Comparative antibacterial activities of extracts of dried ginger and processed ginger

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ABSTRACT

Ginger (Zingiber officinale Rosc.) is a well-known spice and herbal medicine to treat such symptoms as fever, cough, etc, especially its antibacterial activity, which made it widely used in clinic or as preservatives in food industry. The paper compared the antibacterial activities in solvents of dried ginger and processed ginger. The results showed that each organic solvent had antibacterial activity against gram-positive bacteria (two strains) and gram-negative bacteria (four strains). However, no significant differences appeared between dried ginger and processed ginger and among of ginger organic extracts.

Key words: Dried ginger, Processed ginger, Ginger extract, Antibacterial activity.

INTRODUCTION

Ginger (Zingiber officinale (Willd) Rosc.), a member of Zingiberaceae family, is a well-known spice applied to people’s daily diet in Asian and Indian. In China, ginger rhizoma has also been used as a commonly non-prescribed traditional Chinese medicine to treat various diseases including common cold, cough and gastrointestinal upsets.[1] Nowadays, it was reported that ginger had good activities in antioxidant, antibacterial,[2,3] anti-tumor[4] activities, etc,[5-7] especially its antibacterial, which made it widely used in clinic or as preservatives in food industry. The aim of this study was analyzed antibacterial activities of different ginger extracts and further determined its minimal inhibitive concentration (MIC), which would provide a theoretical basis for its clinical application of Chinese medicine or as a food additive.

MATERIALS AND METHODS

Materials
Dried rhizome and processed ginger were obtained from the Shuyu pharmacy of Jinan, China, in March 2010.

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Chemical reagents in the experiment were purchased from the Tianjin Chemical reagent factory.

Aqueous extract of dried and processed ginger
Dried gingers or processed gingers were powdered, and macerated in water for 2 h. The aqueous solution was boiled twice, each 1.5 h and then concentrated to final concentration of 500 μg/mL.

Ethanol extraction of dried and processed ginger
The powder dried ginger or processed ginger (5.0 kg) was macerated in ethanol (70%, v/v) and mixed well, in water bath for 3 h at 50 °C. The solvent was filtered and concentrated to final concentration of 500 μg/mL.

Acetone extraction of dried and processed ginger
The powder dried gingers or processed ginger (5.0 kg) were soaked in acetone (solid/liquid, s/l=1/6) for 72 h at room temperature. The solvent was filtered using six layers gauze and concentrated to final concentration of 500 μg/mL.

Methanol extraction of dried and processed ginger
The powder dried gingers or processed ginger were soaked in methanol for 72 h at room temperature. The solvent was filtered and repeated this step twice, and adjusted to final concentration of 500 μg/mL.

Hexane extraction of dried and processed ginger
The powder dried gingers or processed ginger were soaked in water reflux for 8 h at 70 °C and extracted at room
temperature. The residues were dissolved with hexane and filtered. Filtration solution was concentrated to final concentration of 500 μg/mL.

**Chloroform extraction of dried and processed ginger**
The dried gingers were powdered and soaked in ethanol (95%) reflux and filtered. The solvent was collected and concentrated, and extracted with chloroform. The extraction was adjusted to final concentration of 500 μg/mL. Chloroform extraction of processed ginger was prepared using the same method.

**Antibacterial assay**
Selected test microorganisms were gram-positive bacteria, that was *Staphylococcus aureus* (ATCC25923) and its isolated strain from air; Gram-positive bacteria included *Escherichia coli* (ATCC25922), *Shigella flexneri* (ATCC12022), *Proteus vulgaris* (ATCC13315), *Pseudomonas aeruginosa* (ATCC27853). Antibacterial tests were carried out by the disc diffusion method. Sterile paper discs (6 mm in diameter) prepared from whatman were impregnated with drug-containing solution placed on the inoculated agar. Negative control and positive control was using ethanol and appropriate antibiotics respectively (Table 1). The inoculated plates were incubated at appropriate temperature for 24 h. The antibacterial activity was evaluated by measuring the diameter of inhibition zone against the test microorganisms. Each assay in this experiment was replicated thrice.

**Minimal inhibitive concentration (MIC) assay**
MIC was studied for the microorganisms that were determined as sensitive in the disc diffusion method. The aqueous extract and ethanol extract were first diluted to 250 μg/mL, and then serial two-fold dilutions were made with MH broth in the concentration range from 10 to 250 μg/mL. The last tube containing 2 mL of MH broth without extract and 50 μL of the inocula was used as a negative control.

**RESULTS**

**The effect of ginger extracts on gram-positive bacteria**
The results indicated that organic extracts of dried ginger and processed ginger had an inhibitory effect on *Staphylococcus aureus* (ATCC25923) and isolated strain from air, compared with negative control. Antibacterial activities showed no significant difference among the groups, while aqueous extracts had no inhibitory activity (Fig. 1 and Fig. 2).

**The effect of ginger extracts on gram-negative bacteria**
The results displayed that except aqueous extract, each group had antibacterial activity of four gram-negative bacteria, including *Escherichia coli* (ATCC25922), *Shigella flexneri* (ATCC12022), *Proteus vulgaris* (ATCC13315), *Pseudomonas aeruginosa* (ATCC27853), and no significance appeared between each organic extract. However, their antimicrobial activities were very lower, compared to positive control. Antibacterial activity of hexane extract was the smallest in all the organic extracts. For each extract, the antibacterial activity of processed ginger was better than that of dried ginger (Fig. 3 - Fig. 6).

**MIC of gingers extract**
The results showed that MIC of each extracts were ranged from 50 to 125 μg/mL. For the same strain, each extract had different MIC, such as MIC against *Escherichia coli* (ATCC25922), which was the least, only 50 μg/mL, while

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**Table 1: Antibiotics used in different strains**

<table>
<thead>
<tr>
<th>Bacteria types</th>
<th>Strains</th>
<th>Antibiotics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram-positive bacteria</td>
<td><em>Staphylococcus aureus</em></td>
<td>Erythromycin</td>
</tr>
<tr>
<td></td>
<td><em>Staphylococcus aureus</em></td>
<td>Erythromycin</td>
</tr>
<tr>
<td></td>
<td>(isolated)</td>
<td></td>
</tr>
<tr>
<td>Gram-negative bacteria</td>
<td><em>Escherichia coli</em></td>
<td>Ciprofloxacin</td>
</tr>
<tr>
<td></td>
<td><em>Proteus bacillus vulgaris</em></td>
<td>Ciprofloxacin</td>
</tr>
<tr>
<td></td>
<td><em>Pseudomonas aeruginosa</em></td>
<td>Ciprofloxacin</td>
</tr>
<tr>
<td></td>
<td><em>Shigella castellani</em></td>
<td>Gentamicin</td>
</tr>
</tbody>
</table>

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**Figure 1:** The effect of extracts of dried ginger and processed ginger on *Proteus bacillus vulgaris*. DG means dried ginger extract; PG means processed ginger extract; their concentrations in the experiments were 500 μg/mL (This part was the same as following figures).

**Figure 2:** The effect of extracts of dried ginger and processed ginger on *Proteus bacillus vulgaris* (isolated).
its hexane extract was 62.5 μg/mL. Hexane extract against other gram-negative bacteria, as the highest inhibitory concentration, was 125 μg/mL (Table 2).

**DISCUSSION**

It was reported there were contradictions in antimicrobial activity of ginger, which mainly reflected two aspects.\[10-12\] One was that its active ingredients - essential oils and flavonoids, their antibacterial effects varied greatly in literature. The other was that the same extract had contrary antimicrobial activity.

The study showed that no significance appeared in antibacterial activity of various ginger extracts, which explained the fact that ginger volatile oil and its flavonoids, as the antimicrobial active substances, were all dissolved in organic solvent, and so there was no significant difference. However, the different polarity and solubility of organic solvents, resulted in different antibacterial activities for various strains. Ginger extracts could be used as preservatives, if solvents were not toxic.

Although no significant difference, antibacterial activity in processed ginger extract was slightly higher than that in ginger extract. During the dried ginger were processed, gingerol was dehydrated and formed into flavonoids, which resulted in the higher content of flavonoids in processed ginger than that in dried ginger.\[13\] Correspondingly, its antibacterial activity was higher than that of dried ginger.

In summary, antibacterial activities existed in organic ginger extracts, but no significance appeared among the extracts.

**Table 2: MIC of extracts of dried and processed ginger**

<table>
<thead>
<tr>
<th>Extract</th>
<th>Staphylococcus aureus</th>
<th>Staphylococcus aureus (isolated)</th>
<th>Escherichia coli</th>
<th>Pseudomonas aeruginosa</th>
<th>Shigella castellani</th>
<th>Proteusbacillus vulgaris</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE of DG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>EE of PG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>ME of DG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>ME of PG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>HE of DG</td>
<td>125</td>
<td>125</td>
<td>62.5</td>
<td>125</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>HE of PG</td>
<td>125</td>
<td>125</td>
<td>62.5</td>
<td>125</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>AC of DG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>AC of PG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>CE of DG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>125</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>CE of PG</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>125</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Notes: EE means ethanol extract; AE means aqueous extraction; DG means dried ginger; PG means processed ginger; DIE means dichloromethane extract; ME means methanol extract; HE means hexane extract; CE means chloroform extract; AC means acetone.
REFERENCES


