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THE EFFECT OF ULTRASONIC DURING NaCl AND KCl MEAT BRINING

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Abstract: *The main purpose of the paper is the comparative study of the salting process for pork and beef, in brine of NaCl and KCl at different concentrations, using ultrasonic treatment in order to reduce the time needed salting process (for salting). Ultrasounds accelerates the salting process, due to increased mass transfer, through the generation and collapse of microscopic bubbles in a liquid medium, but also due to changes in the structure of muscle tissue.The study was conducted on Pork M. Longissimus lumborum and on bovine muscle Psoas major. The samples were submerged in brine for 48 hours, at different concentrations (5%, 10%, 15% NaCl and KCl respectively), and then the salt content was determinated. The samples were maintained for 30 minutes in an ultrasonic bath. It was noted that the results are higher at ultrasonic treatment, in the case of pork preserved in brine NaCl, respectively for beef in KCl solution. The potassium ion produces an enhanced efficacy of salting process only at low concentrations of brine. Also ultrasonic treatment acts positively for the diluted solutions. Results showed that in general ultrasound accelerates the process of salting meat.*

Keywords: *NaCl, KCl, salting, meat, ultrasound*

1. Introduction

Salting meat is an important step, during meat processing. Sodium chloride influences the conservation, the flavor and texture of meat products. Its effect of conservation is mainly due to the water activity reduction capacity [1]. Moreover, salt affects some chemical or biochemical phenomena such as proteolysis, lipolysis, or oxidation of lipids that contribute to the development of texture and flavor specific to meat [2]. A low levels of salt in meat products, raises issues in terms of the perception of salinity. Also the characteristic flavor intensity decreases [3]. However, a high consumption of sodium chloride is associated with the occurrence of hypertension [1]. This fact has promoted the current trend to reduce the intake of sodium by partial or total replacement of sodium ion, with other ions such as potassium, calcium or magnesium [4,5,6,7]. Most researchers believe that the most effective substituent as potassium chloride, although it has some disadvantages: in high doses gives the product a metallic taste, astringent and bitter, but modern methods allow to eliminate these inconvenient [8].

On the other hand, the salting can be made with dried salt or with brine by injecting it or by immersion of the pieces of meat in the brine. This latter option is rarely used due to the long time of salting. To increase the mass transfer, can be used ultrasound (US) [9, 10]. Ultrasonic waves occur at frequencies higher than 20 kHz and can be classified according to their frequency into three groups as follows: power US at the frequencies less than 100 kHz, high frequency for frequencies greater than 100 kHz and less than 1 MHz and diagnostic US for frequencies between 1 and 500 MHz. In salting meat is using frequencies from 20 to 100 MHz, this interval being

specific in cases of concern on physical or chemical phenomena [11].

A sound wave in a liquid medium produces a cyclic sequence of compression and expansion. During the phase of expansion, in the liquid medium occur bubbles and due to the lower pressure inside them, these bubbles are filled with gas and vapour. When the bubbles reach a critical size, depending on the wave frequency and the pressure inside the bubbles is much smaller than the outside, occurs a collapse and liquid jets enter into the space that was occupied by bubbles. For this reason, in the space that was occupied by bubbles and in the layer closer, it is found an increase in temperature and pressure. Subsequently the formation and expansion of bubbles is resumed. So, we can say that the effect of ultrasound is due of generation and collapse processes, of cavitation bubbles, which determine the appearance of microcurrents [12].

Shortening the process of salting meat immersed in the presence of ultrasound, can be explained in conclusion by these mechanisms [13]. Thus, the main objective of this work is to provide further information on NaCl and KCl migration within the meat upon salting with or without ultrasonic treatment.

2. Experimental

This study was realized on Pork Longissimus lumborum and M. psoas major bovine muscle, commercially purchased on the day of analysis and maintained at 4°C until analysis. Subsequently it was partitioned, resulting pieces with identical shapes and weights (10 g).

These were maintained in various concentrations of NaCl brine, respectively KCl in Tables 1-2.

Ultrasound treatment was achieved by keeping the samples for 30 minutes in an ultrasonic bath (Elma 60 H). All samples were kept for 48 hours in the corresponding solution at a temperature of 4°C, then were maintained in distilled water for 20 seconds [14] and the salt content was determinated by the method SR ISO 1841:2000 [15].

Table 1

Preparing pork samples

Samples analyzed	
Sample	Pork 10 g /sample
PP1	+50 ml solution NaCl 5%
PP2	+50 ml solution NaCl 10%
PP3	+50 ml solution NaCl 15%
PP4	+50 ml solution NaCl 5% + US*
PP5	+50 ml solution NaCl 10% + US
PP6	+50 ml solution NaCl 15% + US
PP7	+50 ml solution KCl 5%
PP8	+50 ml solution KCl 10%
PP9	+50 ml solution KCl 15%
PP10	+50 ml solution KCl 5% + US
PP11	+50 ml solution KCl 10% + US
PP12	+50 ml solution KCl 15% + US

* *US sonication*

Table 2

Preparing beef samples

Samples analyzed	
Sample	Beef 10 g /sample
PB1	+50 ml solution NaCl 5%
PB2	+50 ml solution NaCl 10%
PB3	+50 ml solution NaCl 15%
PB4	+50 ml solution NaCl 5% + US*
PB5	+50 ml solution NaCl 10% + US
PB6	+50 ml soluție NaCl 15% + US
PB7	+50 ml soluție KCl 5%
PB8	+50 ml soluție KCl 10%
PB9	+50 ml soluție KCl 15%
PB10	+50 ml soluție KCl 5% + US
PB11	+50 ml soluție KCl 10% + US
PB12	+50 ml soluție KCl 15% + US

* *US sonication*

In order to compare between them the results obtained for NaCl and KCl brine, it was preferred the percentage concentration of chlorine from meat samples.

3. Results and Discussion

Figures 1 and 2 shows the concentration of chlorine ions in the pork, respectively beef, maintained under the conditions indicated in Tables 1 and 2.

It can be seen, both for the pork and for beef when brine was obtained with NaCl, respectivley with KCl, the ultrasound treatment had a beneficial effect, favoring the salting. In order to highlight the effect of ultrasound treatment was done the ratio of chloride ion concentrations from the samples meat, held in the same type of brine without or with ultrasound (Fig. 3, 4). All ratios have values higher than one, mostly around 1.5 and for beef that was in 5% KCl solution, this ratio reaches 2.03. It also is found that the results are higher for pork, maintained in brine of NaCl, respectively in the case of beef in KCl solution. Not the least (finally) it may be noted that in general, the effect of ultrasound treatment is greater for dilute solutions.

These results strengthens the hypothesis previously issued namely that ultrasound leads to accelerated salting procces, due to increased mass transfer in the samples analyzed, by the implosion of microscopic bubbles due to their propagation [16-18].

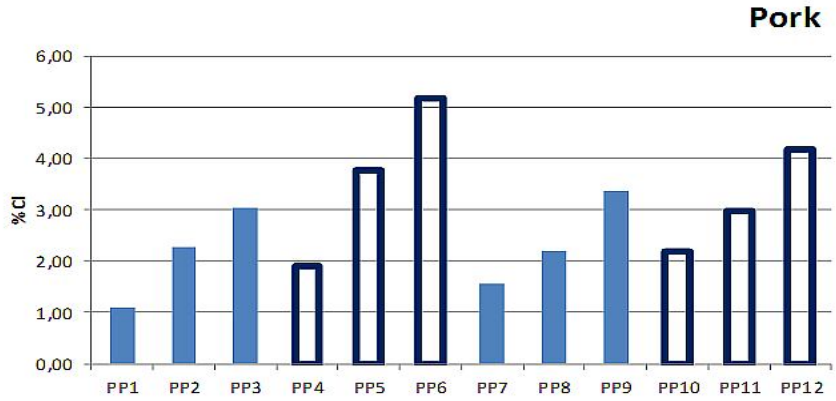

Figure 1. Variation of concentration in chloride ion for samples PP1-PP12 pork, maintained in brine for different concentration (5%, 10%, 15%) of NaCl, respectively KCl.

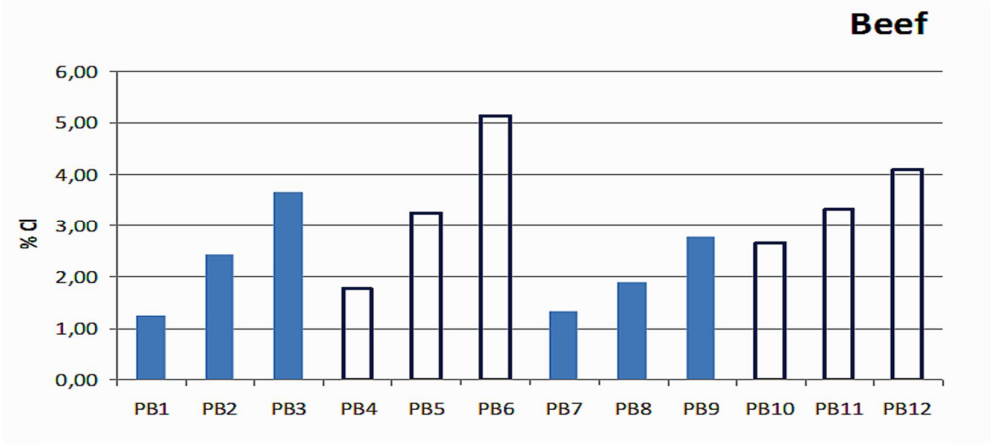

Figure 2. Variation of concentration in chloride ion for samples PB1-PB12 beef, maintained in brine for different concentration (5%, 10%, 15%) of NaCl, respectivelv KCl.

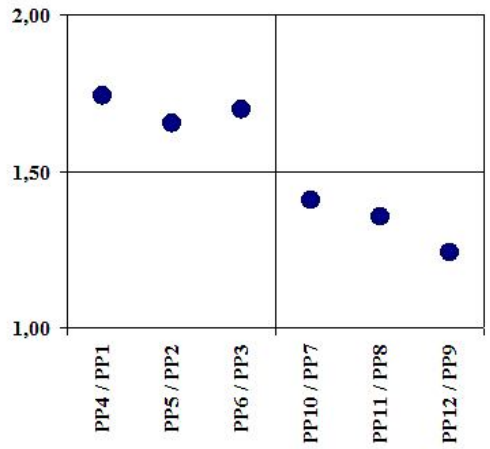

Figure 3. Ratio of the concentration of chloride ions from the samples of pork maintained in the same type of brine with / without ultrasound.

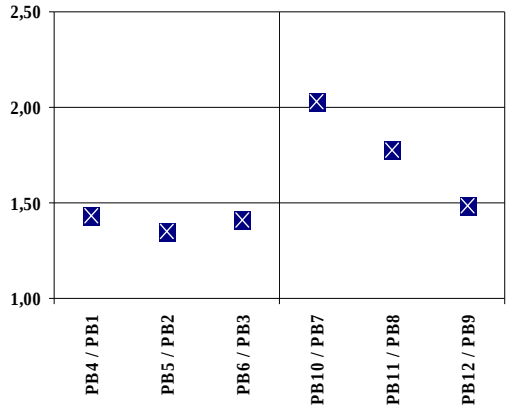

Figure 4. Ratio of the concentration of chloride ions from the samples of beef maintained in the same type of brine with / without ultrasound.

On the other hand, one possible explanation is that at the level of ultrastructure and microstructure of muscle tissue, during treatment with ultrasonic may occur modifications which favoring the salting process. Thus, Reynolds et al. (1978) identified ruptures in the thick fibers and increase in size of endomysum [19]. Similar observations were made by Vimini et al. (1983) [20]. Subsequently, Siró et al. (2009), noted a thickening of myosin filaments and ruptures at the level of Z line due to treatment with ultrasound, thus increasing the space between the fibers [17]. These changes at the muscle structure due to the effects of ultrasound, however are not supported by all researchers. McDonnell (2014) by histological studies could not identify changes in the meat subjected to ultrasound treatment in comparison with the blank [21].

Comparing the effect of Na ions and K on the salting process it is found to be variable. The ions of K favors salting process only at low concentrations.

In the case of pork preserved in brine 5% and subjected to ultrasonic treatment, Cl ions concentration values were 1.91% in NaCl solution and 2.20% in KCl solution. For beef, the highest variation has been reported in favor of K for ultrasound treatment in 5% concentration, namely 1.77% in NaCl solution, respectively 2.66% in KCl solution.

Barat et al (2014) studying the kinetics of the salting process, they have noted that the presence of KCl in brine of NaCl, in proportion 50%, increases the salting speed, and their explanation was that the addition of KCl, decreases the pH from 9.9 to 6.2. The same authors, after some mathematical calculations observes that the diffusion coefficient is higher for ion of K, than for ion of Na, in brine concentration 15% [22].

4. Conclusion

In the pork and beef preserved in brine, intensifies the procces of salting using ultrasound treatment. From the analyses performed, result that at low concentrations of brine, the effect is more intense. Moreover it was evidenced that the variation of ions Cl concentration was higher for beef in brine of KCl. Pork has a higher concentration of chloride ions in brine of NaCl. Thus was presented a possibility to shorten the time required salting process using ultrasonic treatment and its effects during brining on meat.

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