EFFECTS OF CALCIUM CHLORIDE ON SENSORIAL CHARACTERISTICS OF ADULT BEEF MEAT

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Sensorial characteristics of chemical tenderized beef meat with calcium chloride were evaluated on each raw meat and heat-treated after different periods of aging at different temperatures. Beef cuts were injected with distilled water (10% w/w), 0.4 M sodium chloride (10% w/w), 0.2 M calcium chloride (10% w/w) and 0.4 M calcium chloride (10% w/w). Effects generated by injecting samples with sodium chloride and calcium chloride on sensorial characteristics of beef meat were determined after 0, 24 and 48 hours of storage at 4^0C and 15^0C. Non-injected meat pieces were used as control samples.

Calcium chloride treatments resulted in less beef flavour and more off-flavour than sodium chloride treatments. In addition, meat pieces injected with calcium chloride had lower scores of taste but higher scores of tenderness compared to the cuts of beef injected with sodium chloride or distilled water.

Considering the effects on sensorial characteristics, we recommend injecting adult beef meat with 0.2 M solution of calcium chloride to improve the quality of meat.

***Key words**:beef muscle, tenderness, calcium chloride, flavour*

The main consumer requirement is palatability, which comprises tenderness, texture, juiciness, mouth feel and flavour with an overriding assurance of food safety (Dikeman and Devine, 2004) [5]. Meat palatability represents one of the most representative attribute of meat quality and is manifested as consumer satisfaction at consuming cooked meat (Banu, 2006) [2]. For consumers, beef tenderness is the most important meat palatability characteristics (Dransfield, 2003; Huffman et al., 1996; Jeremiah, 1982) and, today, his inconsistent tenderness is a major problem of the beef industry (Belew, Brooks, McKena and Savell, 2003; Morgan et al., 1991) [3, 6, 9, 10, 12].

Consumer's acceptability and perception of quality are the key determinants of the success of a meat product (Grunert, 2006) [8]. A high degree of tenderness by itself does not guarantee a high degree of acceptance – for example, a high degree of tenderness is not necessarily acceptable if the meat is dry or mushy. In addition, other factors such as texture (affected by connective tissue content) mouthfeel (conveyed by level of lipid components) and flavour are required for optimal palatability (Dikeman and Devine, 2004) [5].

Boleman et al. (1997) and Miller et al. (2001) have reported consumers would pay a premium for improved beef tenderness [11]. Results of recent studies have shown that injecting beef carcasses with CaCl2 solution accelerates meat tenderness (Polidori, Fontuz, 2003), the optimal value of $CaCl_2$ marination/infusion to improve beef tenderness is largely unknown [7]. Therefore, the objective of this study was to evaluate the influence of chemical tenderization with different concentrations of calcium chloride on sensorial characteristics of adult beef meat (tenderness, juiciness and flavour).

MATERIAL AND METHOD

The raw material, utilized in research program, was reprezented by the beef thigh from adult cows (more than 9 years old) purchased in hot state from a local abatory at maximum 2 hours post slaughter. Salt and calcium chloride were a food suitable purity, salt being a largely used additive in meat industry.

The adult beef thigh separated from the gross conjunctive tissue and fat was cut into pieces of the same size in length and thickness, weighting approximately 120 g, cuted along the muscular fibers. The meat pieces were then divided into five groups and were used for a certain treatment: control sample (P_1), (pieces of meat were not injected with any solutions); sample P_2 (pieces of meat injected with 10% distilled water); sample P_3 (pieces of meat injected with 10% solution 0,4 M NaCl); sample P_4 (pieces of meat injected with 10% solution 0,2 M $CaCl_2$) and sample P_5 (pieces of meat injected with 10% solution 0,4 M $CaCl_2$). The injection was performed manually with a syringe, so that the entire solution quantity could be uniformly pumped into the whole muscular mass. The eliminated solution was reinjected. The injected beef pieces were wrapped with a polyethylene film and stored at $4^0C \pm 1^0C$ respectively $15^0C \pm 1^0C$ for 0 - 48 hours.

Sensorial analysis was applied on each raw meat and thermal treated meat by boiling as follows:

- on raw cuts were appreciated the general appearance according to a hedonic scale with 9 points: 9 excellent; 8 good; 7 – good; 6 - good enough; 5 - average (satisfactory); 4 - least unattractive (acceptable); 3 - unpleasant (acceptable); 2 - unpleasant (unacceptable), 1 - very unpleasant/very bad (totally unacceptable);
- on thermal treated meat cuts by boiling, sensorial analysis was reached according to the method described by the American Meat Science Association (AMSA, 1995) [1].

RESULTS AND DISCUSSIONS

Sensorial characteristics of beef treated with calcium chloride and sodium chloride were evaluated on each raw meat and thermal treated meat after different periods of aging at different temperatures. From this point of view, the raw meat was appreciated the general appearance of cuts, color and surface section, the quantity and color of juice expressed at storage, and the boiled meat, juiciness, flavour and tenderness.

In *table 1* are given scores on the overall look of chemical tenderized meat pieces, depending on storage time and temperature.

Table 1

Effect of injection with $CaCl_2$ and NaCl interacting with time and ageing temperature on the score for general appearance of meat pieces

Sample*	Storage temperature [°C]	Sensorial characteristic appreciated	Storage time [ore]		
			0	24	48
P_1	4^0C	General appearance	9	8,92	8,55
P_2			8,95	8,75	8,42
P_3			8,92	8,65	8,35
P_4			8,78	7,95	7,76
P_5			8,35	7,82	7,59
P_1	15^0C	General appearance	9	8,95	-
P_2			8,95	8,69	-
P_3			8,92	8,63	-
P_4			8,78	7,94	-
P_5			8,35	7,76	-

*P_1- control, P_2- distilled water, P_3- 0.4M NaCl, P_4- 0.2M $CaCl_2$, P_5 - 0.4M $CaCl_2$.

Shortly after injection, analysts have noted some differences in between samples, the scores having values significantly lower in samples injected with CaCl2. As a result of the cumulative effect of treatment - time and temperature of aging, scores accorded to the general appearance had the same evolution. They decreased with increasing duration of storage, the lowest scores were recorded in samples ageing 48 hours, injected with calcium chloride, mainly at concentration of 0.4 M (storage temperature $4^0C \pm 1^0C$).

Following developments in the general appearance score of chemical tenderized samples and stored at a temperature $15^0C \pm 1^0C$, can be seen a progressive reduction after 24 hours of ageing. Influence of treatment is applied similarly to that described for storage at $4^0C \pm 1^0C$. The samples stored at $15^0C \pm 1^0C$ sensorial analysis was performed only at initial time and after 24 hours because of some changes associated with the meat smell. During the ageing of meat, flavour developed differently depending on the treatment applied (fig. 1). Control samples and samples injected with distilled water and sodium chloride solution were evaluated with scores slightly different for each storage temperatures ($4^0C \pm 1^0C$ and $15^0C \pm 1^0C$). $CaCl_2$ have negatively influenced the sensorial score of flavour, easy identification of a bitter, metallic taste which enhanced with increasing of $CaCl_2$ concentrations and the storage period, went on the significant scores reduction of beef flavour.

Tenderness of the control samples and the samples injected with distilled water were generally low the changes that took place in the miofibrilar system were not sufficiently intense to cause weakening of muscle tissue getting a high meat tenderness, even after 48 hours storage at $4^0C \pm 1^0C$. By injecting adult beef meat with NaCl and $CaCl_2$ have been noted an improvement of tenderness, the highest values of the tenderness score being assigned at 48 hours of storage at $4^0C \pm 1^0C$ for the sample injected with 0.4M $CaCl_2$. Data presented in figure 2 shows the time evolution on tenderness degree of chemical tenderized adult beef with NaCl and $CaCl_2$ in relation to meat injected with distilled water and control sample.

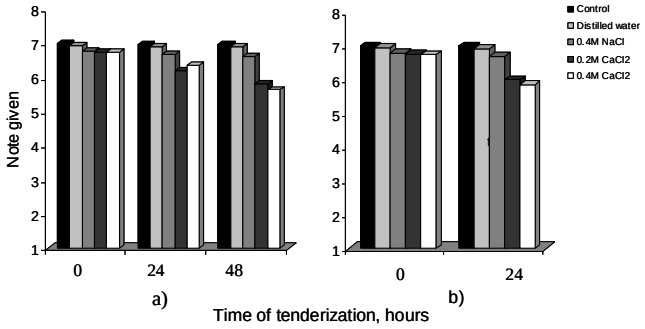

Figure 1 **Score variation accorded to meat flavour depending on chemical treatment applied and ageing time**
(a – $t_{storage}$= 4^{0}C ± 1^{0}C; b – $t_{storage}$= 15^{0}C ± 1^{0}C)

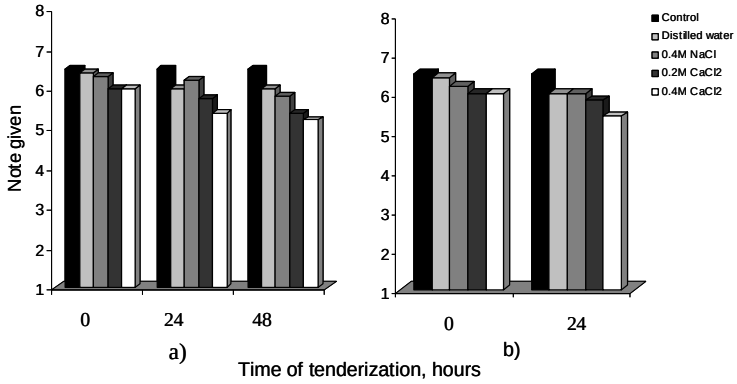

Figure 2 **Score variation accorded to meat tenderness depending on chemical treatment applied and ageing time**
(a – $t_{storage}$= 4^{0}C ± 1^{0}C; b – $t_{storage}$= 15^{0}C ± 1^{0}C)

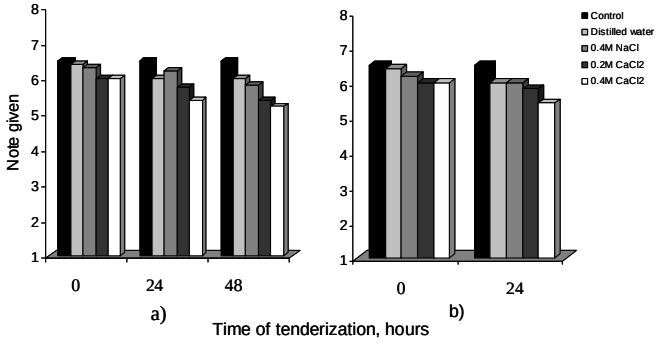

Figure 3 **Score variation of the accorded to meat juiciness depending on chemical treatment applied and ageing time**
(a – $t_{storage}$= 4^{0}C ± 1^{0}C; b – $t_{storage}$= 15^{0}C ± 1^{0}C)

Meat juiciness was also affected by the type of treatment applied. From the data presented in *figure 3* can be seen a decreasing of juiciness during storage. Reasons of juiciness decreasing is the big loss of juice suffered by samples during storage and heat treatment, losses that are brought by physicochemical, biochemical and histological changes occurred during postmortem ageing.

CONCLUSIONS

Calcium chloride injection is eliminating postmortem storage need to maximize adult beef palatability it became similar, as tenderness, with veal meat. Meat juiciness decreasing and appearances of a bitter and metallic taste at increased concentrations of $CaCl_2$ may restrain the use of calcium chloride treatment on improving of beef tenderness. We recommend as optimal level of injection 2M concentration of CaCl2 and time ageing at 4^0C at least 48 hours.

Aging adult beef meat injected with $CaCl_2$ at 15^0C determinate accelerating tenderization process but significantly reduced the preservation time. This kind of treatment could be efficient for rapidly ageing of meat used in public alimentation (restaurants) when the ageing time is not exceeding 4 - 5 hours.

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