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Food Preservatives

This article is intended for high school students pursuing chemistry classes at both beginner and advanced level. The material described in this paper can be used in the discussion about preventing food spoilage. It may also provide additional material for students who want to broaden their knowledge of the properties and uses of selected inorganic and organic compounds.

1. Introduction
People have long sought ways to store food which deteriorated under the influence of bacteria, yeast, mold, light, oxygen and water vapor from the air. Initially, our ancestors used method of drying, smoking and baking. There are many ways to extend the life of food. These include sterilization, freezing, crystallization, exposure to ionizing radiation and the use of preservatives.

2. Functioning of preservatives
Preservatives are one of the groups of food additives that are natural substances of food components.
Preservatives effectively help to prevent and suppress spoilage adverse processes and reduction in the quality of food. The use of these substances affects the life extension of raw materials, semi-finished and finished products, and prevents adverse changes during storage. Preservatives should be used with caution because they may increase the risk of allergic diseases and cancer.

3. Symbols of preservatives
Preservatives, like other food additives are marked with identification number used in the INS and the symbol E. E symbol placed on package is an indication by the manufacturer that used substances are included in the list approved by the European Union. Preservatives are codes E 200 - E 299.
According to The Ministry of Agriculture and Rural Development dated 10 July 2007 (Journal of Laws of 2007 No. 137, item. 966) on the labeling of foodstuffs (as amended) - the used type of food additives should be presented on the label of the product. The manufacturer is required to provide a technological function of the substance and its name or number "E", for example, preservative: sodium benzoate or preservative E 211.

The use of preservatives and other food additives is regulated by the Regulation of the Minister of Health on November 22, 2010 (Journal of Laws of 2010 No. 232, item. 152) regarding the permitted additives. It defines what additives are allowed, and maximum quantity which may be used. Examples of acceptable preservative amount in Poland are shown in the table:

<table>
<thead>
<tr>
<th>Name of the substance</th>
<th>E number</th>
<th>Food products</th>
<th>The maximum amount mg/kg or mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>nisin</td>
<td>E 234</td>
<td>ripened and processed cheese</td>
<td>12.5 mg/kg</td>
</tr>
<tr>
<td>boric acid</td>
<td>E 284</td>
<td>caviar</td>
<td>4 g/kg</td>
</tr>
<tr>
<td>propionic acid</td>
<td>E 280</td>
<td>packed sliced bread</td>
<td>3000 mg/kg</td>
</tr>
<tr>
<td>Dimethyl dicarbonate</td>
<td>E 242</td>
<td>non-alcoholic grape wine</td>
<td>250 mg/l</td>
</tr>
<tr>
<td>nitrate (III) potassium</td>
<td>E 249</td>
<td>meat products</td>
<td>150 mg.kg</td>
</tr>
<tr>
<td>nitrate (IV) potassium</td>
<td>E 252</td>
<td>pickled herring and sprat</td>
<td>500 mg/kg</td>
</tr>
</tbody>
</table>

4. Selected food preservatives

Sorbic acid (E 200) - CH3-CH = CH-CH = CH-COOH - compound from the group of unsaturated carboxylic acids. It is fine, crystalline, odorless solid with a slightly acidic taste. In its natural state it can be found in the rowan berries. It inhibits the growth of yeasts and molds at pH 3 – 6. Sorbic acid is used as a preservative in the manufacture of ensilage, canned fish, processed fruit, yogurts.

Sorbic acid is decomposed in the gastrointestinal tract, however, those with a tendency to urticaria may notice the increase of bubbles.
**Sodium benzoate** (E 211) - C6H5COONa - is the sodium salt of benzoic acid. In the standard conditions it is a white, crystalline solid, soluble in water. In strongly acidic environment it has bactericidal and fungistatic properties. Therefore, it is used for the maintenance of soft drinks (carbonated and non-carbonated), e.g. cola drinks, low-sugar jams, salads, mayonnaise and margarine. Figure 1 shows part of the label regarding a soft drink composition, including the presence of sodium benzoate.

Figure 1

Sodium benzoate may cause irritation of the gastric mucosa, especially in patients with peptic ulcer disease. In some people, especially asthmatics and allergy sufferers may cause allergic reactions. In combination with L-ascorbic acid (vitamin C), there is the possibility of carcinogenic benzene, which is important in the case of carbonated beverages.

**Sulfur oxide** (IV), otherwise sulfur dioxide (E 220) - SO2 - sulfuric acid anhydride (IV). It is a colourless gas with pungent and suffocating odor, heavier than air, soluble in water and acetone. It inhibits the growth of bacteria and mold and has bleaching properties. It is used to maintain jams, juices, dried fruits and vegetables, marinated mushrooms. In wine production it works primarily as an antiseptic and protects wine from adverse biochemical changes.

Figure 2 shows part of the label with information on sulfur oxide (IV) (sulfur dioxide) as a coconut preservative.
Sulfur oxide (IV) destroys vitamin B12. Susceptible people may cause nausea and headaches, and in the case of asthma can cause so-called sulfite asthma (breathing problems).

**Nisin** (E 234) - polycyclic peptide. It is produced by the fermentation of lactic acid by the bacteria Lactococcus lactis. It belongs to the bacteriocins. Nisin is stable at high temperature with low pH. Its antimicrobial activity covers a wide range of Gram-positive bacteria, including Streptococcus, Lactobacillus, Enterococcus, Listeria and the Gram negative bacteria E. coli and Salmonella. Nisin is most commonly used as a natural preservative in the following products: ripened cheeses and processed cheeses, Clotted cream cheese, pudding with semolina and tapioca starch, egg weight.

Nisin is considered to be non-toxic - its LD50 is 6.95 g / kg body weight.

**Propionic acid** (E 280) - C2H5COOH - carboxylic acid group. At room temperature, it is a colorless liquid with an unpleasant odor, soluble in water. Present in milk, and in small quantities in urine and sweat. It can also be produced by fermentation of propionic acid, which is used in production of ripened cheese. Propionic acid inhibits the growth of bacteria, yeasts and fungi. In relation to the Gram-positive bacteria its interaction is weaker than the Gram negative bacteria. Propionic acid is used to prolong the life of bakery products. For this purpose, it is added to packaged sliced bread, rye bread and pastry goods.

The use of propionic acid is uncontroversial because the substance is well metabolized in the human body.
Nitrate (III) sodium, or sodium nitrite (E 250) - NaNO₂ - nitric acid salt (III). At room temperature, is a white to yellowish crystalline substance, well soluble in water. It reduces heat resistance of bacterial spores, inhibits the growth of pathogenic microorganisms, especially Clostridium botulinum (botulism sticks). Nitrate (III) solution is used to cure meat, hence its presence in sausages, canned meat and meat products, convenience foods, where it prevents the proliferation of bacteria and gives the characteristic pink color of the meat.

Figure 3 shows a fragment of the labels relating to the composition of pork sausages, in the presence of nitrate (III) sodium (sodium nitrite) in the product.

![Figure 3](image)

Nitrate (III) sodium reacts with amines, arising from the decomposition of proteins, it can form carcinogenic nitrosamines. Daily intake of the salt should not exceed 0.06 mg / kg body weight. To avoid overdosing nitrate (III) sulfate, it can be used to cure meat only as a blend of NaCl containing 0.5-0.6% NaN0₂.

5. Summary

When you buy food, pay attention to the label, as this will show the composition of the product, including information on the preservatives. Each consumer has to choose what and how much they buy, paying attention to the health, practical and functional aspects.
6. Trivia

Sodium acetate CH₃COONa (E 262) can be used as a canned (or bottled) fruit and vegetable preservative.

Supersaturated solution of sodium acetate (room temperature) actuated with mechanical stimulus gets crystallized, giving off heat. The film presents the experience of "Supercooled liquid or hot ice" is available at:
http://weirdscience.eu/Ciecz%20przech%C5%82odzona%2C%20albo%20gor%C4%85cy%20C3%B3d.html

Bibliography

2. Łatka U., Technologia i towaroznawstwo
5. dobrydietetyk.pl
6. isap.sejm.gov.pl
7. wsse.krakow.pl
8. wikipedia.org

Note to students:

1. Calculate how many milligrams E210 benzoic acid can be found in 0.5 kg of the beverage, if the permissible number of beverages of this compound is 200 mg / kg.
2. Calculate how many 10-percent acetic acid (vinegar) is needed for 150 g of water to prepare marinade for cucumbers. Vinegar water ratio is 1: 3.

Teacher's notes:

1. The article can be an introduction to a discussion on "Do we know what we eat"?
2. Analyze various methods of food preservation.