. However, its excess in diet is associated with the development of chronic non-transmissible diseases [4]. Reduction of sodium in meat products is a challenge and should not occur without proper studies [5]. The objective of this study was to evaluate the effects of ultrasound intensity and time on the color and on the RPS of cooked hams with reduced sodium content by response surface methodology.

II. MATERIALS AND METHODS

Lean pork meat cut into 30 mm discs was added to the brine, composed of the homogenization of all other ingredients, according to the standard formulation: 62.50% lean pork; 32.27% water, 1.5% soybean protein isolate (Bremil, Brazil), 0.75% NaCl, 0.94% california condiment without sodium (Fego, Brazil); 0.1% monosodium glutamate; 0.02% cochineal carmine dye (Christian Hansen, Brazil); 0.28% cure salt with 10% sodium nitrite and 90% sodium chloride (Kraki, Brazil); 0.19% sodium erythorbate; 0.47% sodium tripolyphosphate; 0.47% refined sugar; 0.24% carrageenan (Indukern, Brazil) and 0.28% maltodextrin. In order to observe the ultrasound intensity and time effects, eleven runs were performed according to the central composite design (CCD) with two independent variables (intensity and time) with three repetitions at the central point. To apply the ultrasound, the mixture of the ingredients was packed in a stainless steel cylindrical vessel (21 cm diameter, 42 cm high). The system consisted of a VCX-1500 ultrasound generator (Sonics & Materials Inc., USA), which emits waves at 20 kHz. The generator was equipped with a titanium probe that emits ultrasound in the axial and radial directions - Ti-6Al-4V (Sonics & Materials Inc, Newtown, USA). The probe was immersed in the mixture and positioned in the center of the vessel. After application of the ultrasound, the mixture of each treatment was manually massaged for 20 minutes. Then, 0.4 kg portions of each treatment were put into plastic casings, caliber 95 (Viscofan, Brazil). Subsequently the pieces were immersed in the cooking tank. The cooking cycle ended as soon as the pieces reached 72°C, being cooled promptly. The RPS was obtained by collecting the exudate from each piece when the package was opened and was expressed as a percentage of the drained part of the exudate over the total weight of the piece. The instrumental color was obtained in a Colorflex 45/0 spectrophotometer (HunterLab, Reston, VA, USA) and was expressed in L*, a*, b* and whiteness. The CCD was used to analyze the effect of the independent variables on the RPS and instrumental color of the cooked ham. The data obtained from the CCD were adjusted to a second-order polynomial equation. The quality of fit was determined by the regression coefficient (R^2) and the F-value obtained in the analysis of variance. The statistical software used was Statistica 7.0.

III. RESULTS AND DISCUSSION

For the RPS values, the regression analysis only showed an effect for the time ($p<0.05$) in linear and quadratic terms. The R^2 obtained was 0.86 and the value of $F_{calc.}$ was higher than the value of F_{tab}. Only the ultrasound time has significant effect. By observing the response surface graph for RPS (Fig. 1a), it can be seen that as the ultrasound time increases, the percentage of RPS increases. McClements [6] reported that ultrasound facilitated the extraction of myofibrillar proteins, which have properties of binding to water, thereby increasing water retention capacity. Higher water holding capacity can minimize exudation of the product, increasing its stability. Regarding the instrumental color, for the L* parameter, the regression analysis showed an effect only for the linear and quadratic terms of the time. The R^2 obtained was 0.81 and the value of $F_{calc.}$ was higher than F_{tab}.

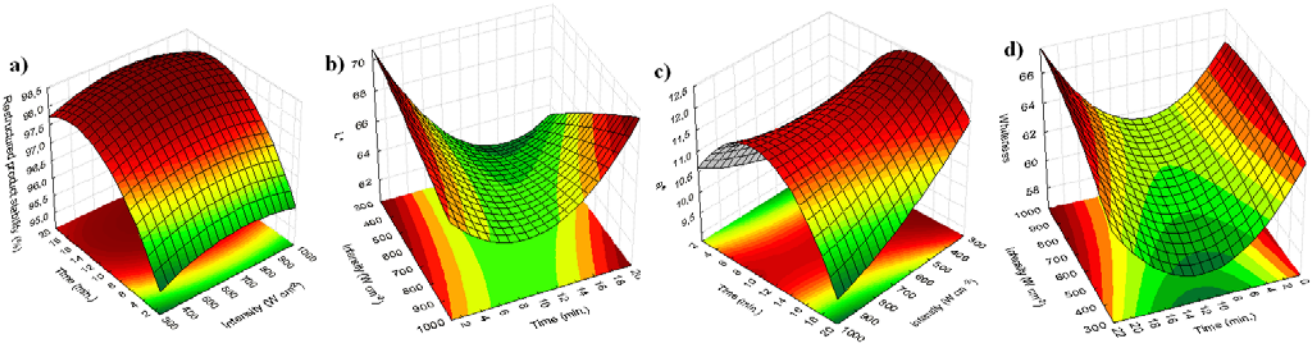

Figure 1. Response surface of RPS (a), L* (b), a* (c) e whiteness (d).

The time interval between 6 and 12 minutes (Fig. 1b) presented the lowest values for L* and above 18 minutes this parameter is higher. For the a* parameter, the regression analysis showed effect for the linear and quadratic terms only of the time. The obtained R^2 was 0.85 and the value of $F_{calc.}$ was higher than F_{tab}. The interval between 4 and 14 minutes (Fig 1c) presented the highest values for this attribute. For whiteness, there was only effect in the quadratic term of the time. The obtained R^2 was 0.84 and the value of $F_{calc.}$ was higher than F_{tab}. The lowest values of whiteness (Fig, 1d) are between 6 and 18 minutes of ultrasound treatment. Pohlman et al. [7] reported lower intensity of a* in beef subjected to ultrasound and refrigerated storage. Stadnik [8] reported that ultrasound in beef caused changes in color stability. However, Chang et al. [2] observed that ultrasound in beef had no significant effect on the color. With respect to b*, it was not possible to construct a model, since R^2 was low (0.7) and $F_{calc.}$ was lower than F_{tab}.

IV. CONCLUSION

Ultrasound treatment influenced the quality of cooked hams with reduced sodium. The time of application of ultrasound produced an effect on the restructured product stability, on the luminosity and intensity of red color and whiteness. Ultrasound technology showed potential for application in cooked hams with reduced sodium, obtaining satisfactory technological results.

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