SHORT COMMUNICATION

Protective Effect of Lipoteichoic Acid from Lactobacillus casei and Lactobacillus fermentum against Pseudomonas aeruginosa in Mice

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Lipoteichoic acid (LTA) from Lactobacillus casei YIT 9018 or Lactobacillus fermentum YIT 0159 augmented the resistance of C57BL/6 mice to infection with Pseudomonas aeruginosa, but conferred no resistance to Listeria monocytogenes. It is suggested that LTA was unable to activate macrophages.

INTRODUCTION

Infection with Gram-negative bacteria such as Pseudomonas aeruginosa and Escherichia coli in immunocompromised hosts is an important problem. To prevent such infection, in addition to chemotherapy with antibiotics, attempts have been made to discover agents capable of augmenting the host defence mechanism, e.g. nonspecific scavenger macrophages. Heat-killed Lactobacillus casei YIT 9018, which is a potent macrophage-activating (Hashimoto et al., 1984; Kato et al., 1983) and antitumour (Kato et al., 1981) agent, is reported to have a protective effect against Pseudomonas aeruginosa in mice (Miake et al., 1985).

In this study, the antibacterial activity of lipoteichoic acid (LTA) isolated from Lactobacillus casei YIT 9018 or Lactobacillus fermentum YIT 0159 was examined. LTA has neither antitumour nor macrophage-activating activity (Hashimoto et al., 1984; Kato et al., 1983; Yokokura et al., 1984).

METHODS

Lactobacillus casei YIT 9018 and Lactobacillus fermentum YIT 0159 were obtained as described previously (Kato et al., 1981). The cells of lactobacilli were heated at 100 °C for 30 min, and lyophilized. LTA was extracted from the lyophilized whole cells with 45% (w/v) phenol at 4 °C by the method of Wicken et al. (1973). The extracted residue was washed with distilled water until there was no absorbance at 260 nm, and then lyophilized. This material was designated as 'phenol-treated cells'.

Female C57BL/6 mice (6-week-old) were purchased from Shizuoka Agricultural Cooperative for Experimental Animals, Hamamatsu, Japan. They were injected intraperitoneally (i.p.) with 1.0 mg of lyophilized whole cells, or LTA or phenol-treated cells of Lactobacillus casei or Lactobacillus fermentum 5 d before i.p. injection with Pseudomonas aeruginosa KC-2 (1.4 × 10⁶ c.f.u. per mouse) or Listeria monocytogenes EGD (4.5 × 10⁸ c.f.u. per mouse). The survival of the mice was monitored for 7 d after infection.

RESULTS AND DISCUSSION

Mice pretreated i.p. with whole cells or LTA but not with phenol-treated cells of Lactobacillus casei or Lactobacillus fermentum had enhanced resistance to Pseudomonas aeruginosa; whole cells and phenol-treated cells of Lactobacillus casei but not of Lactobacillus fermentum augmented

Abbreviation: LTA, lipoteichoic acid.

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Table 1. Effect of LTA from Lactobacillus casei and Lactobacillus fermentum against Pseudomonas aeruginosa and Listeria monocytogenes

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Pseudomonas aeruginosa</th>
<th>Listeria monocytogenes</th>
</tr>
</thead>
<tbody>
<tr>
<td>None (control)</td>
<td>0/7 (0)</td>
<td>1/10 (10)</td>
</tr>
<tr>
<td>Lactobacillus casei</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTA</td>
<td>5/5 (100)</td>
<td>1/10 (10)</td>
</tr>
<tr>
<td>Whole cells</td>
<td>2/5 (40)</td>
<td>10/10 (100)</td>
</tr>
<tr>
<td>Phenol-treated cells</td>
<td>0/5 (0)</td>
<td>10/10 (100)</td>
</tr>
<tr>
<td>Lactobacillus fermentum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LTA</td>
<td>5/5 (100)</td>
<td>0/10 (0)</td>
</tr>
<tr>
<td>Whole cells</td>
<td>5/5 (100)</td>
<td>1/10 (10)</td>
</tr>
<tr>
<td>Phenol-treated cells</td>
<td>1/5 (20)</td>
<td>1/10 (10)</td>
</tr>
</tbody>
</table>

* LTA, whole cells or phenol-treated cells (1.0 mg per mouse) were injected i.p. into C57BL/6 mice 5 d before i.p. injection with Pseudomonas aeruginosa (1.4 × 10⁸ c.f.u. per mouse) or Listeria monocytogenes (4.5 × 10⁷ c.f.u. per mouse). The survival of the mice was monitored for 7 d after infection.

resistance to Listeria monocytogenes, while LTA of Lactobacillus casei and Lactobacillus fermentum did not (Table 1). This indicated that the component in Lactobacillus casei which elicits resistance to Pseudomonas aeruginosa could be separated from that which elicits resistance to Listeria monocytogenes. This agreed with the findings that whereas Lactobacillus casei had macrophage-activating activity Lactobacillus fermentum had none (Hashimoto et al., 1984; Kato et al., 1984).

Some bacterial components exert an antibacterial effect by augmentation of the host defence mechanisms. For example, muramyl dipeptide, a bacterial cell wall component, and its synthetic derivatives have a protective effect against infection by some pathogenic bacteria (Parant et al., 1978). Endotoxin or lipopolysaccharide (LPS) of Gram-negative bacteria have an antibacterial effect by enhancing the function of macrophages (Galleli et al., 1981). Well-known macrophage-activating agents such as Mycobacterium bovis BCG and Corynebacterium parvum could not confer a protective activity against infection with Gram-negative bacteria (Sham et al., 1983; Yoshikai et al., 1982), but treatment with Lactobacillus casei protected mice from infection, since the activated macrophages were less sensitive to the cytotoxic effect of LPS than those activated with Corynebacterium parvum (Miake et al., 1985).

There have been many reports concerning the effect of LTA on immunological activities (Jackson et al., 1981; Whigham & Kleinman, 1983; Wicken & Knox, 1981). Although LTA promotes carbon clearance by the reticuloendothelial system (Miller et al., 1976) and stimulates lysosomal enzyme release from macrophages (Harrop et al., 1980), we have failed to activate macrophages with LTA isolated from lactobacilli, i.e. LTA did not inhibit the growth of Listeria monocytogenes. Resistance to this bacterium in mice is thought to depend on macrophages (Mitsuyama et al., 1978). On the other hand, we have confirmed that i.p. injection of LTA from lactobacilli did not increase the number of peritoneal exudate cells, including macrophages and polymorphonuclear leukocytes, and that it had no mitogenic activity on mouse spleen cells in vitro (unpublished data). From these findings, it was supposed that LTA augments the resistance to Pseudomonas aeruginosa not by elevation of the number but by activation of an existing population of polymorphonuclear leukocytes.

REFERENCES


Short Communication


