SOUS VIDE COOKED BEEF MUSCLES: EFFECTS OF LOW TEMPERATURE-LONG TIME (LT-LT) TREATMENTS ON THEIR SENSORY CHARACTERISTICS AND OXIDATIVE STABILITY DURING STORAGE

Guillermo Sánchez[1,2], Sergio R. Vaudagna[1,2], Jorge A. Lasta [1], Ester Marina Insani[1] and María Marta Gallinger[1]

1. Instituto Tecnología de Alimentos, CA-CNIA, Instituto Nacional de Tecnología Agropecuaria (INTA), Argentina.
2. Member of Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina

Background.

Since May 2000 Argentina was declared as free of Foot-and-Mouth Disease Virus (FMDV) without vaccination. This fact opens new outboard market on one hand in order to export fresh beef. On the other hand, under this new situation, it is also possible the commercialisation of cooked of par-cooked beef based foods applying thermal treatments at temperatures below the necessary to achieve the FMDV inactivation. Thermal treatments at low temperature for long time are able to preserve sensory and nutrient characteristics of the raw material. This kind of process gives the important chance of producing a product having added value. The well known *sous vide* system is a useful tool able for the manufacturing beef based foods achieving such characteristics. A widely accepted definition has been one put forward by the Sous Vide Advisory Committee (SVAC): *sous vide* is an interrupted catering system in which raw or par-cooked food is sealed into a vacuumed laminated plastic pouch or container, heat treated by controlled cooking, rapidly cooled and then reheated for service after a period of chilled storage at temperatures around 0–3°C.

The temperature normally used in the *sous vide* system is ranged between 65 to 90°C for two to eight hours, depending on the food components (Hrdina-Dubsky, 1989). Using this process loss of water and flavour and aroma volatile compounds is reduced preserving thus, the food sensory quality. According to Mason *et. al.* (1990) it is possible to increase from 5 to 21 days the shelf life of some products by using *sous vide* system. One of the reasons is that the low oxygen partial pressure into the container prevents growth of aerobic spoilage micro-organisms and lipid oxidation rancidity, both processes responsible for generation of off-flavours during refrigerated storage (Church & Parsons, 1993). This is particularly relevant in products like meat due to the development of a characteristic off-flavour (identified as Warmer Over Flavour, WOF) which limits the acceptability of conventional cook chill system (Bertelsen et. al, 1996).

Objetive.

To investigate the oxidative stability and the sensory characteristics of *sous vide* processed *semitendinosus* muscles during storage.

Materials and methods.

Beef *semitendinosus* muscles (1.7± 0.5 kg) were excised from steers carcasses (137.2± 4.6 kg) collected at the normal factory 48 h after being slaughtered. Muscles fat was totally trimmed. For each muscle the weight before and after trimming was recorded. Then, the muscles were vacuum packed in cook-in bags (CN510 Cryovac, Sealed Air Corporation, Argentina).

In this way two groups of muscles were prepared. One of them was processed at 55°C during 390 min and the other one was processed at 65°C during 90 min.

The thermal processing was carried out by using a water cascading retort (Microflow Barriquand, Roanne-France). Samples were located in a basket of (69 x 39 x 37) cm with three hollowed trays with 13 cm of clearance between them, was used.For temperature control a T type thermocouple was fixed at the Slowest heating point (SHP) using a stuffing box (Ecklund-Harrison Technologies, Inc., Fort Myers, USA). Time-temperature curves of samples and retort chamber were read using a digital multimeter Hydra 2625A Data Logger (John Fluke Mfg. Co., Inc., Everett, USA) and acquired by a personal computer with a RS232 card. Ended the thermal treatment, samples were taken out from the retort and immersed in an ice-water bath until temperature sample at the SHP reached 26°C. Finally, samples were stored at 1.0± 0.5°C.

The sensory and oxidative stability of the *sous vide* cooked muscles were studied as a function of the storage time (t_S) during chilled storage. Those characteristics were evaluated at the t_S (days): 0, 2, 4, 6, 13, 20, 27, 34, 40, 48 and 55. The oxidative stability was studied determining the number of 2-thiobarbituric acid reactive substances (TBARS) as suggested by Pensel (1990). Eight trained judges evaluated flavour of cooked beef lean (Love, 1988) using a structured scale (1=extremely blend aroma and flavour; 9=extremely strong aroma and flavour). Judges were asked to give descriptions of recognised off-flavours; terms as "painty", "cardboardy", "boiled fish" and "stale" were used to describe WOF (Love, 1988). The panellists were asked to rate the intensity of off-flavours by making a mark on a 10cm bipolar lines scale, which represents the amount of the perceived stimulus. The left end on the scale corresponds to "no off-flavour" while the right end of the line represents "extreme off-flavour". The marks from line scales were converted to numbers by manually measuring the position of each mark.

The analyses were performed at each t_S over three muscles, being the experimental unit defined as composed by those three muscles. Thus for each treatment were available thirty-three muscles for the whole test and a total of sixty-six muscles were processed. The statistical analysis was performed using the Statistical Analysis System (SAS, 1989). Analysis of variance (ANOVA) of sensory and TBARS data were carried out by applying GLM procedure. Data was linear fitted if the storage time effect was significant ($P<0.05$) using procedures GLM and REG.

Results and discussions.

In Figure 1 are presented the cooked beef flavour scores as a function of the storage time for processed samples. During storage similar time behaviour of the cooked beef flavour scores was observed for samples processed under the studies treatments. No tendency was observed at the beginning of the storage period but flavour scores decreased uniformly for both cases from t_S=21 days. A Student's *t* test performed over the slopes obtained by the linear fitting in the decreasing region (0.0539 and 0.0471 for both treatments, respectively) showed no significant

difference (P>0.05) and the elevations comparison (Student's t test) indicated that the linear regression is the same for both kind of samples (P>0.05).

In Figure 2 the results of TBARS numbers are presented as a function of storage time obtained from samples processed by both treatments. Two distinctive regions can be observed. In a first region, at the beginning of the storage period, the TBARS number remained around 0.35 malondialdehyde (MDA) mg/tissue kg for both treatments. This behaviour was observed from t_S=0 to t_S=13 days for 65°C treatment and from t_S=0 to t_S=21 days, for 55°C treatment. In the second region, the storage period remain, an increment in the TBARS number was observed. In this region a linear fitting was performed between t_S=13 days and t_S=41days for 65°C treatment and between t_S=21days and t_S=55 days for 55°C treatment. This analysis showed that after the 13th day of storage the TBARS number of samples processed by 65°C treatment increase at a rate of 0.0161 MDA mg/tissue kg per day, reaching a maximum value of about 0.75 MDA mg/tissue kg at t_S=41days. After t_s=41 days the TBARS value began to decrease, a characteristic feature of TBARS test during long periods of storage that has been extensively described in the literature. The TBARS number of muscles processed by 55°C treatment began to increase at t_S=21days with a rate of 0.0056 MDA mg/tissue kg per day, reaching a maximum value of about 0.5 MDA mg/tissue kg at t_S=55 days. A Student's t test was performed over the linear fitting slopes obtaining significant difference (P<0.05) between them. Thus the oxidation rate of samples processed by 55°C treatment was significantly lower than that one of samples processed by 65°C treatment. This result could be attributed to the lipid oxidation catalyst effect of the released iron during the cooking process. The studied temperature, on one hand, are in the protein denaturation range arising the iron releasing. On the other hand, as a consequence of the processing temperature, the relative content of phospholipids polyunsaturated fatty acids are enhanced (Han et. al., 1993).

In Figure 3 are presented the WOF scores and the TBARS values as a function of the storage time for samples processed under 65°C treatment. It is possible to see a relationship between them, e.g. as the TBARS value raises WOF score increases (particularly since t_S=21 days) what is in agreement with Spanier *et al.* (1992) among other authors. However, for samples processed by 55°C treatment the situation is not so clear. Taking into account low oxidation rates of such samples the observed decreasing in cooked beef flavour scores could be associated with the presence of off-flavour different that those ones which described WOF; in this case the trained panellists marked "blood" as the main off-flavour descriptor and "sour" in a less degree while WOF score was detected at the end of the storage time.

Conclusions.

According to the obtained results cooked beef flavour and oxidative stability of *sous vide* processed *semitendinosus* muscles is kept constant up to 21 days of storage. Since that cooked beef flavour began to decrease following the same behaviour for the studied treatment. Lipid oxidation began to increase after 21 days of storage. However, the oxidation rate of samples processed by 65°C treatment is approximately twice the value of sample processed by 55°C treatment. According to these results shelf life of *semitendinosus sous vide* processed can be estimated in about 21 days. However following *Listeria monocytogenes* criteria the shelf life of this product should not be greater than 10 days.

Bibliography.

Bertelsen, G. & Juncher, D. (1996). Oxidative stability and sensory quality of *sous vide* cooked products. In: *Proceedings of Second European Symposium on Sous Vide*. Pp. 133-145. 10-12 April 1996, Alma University Restaurant/FAIR. University of Leuven. Belgium.

Church, I.J. & Parsons, A.L. (1993). Review: sous vide cook-chill technology. *International Journal of Food Science and Technology* , **28,** 575-586.

Hrdina-Dubsky, D.L. (1989). Sous Vide Finds Its Niche. *Food Engineering International,* **14** (7), 40-42,44, 46, 48.

Han, D., McMillin, K.W., Godber, J.S., Bidner, T.D., Younathan, M.T., Marshall, D.L. & Hart, L.T. (1993). Iron Distribution in Heated Beef and Chicken Muscles. *Journal of Food Science*, **58** (4), 697-700.

Love, J. (1988). Sensory Analysis of Warmed-Over Flavor in Meat. *Food Technology*, **42** (6), 140-143.

Mason, L.H., Church, I.J., Ledward, D.A. & Parsons, A.L. (1990). Review: The sensory quality of foods produced by conventional and enhanced cook-chill methods. *International Journal of Food Science and Technology,* **25,** 247-259.

Pensel, N.A. (1990). Influence of experimental conditions on porcine muscle and its effect on oxidation. *M.S. Thesis*. Graduated School, The Ohio State University, Columbus, Ohio, USA.

SAS (Statistical System Analysis) For Windows, version 6.12, SAS Institute Inc., Campus Drive, Cary, NC, USA. Copyright 1989-1996.

SVAC (Sous Vide Advisory Committee) (1991) *Code of Practice for Sous Vide Catering Systems.*

Spanier, A.M., Vercellotti, J.R. and James, C. Jr. (1992). Correlation of sensory, instrumental and chemical attributes of beef as influenced by meat structure and oxygen exclusion. *Journal of Food Science*, **57**, 10-15.

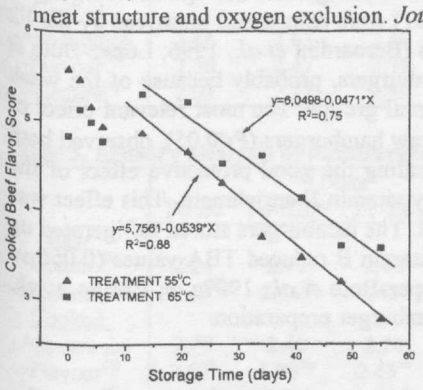

FIGURE 1: Cooked beef flavour scores of *sous vide* cooked beef.

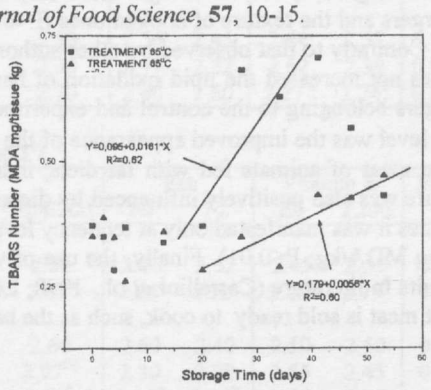

FIGURE 2: TBARS number (MDA mg/ tissue kg) of *sous vide* cooked beef

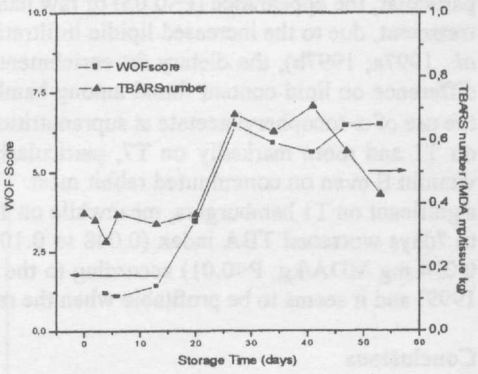

FIGURE 3: Warmer Over Flavour (WOF) scores and TBARS number (MDA mg/ tissue kg) of *sous vide* cooked beef