COOKED VACUUM-PACKED BEEF OBTAINED BY LT-LT PROCESS: EFFECT OF THERMAL TREATMENT ON THE PRODUCT PHYSICAL PROPERTIES

Sergio R. Vaudagna, Guillermo Sánchez, Alejandra Picallo, Carlos.A. Margaría and Jorge A. Lasta
Instituto de Tecnología de Alimentos (CNIA-INTA) CC 77, 1708 Morón, Argentina.

Background.

During the last decade a new technology for the food production known as *sous-vide* cooking method was developed. This method consists of the following steps: preparation, pre-cooking or browning (if it is necessary); vacuum packing in special heat-stable air-impermeable plastic bags; sealing and finally cooking (pasteurising) for appropriate a time and temperature for each type of food. The food may be served immediately or, after chilling, storage at 0-3^{0}C and reheated *(Baird, 1990)*. *Sous-vide* method is applied to the production of ready meals, which combines different ingredients like vegetables, beef, fish, etc. Although its microbiological hazard is still under study *(Hansen, 1995)*, this kind of product could be benefit either for manufactures and consumers *(Baird, 1990)*. Manufacturers are allowed to offer a high quality product with more added-value and consumers can buy fresh products with no preservatives and minimum processing to obtain meals of better taste with less preparation time. The main characteristic of this process is the use of low temperature for long time (LT-LT processes) to ensure that nutrients and flavour are locked in. In the case of beef processed by LT-LT processes these advantages could be added to the possibility of the beef tenderising process and the cooking yield improving.

In the past was not admitted in Argentina the application of LT-LT process for the production of pre-cooked or cooked beef for export due to the presence of Foot-and-Mouth Disease Virus (FMDV). For this reasons the application of severe thermal treatment (85^{0}C for 15 min) was required to ensure the FMDV inactivation *(Masana et al, 1995)*. Since few years ago our country was declared as free of FMDV with vaccination and in next years will be declared as free of FMDV without vaccination. This new situation would allow to produce vacuum packed beef LT-LT processed for both export and domestic market. On one hand the obtained product will have the quality characteristics of meals produced by the *sous-vide* method with lower microbiological hazard due to the absence of other species ingredients. On the other hand LT-LT processes deal with the solution to a problem of economical importance like the cooking weight loss that with the application of severe thermal treatment (80-90^{0}C) it is in the order of 40%. Consequently, LT-LT process is useful tools for produce processed beef with more added-value than the same product obtained by other methods. In previous works, Masana et. al. (*Masana, 1994)* studied the effect of several LT-LT processes developed in waterbath on sensory, microbiological an biochemistry characteristics of small pieces of *Semitendinosus* muscle. The shelf-life of vacuum packed *Semitendinosus* muscle LT-LT processed by an retorter with water shower was studied through the microbiological and sensory properties *(Sánchez et. al., 1999)*.

Objective.

To evaluate the effects of LT-LT processes on the colour parameters Hunter Lab, shear force and cooking weight loss of cooked vacuum packed *Semitendinosus* muscle.

Methods.

Pairs of *Semitendinosus* muscles were excised from both cow carcasses without trimming. Each muscle was weighed before and after trimming and then vacuum packed into cook-in material bags Cryovac CN510.

The temperature measurement was done in the muscle coldest point (CP) (geometrical centre). The CP temperature was controlled by a T type thermocouple fixed to the bag using a stuffing box C5.2 from Ecklund-Harrison Technologies, Inc., USA. Temperature values were obtained using a Fluke Hydra model 2625 Data Logger, the results were acquired by a RS232 card and saved as ASCII files. Thermal treatments were carried out using the autoclave *Microflow* from Barriquand Sterriflow, France. *Microflow* execute cycles of heating and cooling using a water shower, being its operation computer controlled. A four shelf basket allows to lock the packages into the chamber with the possibility of operate the device with the basket in static or rotary mode.

Shear force (WB) measurements were done by the Warner-Bratzler shear device. Colour parameters Hunter Lab (L, a and b) were measured using a ColorView Spectrometer Byk Gardner model 9000. (large view area 10^0 observer, D65 iluminant, viewing geometry 45^0/ 0^0). Cooking weight loss *CL* were determined using the relationship $CL=100x(m_i - m_f)/m_i$, being m_i the mass of the trimmed muscle measured before the thermal processing and m_f the mass of the muscle after thermal processing.

The thermal process consists of three phases: 1) Heating phase: the CP temperature is increased from its initial value to the LT-LT process temperature; 2) LT-LT processing phase: the CP temperature is kept at the working value during the time required by the LT-LT process selected; 3) Cooling phase: The environment was cooling down until room temperature in 5 min, the muscles were removed from the basket and immediately immersed in a waterbath at 0^{0}C in order to produce a fast cooling from the working temperature until 26^{0}C. Eight LT-LT treatments were tested using different combination of Temperature (T) and time (t) as it is shown in Table 1. In the treatments I, II, III and IV the heating phase lasted 55 min; in treatments V, VI and VII the heating phase lasted 90 min and in treatment VIII lasted 120 min. In all cases the cooling phase lasts, approximately, 60 min. Thus, the total processing times for each treatment were: I 205 min; II 235 min; III 385 min; IV 505 min; V 240 min; VI 270 min; VII 420 min; VIII 270 min. Each treatment was performed on groups of three muscles of similar mass, individually packed, each group was defined as an experimental unit. All thermal processes were carried out with the Microflow operating in basket static mode and one muscle by shelf was locked. Two repetitions per treatment were performed. After processing the muscles were storage at 2^{0}C for 24 hours and then the experimental measurements were done. Each muscle was weighed for *CL* determinations, after that was divided in upper third, medium third and lower third. On each part were done measurement of shear force and colour parameters. For shear force measurements were taken ten cylinders of 25.4 mm length and 12.7 mm diameter of each third; for colour parameters measurements five samples of 30 mm x 30 mm and 25 mm thick were taken. Finally, in both cases, the average and the standard deviation for each muscle third were calculated. In all cases analysis of variance, Tuckey and Duncan grouping tests and orthogonal contrasts were carried out for mean comparison.

Results and discussions.

Table 1 shows the obtained results for cooking weight loss (*CL*), shear force (WB) and colour parameters Hanter Lab. In all the cases the processing time did not affect their values. *CL* increases as the processing temperature increases from 50^{0}C to 65^{0}C, being the *CL* highest value around of 19.4% (treat. VIII), quite lower than the cooking weight loss of 40% reported in Argentina during commercial cooking of beef cuts in nylon tubes (*Masana, 1995*) The lowest value was around 8% obtained with treatments II and I. Also *CL* of treatment VIII did not differ from that obtained by treatments VI and VII. Consequently *CL* was affected by increments in the processing temperature greater than 15^{0}C while the time processing (for the used ones in the experience) did not have an important effect on CL. This increasing in CL, particularly over 60^{0}C, was attributed by other authors to the thermal collagen and actin denaturation. According to Offer et. all (1984) losses of water during cooking occurs in two phases: at a temperature about 45-60^{0}C the shrinkage of the meat is mainly transverse to the fibbers. At 60-90^{0}C the shrinkage is parallel to the fibber axis. This would account for the decreasing in sarcomere length and juiciness decreases with increasing temperature.

WB values decreased as the temperature increased, no differences were observed between the WB values obtained by treatments V, VI, VII and VIII. Changes in meat tenderness that occur during cooking are associated with heat-induced alteration of myofibrillar proteins and connective tissue. Heat solubilizes the connective tissue leading to meat tenderization while denaturation of myofibrillar proteins leads to meat toughening (*Laakkonen, 1970*). In the 40-50 °C temperature range toughness as determinated by the shear value increased, this was considered as being due to denaturation of the myofibrillar proteins, primarily the actomyosin complex (*Bailey, 1984*). In small samples of *Semitendinosus* muscles it was observed at 60 °C and 64 °C the lowest values of hardness. During the initial heating (< 50 min for 60 °C) larger hardness reductions were observed then it remained approximately constant until the thermal treatment end (180 min) (*Bertola, 1994*).

Colour parameters Hunter Lab b and L (not showed in Table 1) were not affected by the different treatments. However, the a parameter was strongly affected by the temperature, decreasing as the treatment temperature increases. The highest values of a were obtained by treatments I and II while the lowest one was obtained by treatment VIII. Under 60^{0}C the myoglobin remains undenaturated. At 60^{0}C myglobin denaturation begins and the amount of the denatured mygolobin increases as the holding time at such temperature increases (*Laakkonen, 1970a*).

Conclusions.

The studied LT-LT treatments modified the cooking loss, shear force and the beef redness, being all of them processing temperature dependent. Shear force and redness were reduced when the processing temperature increased from 50^{0}C to 65^{0}C while the cooking weight loss increased reaching a maximum value of about 20% in the same temperature range. Colour parameter Hunter Lab a can be used as objective indicator of the cooking level due to its temperature dependence. LT-LT treatments are suitable for obtain tender cooked vacuum-packed beef with low cooking loss. In future works the addition of chemicals for improve tenderness and water-holding capacity will be studied.

Bibliography.

Baird, B. 1990 *Sous vide: What's all the excitement about?* Food Technology, November 1990, Pag. 92-95.

Bertola, N.C., Bevilacqua, A.E. and Zaritzky, N.E. 1994 *Heat treatment effect on texture changes and thermal denaturation of proteins in beef muscle.* J. Food Process. Preserv. **18** 31-46.

Hansen, T.B. Knochel, S. Juncher, D. and Bertelsen G. 1995 *Storage characteristics of sous vide cooked roast beef* Int. J. F. Sci. Tech. **30**, Pag. 365-378

Laakkonen, E., Wellington, G.H. and Sherbon, J.W. 1970 *Low temerature, long time heating of bovine muscle. 1.Changes in tenderness, water-binding capacity, pH and amount of water soluble components.* J. Foodl Sci. 35, 175-177

Lakkonen, E., Sherbon, H.H., and Wellington, G.H. 1970a *Low temperture, long time heating of vobine muscle. 3.Collagenolytic activity.* J. Food Sci. 35:181

Masana, M., Gallinger, M.M., Pensel, N., Artuso, C. 1994 *Cáracteristicas de calidad de carnes bovinas procesadas termicamente en envases flexibles* VI Congreso Argentino de Ciencia y Tecnología de Alimentos, Buenos Aires, Argentina, 6-9 april 1994, 395-397.

Masana, M. Fondevila, N.A. Gallinger, M.M. Lasta, J. Rodríguez, H.R. and González, B. 1995 *Effect of low-temperature long-time thermal processing of beef-cuts on the survival of foot-and-mouth disease virus.* J. Food Protection, Vol 58, No. 2, Pag 165-169.

Martens, H., Stabursvik, E., Martens, M. 1982. *Texture and colour changes in meat during cooking related to thermal denaturation of muschel proteins.* J. of Texture Studies 13, 291-309.

Sánchez, G. Vaudagna, S.R. Neira, M.S. Insani, E.M. Descalzzo, A.M., Gallinger, M.M. and Grigioni G.M. 1999 *Evaluación de los procesos LT-LT en carnes a través de las cáracterísticas de calidad del producto.* Submitted to VIII Congreso Argentino de Ciencia y Tecnología de Alimentos. 13-16 May 1999, Rafaela, Argentina.

TABLE 1

TREATMENT			*CL*		WB		a	
Number	T (°C)	t (min)	MEAN VALUE (%) *	STD	MEAN VALUE (lb in $^{-2}$) *	STD	MEAN VALUE *	STD
I	50	90	8.33^{A}	1.71	13.67^{A}	3.67	13.64^{A}	2.93
II	50	150	7.56^{A}	1.44	11.89^{A}	3.62	14.48^{A}	1.95
III	50	270	10.80^{AC}	2.80	13.04^{A}	2.28	12.19^{AB}	1.79
IV	50	390	10.82^{AC}	1.62	13.09^{A}	4.19	14.60^{A}	1.34
V	60	90	13,03^{AC}	2.58	9.76^{B}	2.20	9.19^{CB}	1.35
VI	60	150	16,58^{BC}	3.07	9.26^{B}	2.03	8.54^{CB}	1.55
VII	60	270	16.55^{BC}	4.19	7.93^{B}	0.88	10.04^{CB}	1.89
VIII	65	90	19.41^{B}	1.91	8.63^{B}	2.02	6.96^{C}	1.35

(*) Means with different letters are significantly different ($p<0.05$)