Chemometrics for the evaluation of white pudding ageing on the basis of near infrared spectroscopy

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The comprehension of the mechanisms leaded to food spoilage is necessary in order to bring more specific knowledge to the food producers about preparation and preservation. Researches made within the framework of the CONSALIM® project aim to adapt conservation methods to food conservation requirements. The work presented here consists on the development and on-line application of rapid and non-destructive analytical techniques in order to reach those objectives. The technology used in this work is the well known near infrared spectroscopy combined with Chemometric tools.

To link the NIR technique and the consumable state of the product, ageing tests of white pudding were carried out and the evolution of the growth of total flora was followed. Those tests were performed on 6 sets of white pudding from two companies. The ageing was studied as presented below. Samples were analyzed by microbiological assays using the reference methods and by NIR spectroscopy. Only the external face of the whiten pudding was analyzed.

### Experimental plan

<table>
<thead>
<tr>
<th>Company</th>
<th>MAP 1</th>
<th>MAP 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1: production 1</td>
<td>23 days</td>
<td>At 4°C then at 8°C</td>
</tr>
<tr>
<td>Day 2: production 2</td>
<td>28 days</td>
<td></td>
</tr>
<tr>
<td>Day 3: production 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Microbiological results

**Company 1**
- Day 1: production 1
- Day 2: production 2
- Day 3: production 3

**Company 2**
- Day 1: production 1
- Day 2: production 2
- Day 3: production 3

### Spectroscopic results

**Example of NIR collected spectra of white pudding aged**

**Evaluation of total flora of white pudding (company 1)**

**Evaluation of total flora of white pudding (company 2)**

**Distribution of samples of the three productions on the basis of their NIR spectra**

**Graphs of PCA applied on NIR collected spectra of white pudding aged provided from companies 1 and 2**

### Correlation of spectroscopic and microbiological data: individual production sets of each brand

#### Individual PLS models performances for the prediction of total flora values

<table>
<thead>
<tr>
<th>Company</th>
<th>pre-treatment</th>
<th>Statistics values</th>
<th>Production 1</th>
<th>Production 2</th>
<th>Production 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 1</td>
<td>SNV+ 1st derivative</td>
<td>R2-Square</td>
<td>0.99</td>
<td>0.99</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RMSECV</td>
<td>1.34</td>
<td>1.29</td>
<td>1.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RMSEP</td>
<td>1.87</td>
<td>1.21</td>
<td>1.6</td>
</tr>
</tbody>
</table>

**PLS models developed on individual productions of each company showed good performances for the prediction of the total flora of aged white puddings.**
- Calibration set = 24 spectra
- Validation set = 12 spectra

### Correlation of spectroscopic and microbiological data: Total production sets of each brand

#### PLS models performances for the prediction of total flora values for all productions

<table>
<thead>
<tr>
<th>Company</th>
<th>pre-treatment</th>
<th>R-Square</th>
<th>RMSECV</th>
<th>RMSEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company 1</td>
<td>1st derivative</td>
<td>0.81</td>
<td>0.95</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>SNV</td>
<td>0.81</td>
<td>1.35</td>
<td>1.28</td>
</tr>
</tbody>
</table>

**PLS models developed on total productions of each company showed lower performances for the prediction of the total flora than obtained when working on each production separately.**
- Calibration set = 72 spectra
- Validation set = 36 spectra

### Conclusion

Near infrared spectroscopy coupled to chemometric tools has a real potential for the analyses of fresh products. Results obtained on the evaluation of the ageing of whiten pudding are encouraging and studies will be continued in order to better estimate the total flora by the application of other chemometric tools like LS-SVM (Least Squares Support Vector Machines) regression.

CONSALIM (Walloon project): Extension of the duration of the life of food through comprehension and control of the mechanisms leading to their adulteration.