Sensory quality of beef patties inoculated with strains of *Carnobacterium maltaromaticum* with potential as biopreservatives

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Introduction

Biopreservation is a powerful and natural tool to extend shelf life and to enhance the safety of foods by applying naturally occurring microorganisms and/or their inherent antimicrobial compounds of defined quality and at certain quantities (Ghanbari *et al*., 2013).
Carnobacterium maltaromaticum is a lactic acid bacterium (LAB), and many LAB associated with meat are known for their bactericidal or bacteriostatic activity against other strains, species or genera of bacteria. Some *C. maltaromaticum* strains have been reported to produce class I and II bacteriocins, in addition to circular bacteriocins (Tulini *et al*., 2014). Bacteriocin production, however, is not a pre-requisite for the biopreservative efficacy of *Carnobacterium* (Laursen *et al*., 2005). In this way, the presence of certain LAB adapted to a low temperature could extend the shelf life of meat and improve the microbial stability and safety of this product. Nevertheless, undesired effects of Carnobacterium on food quality have been reported, e.g., the production of a malty/chocolate like aroma due to 3-methylbutanal from the catabolism of leucine (Afzal *et al*., 2012).
The aim of the present study was to perform a sensory evaluation of beef patties inoculated with potential biopreservative strains of *C. maltaromaticum* isolated from vacuum packaged long shelf life beef.

Materials and methods

Carnobacterium maltaromaticum *strains*: three different strains of *C. maltaromaticum* (lab. ref. CM_824, CM_827 and CM_829) isolated from vacuum packaged beef with long shelf life were selected for this study according to their genetic profile (genes coding for the 16S ribosomal RNA).
Inoculation of three strains of C. maltaromaticum *on a commercial meat preparation*: commercial bovine meat preparation (89 % beef, water, 0.9 % vegetal fibers (bamboo), salt, silica dioxide, ascorbic acid, sodium acetate and sodium citrate) for the production of beef patties, displaying a shelf life of 8 days, was supplied by a meat plant located in the Walloon region of Belgium. Four meat preparation batches were made. One batch was used as blank and each of the other three batches was inoculated (1 % v/w), in one experiment, with a suspension of one of the selected strains of *C. maltaromaticum* at 10^6 or 10^8 UFC/mL physiological saline, in order to achieve a final concentration of 10^4 and 10^6 CFU *C. maltaromaticum*/g meat. After inoculation, portions of 90 g of meat were molded into 2 cm thick beef patties. The beef patties were packaged in PP/EVOH/PP trays (oxygen permeability of 4 $cm^3/m^2 \cdot 24$ h) sealed with a polypropylene film (52 µm thick, oxygen permeability of 110 $cm^3/m^2 \cdot 24$ h) containing a modified atmosphere – 80 % O_2:20 % CO_2 –, and stored for 5 days at +4°C and the for 5 days at +8°C.
Sensory analyses: an untrained panel of 7 to 12 members was requested to make a sensory evaluation of raw and cooked samples, 8 and 10 days after inoculation, by scoring each descriptor (appearance, odor, color, tenderness, flavor and juiciness) from 1 (= dislike) to 5 (= like). Cooked samples were grilled (frying top Tecnoinox FTL35E/6/0) until they reached an internal temperature of +75°C.
Statistical analysis: Results are expressed as mean ± standard deviation (SD). Experimental data for each response variable was analyzed by ANOVA using the GLM procedure. Whenever necessary, Tukey tests were performed.

Results and discussion

After 8 days of storage (5 days at +4°C and 3 days at +8°C) and before cooking, non inoculated raw samples (blank) were perceived as having the best appearance and color ($P < 0.05$). The appearance of

the samples inoculated with strain CM_827 was similar to the blank. However, the inoculated samples did not differ statistically. Beef patties inoculated with *C. maltaromaticum* at 10^6 CFU/g received scores comparable to those of beef patties inoculated with *C. maltaromaticum* at 10^4 CFU/g.
After 8 days of storage and after cooking, non inoculated beef patties received higher scores than inoculated beef patties, but no statistical difference was observed with samples inoculated with *C. maltaromaticum* at 10^4 CFU/g. Samples inoculated with the strain CM_829 at 10^6 CFU/g received the worst scores for all studied descriptors. For appearance, odor and flavor, beef patties inoculated with the strain CM_829 differed from blank ($P < 0.05$). Samples inoculated with strains CM_824 and CM_827 received scores comparable to the blank, and significantly different from samples inoculated with strain CM_829 for odor and flavor ($P < 0.05$).
After 10 days of storage (5 days at +4°C and 5 days at +8°C) and before cooking, samples inoculated with the strain CM_827 at 10^4 CFU/g received the highest scores, but no statistical difference was found between the analyzed samples. Samples inoculated with *C. maltaromaticum* at 10^6 CFU/g did not differ statistically from blank.
Since after ten days of storage the beef patties were three days beyond the commercial shelf life, only appearance, odor and color were evaluated for cooked samples. A decrease in the sensory quality was observed during the last three days of storage. Most of the cooked samples inoculated at 10^4 CFU/g had a score between 3.0 and 3.5 after seven days of storage. After ten days of storage, most of the scores dropped to between 2.5 and 3.0. A similar loss of quality was observed for samples inoculated with *C. maltaromaticum* at 10^6 CFU/g.

Conclusion

This preliminary study permitted to evaluate the effect of three *C. maltaromaticum* strains on the sensory quality of beef patties. Strain CM_827 did practically not change the sensory attributes of beef patties. Therefore, further research on the biopreservative capacity of *C. maltaromaticum* should be conducted with the strain CM_827.

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