Mechanism of Beef Shelf Life Extension by Sorbate 1

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ABSTRACT

In both beef extract medium and on the surface of rib-eye steaks, potassium sorbate inhibited growth of psychrotrophic beef-spoilage bacteria by prolonging the lag phase of growth without affecting rate of growth. As a result, steak retail shelf life was extended by 2 days following a 10% potassium sorbate dip.

Sorbic acid and its potassium salt have been included as compounds “generally recognized as safe” (GRAS) by the United States Food and Drug Administration and are currently used as preservatives in a variety of foods (5.11). Although their original use was limited to inhibition of molds and yeasts (5), they have also been found to inhibit growth of Staphylococcus aureus (7,12,13), Clostridium botulinum (4,12), salmonellae (6,12,13) and psychrotrophic pseudomonads (9,10). Due to their antibacterial properties, sorbates have been shown to increase the safety and/or shelf life of a number of meat and poultry products (1,4,8,11,12,13). Recently Robach (8) reported a 9-day extension in the shelf life of whole broilers dipped in 5% potassium sorbate. There is no evidence, however, which demonstrates the effects of potassium sorbate on growth of psychrotrophic pseudomonads isolated from spoiled beef and identified as a member of the Pseudomonas fluorescens group by the API 20E System (API Laboratory Products Ltd). Initially, the effects of potassium sorbate on bacterial growth were examined by adding filter-sterilized potassium sorbate (Monsanto Co.) to a beef extract medium to give final concentrations ranging from 0.0125 to 1% (w/v). This medium was prepared from homogenized, beef longissimus dorsi muscle according to the procedures of Gill (2), modified by replacing phosphate buffer with distilled water to maintain a pH of 5.6. A saline solution (0.85% NaCl)-washed suspension of P. fluorescens was added to give an initial concentration of 107 bacteria/ml of culture medium. To simulate retail conditions, incubation was carried out in a retail display case (Hill Refrigeration of Canada, Ltd.) under 800 lx of incandescent lighting and operating at a mean temperature of 3 C (3). Bacteria were enumerated by aerobic plate counts following incubation of Plate Count Agar (PCA, Difco) at 25 C for 48 h.

The effects of sorbate on psychrotrophic bacterial growth and steak shelf life were determined by dipping rib eye steaks for 1 min in a 10% (w/v) solution of potassium sorbate (pH 8.7). This concentration was chosen since it has been shown to extend poultry shelf life without alteration in desirable sensory properties (1). Steaks dipped in distilled water served as controls. Following each treatment, samples were wrapped in an oxygen-permeable polyvinyl film and placed on retail display. Daily, from day 0 to day 7, the appearance of 5 steaks from each treatment was evaluated by a 4-member sensory panel, using the seven point subjective scale (1 = extremely undesirable, 7 = extremely desirable) previously described (3). As described in a previous report (3), steak shelf life was defined as the time, in days, for samples to reach a retail acceptance value of 3.5. An area of 4 cm2 of the same samples were swabbed and the initial psychrotrophic bacterial load determined following PCA incubation at 7 C for 10 days (3). These experiments were replicated three times to give a total of 15 steaks for each day of retail display at each treatment. The surface pH of 5 steaks was monitored daily for 7 days, using a Corning flat surface electrode. Data were analyzed by linear regression analyses and the significance of differences between treatments determined by the Student’s “t” test.

RESULTS AND DISCUSSION

Addition of potassium sorbate to beef extract medium affected the growth of P. fluorescens by producing a dose-dependent increase (r = 0.988, p < 0.01) in the length of the lag phase (Fig. 1). Exponential bacterial growth rates in the presence of 0, 0.0125, 0.025, 0.05 and 0.10% (w/v) potassium sorbate were 0.16, 0.15, 0.15, 0.13 and 0.17 generations/h, respectively, and regression analyses revealed no significant correlation (r = 0.267, p
Figure 1. Relation between sorbate concentration and the duration of the lag phase of *P. fluorescens* growth in beef extract medium.

Following this initial delay, no significant differences (p = 0.1) could be determined in the rate of bacterial growth on sorbate-dipped steaks (0.24 generation/h) when compared to control steaks (0.23 generation/h, Table 1). These findings demonstrate that potassium sorbate acts, both in beef extract medium and on steaks, by prolonging the lag phase of bacterial growth without affecting the subsequent rate of growth. As a consequence of the extended lag phase, the bacterial load on sorbate-dipped steaks was reduced when compared to controls (Fig. 2) and shelf life significantly (p < 0.001) increased from 2 to 4 days (Table 1). These results complement findings with poultry (1,8) and other meats (4,7,11,12) by demonstrating that potassium sorbate can also improve the keeping quality of fresh beef. Further research would be of value to determine the mechanism of the transient, sorbate-induced bacteriostasis and to establish how this effect is eventually overcome by the organisms.

**Figure 2. Effect of potassium sorbate on psychrotrophic bacterial growth on rib-eye steaks.** Bacterial growth on sorbate dipped steaks (---) was compared to controls (-----) and results are expressed as the mean of 15 steaks ± 1 standard deviation.

**TABLE 1. The effect of potassium sorbate on psychrotrophic bacterial growth and steak shelf life**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Lag phase (Days)</th>
<th>Bacterial growth Rate (Generations/h)</th>
<th>Steak shelf life (Days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.44 ± 0.10</td>
<td>0.23 ± 0.01</td>
<td>2.09 ± 0.09</td>
</tr>
<tr>
<td>10% potassium sorbate dip</td>
<td>3.95 ± 0.37</td>
<td>0.24 ± 0.07</td>
<td>4.04 ± 0.26</td>
</tr>
<tr>
<td>p</td>
<td>0.001</td>
<td>0.100</td>
<td>0.001</td>
</tr>
</tbody>
</table>

*The treatment means and standard errors for 15 steaks were compared using the Student's 't' test.*

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REFERENCES


Greer, con't. from p. 84