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EFFECTS OF SODIUM LACTATE ON THE MICROBIOLOGY OF VACUUM-PACKAGED, SLICED LUNCHEON MEATS

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INTRODUCTION

Processed meat products stored and displayed at refrigeration temperatures have limited shelf-life expectancies. A variety of packaging treatments and/or additives with potential for inhibiting various groups of micro-organisms have been investigated for their use with meat products. The bactericidal properties of lactic acid are well-established. Sodium lactate is currently approved for use as a flavour enhancer in fresh and cooked meat and poultry products. Its effects on suppressing microbial growth and therefore extending shelf-life have been reported in ham (Anon. 1988), chicken rolls (Burik and de Koos, 1990), cooked beef (Papadopoulos *et al.*, 1991), fresh pork sausages (Brewer *et al.*, 1991) and frankfurters (Bacus and Bontenbal, 1991). However, its effect on the commonly consumed processed meat products in Australia has not been studied. Experiments were therefore conducted to determine the effect of sodium lactate on the microbiology of sliced and vacuum-packaged luncheon meats, with high water activity.

MATERIALS AND METHODS

Sample preparation

Approximately 20kg of devon were prepared in the pilot-plant facility of the CSIRO's Meat Research Laboratory. The devon formulation consisted of the following: pork trims (90%CL), 56.2%; pork back fat, 23.8%, sodium nitrite, 0.01%; sodium chloride, 2.0%; spices, 0.5%; sodium tripolyphosphate, 0.3% and ice, 20.0%. Lean and fat pork were coarse-ground separately through a 13mm plate in a Hobart mincer (Model A-200 Hobart, Brisbane, Australia). After the meat was chopped in a Strommen 30 litre cutter (Model 423.13, Randers, Denmark), the pork back fat was added. The batch was subdivided into five treatment groups with 0%, 1%, 2%, 3% and 4% sodium lactate, based on final product weight. The sodium lactate, Purasal^{R}S, was a 60% aqueous solution supplied by Purac Far East, Singapore. The batter was mixed, vacuumed three times then stuffed into 90mm fibrous casings by means of a Dick, 12 litre manually operated sausage stuffer and clipped using a Poly-Clip System (Niedecker GmbH, Frankfurt, Germany, Type 5FC). The devon was cooked to an internal temperature of 68°C in a smokehouse (Alkar, Australia) followed by about 30 minutes showering then stored at 0°C for about 70 hours. Following chilling, the product was sliced and vacuum-packaged (250 g per pack) at a commercial processing plant. All packs were held at 5°C for either 0, 5, 8, 12, 16, 19, 22, 26 or 29 days for microbial analysis.

Microbiology

At each interval, 20g of a representative cross-sectional area of the devon were removed, observing aseptic techniques, and macerated in 180ml of sterile 1.25% NaCl solution (w/v) using a stomacher (Colworth, Model No.400, London, U.K.). Subsequent serial dilutions were made in 0.1% sterile peptone water. Each dilution was spread-plated in duplicate on the surface of the prepoured medium of TYSG (Oxoid Tryptone Soya Agar supplemented with 0.2% glucose and 0.2% Oxiod Extract) for total plate counts (TPC), Peptone Agar (Grau 1983) for Gram-negative counts,

Yeast (antibiotic media) for yeast and Gardiner's media for *Brochothrix thermosphacta* count. The plates were incubated at 25°C for 72 hours under aerobic conditions. Total plate counts and counts for lactic acid bacteria, *Brochothrix thermosphacta*, Gram-negative bacteria and yeast were determined at each interval and expressed as the log of the numbers of Colony Forming Units/cm^2.

Determination of pH

The pH of devon was determined on the remainder of the sample used for the microbial analysis using a digital pH meter (TPS, Model LC80, Brisbane, Australia) fitted with a Philips C64 combined electrode.

Determination of water activity

The water activity of devon was determined, in triplicate, using the Novasina aw-centre and aw-box (Novasina AG, Zurich, Switzerland) on devon samples blended dry in a blender bowl.

RESULTS AND DISCUSSION

In this study, initial total plate counts were 3.71×10^3 (Figure 1a). Sodium lactate appeared to prolong the lag phase at all addition levels. TPC of devon containing 0% and 1% or 2% sodium lactate increased to greater than 10^7/cm^2 by the 8th day and 9th day respectively. TPC of devon containing 3% and 4% sodium lactate did not reach 10^7/cm^2 until 21 and 26 days respectively. This inhibitory effect of sodium lactate was in agreement with that observed in ham (Anon, 1988), chicken rolls (Burik and de Koos 1990), cooked beef (Papadopoulos *et al.*, 1991), fresh pork sausages (Brewer *et al.*, 1991) and frankfurters (Bacus and Bontenbal 1991).

Figure 1b shows lactic acid bacteria were the major group of spoilage bacteria in devon stored at 5°C in this study. The time taken for the count of this group of bacteria to reach 10^7/cm^2 was extended by 14 days with 3% sodium lactate and by 18 days with 4% sodium lactate. This appeared to result from both an extended lag phase and a reduced growth rate of these spoilage bacteria. These results support those of de Wit and Rombouts (1990), who demonstrated the antimicrobial effects of sodium lactate exist towards various lactic acid bacteria. This inhibitory effect, however, was significant only at concentrations higher than 2%.

Addition of sodium lactate had no effect on initial pH of devon (mean pH=6.37). pH decreased over storage time at 5°C, regardless of sodium lactate level, to 6.01 for controls and to 6.05, 6.10, 6.06 and 6.21 for devons containing 1%, 2%, 3% and 4% sodium lactate respectively at the end of storage (day 29). These results support our earlier findings with the same type of product (unpublished results 1992) and those of others with fresh pork sausage (Brewer *et al.*, 1991), cooked beef (Papadopoulos *et al.*, 1991), beef bologna (Brewer *et al.*, 1992) and frankfurters (Anon, 1992).

By inhibiting the lactic acid bacteria, sodium lactate seemed to stabilise the pH of the product, particularly at high concentration as indicated by a lower rate of decrease in the pH of devon containing 4% sodium lactate when compared to the control. These results support those reported in fresh pork sausage containing up to 3% sodium lactate (Brewer *et al.*, 1991) and in frankfurters with 2% sodium lactate (Anno, 1992). They are, however, contrary to those of Brewer *et al.* (1993) who reported that pH decreased with increasing sodium lactate over storage time in fresh pork sausage. This may be explained by the higher buffering capacity of our emulsion system.

The effects of sodium lactate on the water activity of devon are shown in Figure 2. Addition of sodium lactate decreased water activity and this reduction in water activity was consistent with increased sodium lactate concentrations, from 0.973 with no sodium lactate to 0.952 with 4% sodium lactate. This is in agreement with our previously observed decrease in water activity in devon containing the same amount of sodium lactate, i.e., the water activity dropped from 0.976 in devon with 0% sodium lactate to 0.959 in devon with 4% sodium lactate (unpublished results 1992). Sodium lactate, in a concentration of 2% as used in meat products, has been reported to have a marked effect on water activity (Chirife and Fontan 1980). Debevere (1987) demonstrated reduced water activity in pork-liver pate containing 1% and 2% sodium lactate. The effect of sodium lactate in decreasing water activity is believed to contribute to its observed antimicrobial effect. However, it is likely this compound has an additional action on microbial growth, as its

antimicrobial effect is greater than that which would be expected from lowering water activity alone (de Wit and Rombouts 1990). We are currently investigating the inhibitory effect of sodium lactate on specific spoilage organisms in pure culture systems.

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