Impact of waiting time between injection and cooking with or without vacuum packaging on technological properties of Heifers *Semimembranosus* roasts

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Abstract—**Nine heifers *Semimembranosus* muscles were used in this study. Each muscle was cut into 5 roasts and injected at 110%. A first experiment (feasibility study) was carried out by cooking vacuum packaged cubes in a water bath at 70°C. The second experiment (validation study) was carried out on whole roasts steamed in an oven until they reach a core temperature of 60°C. Different waiting times between injection and cooking were used : i) no waiting time, ii) 24H at 4°C, with or without vacuum packaging iii) 48 H at 4°C, with or without vacuum packaging. Warner Bratzler shear force measurements were carried out on the inside part of cooked meat.**

In both experiments, the tenderness is significantly improved ($p<0.05$) when the meat is not directly cooked after injection, especially when it is stored under vacuum packaging during 48h. With or without vacuum packaging, the cooking yields in both experiments were independent from the waiting time (24H or 48H).

Keywords—**Tenderness, waiting time, vacuum packaging**

I. INTRODUCTION

Consumers want a tender meat. Meat tenderness is a function of breeding, processing, added value and cooking methods used to prepare it [1]. Tenderizing meat allow manufacturers to reduce losses due to unsold meat. Consumer request tend to more elaborated products, already cooked and ready to eat. For this purpose, processes such as blade tenderization, injection and tumbling are particularly suitable. Lapendrie and Parafita demonstrated that blade tenderization followed by injection provide tenderer cooked meat [2]. However, Gill and al (2007) have shown that this process increase the microbiological hazard [3]. In this study, in order to avoid this microbiological hazard and to improve beef *Semimembranosus* tenderness, no blade tenderization was used, but it was replaced by a waiting time before cooking. The aim of this study was to investigate whether waiting time with or without vacuum packaging after injection may affect meat palatability.

II. MATERIALS AND METHODS

Nine *Semimembranosus* muscles from three- to four years old Charolais heifers were used in this study. Muscles were purchased 3-4 days after slaughter and vacuum packaged. The average pH of the meat was 5.43 +/- 0.083. Each muscle was cut into 5 roasts 7x7x10cm. Two experiments were carried out, the feasibility study and the validation. For the feasibility study, 3 muscles from 3 different animals were used (15 roasts) and for the validation 6 *Semimembranosus* muscles from 6 different animals were used (30 roasts). The roasts were cut randomly in order to avoid the influence of the location into muscle on results.

Each roast was subjected to the same injection rate on entire roasts. Concerning the cooking methods, there was a difference between the feasibility study and the validation study. For the feasibility study, roasts were cut into cubes before cooking. For the validation experiments, roasts were cooked entire in an oven in order to be more representative of an industrial process.

In each experiment, 3 processes were compared, i) roasts cooked directly after injection, ii) roasts under vacuum packaging or without packaging were stored 24H at 4°C, iii) roasts kept 48H at 4°C with or without vacuum packaging.

A. Injection

Each roast was injected with a multi-needle injector at 110% over the raw meat weight with a brine solution containing 5.6% of salt, 4% of sodium lactate, 5% of lactose, 0.5% of sodium ascorbate diluted in water.

B. Cooking

Concerning the feasibility study, the fifteen roasts were cut into cubes. The cubes were vacuum packaged in cooking bags and cooked in a water bath at 70°C +/- 0.3°C. The water bath temperature was monitored with a temperature probe. Bags containing cubes were put in the water bath until the meat core temperature reach 60°C.

Concerning the validation study, the roasts were kept entire and steamed in an oven with a three steps cooking method : Roasts were introduced in the oven at 90°C until their core temperature reach 55°C, then, the oven temperature was set at 60°C until the core temperature of the roasts reach 58°C, finally, the oven temperature was set at 58°C for 26 minutes. The temperature evolution was continuously monitored with temperature probes inside the roasts and inside the oven.

After cooking, meat was submitted to a fast cooling at 0°C for 24H.

C. Analysis

For the validation study; four technological properties were evaluated : cooking and technological yields, colour measurements and shear force measurements. For the feasibility study, due to the small sample size, only two measurement were carried out : cooking yield and shear force.

The colour measurement was made with a Minolta Chromameter (CIE L, a* b* colour space). Roasts of the validation study were cut into slices of 1.5cm thick after cooking and colour measurement was made for each slice.

The cooking yield was calculated by weight difference before and after cooking whereas the technological yield corresponded to weight difference between before injection and after cooking.

The shear force was measured both for feasibility and validation study thanks to a Warner Bratzler shear test according the method from Honikel, 1998 [4]. All samples were sheared perpendicular to the fibre direction.

For each study, results are analyzed with an ANOVA test providing a Fisher's PLSD for each parameter chosen.

III. RESULTS AND DISCUSSION

A. Animal effect

On the overall experiment, differences between animals appear to be one of the major discriminate factor. In order to cancel this unwanted effect, an average correction has been made in order to bring back all animal average at the same level as the population mean.

B. Shear force

The impact of the 3 factors (cooking method, packaging and waiting time) on shear force was evaluated.

Cooking method has no significant effect on tenderness ($p>0.999$). As the cooking method was the only difference between feasibility and validation study, the results obtained were gathered. This cohesion allowed to have more results for the shear force measurement with different waiting time and packaging.

The second parameter analyzed likely to influence tenderness was the packaging. A comparison of roasts tenderness after cooking was done for roast with or without vacuum packaging during the waiting time (figure1).

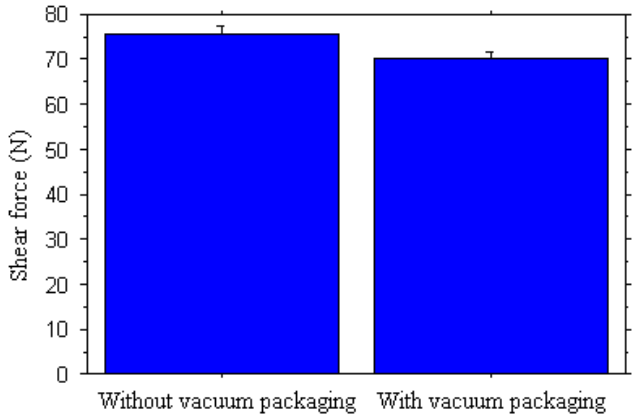

Figure 1 Impact of vacuum packaging on tenderness

Results for roasts with vacuum packaging and roasts without vacuum packaging are significantly different ($p<0.05$) Roast having a vacuum packaging were 6% more tender than those without vacuum packaging (70.018 N vs 75.379 N respectively). These results can be due to the fact that during the waiting time, brine diffuse into meat and with the vacuum packaging, brine is more in contact with meat than without packaging. Moreover, stored meat without packaging might dry the meat precluding the brine diffusion.

As the tenderness was significantly better for roasts with vacuum packaging during the waiting time, the effect of the waiting time on roasts only with vacuum packaging was analyzed (figure 2).

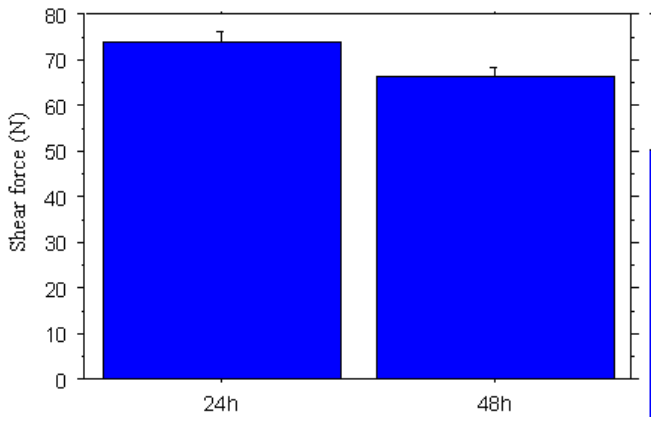

Figure 2 Impact of waiting time on Tenderness for roasts under vacuum.

Samples stored 48H before cooking were significantly ($p<0.05$) tender than those stored only 24H. Roasts stored 48 hours under vacuum packaging have a tenderness average of 66.203 N against 73.832 N for those stored 24H. Tenderness is 10.33% better for samples stored 48H vacuum packaged compared to 24H vacuum packaged.

If the comparison is made with the control (no waiting time and no packaging before cooking), roasts with 48H waiting time under vacuum package are 10.98% more tender

Storage of meat especially beef *Semimembranosus* muscle 48H under vacuum packaged improved significantly ($p<0.05$) tenderness by approximately 10 %.

C. Cooking and technological yield

There is not a significant impact of waiting time and packaging on cooking and technological yield ($p=0.39$ and $p=0.21$ respectively). It seems there are the same losses during cooking.

D. Colour measurements

Stored *Semimembranosus* with or without vacuum packaging during 24h or 48h had no significant effect on the meat colour. Unlike it was expected, the a*, b*, and L value remain stable.

III. CONCLUSIONS

These results show that a waiting time of 48h under vacuum before cooking improve *Semimembranosu*s shear force approximately by 10%. However it would be better to carry out a sensory analysis by a consumer panel to assess if such a difference induces a real perception difference by consumers. Indeed, according to Destefanis *and al.* (2008), shear force measured by Warner Bratzler do not represent really the consumer's tenderness perception [5]. This storage has no effect on the cooking yield and the technological yield and do not affect meat colour. It could be interesting to do the same experiment with packaging in modified

atmosphere in order to know if it is more appropriate to tenderize meat than vacuum packaging. Nevertheless, waiting time is cost consuming for manufacturers and the cost of packaging and storage has to be evaluated compared to approximately 10 % of tenderness gain.

ACKNOWLEDGMENT

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