Beef Meat Aged at Mild Temperature: Preliminary Qualitative and Microbiological Results

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Abstract— **Meat production is expensive and time demanding. In order to reduce inputs in meat production we tested applicability of a new technique based on a lower working temperature over ageing that is perhaps the most consuming phase long meat's pathway. Besides, we employed a solution of NaCl and $CaCl_2$ on meat's surface for containing bacterial spoilage and speeding ageing up. Six Fresian bullocks was used. At slaughter shoulders were taken and refrigerated at 8°C, after being sprayed by salt solution, or at 2°C without spraying (control). Preliminary results were cheering. In fact, microbiological count remained below the level imposed by the law at least up to fifth day after slaughter. Some important meat quality traits (e.g., Warner Blatzer Shear Force on cooked meat - WBSc) were positively affected by treatment (confirmed by sensory test). Oxidation (TBARs) and colour (L*, a*, b*) were not different when compared to control group (C) at day 5th. Use of active-films for shelf life extension is needed.**

Keywords— **sustainability, beef meat, temperature**

I. INTRODUCTION

Meat production is a very energy and time demanding process. Several factors are involved from primary production for livestock feeding to final phases of commercialization and distribution of meat products, including the low efficiency of *in vivo* conversion of energy intake into meat, the unfavourable water balance and the overuse of electric power. Consequently, due to the global need of sustainable production techniques, it is often exposed to strong criticisms. Moreover, meat price may result high and the access uneasy, especially for low income countries and poor and disadvantaged groups of population. It is worthwhile to set up alternative strategies, particularly with regard to ageing and preservation.

Standard production process of beef meat includes a quite long and indispensable period of time necessary for obtaining edible meat and important for its strong correlation with organoleptic quality. Tenderness and flavour are deeply influenced by this phase. That period may last more than 20 days as function of genetic type, usually at temperature within 0°C and 2°C. From a commercial point of view, it represents a slack period as meat is not yet edible, though very expensive, due to forced refrigeration and storage costs. The aim of our study was the evaluation of microbiological and organoleptic quality of beef meat aged in moderate refrigeration conditions (8 °C) instead of in traditional way (2 ± 1 °C). Other specific objective was to study the following issues: the effect of the employ of a NaCl and $CaCl_2$ mixture on total bacterial count of carcasses and meat tenderness and the effect of different preservation temperatures on organoleptic meat quality and fat oxidation of meat from moderate cooling room.

II. MATERIALS AND METHODS

Six Fresian bullocks were slaughtered. Shoulders were separated and split randomly into two groups. One group was aged at a 2°C temperature (F). The other one was first sprinkled by a mixture containing NaCl 4M and $CaCl_2$ 400 mM and then stored at 8°C (C). Before storage, shoulders was wrapped in cling film in order to reduce surface evaporation due to osmotic effect of salt and temperature. So plastic wrap was useful to avoid dehydration and oxidation. Five days later all samples were dissected and *caput longum triceps brachii (CL)* and *suspraspinatus* (SS) muscles collected, parted into three portions and vacuum packaged. Then, specimens were stored at

three different temperatures (2, 4, 8 °C) five days more, in order to evaluate shelf life up to day 10th.
Following analyses were performed:

- Chemical composition (dry matter, fat, protein, ash) AOAC, 1990 [1]
- Physical analiyses: pH by a pH meter "Hanna" Hi 98240 with a probe; drip loss according to bag method [2]; cooking loss was obtained in water bath at 75°C [2]; Warner-Blatzer shear force on cooked meat (WBSc) was determined in four 1 x 1cm cross section strips using an INSTRON 5543 texturometer. A 50-kg compression load cell and a crosshead speed of 100 mm/min were used. Force-deformation curves from the Warner-Brätzler shear device were obtained on cooked meat by steps of 0.5 mm; colour indices (lightness, red and yellow) were determined on raw meat by using D65 illuminant after 1 h of oxygen exposition by a reflectance spectrophotometer Minolta CM-2006d [3]; sarcomeres length were assessed on a 1 cm cube of meat after a 5 days ageing by homogenization in buffer. A drop of homogenized was posed on a slide and analysed by an optical microscope using a 100x oil immersion objective lens. Ten sarcomeres from four different myofibrils were measured and length was expressed as average in ηm.
- TBARs assay of lipid peroxidation [4]
- Myofibrillar fragmentation index [5]
- Sensorial analysis (panel test): a slice 2,5 cm thick of CL muscle was cooked on grill till 75 °C core temperature. Fat and connective tissues were separated and 1,5 cm cube specimens were given to a panel of 8 trained tasters. Tenderness, juiciness and flavour were evaluated on a 10 points structured scale, the extremes being "very low" and "very high" and the sample order was randomized.
- Microbiological tests: total mesophilic count, fecal coliforms, Escherichia coli, Staphilococcus aureus, Salmonella spp. were determined according to [6]
- Statistical analysis: data were analysed by GLM procedure [7] using a factorial model with interaction with thermic treatment, muscle, and storing temperature and time as factors. Data of panel test were analysed without considering the effect of muscle.

III. RESULTS

A.General traits

Animal were slaughtered at 550 ± 13 kg live weight and carcass composition resulted rather uniform. No differences there were in chemical meat composition.

B. Microbiological results

Up to five days after slaughter microbiological count remained below the level imposed by the law both for total count and E. coli. Regulation 2073/2005 of European Union sets a lower limit and a cut-off point for bacterial count. A value must be considered acceptable when it lays below the lower limit, tolerable when it remains within limits and unacceptable if it exceeds the safety limit. As for C group, at slaughter, only one sample was not conformable, showing E. coli contamination. This unconformity obviously worsened five days later (Table 1).

Table 1: Microbiological values as log CFU/cm^2 (bold type means uncoformity)

Sample	Total count	E. coli	Coliform	Salmonella
C group, 2 hours post-mortem				
1	2,24			
2	3,70			
3	2,48			
4	3,65			
5	3,95	**2,18**		
6	3,48			
C group, 5 days post-mortem				
1	3,87			
2	5,00			**2,04**
3	4,58			
4	4,84			
5	**5,16**	**3,45**		
6	4,96			

C. Meat quality

Both instrumental and sensorial analysis showed meat from C thesis to be more tender (Table 2). At the same time a higher temperature determined a deeper and faster softening also in meat from F group, when stored at three different temperatures (2, 4, 8 °C) five days long (Fig. 1 a, b). Moreover, oxidation (TBARs) was not different between F and C groups at day fifth and neither was colour (L*41,73 ± 4,89 Vs 41,24 ± 5,67; a*14,09 ± 2,05 Vs 13,98 ± 1,99; b*12,53 ± 2,17 Vs 12,57 ± 2,47). On the other hand at day 10th TBARs showed a meaningful increase (Fig. 1 c, d). As for sensorial analysis, panel test results were not different when different preservation temperatures were compared at day10th.

Table 2: effect of ageing temperature on some meat quality traits

Group	F	C
WBSc (kg)	*6,24±0,85a*	*5,06±0,37b*
Tenderness (panel)	*3,81±1,01b*	*5,02±0,73a*
TBARs	*1,36±0,22*	*1,45±0,15*

Different letters means P<0.01
Values registered 5 days after slaughteR

IV. DISCUSSION

Shoulder contamination depends on its position in the carcass. In fact, animal, hung by his hind leg (Achilles tendon), is skinned downwards and shoulder is easily contaminable by skin or digestive tract during dissection. Therefore, contamination of this specimen was completely accidental.

Meat tenderness is clearly related to storage temperature through a strong influence of post mortem proteolytic activity of muscle. Several studies also confirmed this connection. As long ago as sixties [8] established that optimal tenderisation occurred after 10-13 days at 0°C, 4-5 days at 10°C, 30-40 hours at 20°C and 10-11 hours at 30°C. Likewise, after having tested 4 different temperatures (0, 7, 14, 21°C), [9] concluded pig meat to be more tender when conditioned at 14°C. Our findings are consistent with aforementioned conclusions.

TBARs trend over the preservation period was very expected. Oxidation, in fact, is a degradative process depending on temperature and, owing to residual biochemical activity, it may progress also during preservation. In order to solve this last matter, industry provides lot of molecules or substances for active packaging able to reduce oxidation progress. There are also many natural bactericides and bacteriostatics such as metallic ions (e.g., Ag) organic acids (lactic, acetic, sorbic, propionic etc.) and their salts, bacteriocins (e.g., nisin), enzymes and so forth. Besides, the use of essential oils or extracts derived from vegetables (e.g., tea, rosemary, oregano) or animals (e.g., propolis, lysozime) [10] are supposed to be very effective in preserving food products and shelf-life extension. Very interesting in this perspective is the employment of low cost antioxidants derived from residuals of agriculture or industrial production and practices such as potato peel, grape seeds, citrus peel and seeds, carrot waste as reported by [11].

All the processes described above might be associated with vacuum packaging and high pressure sanitization, both of them easily practicable even in low operating systems and family-owned businesses.

With regard to outcomes of sensorial analysis at day 10th, most probably proteolysis was so advanced that tasters were not able to detect differences that would have been revealed by devices (WBSc).

V. CONCLUSION

The use of combined mild temperature, $CaCl_2$ and NaCl leads to a faster and deeper softening. By fulfilling good hygienic practices and set of rules, it is possible to obtain a healthy raw product. Staff training is a prerequisite. Up to 5th day post-mortem, total bacterial count and oxidation are acceptable.

The use of active films is needed in order to provide meat shelf-life over an extended period of time.

Due to remarkable energy demand of classical meat production process further investigations in this field are desirable.

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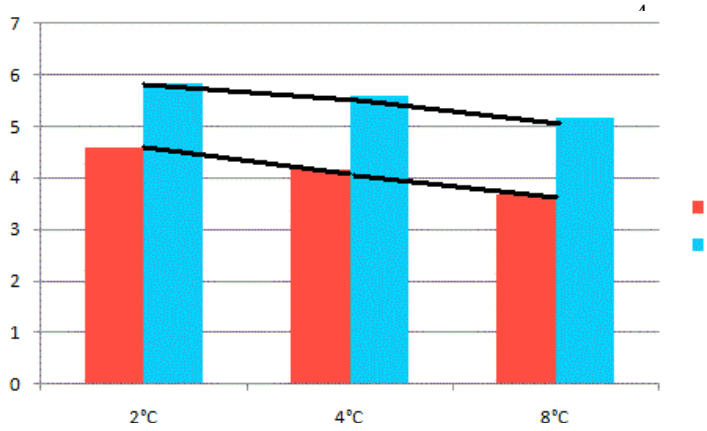

Fig. 1a: effect of different temperatures on WBSc of CL muscle at day 10th

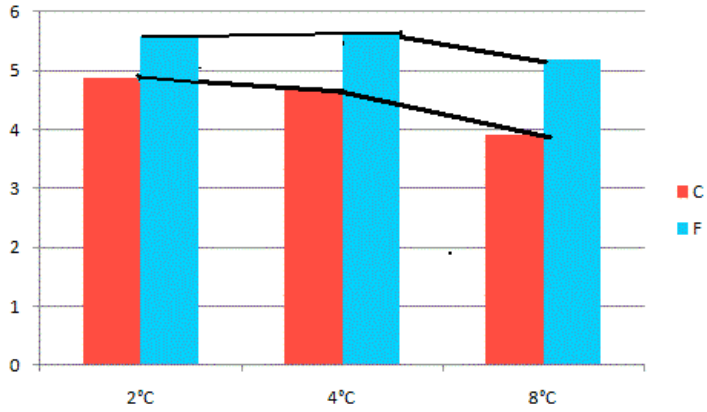

Fig. 1b: effect of different temperatures on WBSc of SS muscle at day 10th

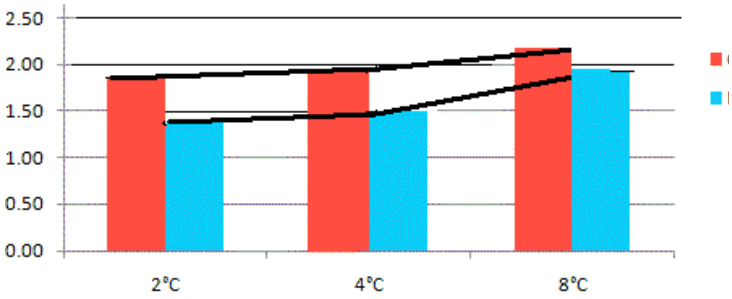

Fig. 1c: effect of different temperatures on TBARs of CL muscle at day 10th

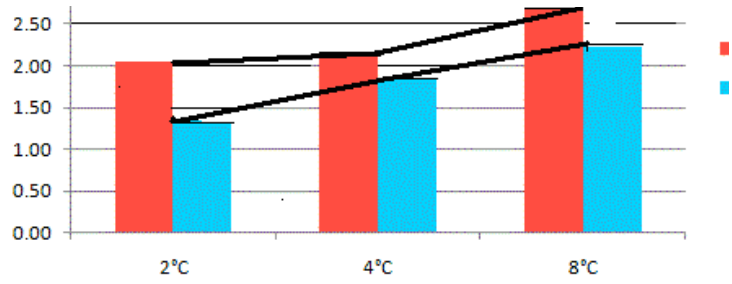

Fig. 1d: effect of different temperatures on TBARs of SS muscle at day 10th