MANGANESE ACCELERATES FERMENTATION OF DRY FERMENTED SAUSAGES

Beate F. HAGEN AND Askild L. HOLCK

MATFORSK, Norwegian Food Research Institute, Osloveien 1, N-1430 Ås, NORWAY

BACKGROUND

It has long been known that a component in spices acts stimulatory on acid production of starter cultures (Nes and Skjelkvåle 1982) and Zaika and Kissinger (1984) showed that one factor in spices that has this property is manganese. It is established that many lactobacilli require high levels of manganese (Archibald 1986), and that the requirement of manganese differs among the different lactobacilli. Meat as a substrate has low levels of manganese, and addition of manganese may thus stimulate the lactobacilli during fermentation.

OBJECTIVES

The objective of this work was to evaluate the effect of different concentrations of manganese on two lactobacilli starters in pilot-scale sausage production.

METHODS

The level of manganese in ordinary salami spice mixture was investigated by flame atomic absorption spectrometry.

Two non-commercial meat starter cultures were selected for the experiment; one that has been isolated from meat at our own laboratory, and that has shown good starter abilities ("MATFORSK"), the other is the starter culture that has been used for decades in a local factory ("FACTORY"). Both these cultures were assumed to have adapted very well to meat as a substrate.

A model salami (without spices and not subjected to smoking) was made which contained (% w/w): beef (51.8), pork (18.8), lard (25.6), sodium chloride (3.3), nitrite (0.02), glucose (0.4) and ascorbic acid (0.04). Two sets of 50 kgs were made. To set 1, "MATFORSK" was added as starter culture and supplied at 6×10^6 cells/g sausage mixture. To set 2, "FACTORY" was added as starter culture and supplied at 4×10^6 cells/g. For each set the ingredients were mixed and divided into 5 batches (10.0 kg each). To batch 1 was added 7.7 ml distilled water. To batch 2 was added 7.7 ml of a solution of $MnSO_4$ in distilled water that gave a final concentration in the sausage batter of 0.25 ppm Manganese. To batches 3 and 4 were added $MnSO_4$ to give a final concentration of 1.0 ppm manganese, and likewise, batch 5 had a final concentration of 2.5 ppm manganese. From each batch, 25 sausages of $\approx$ 400 g were prepared. The sausages were stuffed in artificial casings (50 mm diam) and placed in a ripening chamber under the following conditions: 3 days at 24°C, 96% relative humidity (RH), 2 days at 16°C, 92% RH, 2 days at 16°C, 88% RH and finally the sausages were allowed to ripen at 16°C, 85 % RH until they were mature.

Samples were collected for analyses after 0, 2, 3, 6, 9, 14, and 23 days. All analyses were performed on duplicate samples. The weight of each sausage was determined before and after the time in the ripening cabinet and the weight loss calculated.

pH was assayed on 10 g sausage homogenized in 90 ml peptone water (0.1 % (w/v) Bacto Peptone (Oxoid) and 0.85 % (w/v) NaCl in distilled water). a_w was measured by an electronic hygrometer (NOVASINA a_w-center, sensor: enRSK-4/CT-4, Novasina AG, Phäfficon, Switzerland) on 10 g sausages cut into 5 mm cubes. Growth of the added starter cultures was assayed by plating appropriate dilutions of sausage homogenised in peptone water on MRS agar (Oxoid). The same dilutions were also plated on blood agar (Difco) to check for possible contamination. The plates were incubated at 30°C for 2 days.

Texture of the sausages was evaluated by Texture Profile Analysis (TPA) using a Texture Analyser TA-XT2 (Stable Micro Systems). A bite size sample was compressed to 50 % of its original height two times in a reciprocating motion that imitated the action of the jaw. Analyses of force-time curves led to the identification of four measured textural parameters (hardness, springiness, cohesiveness and resilience) and two calculated parameters (gumminess and chewiness).

Sensory descriptive profiling was carried out by 10 trained assessors at 14 and 23 days after production. The flavour profile of the sausages was determined using an unstructured line with end points (1-9) where 1 denoted low intensity and 9 high intensity for each of the following 18 characteristics: Odour intensity, acidic odour, colour tone of fat, whiteness, overall colour tone, colour intensity, flavour intensity, maturity flavour, fresh flavour, acidic taste, sour taste, salty taste, bitter taste, rancid flavour, hardness, fattiness, juiciness and stickiness. Differences in sensory score were evaluated using Tukey's test.

All data were treated using an analysis of variance to detect the effect of the two treatments.

RESULTS AND DISCUSSION

The levels of manganese to investigate were determined by the level in the spice mixture, which was 131 ppm. As the addition of spices to salami is in the range of 0.5-3 %, we decided to investigate the levels 0, 0.25, 1 and 2.5 ppm manganese.

The weight loss and water activities were at levels normal for Norwegian sausages; all sausages had a water activity lower than 0.90 at the end of ripening, and a weight loss of about 35 %. For these parameters, there were no significant differences between the different levels of manganese or the different cultures. The pH drop and lactobacilli counts were dependent upon the concentration of manganese, giving a faster pH drop and faster growth of lactobacilli in the sausages with manganese. However the effect of manganese was much greater in the sausages fermented with "MATFORSK", the effect of manganese was only evident the first three days in the sausages fermented with "FACTORY".

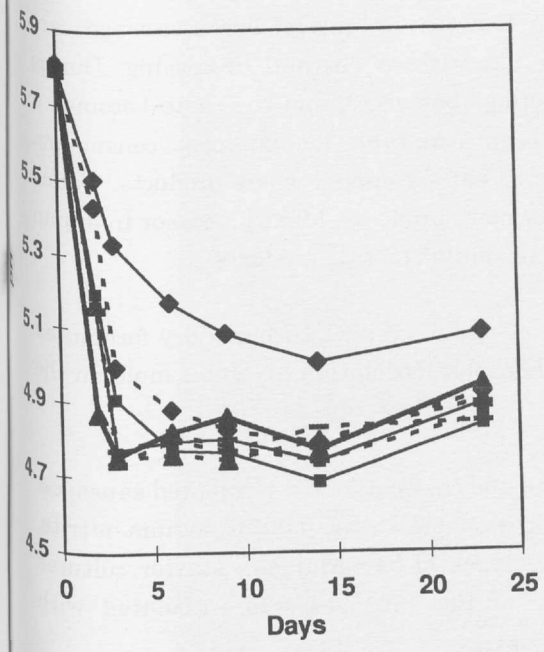

Figure 1: pH drop in sausages. Each curve is the mean of 4 replicates.
◆ = 0 ppm Mn, ■ = 1 ppm Mn, - = 1 ppm Mn, ▲ = 2.5 ppm Mn,

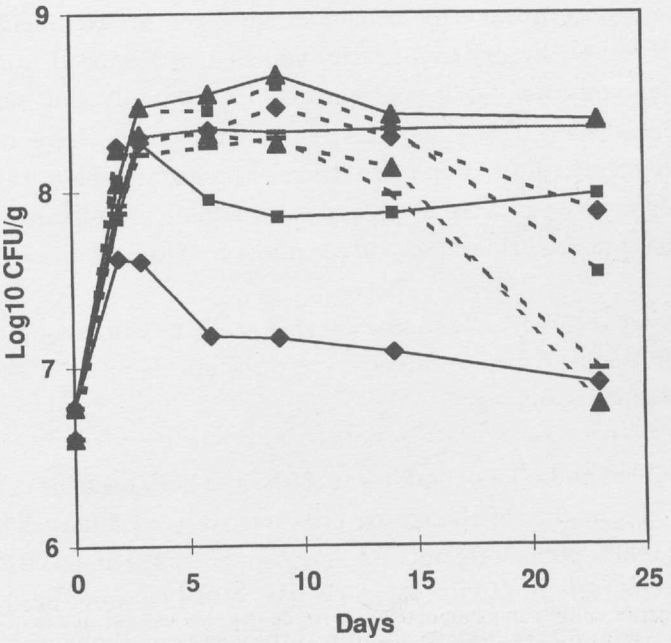

Figure 2: Lactobacilli count in the sausages.
———— = "MATFORSK", ---------- = "FACTORY"

Instrumental measurements of texture showed that sausages fermented with "FACTORY" obtained more cohesiveness, springiness and resilience after 3 days, these differences lasted until after 14 days of ripening when there were no differences. After 23 days, the "MATFORSK" fermented sausages rated higher on resilience, gumminess and chewiness.

For the sensory analyses, there were no marked differences between sausages fermented with the two starters, apart from rancidity that was more pronounced in the "FACTORY" fermented sausages. The attribute that varied most with increasing concentration of manganese was maturity flavour. Both after 14 and 23 days, the sausages with more manganese were evaluated as more mature. Several characteristics varied with maturation time; both whiteness, colour intensity, maturity flavour and rancid flavour were more pronounced after 23 than after 14 days, whereas fresh flavour and cohesiveness decreased with time.

CONCLUSIONS

We found that manganese is indeed stimulatory to lactobacilli starter cultures, giving a more significant pH-drop in the fermentation period (0-3 days) for both starter cultures. However, for one of the starters, the differences levelled out after 6 days, whereas for the other the end products with and without manganese were different, giving a sausage with lower pH and more starter bacteria when manganese was added. This shows that bacteria differ in their requirements for manganese, and that manganese for some strains may be employed to enhance maturation rate during sausage production.

LITERATURE

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