Modelling the Growth Inhibition of Common Food Spoilage and Pathogenic Micro-organisms in Presence of Solvent Extract from Irish York Cabbage

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Modelling the growth inhibition of common food spoilage and pathogenic micro-organisms in the presence of solvent extracts from Irish Crucifer vegetables

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Abstract

Crucifer vegetables are a rich source of phytochemicals such as flavonoids and glucosinolates and their hydrolysis products. These phytochemicals possess antimicrobial and anti-oxidant activities. In order to assess the antimicrobial potential of different members of crucifer family, Irish York cabbage, Broccoli and Brussels Sprouts, the effect of solvent extracts on the growth inhibition of common food spoilage and pathogenic bacteria was studied. Broccoli and Brussels sprouts, at a concentration of 2.8%, showed a weak inhibition in the range of 11.50% and 7.38%, respectively, against the different micro-organisms. Extracts from York cabbage were highly effective at a concentration of 2.8% resulting in 100%, 75% and 57% inhibition against Listeria monocytogenes, Salmonella abony and Pseudomonas aeruginosa, respectively. Growth/survival of the micro-organisms in presence of York cabbage extract was mathematically modelled using the Baranyi model. Lower concentrations of cabbage extract prolonged the lag phase and reduced both the maximum specific growth rate and final population densities.

Raw Material

Broccoli, Brussels Sprouts, York Cabbage

Materials and Methods

Extraction Procedure (Gupta et al., 2010)

5 gm sample was crushed with liquid nitrogen
Extraction with 60% methanol under nitrogen atmosphere
Shaking at 40°C and 100 rpm for 2 h
Extracts filtered and evaporated to dryness

Antimicrobial Analysis

Bacterial cultures used in the present study

Gram Positive
- Food Pathogen: Listeria monocytogenes
- Food Spolilage: Enterococcus faecalis

Gram Negative
- Food Pathogen: Salmonella abony
- Food Spolilage: Pseudomonas aeruginosa

Microtitre plate based analysis (Gupta et al., 2010)
Extract concentration: 5.6%

Extracts were filtered and evaporated to dryness in the first row of microtitre plate
Extract was serially diluted down the plate
100 µL bacterial culture added to all wells
Plates incubated at 37°C for all bacteria and at 30°C for Pseudomonas
Absorbance read at 600nm (Powerwave, BioTek) every hour for 24 h

Antimicrobial activity was calculated in terms of % inhibition of growth as follows (Casey et al., 2004)

\[
\text{Percentage Inhibition} = \left(\frac{C_T - C_0 - T_T}{T_T}ight) \times 100
\]

\( C_0 \) is the OD absorbance of the bacteria at 24 h, \( C_T \) is the OD absorbance of the bacteria at 0 h, \( T_T \) is the OD absorbance of the organism in the presence of extract at 24 h, \( T_0 \) is the OD absorbance of the organism in the presence of extract at 0 h.

Analysis of Growth Kinetics

The OD values were converted into log CFU/ml by a standard curve for each bacterium. Growth kinetics in the presence of cabbage extract was described by DM-Fit program implemented in Microsoft excel (DM-Fit; Institute of Food Research, Norwich, UK, (Baranyi et al., 1993)).

Kinetic parameters calculated were:
- Maximum specific growth rate (\( \mu_m \))
- Log, maximum population density (y)
- Lag time (\( \lambda \))

Results and Discussion

Antimicrobial Activity

- Extracts from York Cabbage were the most effective followed by Broccoli and Brussels sprouts which had weak inhibition.
- L. monocytogenes and E. faecalis were the most sensitive and resistant organisms, respectively.
- An inhibition of 100% and 75% was observed against L. monocytogenes and S. abony, respectively, with 2.8% York cabbage extracts.
- The inactivation effect reduced with a reduction in extract concentration.
- York cabbage extracts, with an inhibition of 100%, were more potent than sodium benzoate (84.4%) and sodium nitrite (96%) against L. monocytogenes at a concentration of 2.8%.

Growth/Inhibition Kinetics

- Kinetics studied with extracts from York cabbage.
- A rapid and prolific growth was observed in control samples.
- An extract concentration of 1.4% resulted in complete inactivation of L. monocytogenes whereas 0.7% extract resulted in 76% reduction in the stationary level growth as compared to the control.
- For the other three organisms, addition of 2.8% extract resulted a reduction of 72, 64 and 32% in the stationary level growth of S. abony, P. aeruginosa and E. faecalis as compared to the control.
- Maximum specific growth rate was reduced and lag phase increased upon addition of extract.

Extracts filtered and evaporated to 2.8%, 7.01, 0.469, 1.4% 5.62, 0.533, 0.7% 5.4, 1.06 control 3.9, 1.1

Table 1: Value of model parameters

<table>
<thead>
<tr>
<th>Bacterium</th>
<th>( \mu_m )</th>
<th>( \mu_0 )</th>
<th>( \lambda )</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. monocytogenes</td>
<td>2.8%</td>
<td>2.5%</td>
<td>0.5</td>
</tr>
<tr>
<td>S. abony</td>
<td>2.8%</td>
<td>2.5%</td>
<td>0.5</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>2.8%</td>
<td>2.5%</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Conclusions

- Extracts from York cabbage have the potential of imparting microbiological safety to food products.
- Higher antimicrobial activity was seen against L. monocytogenes and S. abony as compared to typical food preservatives such as sodium benzoate and sodium nitrite.
- The present finding brings out a new insight towards the development of natural antimicrobial agents against L. monocytogenes from Irish York cabbage.

References


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