Food and cooking as context for science teaching

Practical activities and possibilities for inquiry

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Outline of the workshop

14.00-14.15: Introduction

14:15-14:45: Sugar sticks - mixtures and separation methods
   - Lecture/demonstration

14:45-16:00: Berry trio and pH
   - Lecture, practical activity, discussions

16:00-17:00: Leavens in cookies - chemistry, physics and sensory evaluation methods
   - Lecture, practical activity, discussions

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The majority of the students in school will *not* pursue a future career in science/technology

Has consequences for

- Content
- Teaching perspective/approach
- Methods

Issues (II) – Context and knowledge transfer

Student teacher “Karen” (home economics)

“When we cook food together my friends say I have started to speak so strangely/differently”

A model of science vs. society

\[ \text{Ag}^+_{(aq)} + \text{Cl}^-_{(aq)} \rightarrow \text{AgCl}_{(s)} \]

Experiment & inquiry

Reasons & argumentation

Everyday choices
(socioscientific issues)

Sugar sticks – Demonstration/activity (Maiju)
Berry trio activity
The classic: red cabbage indicator
Red cabbage indicator in chemistry teaching

Plantefargar som indikatorar

Du kan lage ei «raudklokke» av ei blåklokke ved å setje henne i ein vase med fortyne eddikesyreløysning. Dersom du i staden har fortyne ammoniakkloëysning i vasen, blir blåkloka til ei «grønklokk». Saft frå både blomar, bær og grønsaker kan fungere som syre-base-indikatorar. Tabellen viser dei forskjellige fargenyansane av rauðkalsaft, og kva dei fortel om pH-verdien i løysninga.

<table>
<thead>
<tr>
<th>Indikatorfarge raudkål</th>
<th>raud</th>
<th>lyseraud</th>
<th>fiolett</th>
<th>blågrøn</th>
<th>grøn</th>
<th>gul</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH-område</td>
<td>0–3</td>
<td>3–4</td>
<td>4–6</td>
<td>7–8</td>
<td>9–12</td>
<td>12–14</td>
</tr>
</tbody>
</table>

Rauðkalsaft er ein flott indikator!

Kjemien stemmer Kjemi 1 (Cappelen)
Blueberries (bilberries) are indicators

Egg white foam w/blueberries (pH in eggs increase w/age → pH = 9)

Cream w/ yoghurt/sour cream, lemon and blueberries

Blueberries

Purpose of the activity

- Context-based teaching of pH and indicators
  - Linking the chemistry to experiences outside science class

- Argumentation
  - Discussions, building coherent arguments, justifying one’s claims

- Possible to extend into further inquiry

- Framework
  - One 75 minute lesson (chemistry or interdisciplinary)
  - Lower or upper secondary school (8th-9th grade or higher)
  - May be adapted to lower grades

pH, indicators and argumentation

• Students should make justified decisions about these claims:
  1. In a basic environment the blueberry juice appears red
  2. Blueberry juice makes the yoghurt acidic
  3. Lemon juice is more acidic than yoghurt

• Support
  – textbooks, ingredients, pH paper

• Support
  – I think this is false because...
  – My data or reason for this is...
  – Some might argue that...
  – This is how I would present my argument to the person being of different opinion...
Blueberry trio – Activity (Maiju)
Extending the trio (I)

"Blueberry quartet"

Muffin with blueberry and extra added baking soda
Extending (II) – focus on egg white foam
Egg white foam extension - Purpose

- Inquiry focus
  - Get experience with systematic experimentation
  - Focus on methods/thinking or methods/thinking + chemical declarative knowledge
  - Using non-lab context for experimenting

- Get to know better the structure, function and properties of proteins

- Get to know the structure of foam
  - A mixture of states of matter (not solid, nor gas, nor liquid)

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Leavens in cookies
Chemistry, physics and sensory evaluation methods

Purpose, time etc.

• Multiple purposes possible
  – Chemical reactions in general
  – Acid/base chemistry, carbonate reaction/equilibrium
  – Properties of gases
  – Everyday chemicals
  – Experiment design
  – Conscious tasting; evaluation of data
  – Sensory evaluation methods: it is possible to measure taste(!)

• Connecting chemistry and science to everyday life
  – Apply scientific and systematic thinking at home as well as in school

• Framework
  – 2 (or 3) sessions of 75 minutes each, incl. homework
  – Lower- or upper secondary school
Main question for inquiry

*Why do we need three different leavens?*

*Does it make a difference if we change from one to another?*
Lesson 1 – traditional lab

- Balloon + Erlenmeyer flask
- 1 ts leavening agent in the balloon, some room tempered water in the flask
  - Baking powder, \( \text{NaHCO}_3 \) + acids
  - Baking soda, \( \text{NaHCO}_3 \)
  - Hartshorn salt, \( (\text{NH}_4)\text{HCO}_3 \)
    - Hirschhornsalzes(?)

- What happens, or does not happen?
  - Class discussion

- Explore properties by making changes
  - Temperature, additions (acid)
<table>
<thead>
<tr>
<th></th>
<th>Baking powder</th>
<th>Baking soda</th>
<th>Hartshorn salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaction w/water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>With warm water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lemon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vinegar</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citric acid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Homework

- Students bake cookies with different leavens
  - Same recipe

- 1 ts baking powder ≈ ½ ts hartshorn salt ≈ ¼ ts baking soda
  - Source: www.naturfag.no/mat

<table>
<thead>
<tr>
<th></th>
<th>Baking powder</th>
<th>Baking soda</th>
<th>Hartshorn salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Group 2</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Group 3</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Group 4</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Group 5</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
## Sensory analysis – Table 1 (per group)

<table>
<thead>
<tr>
<th></th>
<th>Baking powder</th>
<th>Baking soda</th>
<th>Hartshorn salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td><img src="image1" alt="Baking powder" /></td>
<td><img src="image2" alt="Baking soda" /></td>
<td><img src="image3" alt="Hartshorn salt" /></td>
</tr>
<tr>
<td>Group 2</td>
<td><img src="image4" alt="Baking powder" /></td>
<td><img src="image5" alt="Baking soda" /></td>
<td><img src="image6" alt="Hartshorn salt" /></td>
</tr>
<tr>
<td>Group 3</td>
<td><img src="image7" alt="Baking powder" /></td>
<td><img src="image8" alt="Baking soda" /></td>
<td><img src="image9" alt="Hartshorn salt" /></td>
</tr>
<tr>
<td>Group 4</td>
<td><img src="image10" alt="Baking powder" /></td>
<td><img src="image11" alt="Baking soda" /></td>
<td><img src="image12" alt="Hartshorn salt" /></td>
</tr>
<tr>
<td>Group 5</td>
<td><img src="image13" alt="Baking powder" /></td>
<td><img src="image14" alt="Baking soda" /></td>
<td><img src="image15" alt="Hartshorn salt" /></td>
</tr>
</tbody>
</table>
### Sensory analysis – Table 2 (individual)

<table>
<thead>
<tr>
<th></th>
<th>Baking powder</th>
<th>Baking soda</th>
<th>Hartshorn salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweetest</td>
<td>10</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Most bitter</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Most brown</td>
<td>0</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Hardest</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Softest</td>
<td>3</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>Most porous</td>
<td>5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Most nutty flavour</td>
<td>0</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Most buttery flavour</td>
<td>7</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Most caramel flavour</td>
<td>7</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

**Comments**

*NB: Counting number of hands → quantitative measure of taste!*
Discussion and conclusion

Guiding question

Why do we need three different leavens?

Does it make a difference if we change from one to another?

- Can we make some educated guesses based on our results?
- Can we find any other information that can help us interpret?
  - Second-hand investigations/inquiry
    - Palincsar & Magnusson (2001)
Evidence (second-hand investigations)

- **Baking powder and baking soda**
  - With acid: $\text{HCO}_3^- \quad (\text{aq}) + \text{H}^+ \quad (\text{aq}) \rightarrow \text{H}_2\text{CO}_3 \quad (\text{aq}) \rightarrow \text{CO}_2 \quad (\text{g}) + \text{H}_2\text{O} \quad (\text{g/l})$
  - Without acid: $\text{HCO}_3^- \quad (\text{aq}) + \text{H}_2\text{O} \quad (\text{g/l}) \rightarrow \text{H}_2\text{CO}_3 \quad (\text{aq}) + \text{OH}^- \quad (\text{aq})$
  - Without water: $2 \text{NaHCO}_3 \quad (\text{s}) \rightarrow \text{Na}_2\text{CO}_3 \quad (\text{s}) + \text{CO}_2 \quad (\text{g}) + \text{H}_2\text{O} \quad (\text{g})$

- **Hartshorn salt**
  - Without water: $(\text{NH}_4)\text{HCO}_3 \quad (\text{s}) \rightarrow \text{CO}_2 \quad (\text{g}) + \text{H}_2\text{O} \quad (\text{g}) + \text{NH}_3 \quad (\text{g})$

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Evidence (second-hand investigations)

- Gluten formation is promoted in acidic conditions

- Maillard (browning) reaction is promoted in basic conditions