Comparison between using starter culture, GdL, and a combination of both in the production of salami

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Abstract

In the processing of fermented, dry sausages (salami) it is important to oppress the acidification to ensure a safe and controlled processing. The acidification may be achieved by applying a starter culture containing lactic acid bacteria (LAB), chemically by e.g. glucono-delta-lacton (GdL, E 575), or relying on the indigenous LAB flora.

In salami meat model the acidification and LAB development with GdL in two levels, 0.4% and 0.8%, with and without starter culture were compared. The starter culture was *Lactobacillus curvatus* applied with approximately $2x10^6$ CFU/g as the acidifier resembling the Sacco starter culture Lyocarni RBL-73. In parallel a control without any acidifier added was followed.

An initial pH decline to pH <5.3 at 25°C was obtained with both GdL applications. In comparison it took approx. 17 hours for the starter culture to achieve the same pH. Furthermore it was demonstrated that GdL did not control the indigenous flora which the starter culture was capable of. Consequently, if the application of GdL is required it is recommendable to combine low amounts of GdL with a starter culture to control the processing.

Introduction

An important hurdle in the production of salami is lowering of water activity by drying out the salami (Leistner, 1994). The water-holding capacity is pH dependent and the dehydrating process is enhanced by pH decline which, in a controlled way, may be obtained by an applied acidulate (Stiebling and Roedel, 1989). It is perceived that pH decline to <5.3 is important before the drying process is initiated. With less controlled processing a specified amount of GdL is often exploited as pH <5.3 can be obtained initially. When a starter culture is utilised more controlled temperature, humidity and air velocity are recommendable until pH <5.3 is attained. Furthermore, lowering in pH is not only of technological advantage it also supplement as safety hurdle inhibiting spoilage and pathogenic bacteria that may be present in meat (Uenluetuerk and Turantas, 1991).

Microbial acidification takes place when e.g. LAB breakdown fermentable carbohydrates present and produce organic acids, preferable primarily lactic acid. The fermentation pace is greatly influenced by selected LAB strain(s), booster system, and fermentation temperature. The chemical acidulation by GdL takes place when the ester with present water creates gluconic acid (Feiner, 2006), and consequently, this process is comparatively instantaneous and temperature independent. Nevertheless, application of GdL might negatively influence the taste (metallic off-flavour, sourness and bitterness), texture (grittiness), and colour (paleness) of the salami relative to the amount of GdL added (Schillinger and Luecke, 1989). Furthermore, high levels of GdL might promote growth of peroxide-forming lactobacilli resulting in rancidity and further colour problems (Feiner, 2006). The addition of GdL might be regulated by local legislation.

The aim of this investigation was to study the growth kinetics of indigenous LAB and starter culture LAB with and without GdL applied in a meat model. The recommendable alternative to GdL could be the fastest starter culture in the Sacco range: Lyocarni RBL-73 consisting of *Staphylococcus carnosus*, *Staphylococcus xylosus*, and *Lb. curvatus* (Lc). Since staphylococci do not influence the acidification the survey did not include staphylococci.

Material and methods

Meat model and pH registration

The meat mince was prepared at a local manufacturer with approximately 1/3 pork, beef and back fat, respectively. Additionally 1.7% salt, 1% nitrite salt (0.6% Na-nitrite), 0.4% glucose, ascorbate and black pepper were included (Sacco method M55). After arrival the meat mince was kept frozen and thawed overnight at 5°C before use. 200 g meat mince at ambient temperature were mixed with 1 ml water obtaining the concentrations described below, cooled to 5°C, and when all codes were prepared they were immersed in water-bath at 25°C (Sacco method M56).

The acidification test at 25°C was conducted as continuously pH and temperature registration with

Cinac apparatus (Alliance Instruments, France). The data registration illustrated below was initiated at 20°C (Sacco method M56).

Test codes

All acidification tests were conducted in replica in parallel and on two separate days. The data displayed are one representative set of data per code.

The following codes were investigated: control without culture applied, added 0.4% GdL, added 0.8% GdL, added $2x10^6$ CFU Lc/g, added 0.4% GdL and $2x10^6$ CFU Lc/g, added 0.8% GdL and $2x10^6$ CFU Lc/g.

Bacteriological investigation

The samples were analysed on day 0 and after 6 days of fermentation. LAB were detected on MRS pH 6.5 (Oxoid), surface plating, and anaerobically incubated for three days at 30°C. For verification purposes a proportion of each colony type deviating in colony morphology was microscopically examined. Analyses were performed on a sample size of approximately 35 g meat mince.

Results of investigation and discussion

Continuous pH measurement is a good tool to investigate lag phase, acidification profile, and to compare the performance relatively between acidulates. Nevertheless, it is a model system with e.g. optimal heat transfer at a favourable temperature for acidulates and no water loss. Consequently, it will not reflect what actually happens in all-purpose salami production as other parameters, such as recipe and processing, also influence the fermentation process. Figure 1 illustrates pH kinetics of all six codes, and for giving a more comprehensible embodiment: Figure 2 demonstrates pH kinetics of codes only with GdL applied, and Figure 3 demonstrates codes applied starter culture with and without GdL added.

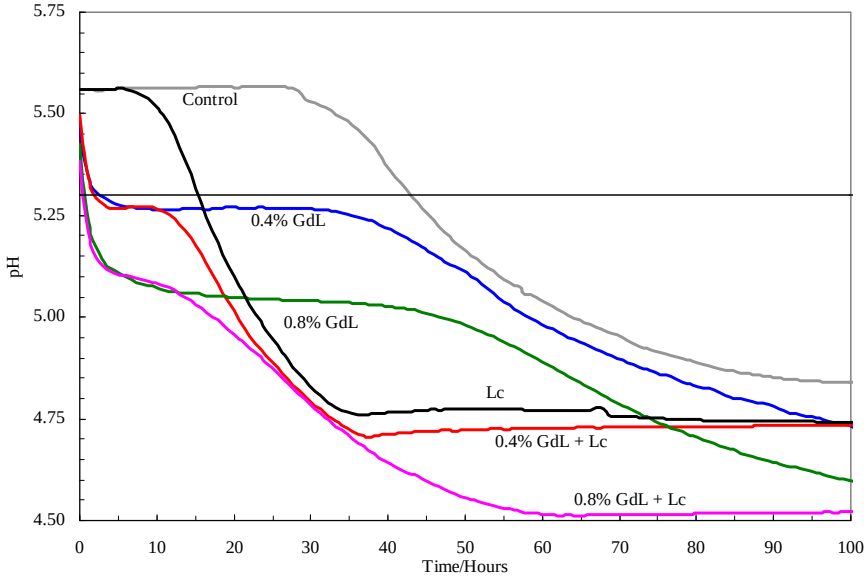

Figure 1. pH kinetics of control code, codes with GdL, and culture with and without GdL.

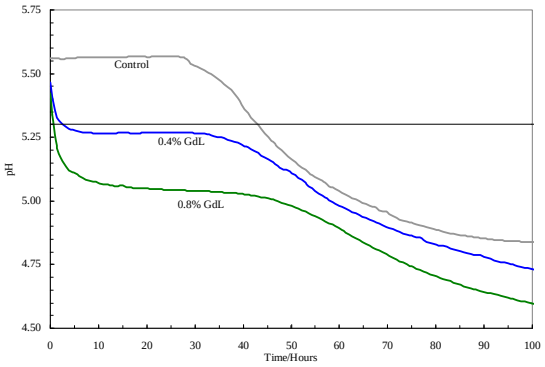

Figure 2. Control code and codes with GdL**.**

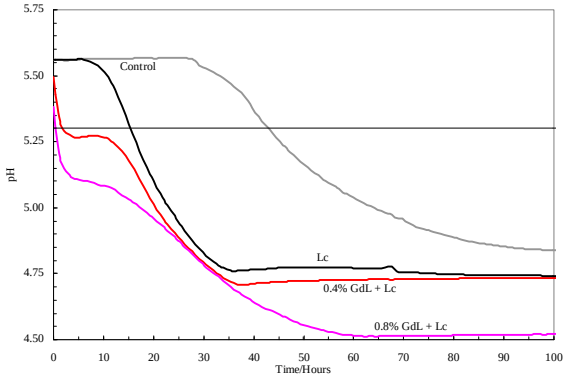

Figure 3. Control code and codes with LAB.

The lag phase of Lc was slightly influenced by GdL given approximately 7 hours without GdL, 11 hours with 0.4% GdL, and 13 hours with 0.8% GdL applied. The slope of code with starter culture and culture with 0.4% GdL was comparable whereas the culture with 0.8% GdL visibly was "softer" indicating that the culture was inhibited by 0.8% GdL although acidification took place. The growth dynamics of LAB are shown in Table 1.

Table 1. Investigation of control code, codes with GdL, and culture with and without GdL

Code	**LAB initially** CFU/g	**LAB after 6 days** CFU/g	**Composition**
Control	$2.5x10^3$	$5.5x10^8$	Mixed flora
+ 0.4% GdL	$2.5x10^3$	$6.8x10^8$	Mixed flora a la control
+ 0.8% GdL	$2.5x10^3$	$3.8x10^8$	Mixed flora a la control
+ Lc	$2.9x10^6$	$1.3x10^8$	Pure flora a la Lc
+ 0.4% GdL + Lc	$2.1x10^6$	$1.6x10^8$	Pure flora a la Lc
+ 0.8% GdL + Lc	$2.1x10^6$	$1.4x10^8$	Pure flora a la Lc

The initially LAB cell count in control code and codes with GdL applied were the same and showed that the meat mince was of a good bacteriological standard. The inoculated level of culture was slightly above the specification ($2x10^6$ CFU Lc/g). After six days of fermentation the level of starter culture had increased two log units as expected and the flora was similar in all three codes indicating that the starter culture dominated and controlled the development. In the codes without culture applied the indigenous LAB had increased five log units and all three codes showed a comparable mixed flora. Thus, the level of bacteria was slightly higher in the codes without culture added and the composition of bacteria present was uncontrolled.

These findings support the pH kinetics indicating that GdL does not control the indigenous flora, and consequently, using only GdL might result in disproportionate processing time and post-acidification giving fault fermentation and sensory drawbacks.

Conclusions

In this study 0.4% GdL was sufficient to lower pH <5.3 initially and generally there is no need to apply a higher amount of GdL with the increased sensory disadvantages that might provoke. Neither 0.4% nor 0.8% GdL were able to control the indigenous LAB flora which will increase the probability of post-acidification and negative sensory impact on the salami. Applying a starter culture will entail an initial lag phase in which temperature and humidity must be considered while adding a chemical acidulate these hazards need not to be contemplated. Under less controlled processing conditions a combination of 0.4% GdL and a starter culture to control the indigenous LAB might be recommendable. The aim of this investigation was to find an adequate starter culture substitute for GdL, and therefore, the fastest Lyocarni starter culture was tested. It might be more feasible to apply a traditional culture that also would be able to control the indigenous LAB in addition to GdL ensuring the initial pH-drop to <5.3.

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