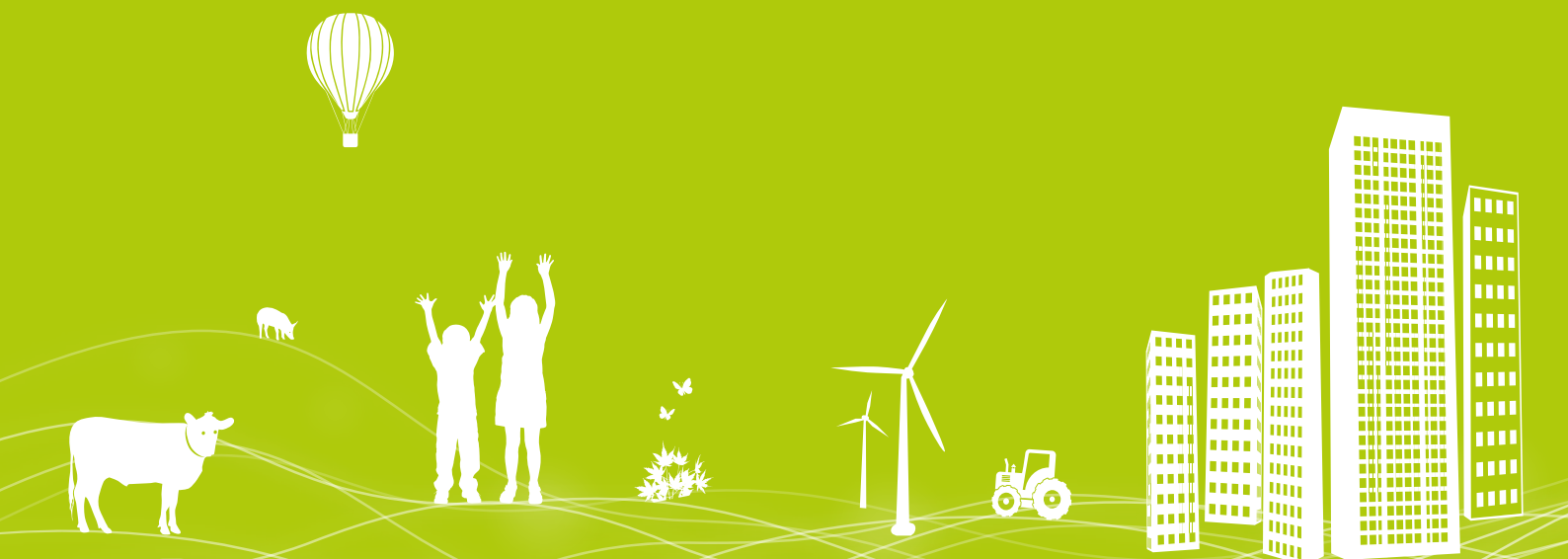
SUSTAIN

FOOD IN ESD



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With the support of the Lifelong Learning Programme of the European Union

The SUSTAIN network has been created to develop significant connections between Inquiry-Based Science Education (IBSE) and Education for Sustainable Development (ESD) in order to create classroom activities and professional development resources for teachers and teacher educators.

To reach this goal, the network uses and disseminates effective and well-tried methods of IBSE, that have been extensively developed throughout Europe in previous activities, especially in the Fibonacci project .

The network is composed of 11 European institutions actively involved in providing continuing professional development (CPD) to teachers and teacher educators in science in 10 European countries.

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FOOD IN ESD

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Introduction

Why address sustainable development through science education?

Climate change, loss of biodiversity, management of natural resources, pollution, are examples of global issues that are key for sustainable development which are related to science and technology and also have important implications for the socio-economical structure of a community. Consequently, they suggest a need for citizens and societies to engage in a deep behavioural change.

Education has a crucial role to play as a prerequisite for promoting change and providing all citizens with key competences needed to participate in the democratic debate. Citizens need better understanding of the scientific ideas that are inherent to these global issues in order to understand their causes and consequences, and the alternative choices that are proposed by the governments and also by the corporate world. They also need to look at those issues critically and be aware that in many areas there are several options and choices with different consequences.

This is why new skills, methods and connections are required among pupils and teachers in order to create better links between education for sustainable development, scientific literacy, and active citizenship.

The SUSTAIN network has developed this handbook with the aim of contributing to the development of the understanding of ESD topics in the context of science teaching.

What is Inquiry-Based Science Education?

"Inquiry is a term used both within education and in daily life to refer to seeking knowledge or information by asking questions. It is sometimes equated with research, investigation, or 'search for truth'. Within education, inquiry can take place in several subject domains, such as history, geography, the arts, as well as science, mathematics and technology, when questions are raised, evidence is gathered and possible explanations are considered. In each area different kinds of knowledge and understanding emerge. What distinguishes scientific inquiry is that it leads to knowledge and understanding of the natural and made world around through methods which depend on the collection and use of evidence."[1]

1 From *Inquiry in science education*, Wynne HARLEN, 2013

The process of IBSE begins by trying to make sense of a phenomenon, or answer a question, about why something behaves in a certain way or takes the form it does. Initial exploration reveals features that recall previous ideas leading to a possible explanation or hypothesis to be tried. Working scientifically, students then proceed to see how meaningful the existing idea is by making a prediction based on the hypothesis, because ideas are valid only if they have predictive power.

To test the prediction, new data about the phenomenon or problem are gathered, then analysed and the outcome used as evidence to compare with the predicted result. From these results a tentative conclusion can be drawn about the initial idea. If it gives a good explanation then the existing idea is not only confirmed, but becomes more powerful –'bigger'– because it then explains a wider range of phenomena. Even if it doesn't produce the expected result, and an alternative idea has to be tried, the experience has helped to refine the idea, so knowing that the existing idea does not fit is also useful.

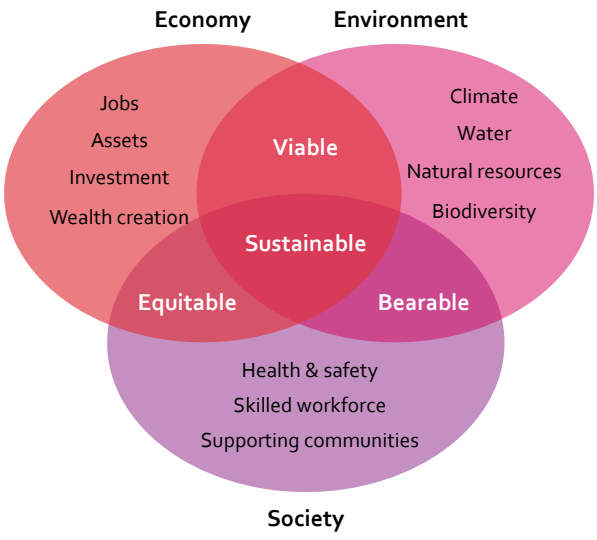
This process of building understanding through collecting evidence to test possible explanations and the ideas behind them in a scientific manner, we describe as learning through scientific inquiry.

What is Education for Sustainable Development?

Before defining ESD, it is important to consider what sustainable development is.

Sustainable development is commonly defined as 'development which meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, Brundtland Report, 1987).

It is usually depicted through a model of three-interdependent-pillars environmental, social and economic, as illustrated in the diagram below.



The Three Pillars of Sustainable Development

Sustainable development is a holistic society project and as such it cannot be defined and implemented without science; indeed science plays a huge role in all the three pillars (the way we produce goods, the way we use natural resources, the way we care for people's health or we communicate…) and also forms part of our common culture, this being now often considered as a fourth pillar or rather a cross-cutting dimension of sustainable development. This is why cultural issues are addressed in this book, particularly within the Society pillar.

Because of this strong and crucial connection between science and the global ambition towards sustainable development, it is important to reinforce the links between Education for Sustainable Development and science education.

Education for Sustainable Development is defined by Unesco as "[education which] allows every human being to acquire the knowledge, skills, attitudes and values necessary to shape a sustainable future.

Education for Sustainable Development means including key sustainable development issues into teaching and learning; for example, climate change, disaster risk reduction, biodiversity, poverty reduction, and sustainable consumption. It also requires participatory teaching and learning methods that motivate and empower learners to change their behaviour and take action for sustainable development. Education for Sustainable Development consequently promotes competencies like critical thinking, imagining future scenarios and making decisions in a collaborative way."[2]

The educational responses to the challenge of sustainable development, however, cannot be reduced to a unique perspective. In fact, as Sterling (2001)[3] underlines, three approaches can be identified:

- **Education about sustainability**; the emphasis is on knowledge related to sustainability. It assumes that sustainability can be easily defined and so it can become a separate subject within school curriculum. This response supports a "conservative learning" and the current educational paradigm remains unquestioned;
- **Education for sustainability**; the emphasis is on "learning for change" (as in the UNESCO's approach). It includes knowledge but goes further to involve values, attitudes, skills and behavior. This response includes a critical and reflective thinking;
- **Education as sustainability**; the emphasis is on the process and on "the quality of learning". It includes all the above responses but emphasizes "learning", seen as "a creative, reflective and participative process". In this perspective, learning is considered "as change" and involves individuals and institutions. The current educational paradigms are put into discussion, supporting a transformative and creative response to sustainability.

Within this global framework, it is clear that ESD, supporting individual's engagement through quality learning, can lead to positive personal and community actions.

On these presuppositions, IBSE can contribute to ESD as they share common values: cooperation, creativity, innovation. It can particularly help building the knowledge, skills and attitude that support an objective reflection on environmental, social and economic phenomena which goes beyond opinion and anecdote.

Education for Sustainable Development and the place of inquiry: the contribution of SUSTAIN

Despite the fact that the three pillars of sustainable development are intertwined, educational disciplines tend to invest attention in just one of the three, thus perpetuating the compartmentalisation of traditional curriculum subjects.

Yet, ESD encourages more complex and multidimensional approaches. It includes a number of dimensions: scientific, geographical, economic, political, social, cultural.

Combining ESD with IBSE gives explicit attention to developing young people's awareness and ability to approach problems and imagine new scenarios through the active learning processes of conceptualising, planning, acting and reflecting. It provides the space for critical thinking to be combined with the creative act of interpreting images of the future.

This handbook explores the way IBSE can contribute to developing ESD: connecting more teachers and pupils with real life challenges and contemporary science; introducing topical issues related to science and technology, economy, culture, as they are debated

2 Unesco website: http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-sustainable-development/

3 Sterling, Stephen. Sustainable Education – Re-visioning Learning and Change, Schumacher Briefings, Green Books, Dartington, 2001.

in society; applying inquiry skills to issues related to sustainability in the wisest sense; connecting schools to the great diversity of sustainable development stakeholders within the different communities.

Some examples of the way IBSE can contribute to ESD

ESD is not only about environmental problems, it assumes a cross-disciplinary approach encompassing economic social and cultural factors	IBSE is a method that develops the ability to approach complexity in a scientific way
ESD deals with complex issues, highly intertwined from personal to local to global levels	IBSE provides opportunities to develop deeper scientific conceptual understanding and understanding about the nature of science that are needed to approach a complex world
ESD is oriented towards change of values, attitudes, behaviour and action patterns	IBSE develops a diversity of skills as well as knowledge; as such it engages children to seek answers and equips them to make informed decisions
ESD involves a wide range of subjects/ stakeholders	IBSE encourages an approach which develops strong links with economists, scientists and local communities.
ESD often deals with controversial and debated issues	IBSE can help go beyond debate based on opinion by developing critical thinking and evidence-based arguments

Assessment within SUSTAIN

Assessment of students' learning can take many forms and serve many purposes:

- *formative assessment* can be done at any time to provide ongoing feedback and should influence your plans and practices in the classroom;
- *summative assessment* usually happens at the end of a sequence of lessons to determine the impact on student learning and the effectiveness of teaching.

SUSTAIN has a focus on integrating IBSE and ESD approaches, and so assessment needs to consider different types of learning outcomes. IBSE involves not only scientific knowledge, but also the ability to carry out and understand scientific inquiry. Learning outcomes in ESD include critical thinking and changes in attitudes and behaviour. Assessing this range of learning outcomes is challenging, and will involve a range of approaches, such as: looking at written reports about hands-on activity, science notebooks, posters or worksheets, listening to students' arguments and explanations, observing how students undertake inquiries and questioning them about their decisions and conclusions.

Below we offer some tools to support you in assessing your students' progress, which you can use within the context of your own National Curriculum. These may also provide a useful basis for evaluating your own planning and teaching by considering whether you have provided adequate opportunities for the different kinds of learning activity. We also recommend more detailed information about assessment in IBSE which was developed by the Fibonacci Project, and which is available at http://www.fibonacci-project.eu[4].

For IBSE[5] These indicators are phrased in terms of student activity and could also be used to evaluate the learning opportunities provided.

4 Tools for enhancing inquiry in science education (2012),

5 Adapted from: National Research Council (2000). *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning.* Washington, DC: National Academic Press

Key elements	Example indicators	Yes	No
Students engage in answering scientifically oriented questions	A starting point is linked to a real situation		
	Students consider what they already know and what they want to find out		
	Productive questions are selected		
	Students make predictions and conjectures		
Students give priority to evidence	Students decide what data to collect		
	Students design the procedure for collecting data, and how to ensure accuracy		
	Students collect data		
Students formulate explanations from evidence	Students analyse data and identify evidence		
	Students formulate conclusions or explanations based on evidence		
	Students answer the inquiry question(s) using this evidence		
Students evaluate their explanations	Students check whether the evidence supports the explanations, and adequately answers inquiry question(s)		
	Students check for any biases or flaws in their reasoning		
	Students check their results with those of their classmates		
	Students consider alternative explanations and link their results to scientific knowledge		
Students communicate and justify explanations	Students share their results and explanations with each other through written, visual or oral reports		
	Students explain why evidence is important, and link this to specific concepts or assumptions		

For ESD[6] These indicators are phrased in terms of the design of learning opportunities and give some guidance about areas in which student learning could be assessed.

6 Based on: UNESCO World Conference on Education for Sustainable Development (Bonn 2009), Bonn Declaration (http://www.esd-world-conference-2009.org/fileadmin/download/ESD2009_BonnDeclaration.pdf), Sterling, S. (2006) *EducazioneSostenibile*, Anna Mundi Editrice, Cesena, UNECE Strategy for Education for Sustainable Development (2005) (http://www.unece.org/fileadmin/DAM/env/documents/2005/cep/ac.13.2005.3rev.1.e.pdf)

Key elements	Example indicators	Yes	No
The topic is developed in reference to the dimensions of sustainability	Its environmental implications are identified and analysed		
	Its social implications are identified and analysed		
	Its economic implications are identified and analysed		
	Local and global contexts and past/present/future perspectives are considered		
The topic is developed using an holistic approach	Connections between dimensions of ESD are sought and different disciplines are involved		
	The complexity of relationships between the natural environment and human activity are considered		
	There is awareness of uncertainty and its role in decision making		
The topic is developed using a participative approach	The activities support reflection on our (individual and collective) role as citizens and as consumers of goods and services		
	Different points of view and opinions, and the conflicts which may arise, are taken into account		
	Responsibility towards the environment and the 'common good' is highlighted		
The topic is developed using a transformative approach	The activities stimulate critical reflection on issues		
	The activities promote creativity and pro-active responses		
	Attention is focused not only on knowledge, but also on values, life styles and behaviours		
	Alternatives for change are explored		

Presentation of the set of three handbooks

This handbook dedicated to the issue of food is part of a set that includes two other handbooks on the issues of energy and everyday objects.

Together, these three handbooks form a large ESD-oriented science teaching resource that allows teachers to approach sustainable development issues on the basis of children's everyday life and experience. Such an approach considerably enriches the teaching content and relevance for the children of big ideas[7] and key competences of science.

Why those issues?

Food is a normal, but essential commodity in our daily lives. The handbook will enable teachers to examine different foods regarding their composition (nutrition), production (growth), distribution and consumption. In that way, children will not only increase their scientific knowledge and skills, but also their knowledge about the interconnectivity between environment, society and economy. Since the pupils will also reflect on their attitudes and values, they will be empowered to take action by making informed decisions and if wanted by changing their lifestyle.

Energy is essential to all our lives. However, global warming seems to be underway as a consequence of our pursuit to increase energy supply to meet the needs of development and population expansion. Concern about this has given risen to limitations on the use of fossil fuels, improving energy efficiency and the use of renewable energy systems. These initiatives have an important role to play in the debate about and for sustainability; as such understanding the issues involved (using non-renewable and renewable energy; energy usage and conservation) is an important part of scientific literacy for the future.

Everyday objects that we almost always take for granted can be a source of stimulating and accessible scientific inquiries for children. The handbook will explore how investigating the ways that familiar objects work can provide opportunities to develop both scientific understanding and inquiry skills. But objects also have life stories: investigating how they were made, and what will happen to them after we have finished using them engages children in perspective beyond their own needs and experiences, considering the environmental, social and economic issues relating to sustainable development, and gives interesting opportunities for cross-curricular activities.

7 *Principles and big ideas of science education*, Wynne Harlen Ed., Association for Science Education, 2010



Introduction to Food in ESD

Food is an excellent topic to combine the methods of IBSE and ESD. Children have everyday experience with it; they have their preferences and habits. It is possible to draw their attention to different aspects of food which they have not noticed before and thus influence the way they act. They may ask questions like: Does it make any difference if I buy this product instead of that one? Where does my food come from? Why is this product cheaper and that one more expensive? By answering those questions, they may be already making a contribution to a more sustainable future by changing their consumption habits. For example, a child can decide to eat locally grown apples, rather than imported fruit, after learning about the economic issues surrounding supporting the local community or the energy needed to transport certain products long distances. When they find out how much food is wasted, children can, with the help of their families, try to stop adding to the problem by learning about alternatives, such as making desserts from old bread instead of throwing it out. In this booklet, the focus is on specific food commodities: milk, bread, honey, and seasonal food. For each of these commodities, four sets of activities have been developed dealing with the characteristics of the food, and its production and distribution, as well as its consumption.

Sustainability implies the use of resources at rates that do not exceed the capacity of the Earth to replace them. For food, a sustainable system might be seen as encompassing a range of issues such as the security of the supply of food, health, safety, affordability, quality, a strong food industry in terms of jobs and growth, and, at the same time, environmental sustainability in terms of issues such as climate change, biodiversity, water and soil quality. There is a need to reduce inputs, minimise waste, improve management of resource stocks, change consumption patterns, optimise production processes, management and business methods, and improve logistics. When discussing the sustainability of food one needs to take into consideration increased global population growth, current diets which are becoming less healthy, costs, supply chains and their industrial and environmental impact, the loss of biodiversity, food waste, and many other factors.

General approach to the topic

The four commodities used in this booklet (i.e. bread, honey, seasonal food and milk) demonstrate the possibilities to investigate the environmental, economic and social dimensions of any other commodity. The presented research designs analyse composition and properties, and monitors different aspects of growth and production, distribution and selling as well as consumption. Those four areas allow for the move from the familiar and, for children, more obvious characteristics (e.g. taste, appearance, shelf life, food waste, etc.) to the less familiar (e.g. local versus global impact, employment, price formation, etc.). Local research and local resources should be a springboard for further research, exploring other geographical, economic and social locations and environments.

The proposed activities can be used by pupils at either primary or secondary level. Exploring bread is suitable for working with younger children, while honey, milk, and seasonal food are designed for older pupils. Teachers can simplify or adapt the ideas for various age groups according to their needs. The activities are not necessarily interconnected. Teachers can choose the ones which best fit into their syllabus or help them reach certain goals. The following list of activities, the different concepts they help develop, and the inquiry skills they implement offer material which is ready to use or easily modified according to any given curriculum, local circumstances, and objectives of the teacher.

Overview of activities

Commodity / Area	Bread	Honey	Fruit and vegetables	Milk
Characteristics/ properties	1.1 Sorters and Sifters: Characteristics of different kinds of bread	2.1 What is honey? What is the criteria for the composition of honey?	3.1 Characteristics of fruit and vegetables	4.1 What is milk?
Production/growth	1.2 The rising of dough	2.2 Harvesting honey	3.2 Do seasons matter?	4.2 The production and consumption of milk
Distribution/trade	1.3 The cost of bread	2.3 Selling honey	3.3 How to keep it fresh longer?	4.3 How is milk packaged?
Consumption	1.4 Avoiding the wasting of bread	2.4 The consumption and value of honey	3.4 Reading labels and logos	4.4 Is local food better?

Specific topics investigated in the activities		Bread	Honey	Fruit and vegetables	Milk
Composition				3.1	4.1
Origin	*growth, production, harvesting*	1.2	2.2	3.2	4.2
	location import / export		2.3	3.2	4.4
Properties		1.1	2.1	3.1	4.1
Price		1.3			
Shelf life	*conservation*			3.3	
	waste of food	1.4			
Sales, Distribution	*regulations, labelling requirements*		2.3		4.3
	special logos			3.4	
	containers, packaging				4.3
Consumption		1.4			4.2
Customer choice			2.4	3.1	
Advertising					4.3

1 BREAD

1.1 Sorters and Sifters: Characteristics of different kinds of bread

Objectives

- Pupils sort bread according to common categories determined by different groups of pupils.
- Pupils are able to communicate the categories they have found.
- Pupils recognize the differences between different types of bread.
- Pupils describe a previously unknown type of bread (by close observation).

Research question

Do different sorts of bread look and taste different?

Duration

50 minutes

Required material

- Bread matching the evidence cards (sourdough, white slice "toast"), brown bread, white bread, pumpernickel bread, etc. and 1 type of bread for own evidence card
- Evidence cards, one blank evidence card

Possible teaching sequence

1. Divide pupils into groups of 4 or 5 children. Ask children to sort bread according to their own criteria. What possible criteria are there to sort bread?
2. The pupils present their ideas and give reasons for their categories. Important: Each classification e.g. colour, shape, variety, grain, presumed age, etc., is correct if the children can justify it.
3. Discuss: What criteria are there to sort bread? Write them down on the worksheet. The teacher presents particular criteria and pupils sort bread accordingly.
4. Distribute the evidence cards to the groups. Pupils match bread to the evidence cards. Compare the results.
5. Pupils need to write their own evidence card for a new kind of bread.
6. Conclusion: Bread tasting – the pupils give their opinion on which sort of bread tastes the best.

Background information

Bread and pastries always contain the same four basic ingredients: flour, water, salt, and yeast, or sourdough. Sourdough is defined as a pre-dough consisting of flour, water and microorganisms (yeast fungus, lactic acid bacteria, or acetobacteraceae). Sometimes baking soda is used instead of yeast – it is suitable for both light and heavy dough. If baking soda is used, you also need an acidic ingredient such as any leavened dairy product. An acidic component reacts with the baking soda to produce CO_2 which is released. This makes the dough rise during the baking process. You cannot identify ingredients used to make bread from the colour of the bread. Dark bread does not mean it is a whole grain rye product because rye bread can also be light. The dark colour is usually achieved by malt or toasted flour. Malt is germinated cereal (wheat, rye, etc.) which contains a lot of starch-degrading enzymes. Malt is often used in both wheat bread and white bread ("toast").

Why is the long, white loaf of bread so soft and light compared to darker, rounder bread? A white loaf of bread ("toast") is made of wheat flour dough, more fat (margarine or butter) and some sugar. Sometimes milk is also added.

The main difference between soft flour and whole grain flour is already apparent from their names. While whole grain flour contains whole grains containing all parts of the entire grain in its original proportions (i.e. the original kernel, all of the bran, germ, and endosperm), common flour only contains the finely ground bright endosperm of the grain. The bran is completely removed before grinding. Thus, common flour is lighter than whole grain flour. But the whole grain flour is much healthier because the bran contains many vitamins and fibre.

Further ideas

The pupils could taste different kinds of bread every other day over the next four days and discuss which one tastes the best after four days.

Types of bread:	
We can see the following features:	
Feature	**Variations**
Shape	*Round, angular, oval, …*

Evidence Card 1

The crust is dark.
The inside is brown.
No grains are visible.
It feels solid.
It is narrow and oval.
It is sourdough bread.

Evidence Card 2

The crust is light brown.
The inside is almost white.
No grains are visible.
It feels very soft.
It is rectangular.
It is a loaf of white bread ("toast").

Evidence Card 3

The crust is dark.
The inside is light brown.
No grains are visible.
It feels soft.
It is almost oval.
It is brown bread.

Evidence Card 4

The crust is light brown.
The inside is almost white.
No grains are visible.
It feels very soft.
It is almost oval.
It is white bread.

Evidence Card 5

The crust is dark.
The inside is brown.
Grains are visible.
It feels solid.
It is rectangular.
It is pumpernickel bread.

Evidence Card 6

_____
_____
_____
_____
_____
_____

1.2 The rising of dough

Objectives

- Pupils pose scientific questions regarding the making of bread.
- Pupils formulate predictions and write them down.
- Pupils are able to carry out an experiment and document it.
- Pupils learn that yeast in connection with water and starch is responsible for the rising of dough.

Research question

What makes bread dough rise?

Duration

3 lessons – 50 minutes each (ideally 2 consecutive lessons and 1 lesson the next day)

Required materials

For teacher's demonstration: bread, prepared bread dough mixture (2 teaspoons of flour, 50 ml of warm water, ¼ package yeast, 1 teaspoon of sugar, ½ teaspoon of salt), 1 clear plastic cup

For pupils' experiments (for 5 groups): 8 teaspoons of flour, 200 ml of warm water, 1 package yeast, 4 teaspoons of sugar, 2 teaspoons of salt, 5 clear plastic cups, 5 waterproof pens, 5 teaspoons, 5 stirring rods, worksheets

Possible teaching sequence

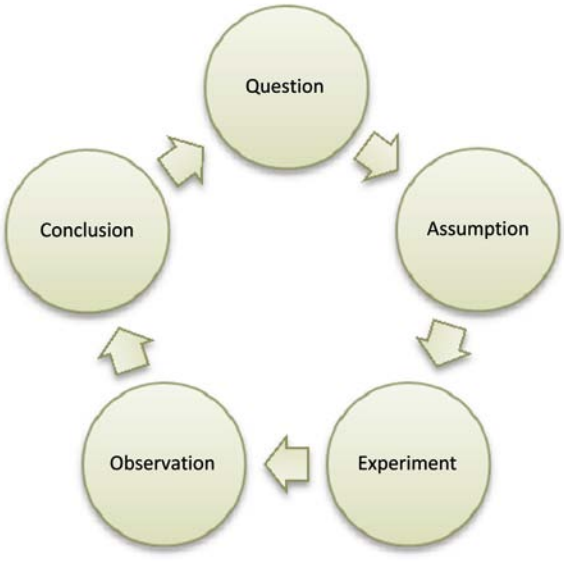
1. The teacher shows the raw dough and the baked bread to the children. The children describe what they see and name the differences (e.g. the baked dough is bigger and has holes in it).
2. Pupils brainstorm to come up with what ingredients are needed to make bread (i.e. yeast, water, flour, sugar, salt).
3. Which ingredient is responsible for the dough rising? The teacher encourages pupils to think about how to answer the question. The teacher presents all the ingredients and the plastic cups. The teacher measures and mixes all the ingredients needed to make bread in front of the children. Pupils also formulate predictions about which ingredient makes the dough rise. At the end, compare the predictions with the result. Usually the children predict that yeast is needed. They can test that by comparing one cup with all the ingredients and one cup with everything except the yeast. After the experiment children see that yeast is needed. But what else is needed the make the dough rise?
4. The teacher explains to the pupils how scientists work by using the 5-step diagram starting with the Question: "Why does the dough rise?" Then comes the Prediction/Hypothesis: "The yeast is responsible for it, etc." It is important to stress that conclusions lead to new questions, for example, "What else is needed to make the dough rise?"
5. A teacher divides pupils into 5 groups. Each group is given a cup and all the ingredients but for one (group 1 gets no water, group 2 no flour, etc.). Pupils label the cups with their group number and fill out their worksheets.
6. Compare and discuss the results. Complete the worksheets.

Background information

Scientific work

From the very start, it is important that children learn how scientists work. We want them to understand that scientific work is not only about doing experiments but also includes discussions about planning an investigation in advance, and thinking about what has to be done. Based on observations, a scientist raises various questions. Then he/she presents a hypothesis (a scientific assumption) which he/she then tests. Based on the result, a scientist draws a conclusion.

"The rising of dough" lesson offers the opportunity for the children to work like scientists. They start by observing the bread and bread dough. This raises the



question of how holes get into the bread. To answer this question, experiments are conducted which include the formulation of assumptions, fair testing (the control of variables), and the drawing of conclusions on the basis of their own observations. The conclusions may lead to new research questions.

Yeast and its metabolism

Yeast fungus is present everywhere in our environment. Yeast is a single-celled living organism. It is able to live in aerobic and anaerobic conditions. It uses sugar as its source of energy. Aerobic metabolism: Sugar → H_2O + CO_2 + Energy. Anaerobic metabolism: Sugar → alcohol + CO_2 + (less) energy.

The CO_2 is responsible for the rising of the dough.

Why does the dough rise without sugar?

Bread flour contains starch which is a long chain of sugar molecules joined together in a string to make one larger molecule. The yeast converts starch into simple sugar that can be metabolized (see above), so even without adding sugar, the bread dough can rise.

Further ideas and links

Baking bread: The ingredients used by the children should not be thrown away. It is recommended that they use them to bake bread/buns. With one cube of yeast (42 g) and 500 g to 1 kg flour, every child can have their own bun. Remember to add the ingredient missing from each of the experimental mixtures so that every cup has all the ingredients needed.

The teacher provides the remaining flour (about 1 kg), 1 empty cup for each child, herbs, salt, an oven, a baking tray, and baking paper.

Warm water can be added if needed. Ingredients from all the cups can be mixed together and the dough divided into as many lumps as there are pupils. Every child can form his/her own bun and sprinkle it with herbs and/or sea salt. Preheat the oven to 220°C. Put the buns on the baking paper on the baking tray and bake for approximately 20 minutes. If no oven is available, the children can take the cups home and bake the bun at home with the help of an adult. The costs of the bun can be calculated afterwards (see activity 1.3).

Name:	Date:

Ingredients needed for bread dough:

_____

_____

Research questions: **What makes the dough rise?**

My assumption: _____

Draw the way you are going to test your assumption:

My observation:

My conclusion:

Our research question: What else is needed to make the dough rise?

Our assumption:

_____

Our experiment

	We use ✓ We do not use ✕					Our assumption		Result
	W	**F**	**Su**	**Sa**	**Y**	**Rises**	**Does not rise**	
Group 1								
Group 2								
Group 3								
Group 4								
Group 5								

Abbreviation:

W = 50 ml warm water, **F** = 2 teaspoons flour, **Su** = 1 teaspoon sugar, **Sa** = ½ teaspoon salt, **Y** = 10 g yeast

Conclusion

1.3 The cost of bread

Objectives

- The children realize that the price of bread is the result of several factors.
- The children realize that there are many different values in the range between pure production costs and the selling price.
- The children become familiar with terms used in the business world (e.g. production, business, wage, tax).
- The children understand simple economic relationships.

Research question

Why is there a difference between the production costs of making bread and its selling price?

Duration

2 lessons – 50 minutes each

Required material

Concept Cartoon and 3 flashcards to facilitate discussion

Recommended for this unit:

- Experience with having baked bread themselves.
- Knowing the price of one homemade bun (see activity 1.2).

Children have already made their own bun and know that they can make 22-24 buns from one kilogram of flour. They have also calculated the price of a homemade bun (30 cents in Austria).

Possible teaching sequence

1. Use the Concept Cartoon to start a discussion about the cost of bread.
2. Initiate discussion by asking questions about the Concept Cartoon:

   What do you think the girl is going to say?

   Is she going to complain how expensive the bread from the bakery is?

   How can you explain the price difference?

   Is the baker who sells buns a rich man?

3. Roleplay: Let's buy some bread in a small bakery: 2 salespersons, 1 accountant and 3 customers.

Costumer 1 buys a 1 kg loaf of organic spelt bread. It costs 6.36 Euro. They discuss the high price of the bread: organic, handmade, healthy, longer fresh, and delicious taste.

Costumer 2 buys a 1 kg loaf of brown bread and 4 buns for 3.34 Euro.

Costumer 3 buys 4 grain buns and a 1 kg loaf of rye bread for 6.26 Euro.

The accountant counts the earnings:

In 15 minutes, the baker makes: 6.36 + 3.34 + 6.30 = 16 Euro

In 1 hour, the baker makes: 16 x 4 = 64 Euro

In 1 day, the baker makes: 16 x 10 = 640 Euro

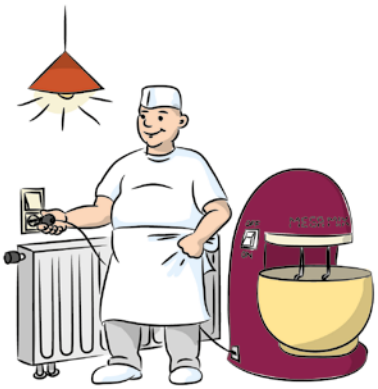
In 1 month (open 25 workdays) = 16,000 Euro

4. Discuss the figures with the students. Is the owner of the bakery a rich person?
5. Show students Flashcard 1 about production costs and discuss it with the class. The accountant subtracts the amounts from €16,000:
   - The owner pays €1050 for the flour.
   - He pays €1050 for yeast, salt, grain, and spices.
   - He pays €1200 for energy and water.
   - He pays €800 in rent for the shop where he sells the bread.
   - Accountant: €16,000 - €4,100 (production costs) = €11,900
6. Show the students Flashcard 2 about salary and social security for employees and discuss it with the class. The accountant subtracts the amounts from €11,900.
   - Salesperson 1 gets €1300 per month.
   - Salesperson 2 gets €1300 per month.
   - The baker gets €1900 per month.
   - The accountant gets €600 because she only works 10 hours per month for the owner. She works as a freelancer for different businessmen.
   - For his three employees, the owner pays €1400 for their health and social insurance.
   - Accountant: €11,900 - €6,500 (costs for employees) = €5,400
7. Discussion about the flashcards and information. The term *work* is to be linked to salaries. Why do parents work? What has to be paid for with their salaries: food, housing, hobbies, etc. The term *health insurance* has to be clarified: What do you do when you are sick? Have you ever been in hospital? Who paid that? This discussion leads to the monthly payment made to a health insurance company. Health insurance is paid on a monthly basis so that treatment by a doctor or at a hospital can be paid if and when necessary. The term *social insurance* is clarified: We know now what health insurance is, but what is social insurance? What are your grandparents' professions? What do they do? Why do many of them no longer work? How do they pay their expenses? While we work, we pay social insurance on a monthly basis so that we have money to live on when we grow old and do not work anymore. Additionally, if we lose our job, we get unemployment benefits until we can find a new job.
8. Show the students Flashcard 3 about social security and tax. Discuss it with the class. The accountant subtracts the numbers from €5,400.
   - For his own health and social insurance, the owner pays €592.
   - Additionally, he has to pay tax: €3,030.
   - Accountant: €5,400 - €3,622 (social security and tax) = €1,778
9. The term *taxes* is clarified: Who knows what taxes are and what they are good for? Who pays the salary of teachers, policemen, nurses, doctors, firefighters, etc.? Who builds and cleans our streets? Who builds schools, hospitals? Everyone who works pays taxes so the costs of taking care of public life can be paid.
10. Link to the discussion at the beginning of the lesson. Is the owner of the bakery a rich person? What about you? What job do you want to have when you grow up? What do salespeople, doctors, lawyers, teachers earn in your country (research on the internet)? What education or training do you need to get that job? What else is important in order to have a fulfilling job? Is it the salary the most important thing?

Further ideas and links

POLIS – Interesting teaching material regarding money, business, jobs (German only) http://www.politik-lernen.at/site/gratisshop/shop.item/106166.html

Flashcard 1: Production Costs



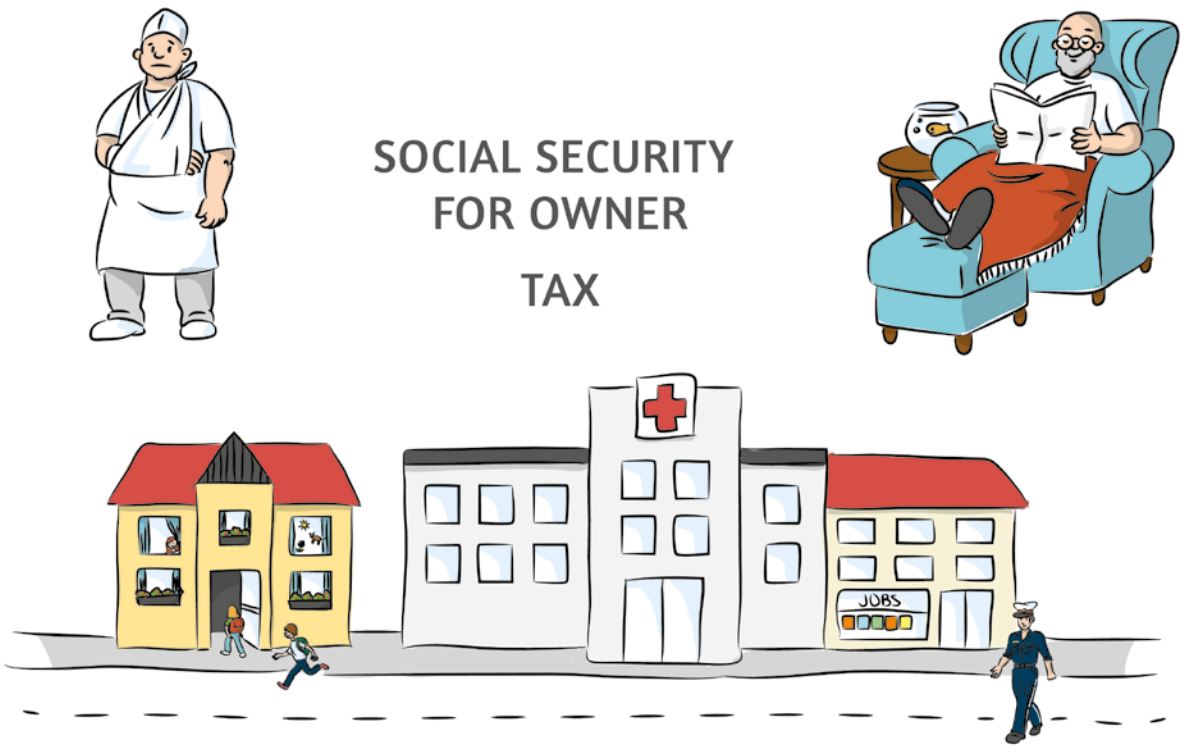
PRODUCTION COSTS

Flashcard 2: Salary and Social Security for Employees

SALARY FOR EMPLOYEES

SOCIAL SECURITY FOR EMPLOYEES

Flashcard 3: Social Security and Tax



1.4 Avoiding the wasting of bread

Objectives

- Pupils reflect on the purchasing behaviour of their families.
- Pupils learn to deal with food responsibly.
- Pupils form a simple bar graph based on their shopping behaviour.

Research question

What happens to bread if you do not eat it?

Duration

2 lessons – 50 minutes each

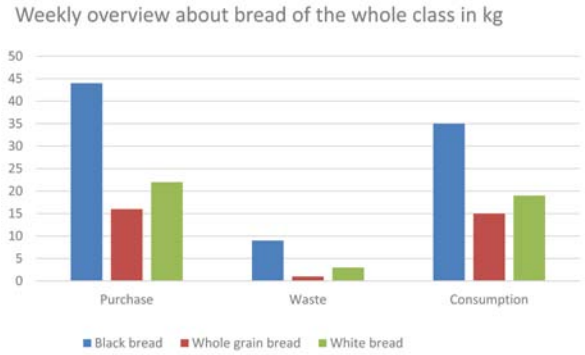
Required material

- Cheap bread from a supermarket, more expensive bread from a bakery (for storage experiment)
- Video[8]
- Bread diaries and worksheets
- Bread bin, plastic bags, paper bags

Possible teaching sequence

1. About 2 weeks before classwork on the subject: Pupils get bread diaries and take notes for one week about the purchase and consumption behaviour of their families regarding bakery products (bread, rolls, sweet baked goods, ...).
2. Pupils bring in their bread diaries and share their notes. Discuss what happened to the bread that was not eaten.
3. Analyse the collected data using bar graphs and interpret them (e.g. compare the total weight of the various kinds of bread, pastry and pastries that were bought. What was bought most? Compare how much is bought with how much is thrown away. Why is bread thrown away? – see bar chart below). Use appropriate units.
4. Watch the video. Brainstorming: What do we need to do in order not to throw away so much bread?
5. Run an experiment in a class. Test for the most appropriate way to store bread. Test the shelf life of bread: store bread in a bread bin, in a plastic bag, in a paper bag, etc. (you can choose various storage types mentioned by children in their bread diaries). Check it daily and observe how it changes. Bread can also be tasted every day (note: do not eat mouldy bread!).
6. At the same time, pupils should taste bread from a bakery and bread from a supermarket. This should be done 3 days in a row. Children should decide which tastes better after the 3rd day. Discuss: Is it worth it to pay more money for bread which can be consumed longer?
7. After getting the results about the shelf life experiment, compare the worksheets of the children about how they store bread at home.
8. How do bakeries deal with the bread they have not sold by closing time? Suggestion: Contact bakeries via e-mail and ask what they do with their old bread.

Example of a bar graph



Background information

Bread storage

The ideal way to store bread is in clay or earthenware containers because these absorb excess moisture and if necessary return it to the bread. This reduces the formation of mould. Bread can also be stored in non-airtight containers where air can circulate freely. Another storage possibility is in a wax-coated bag made out of fabric. A cheap method for storing bread is to use a paper bag from the bakery. If a loaf of bread is already cut you should store it so the sliced side is on a flat surface. It is also important to store pastries at room temperature. In the fridge, a pastry would quickly lose flavour and moisture. Sourdough bread, rye bread, and whole-grain have a longer shelf life.

The shelf life of bread in optimum conditions:

Wheat bread – up to 2 days

[8] https://www.youtube.com/watch?v=RHueqX8fOh4

Mixed wheat bread – 2 to 4 days

Mixed rye bread – 3 to 5 days

Rye bread – 4 to 6 days

Whole grain bread – 7 to 9 days

What is mould?

The mould fungus is often called mould in everyday language. Moulds are multicellular microorganisms that reproduce by sporulation. Food is affected by direct contact or via airborne spores. These spores germinate on suitable breeding grounds. It creates an invisible network of mycelium. Later on, the visible fungus starts growing on the surface and these are the sporophores.

How to deal with mouldy bread

As mentioned before, mould is not only visible on the surface of bread but also invisible. These moulds are toxic to the liver and kidneys. Therefore, the entire loaf of bread has to be discarded. If mouldy bread is eaten unintentionally, it is unlikely to cause sickness. Frequent consumption of mouldy bread, however, leads to a high risk of disease. Mouldy bread must not be given to animals either.

Further ideas and links

Tips on the proper storage of bread and an example how bakeries deal with bread not sold by closing time on the day it was made (German only): http://www.bmlfuw.gv.at/land/lebensmittel/kostbare_lebensmittel/lmskbrot.html

Other useful links:

http://www.baeckerhandwerk.de/baeckerhandwerk/verbraucherinfos/brotlagerung/

http://www.was-wir-essen.de/abisz/brot_verbraucherschutz_schimmel.php

http://www.wissensforum-backwaren.de/files/lernreihe/kap_IX-1.pdf

Bread Diary

Please fill out this sheet with your parents!

How do you plan your shopping for bread?

- We plan a whole week at a time.
- We plan what to buy the evening before we go shopping.
- We buy bread whenever we feel like it. We don't plan.
- _____

How do you store your bread?

_____

What do you do with bread you've decided you're not going to eat anymore?

_____

_____

Where do you usually buy your bread?

_____

Bread Diary

Name: _____

Day of the week: _____

Number of people living in the household: _____

	Purchased	Consumption	Waste	Reason[1]
Dark bread	dg[2]	dg	dg	
Whole wheat bread	dg	dg	dg	
White bread	dg	dg	dg	
Pastries	dg	dg	dg	
Sweet baked goods (cake, biscuits, etc.)	dg	dg	dg	

[1] e.g. hard, mouldy, because we bought new bread, etc.

[2] 1 dg = 10 grams

2 HONEY

2.1 What is honey? What are the criteria for the composition of honey?

Objectives

- Pupils learn what honey is.
- Pupils learn about the rules for selling honey in the EU.
- Pupils learn to identify an unknown unifloral honey by comparing its taste, smell, colour and viscosity (sensory testing) to known unifloral honey types (e.g. clover, linden, robinia, honeydew and rape honey).
- Pupils measure the pH of the unknown honey in order to gather additional data confirming the identity of the honey and learn that something sweet (honey) can be acidic.
- Using additional material on the SUSTAIN website, pupils will be able to compare the pollen isolated from the unknown honey (rape honey works best) with the pollen of known honey types, thus confirming the identity of the unknown honey.
- Using additional material on the SUSTAIN website, pupils will be able to measure the conductivity of honey, enabling them to distinguish between honey produced from nectar and honey produced from honeydew.
- Using additional material on the SUSTAIN website, the children will measure the water content of honey. Only honey with a maximum of 20% water is allowed to be sold, thus measuring the water content is part of quality analysis.

Research questions

- What is honey?
- Which honey type is the unknown honey?

Duration

3 lessons - 45 minutes each

Required material

Lesson 1: Worksheet 1 (modified excerpts of the COUNCIL DIRECTIVE 2001/110/EC).

Lesson 2: Different honey types (e.g. robinia, rape, linden, sunflower, and honeydew honey), unknown honey (one of the honeys, rape works best), stir sticks for tasting.

Lesson 3: 1 set of scales (able to measure grams), pH paper (range: 0 to 7), 4 beakers (100 ml), 1 spoon, distilled water, cola, liquid soap, 1 magnetic stirrer with stir bar (optional), 1 measuring cylinder (100 ml), unknown honey.

Possible teaching sequence

1. During the first lesson, pupils come up with ideas about honey and the topic of honey is introduced. They read the card concerning the COUNCIL DIRECTIVE 2001/110/EC. Pupils' answers to the question what honey is might be that it is a sweet substance that is produced from nectar or honeydew by bees. The beekeeper from the story cannot sell his honey in the European Union because honey is not allowed to have added any food ingredients. He must also add more information on his labels.
2. During the second lesson, pupils analyse an unknown honey in teams. Pupils taste different types of honey and formulate a hypothesis about which honey the unknown honey could be. Important: The unknown honey type – marked as 'unknown honey' – should be one of the different honeys tasted, so that the pupils can compare the tastes and figure out which one it is.
3. In the third lesson, pupils measure the pH of the unknown honey, water, soapy water and cola. They then analyse their data and reflect on the hypothesis. When analysing honey, the pupils investigate several characteristics of honey by using various scientific methods. Through the use of sensory and physical testing, and the analysis of the pollen content, pupils will be able to determine the quality as well as the type of unknown honey.

Background information

The council directive (COUNCIL DIRECTIVE 2001/110/EC)[9] of 20 December 2001 applies to all honeys sold in the European Union. The directive includes names, product descriptions, and definitions as well as

[9] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:010:0047:0052:EN:PDF

composition criteria and labelling rules. The directive also asks for the enforcement of these rules.

Definition: "Honey is the natural sweet substance produced by *Apis mellifera* bees from the nectar of plants or from secretions of living parts of plants or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature."

Honey consists of a variety of sugars (predominantly glucose and fructose, 60-80%), organic acids (e.g. gluconic acid, formic acid, citric acid), enzymes (e.g. invertase, an enzyme that is involved in breaking down sucrose into glucose and fructose), amino acids (e.g. proline) and solid particles (mainly pollen). The colour (ranging from nearly colourless to dark brown) and consistency (ranging from fluid to viscous to crystalline) can vary. All honey types start fluid and almost all crystallise at different speeds over time. The flavour and aroma are derived from the plant origin and vary as well.

Product descriptions: Honey types are defined. One distinguishes between honeydew honey (mainly produced from secretions of plants or of plant-sucking insects) and blossom or nectar honey, also called floral honey. Floral honeys can be distinguished in honey produced from nectar from multiple plants and honey produced mainly from one type of flower (e.g. linden or rape honey)[10].

Composition criteria: The composition of honey shall not be changed. Removing an ingredient (e.g. water) or add an ingredient (e.g. vanilla pods) is not allowed. Also not allowed are changes to its acidity. Honey also should not have any foreign tastes or odours (with the exception of bakers' honey which is suitable for industrial use or as an ingredient in other foodstuffs). It cannot be fermented or heated so that natural enzymes are significantly inactivated. There are other limits as well, such as water content not being allowed to exceed 20%.

Further ideas and links

Additional tests concerning water content, conductivity, and pollen analysis can be found online on the SUSTAIN website.

[10] Livia PERSANO ODDO, Roberto PIRO et a. (2004) Main European unifloral honeys: descriptive sheets Apidologie 35, S38–S81

What is honey? A European law concerning honey

1. First read the information card aloud and discuss with your partner (if necessary, makes notes of any questions you have).

Information Card:
Modified excerpts of the COUNCIL DIRECTIVE 2001/110/EC, a European law concerning honey

§ 1 – "This Directive shall apply to the products" which are sold as honey.

ANNEX I: NAMES, PRODUCT DESCRIPTIONS AND DEFINITIONS

1. "Honey is the natural sweet substance produced by *Apis mellifera* bees from the nectar of plants or from secretions of living parts of plants or excretions of plant-sucking insects on the living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and leave in honeycombs to ripen and mature."

2. The main types of honey are according to origin: nectar honey, which is obtained from the nectar of plants, and honeydew honey, which is obtained mainly from the excretions of plant sucking insects.

This is why each honey has its own special flavour!

ANNEX II: COMPOSITION CRITERIA FOR HONEY

1. "Honey consists essentially of different sugars, predominantly fructose and glucose as well as other substances such as organic acids, enzymes and solid particles derived from honey collection. The colour of honey varies from nearly colourless to dark brown. The consistency can be fluid, viscous or partly to entirely crystallised. The flavour and aroma vary, but are derived from the plant origin."

2. Honey, in general, is not allowed to be more than 20% water.

3. Electrical conductivity
   - honey from nectar max. 0.8 mS/cm
   - honey from honeydew min. 0.8 mS/cm

4. The pH is honey-type specific.

"... honey shall not have added to it any food ingredient, including food additives, ..."

2. Write what honey is.

3. Read the text about beekeeper Juan Carlos Santiago from Mexico.

So far, Mexican beekeeper Juan Carlos Santiago has sold his honey only in his neighbourhood. He has labelled his honey jars with "Honey from Yucatan". Because of a parasite in his colonies, his bees do not produce as much honey as before. In order to pay the veterinarian and to feed his family, he needs to earn more money. That is why Juan Carlos Santiago decided to mix his honey with sugar and water in order to have more honey to sell. He did not feel bad because pure honey consists mainly of water (maximum 20%) and sugar (79%).

4. Discuss with your partner: Can Juan Carlos Santiago sell his honey in the European Union?

Sensory testing

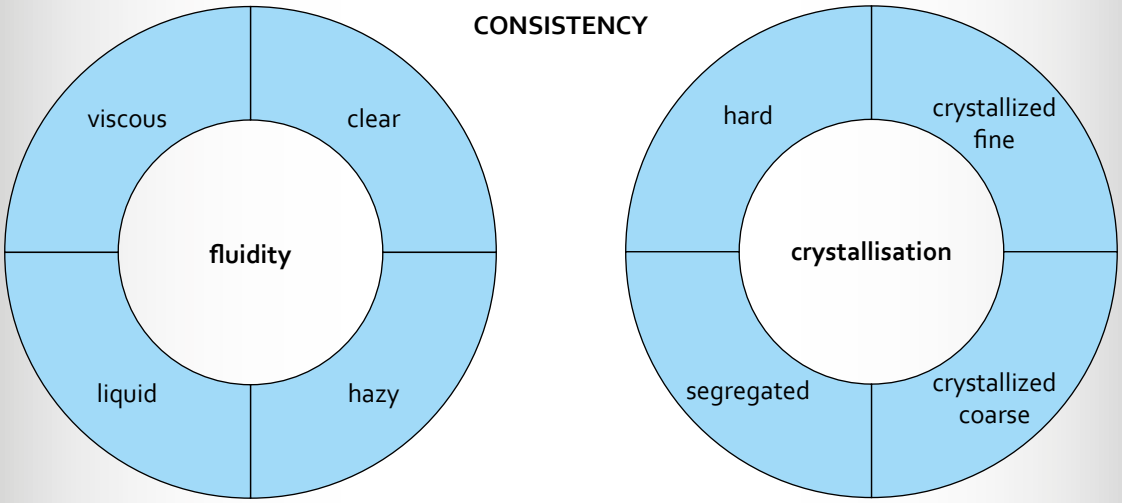
Sensory testing is an important method when investigating the quality of food. Strawberry yoghurt should smell and taste like strawberries and not like cherries. Sensory testing is also a required method when investigating honey because different types of honey have distinctive tastes and smells. Linden honey should taste and smell like linden blossoms and not honeydew honey. Scientists have defined particular words for specific tastes, so that all scientists use the same word for the same taste. Besides testing taste and odour, we will also investigate the consistency and colour of the honey.

Procedure

First read the information card about honey testing aloud and discuss with your partner (if necessary, makes notes of any questions you have). Then follow the instructions.

Information Card: Consistency

The consistency of honey can be either fluid or crystalline. Crystalline honey contains tiny crystals which you can feel on your tongue. Almost all honeys are able to crystallize and become hard. An exception is robinia honey.



Instructions

Take one of the honeys and determine its consistency with the help of the charts on the information card. Record your results.

Honey type:	*Consistency*
Robinia honey:	_____
Rape honey:	_____
Linden honey:	_____
Sunflower honey:	_____
Honeydew honey:	_____
Unknown honey:	_____

Information Card: Colour

Another important characteristic of honey is its colour. Different colour scales are used for fluid and crystalline honey.

Colour scale for fluid honeys

Photo: Länderinstitut für Bienenkunde Hohen Neuendorf e.V.

clear, like water	yellow	golden yellow	light amber	dark amber	red-brown	brown	dark brown

Colour scale for crystalline honeys

Photo: Länderinstitut für Bienenkunde Hohen Neuendorf e.V.

almost white	light beige	beige	yellow	golden yellow	light brown	redish yellow	dark brown

Instructions

Determine the colour of the different honeys using the colour scales on the information card. Record the colours below.

Honey type:	*Colour*
Robinia honey:	_____
Rape honey:	_____
Linden honey:	_____
Sunflower honey:	_____
Honeydew honey:	_____
Unknown honey:	_____

Information Card: Smell and Taste

There are special scientific terms used to describe the smell and the taste of the types of honey you are using.

Honey type:	*Odour*	*Taste*
Robinia honey:	weak floral-fruity	weak floral-fruity
Rape honey:	weak spoiled and vegetal	weak floral, fruity, spoiled and vegetal
Linden honey:	strong minty, like menthol	strong minty, like menthol
Sunflower honey:	weak floral-fruity	medium floral-fruity
Honeydew honey:	medium woody, malty	medium woody, malty

Instructions

1. Take the first honey and read the words describing its smell aloud. Smell the honey and remember the word describing that smell. Repeat this procedure with the other honeys. At the end, smell the unknown honey and record its smell.

Smell of the unknown honey: _____

2. Take the first honey and read the words describing its taste aloud. Taste the honey using a stir stick and memorise the word describing its taste. Careful: Use a new stir stick for each taste test. Repeat the procedure with the other honeys. At the end, taste the unknown honey and describe its taste using the appropriate word.

Taste of the unknown honey: _____

What honey do you think the unknown honey is?

Measuring pH

First read the information card about the pH value aloud and discuss with your partner (if necessary, makes notes of any questions you have).

Information Card: pH Value

The pH value reveals whether a particular solution is acidic, neutral or basic (alkaline). Solutions with a pH less than 7 are acidic and solutions with a pH higher than 7 are basic or alkaline. Pure water has a pH of 7 and is neutral.

One way to measure the pH is to use indicator paper. This paper changes colour depending on the pH value. The colour of the indicator paper is compared with the colours on a colour scale that comes with the indicator paper.

Honey is acidic, but different honeys have different but typical pH values. Therefore, the pH value can be used to help identify the unknown honey. First you measure the pH of cola, water and soapy water to familiarize yourself with measuring pH values with other indicator paper that measures pH values from acidic to basic values. For the unknown honey, you will use indicator paper used for acidic fluids.

The honeys being used have the following pH values:

Honey type:	pH-value
Robinia honey	3.7 – 4.3
Rape honey:	3.7 – 4.4
Linden honey:	3.9 – 5.0
Sunflower honey:	3.5 – 4.2

Write down the pH value you expect the unknown honey to have: _____

Read the instructions first and then perform the test.

Making the Honey Solution

1. Put an empty beaker on the scale and pour 5 g of honey into it.
2. Use the measuring cylinder to measure out 37.5 ml of distilled water and add it to the honey.
3. Stir the mixture until the honey is dissolved.
4. Dip the indicator paper into the honey solution.
5. Compare the colour of the indicator paper with the colour scale accompanying the indicator paper.
6. Read the pH value off the colour scale.
7. Record your value.

The pH value of the unknown honey is

_____ .

Preliminary Test

1. Pour water, soapy water and cola into different beakers.
2. Measure the pH value of each solution using the indicator paper that measures both acid and basic values.
3. Record your data.

pH value

water _____

soapy water _____

cola _____

1. Does the measured pH value agree with your prediction?
2. Does the measured pH value agree with the pH of known honey types? If so, which one?

2.2 Harvesting honey

Objective

- Pupils learn how honey is harvested.
- Pupils learn about the importance of pollination.
- Pupils learn about the differences between hobby beekeepers, professional beekeepers, and honey importers.
- Pupils compare the benefits and disadvantages of the different ways of beekeeping.

Research questions

- How does a bee produce honey?
- Are there differences in the work of hobby beekeepers, professional beekeepers, and honey importers? What are the benefits and disadvantages of each kind?

Duration

Two 90-minute lessons and one 45-minute lesson

Required material

A beekeeper to interview, a computer

Possible teaching sequence

1. Lesson 1 (2 x 45 minutes) "From the honeycomb to the jar": Discuss how bees produce honey by organising a visit to a beekeeper. (Pay attention to the bee season, get the beekeeper's permission to visit, and ask the parents about possible allergies of pupils to bee stings). Exercise: Conduct your own interview with a hobby or professional beekeeper.
2. Lesson 2 (2 x 45 minutes): Pupils read the two interviews, one with a hobby beekeeper and one with a professional beekeeper, to highlight the differences in beekeeping and to introduce additional factual knowledge. Pupils learn about the subjectivity of interviews.
3. Lesson 3 (1 x 45 minutes): Pupils compare the number of beekeepers, the number of bee colonies, and the amount of honey they produce in different European countries. For example, there are more hobby beekeepers in Germany and more professional beekeepers in Spain. A possible correlation will be discussed. Students are also asked to think of possible reasons why Mexican beekeepers produce so much more honey than Polish beekeepers.
4. Students prepare and deliver a final speech to defend a hobby beekeeper, a professional beekeeper or a honey packer.

Photo: Benedikt Polaczek

Background information

How do bees produce honey?

Bees use the nectar of flowers as their food. In addition, some bees also use the sugary excretions of plant-sucking insects like aphids and mealy bugs. The bees suck up both the nectar and the sugary excretion into their honey stomach. The chemical transformation of the fluid by enzymes already starts in the bees on the way back to the bee hive. The enzymes break down the sugar. This process continues in the hive, where hive bees suck up and release the fluid (regurgitate) thus adding further enzymes. So the sucrose is broken down into glucose and fructose. There are also antimicrobial substances in the honey, which reduce the growth of bacteria and yeast. In addition, the water content is reduced because water evaporates due to the warm temperatures in the hive and the bees' wings fanning the liquid. The filled honeycomb cells are sealed with a water impermeable wax cover.

Possible questions for a beekeeper

1. What are the daily chores a beekeeper has to do to keep the bees healthy?
2. Can you "train" bees to collect nectar or honeydew from a particular plant?
3. Can pesticides or insecticides end up in the honey?
4. How do you extract honey from the honey-comb?
5. Can anything be added to the honey?
6. What is the best way to store honey?
7. Do bees hibernate?
8. Additional questions from pupils for the beekeeper!

How do beekeepers harvest honey?

Beekeepers collect the honey from honey bees. Because honey is also bee food, the beekeepers need to feed bees in late summer with sugar and/or honey. On average, a bee colony in Europe produces 20 to 50 kg of honey a year. The amount of honey eaten and the number of bee colonies a beekeeper has varies from country to country in Europe.

Possible questions for a beekeeper

1. How do bees produce honey from nectar?
2. Is a solution of sugar with water also honey?
3. Why do bees produce honey?
4. Does every bee collect nectar?
5. When the foraging bee transfers nectar to the hive bee, how do they communicate?
6. Where do bees store the honey?
7. Additional questions from pupils for the beekeeper!

Why do Mexican beekeepers produce so much more honey than Polish beekeepers?

There is a longer honey season in Mexico than in central European countries due to a longer blooming season and less variation in temperature across the different seasons. Therefore, there is a longer period of honey harvesting and thus a larger honey production. In Mexico the beekeepers use a different type of bee that produces more honey.

Take a few notes concerning the key words in the table below:

	Professional Beekeeper	Hobby Beekeeper
Number of colonies	more than 100 to several thousand	varies, mostly less than 10
How did the beekeeper learn about beekeeping?	3 years of training travelling and books personal experience, often professional beekeepers are first hobby beekeepers	seminars books personal experience
Location of the bee colonies	colonies have to transported to the flowering plants to make unifloral honey fields, woods, roofs in cities	colonies stay in one place all year garden plot, allotment, balconies, roof, etc.
Honey harvest (in Germany)	2 to 3 times a year spring harvest: mid-June summer harvest: June to August fall harvest: August to October	1 to 2 times a year when needed
Honey marketing	barrels and buckets bought by honey packers other beekeepers – direct sales at farmers' and Christmas markets, etc. in shops that sell local products	personal use used to feed colony during winter sell to family and friends sales at farmers' and Christmas markets etc.

Interview with a beekeeper

Task 1

Visit a beekeeper with your class and find out how honey is produced.

1. *How do bees produce honey?*
2. *How does honey end up in a jar?*

Do some online research to find additional questions for the beekeeper. What aspects of honey production interest you?

Don't forget to write down the beekeeper's answers!

Task 2

Honey production: There are hobby beekeepers and professional beekeepers. We have interviewed both.

1. Read both interviews.
2. With the help of the interviews, compare the hobby beekeeper to the professional beekeeper.
3. Describe how the two beekeepers sell their honey?
4. Give the reasons the interviewees became beekeepers and what they see as the benefits and disadvantages of their profession.

Interview with a hobby beekeeper

- *What is a hobby beekeeper?*

A hobby beekeeper has fewer bee colonies (about two to 15 colonies) than a professional beekeeper (more than 100). The hobby beekeeper does not depend on the honey for his income or livelihood.

- *Why did you become a hobby beekeeper?*

I have fruit trees in my garden and I was puzzled that they were bearing so little fruit. Of course, there weren't enough bees. Together with an experienced beekeeper I took care of a bee colony for one season. I enjoyed it so much that I couldn't stop.

- *What was the reaction of your family and your neighbours when you became a beekeeper?*

Of course, bees need a lot of time. My family convinced me to do it and my wife helps me. They think beekeeping is exciting and they enjoy eating the honey.

- *Name three benefits and three disadvantages of your hobby?*

Benefits: Neighbours enjoy the better fruit harvest. Beekeeping is enjoyable, fulfilling, and a good change from my regular job. I also always have enough honey for myself.

Disadvantages: I had no official training, no apprenticeship. One should check for possible allergies, also in the family. It is sometimes hard to combine the hobby and work (not everyone is retired or self-employed).

- *How much honey do you produce?*

From my six colonies, I harvest about 100 kg.

- *What do you do with the honey you produce?*

My family eats one jar of honey each week. I sell the rest over the garden fence or give it to friends, neighbours and acquaintances. I don't like to sell honey at farmers' markets like other hobby beekeepers because it takes too much time.

- *Should honey be bought from a beekeeper or in a supermarket?*

Buy your honey from a beekeeper you trust and, if at all possible, in your neighbourhood. This way, you support the regional flora and regional fruit varieties. Only if you enjoy special flavours (e.g. lavender honey from France, and lemon or orange honey from Spain) is it necessary to buy imported honey.

Interview with a professional beekeeper

- *Why did you become a professional beekeeper?*

I enjoy my profession. I enjoy working outside with animals and in nature.

- *Where did you get all your knowledge?*

Mainly from my apprenticeship, but also from a work and travel program.

- *What is the difference between beekeeping in Germany and beekeeping in other countries?*

Beekeepers in Poland and France have more bee colonies than beekeepers in Germany – between 1000 and 6000 colonies. In Germany, only the largest five beekeeping businesses have more than 1000 colonies. Most professional beekeepers have 400 to 500 colonies.

In New Zealand beekeepers can have more than 15,000 colonies. Of course, with so many colonies, additional employees are needed. One reason German beekeepers have fewer colonies is the relatively small area that is available for beekeeping. Germany is large, but also has a high population density. Another difference between Germany and other countries is the bee season. In Germany, the actual honey harvest is limited to just three months. In contrast, the harvest in Australia lasts 11 months.

- *What do you do during the off-season?*

During winter, we have a lot of time because we do not sell our honey directly at farmers' markets or Christmas markets like some other beekeepers. We sell our honey in large units (40 kg buckets) to honey packers or dealers. The honey packers put the honey into jars and sell them as a regional product to supermarkets. We also sell to other beekeepers that sell the honey at farmers' markets and who do not have enough honey themselves to serve all their customers.

- *What are the differences between hobby beekeepers and professional beekeepers?*

Hobby beekeepers have the same duties as a professional beekeeper during the year, but have fewer colonies. Therefore, they cannot earn a living from the honey they produce. In other countries like the USA, a professional beekeeper can also earn money by hiring out their hives for the pollination of blossoms in fruit orchards.

- *How much honey is produced?*

A beekeeper doesn't sell all the honey produced by the colony. A colony needs about 80 kg for its own use for the whole year. The beekeeper can harvest an additional 20 to 60 kg per colony. The amount depends on the location and the weather.

A comparison across countries

Beekeepers, bee colonies, and honey in Europe and the world – a comparison of different countries (2013)

	Beekeepers (total)	Bee colonies (total in millions)	Bee colonies / Beekeeper (average)	Honey (in tons)
Germany	ca. 103,000	0.7	~ 7	15,700
France	ca. 69,000	1.3	~ 19	11,414
Poland	ca. 40,000	1.5	~ 40	15,498
Spain	ca. 25,000	2.43	~ 100	30,613
New Zealand	ca. 23,000	0.45	~ 20	17,852
Mexico	ca. 45,000	1.93	~ 42	56,907

Source: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS 2013[11]

Photo: Melanie Röck

1. In the interview, we read that a beekeeper can live from the sales of the honey from 100 to 150 bee colonies. Compare the total number of beekeepers in Spain and Germany to the total number of bee colonies in those two countries. What deduction can you make from the comparison?

_____

_____

_____

2. There are almost the same number of beekeepers in Poland and Mexico. Mexican beekeepers only have 20% more bee colonies but produced almost 4 times the amount of honey in 2013.

Why do you think Mexican beekeepers produce so much more honey than the Polish beekeepers?

_____

_____

_____

[11] http://imkerinfo.de/jungimker/motivation/honigpreisehierundimausland/index.html
http://www.diebiene.de/neuseeland-100
http://www.apiservices.com/countries/mexico.htm

2.3 Selling honey

Objectives

- Pupils learn which information has to be declared on a label.
- Pupils learn about the consumption of honey on a global and local scale.

Research questions

How much honey is consumed by each student and their family?

Duration

2 lessons - 45 minutes each

Required material

A camera, a world map, and sticky dots to mark the countries on the map

Possible teaching sequence

1. Pupils put together a collection of photographs of honey jar labels from a supermarket, from a wholefood store, and from a hobby beekeeper. To get an overview of the distribution of honey, the class should locate on a world map the countries of origin identified on the labels.
2. Pupils read a short text about what has to be on a honey label.

Photo: NatLab

Mapping the countries from which honey originates on a world map

Preparatory homework: Bring your breakfast honey to school. If you don't have honey at home, take a picture of a honey jar label in the supermarket (don't forget to ask a salesperson in the supermarket if you can take a picture for school).

Your teacher will provide a world map. Read your honey label from home or the label you photographed to find out where the honey was produced. Mark the country on the map with a sticky dot.

Class discussion: Discuss what other food items you know that are imported from other countries or what food items your country exports to other countries.

Vocabulary:

To import: to buy a product from another country

To export: to sell a product to another country

Read the information card aloud and discuss with your partner (if necessary, write down any questions).

Information Card: What has to be on a label

1. Type/name of food defined by law: Honey
2. Name and address of the manufacturer, packager or seller, e.g. the name of the beekeeper
3. Expiration date
4. Country of origin
5. Weight
6. Batch identification

Create and design your own honey label.

2.4 The consumption and value of honey

Objectives

- Pupils collect and compare honeys bought in a supermarket, in a health food store, and directly from a hobby beekeeper.
- Pupils identify factors which influence the price of honey.
- Pupils make a reflective decision about which honey they want to buy. They work with various sources of information and arguments.
- Pupils learn about important characteristics of sustainable development. Pupils are introduced to the complex links between economic development, globalisation, consumption, ecology, and social circumstances.

Research questions

- As a consumer, which honey would I buy?
- Do I prefer fair trade honey from Yucatan, Mexico, or would I buy local honey from a beekeeper in my neighbourhood?

Duration

Two 90-minute lessons

Required material

Role cards

Possible teaching sequence

Consumer behaviour – assessment game "Buying Honey"

Homework: Each pupil visits a supermarket, a weekly market, or a health food store in order to find out which types of honey they offer. If possible, the pupils take pictures of honey labels. They print one of the pictures they took of a label and write down the price and the country of origin on two different pieces of paper. The children could also bring a jar of honey from home.

1. **Exploration of criteria to buy honey:** All students put their honey labels or their honey jars in the middle of a circle of chairs. Students have three minutes to look at the different honeys. Afterward, the pupils discuss which criteria could be used to buy honey. Students should explain why they would buy a particular honey. The teacher collects these criteria on the blackboard.

> *Possible criteria:* Honey type (e.g. rape, linden, sunflower, etc.); country of origin (e.g. France, local, blend of EU honeys, blend of non-EU honeys); producer (hobby beekeeper, professional beekeeper, honey packer); taste; colour; packaging; brand; price; specially labelled (fair trade, organic).

2. **Introduction to the roleplay:** By collecting purchase criteria, the students are made aware of the multitude of buying criteria. In order to collect additional criteria and to show the different ways criteria can be used, the pupils will do a roleplay.

> *Scenario:* An 8th-grade class in Berlin wants to go on a weeklong class trip to the countryside. The teacher tells the class that they will have to prepare their own breakfast. Of course, they want to take a jar of honey. Like your class, the class from Berlin has to realize that there are many types of honey in the supermarket or health food store.

Identifying with the role: Pupils form 5 to 8 groups. Each group will receive a role card. There are 8 different role cards. As the teacher, you might decide not to use all of them. Within their groups, the pupils read their role card and come up with arguments supporting the opinion on the care, the opinion about which honey to buy. Sometimes the children find it difficult to distinguish between the role and position they have to take and their own opinion.

3. **Presenting arguments of role's opinion:** Each group chooses a representative who presents the arguments for the opinion on their role card. The arguments must be justifiable. The teacher adds new criteria to the blackboard.

4. **Choosing the honey for the class trip:** After each group has presented its arguments, the children have 10 minutes to discuss which honey to buy. An expensive honey would put a burden on the budget. Are there reasons to still buy the honey? They vote for which honey to buy.

5. **Using an evaluation matrix (optional):** Even if it was easy to decide which honey to buy, it might be beneficial to introduce an evaluation matrix. This might also help if the decision was not easy or if the opinion of a particular group of persuasive and convincing students dominated the decision-making. With the help of the criteria collected on the blackboard, an evaluation matrix is created.

Example of an evaluation matrix[12]:

Criteria	Importance factor (e.g.)	**Honey 1** squeezable bottle	**Honey 2** organic honey	**Honey 3** fair trade	**Honey 4** local beekeeper	**Honey 5** supermarket	6	7	8
Type	2	3 (x2)	1 (x2)	1 (x2)	3 (x2)	3 (x2)			
Label / packaging	1	1	5	5	5	1			
Country of origin	1	1	3	3	3	1			
Producer	1	3	5	5	5	1			
Taste	2	2 (x2)	2 (x2)	2 (x2)	2 (x2)	2 (x2)			
Brand	1	3	1	1	2	1			
Price	2	4 (x2)	1 (x2)	1 (x2)	2 (x2)	5 (x2)			
Other									
Total		26	22	22	29	24			

Each pupil fills out the matrix. The first step is to decide which criteria are important to them. The ones that are less important will get a factor of 1, the criteria that are more important a factor of 2. In the example matrix, the criteria that were valued as important are type, taste, and price.

Each honey will be rated one at a time on a scale of 1 to 5 for each criterion (5 being the best). How good does the honey in the squeeze bottle taste? How important is the fair trade label for me? How important is the country of origin? If the fair trade label is very important to a pupil, he or she can give 5 points for that criterion, as shown in the example matrix. If a pupil thinks the price of the fair trade honey is too high, they can give it only 1 point for the criterion price.

When everyone has filled out their matrix, all the points are added and the totals recorded. Each student announces which of the honeys got the most points in their matrix. The teacher records the tally on the blackboard. Together, the class reflects on their decision-making. Did the decision which honey to buy change between the first vote and the vote after filling out the matrix? Would the students really buy the honey with the most points? Would the students decide which honey to buy based on feelings? Are particular criteria so important that they have to be met? Are moral criteria important?

Take-Home-Message: Decision-making is complex. In order to make the right decision, it is helpful to make an evaluation matrix. It is also important to know something about environmental, social and economic relationships. After these lessons, the pupils should be able to make well-grounded arguments.

[12] Adapted from: Susanne Bögeholz (2006). Expliziertes Bewerten und Urteilen. Beispielkontext Streuobstwiese; In: Praxis der Naturwissenschaften – Biologie in der Schule, 55, S.17-24.

Student 1

wants to buy honey in a **squeeze bottle.**

We've always had that one at home and there's such a cute bear on the label. It's much easier to get the honey out the bottle and it doesn't make such a mess. It's not as heavy as the glass honey jars either.

The honey our family buys is like a liquid and very light in colour. That's really important to me. And the taste is always the same so I'm never surprised by a taste I don't like. It's also quite inexpensive.

Student 2

wants to buy honey with an **organic label.**

I definitely want to take organic honey. It's never been treated with anything. A lot of honey that comes in a squeeze bottle has been filtered so that it won't become hard (so it never crystallizes). That means the pollen has been filtered out of it. I think it's perfectly natural for honey to crystallize!

Organic beekeepers are also careful to take care of their bees in accordance with the Animal Welfare Act. Only natural materials are used for the construction of their beehives and for pest control against the Varoa mite. They never trim the wings of their organic queen bees, either, so that they can continue to swarm.

Student 3

wants to buy honey with a **fair trade label.**

My dad's a political scientist. He says it's important to support the beekeepers in Yucatan, Mexico. They depend on selling their honey abroad (export) for their livelihoods. That way they have regular incomes and can better provide for their families. The Yucatan beekeepers have formed a community of beekeepers to sell Mexican honey together. The honey's a bit more expensive, but these beekeepers stick to fair-trade regulations when harvesting their honey.

"Fair trade" means:

- a fixed minimum price for the producer
- no child labor
- fertilizer and pesticides are seldom used
- forced labor is prohibited

Student 4

wants to buy **local honey.**

It doesn't really matter to me whether we buy honey from amateur or professional beekeepers. What's important to me is that the honey is local and that I know where it came from. There's no way to find the origin of the honeys used in mixed honeys and filtered honeys. That makes quality control really difficult. In some countries, for example, they treat sick bees with antibiotics. And then there are traces of those antibiotics in the honey those bees produce. If I don't know which countries the honey originates from, I won't be able to tell under what circumstances the honey was produced.

Student 5

wants to buy honey from a **local beekeeper.**

We should support beekeepers who come from around here. That way we'll be promoting regional diversity. Regional honey doesn't have to be transported long distances. When stuff has to travel many kilometres, that costs trucks and airplanes a lot of fuel and harms the environment (CO_2 emissions). It's also a waste of money. Our beekeeper in the neighbouring village sells his honey to an initiative that then sells all the local beekeepers' honey. The cooperative helps them sell their honey better.

Student 6

wants to buy **cheap honey from the supermarket.**

Let's take the cheap honey from the supermarket. It's easy to spread on bread and the taste is reliable. It always tastes the same. We'll also save money on the 4 jars we have to buy to feed everyone on our class trip. We can eat more ice cream or go to the movies with the money we save!

So, I don't see why we should buy expensive organic honey. The beekeepers have to follow strict EU guidelines for the use of pesticides. Because farmers have to produce and harvest more and more grains and vegetables, the use of pesticides is also necessary. Besides, there is no evidence that the chemicals used for pest control are responsible for bee deaths.

Student 7

wants to buy honey from a **major brand company.**

The mother's best friend is a professional beekeeper. She takes care of 150 hives and her bees produce a lot of honey. She sells it in barrels to a large honey company. That company mixes honey from various professional beekeepers from around the world to create the unique taste of their brand.

Professional beekeepers are really important. They have many bees that pollinate thousands of farms and orchards. That pollination is important to agriculture earnings. When a bee pollinates a fruit tree, for example, that tree will bear more fruit.

Without bees, the yields in agriculture will be lower. And that would be a problem when we need to produce enough food to feed the world's growing population.

Student 8

wants to buy honey from a **hobby beekeeper.**

I'd like to buy honey from our neighbour. He is a hobby beekeeper and keeps 3 colonies of bees in his garden. The numbers of professional beekeepers are decreasing in Germany. But bee pollination is kept going by hobby beekeepers. More and more people are becoming more aware of the usefulness of bees. In beekeeper associations, almost 90% of the members are hobby beekeepers. I really want to support this type of nature conservation. Our neighbour sells his honey straight from his garden or at weekly markets. I'm glad we eat honey that's from our region.

3 SEASONAL FOOD – FRUIT AND VEGETABLES

3.1 Characteristics of fruit and vegetables

Objectives

- Pupils read labels and information about fruit and vegetables with understanding.
- Pupils find out product information, and its nutritional value from its package (food label, box).
- Pupils formulate research questions.
- Pupils make an informed decision based on their research.

Research questions

- What can you find out from a product's package (the food label)?
- What do you need to ask in order to understand the information provided on it?
- What (else) would you like to find out about the product?

Duration

One 45-minute lesson to start with. The research can last much longer based on the research questions pupils formulate.

Required materials

Fruit and vegetables in various packaging, original boxes with fruit and vegetables, pictures of labels from a store or the internet. The fruit and vegetables can be either fresh or preserved in some way (e.g. tinned, dried, etc.).

Possible teaching sequence

Pupils work with a food package. Their task is to find out as much information as possible about the product. If they do not understand some fact or statement, they need to formulate a question (or directly a research question) in order to find out what that information means. Those questions can lead to further investigation and possible research. To manage the possible resulting research, it is recommended that only one or two fruits or vegetables are chosen for each group or even for the entire class.

Possible findings and questions:

Information from a package, box, shelf in a store, etc.	Examples of research questions
Composition, Nutrition facts	• What does our body need it for? • How much do I need every day?
Energy value	• Does this energy come directly from the food or from the way it is preserved?
Conservation/Preservation	• How does it work?
Shelf life	• What happens after the expiration date?
Storage recommendations/ requirements	• What happens if I do not store it the recommended way?
Place/Country of origin	• What can I find out about this place? • Can I get it from a place closer to me?
Manufacturer/ Distributor	• Why are the producer and the distributor different? Why is not it the same company?
Material used for packaging	• Why is this material/ shape being used?

At the end, pupils discuss if they would buy a particular product or not. They support their decision with the information they have found.

Background information

All food manufacturers are required by law to provide food label claims with specific information about the food you are buying to help you make informed and healthy decisions.

Labels with nutritional data contain many nutrition facts, as well as information about the country of origin and other information (shelf life, storage requirements, preparation instructions, etc.).

Characteristics of fruit and vegetables

Have you ever wondered what you know about _____?
Try to summarise what you know about it in a group. Write down your summary.

What can you find out about _____ when you study its package/box/the information from the store shelf?

Find out as much information from the package as possible.
Record your findings in the table (1st and 2nd column).

Information about _____ learned from its package, box, or the store shelf where I bought it.

Characteristic	Value/Specification	What would you like to ask? / What do you not understand?

Mark (circle or use a different colour) the information you do not understand.

What would you want (need) to ask or find out in order to understand? Formulate research questions. Record them in the 3rd column of the table.

If possible, do research in order to find the answers to your questions.

Would you buy that produce based on your findings? Give arguments for your answer.

3.2 Does season matter?

Objectives

- Students learn that not all fruit and vegetables they buy is grown in their country, especially if they do not buy it during its local harvesting time.

Research questions

- What fruits and vegetables are usually grown in my country? When is each in season? When is each harvested?
- Where do all the fruits and vegetables I eat come from?

Duration

2 consecutive 45-minute lessons and extra time if needed to go to shops

Required material

Coloured pencils, store sales flyers, internet access, a world map (optional)

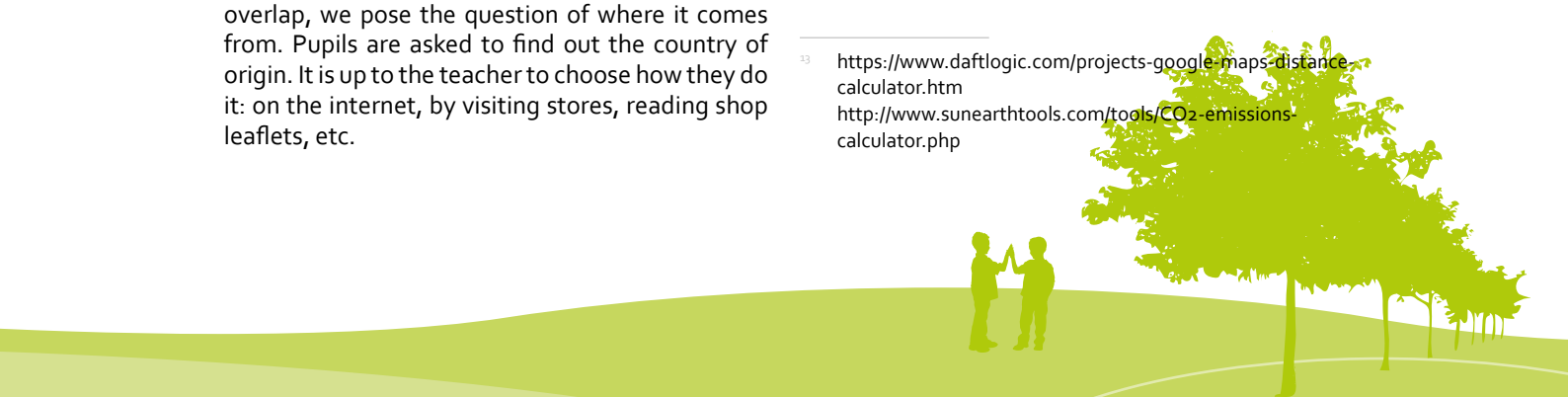
Possible teaching sequence

1. The teacher asks students which fruits and vegetables they eat in summer and which in winter.
2. In the chart, using the natural seasonal appearance of the fruits and vegetables at the top of the chart, pupils choose the correct month in which that fruit or vegetable is in season in their country (local fruits and vegetables). They use a green pencil to tick that box. They can cross out and add more fruits and vegetables if needed.
3. In the chart, students indicate what fruit and vegetables they have at home or what fruit and vegetables they like eating in winter. They use a red pencil to tick that box. If it is not in the chart already, they write it down below the table in red. They might need to add some fruits and vegetables to the chart at this point. They can add bananas, oranges, etc. If the green and red ticks overlap, we can assume that the fruit or vegetable is local. If they do not overlap, we pose the question of where it comes from. Pupils are asked to find out the country of origin. It is up to the teacher to choose how they do it: on the internet, by visiting stores, reading shop leaflets, etc.
4. Pupils mark on the map the locations where their fruit and vegetables come from (local and imported) or they can make a list the places with the distances from their town[13].
5. Students are asked to come up with possible positive and negative consequences of exporting and importing fruit and vegetables, and buying and eating local fruits and vegetables. Conclusions might lead to changing some behaviours in their shopping and eating habits.

Background information

There is a time shift of seasons between the Earth's northern and southern hemispheres. During European winter, vegetables and fruit usually come to Europe from the southern hemisphere. Often, these are long distances; it takes time and energy to transfer fresh products to Europe. Compare how the same fruit or vegetable differs when bought in different seasons (produced locally in natural season and then imported in winter). How do they differ in price, taste, etc.?

[13] https://www.daftlogic.com/projects-google-maps-distance-calculator.htm
http://www.sunearthtools.com/tools/CO2-emissions-calculator.php



Does season matter?

What fruit and vegetables do you grow in your country? In the chart below, add more items if needed and indicate in green when it is harvested in your country.

Natural seasonal appearance of typical fruit and vegetables in my country

										
January										
February										
March										
April										
May										
June										
July										
August										
September										
October										
November										
December										

What fresh fruit and vegetables do you eat in summer?

What fresh fruit and vegetables do you eat in winter?

In the chart above, tick in red the fresh fruits and vegetables you like. Make a list here of the fruits and vegetables not grown in your country.

In the chart above, tick those fruits and vegetables in green.

If red and green overlap, the fruits and vegetables you like are probably grown and harvested in your country. If the colours do not overlap, they must be imported from elsewhere.

Where do they come from? Find out the countries of origin for the fruit and vegetables that are not grown in your country.

Mark on a map or write down the distance from the country of origin to your country (or town).

Fruit or Vegetable	Area / Country of Origin	Distance (km) "food kilometres"

Characterise your local and imported fruits and vegetables. What is good and what is not so good about it? You might consider appearance, taste, and price, but also look further. How are your fruits and vegetables brought to your store? Who brings them? Can you track their journey?

Local + / -	Imported + / -

3.3 How to keep it fresh longer?

Objectives

- Pupils observe various changes in seasonal food caused by biochemical processes taking place in the food.
- Pupils learn about different means of conservation and preservation.

Research questions

- What happens to selected fruits and vegetables when left on the kitchen table for several days?
- How can we keep seasonal food from spoiling?

Duration

To observe unpreserved selected fruits or vegetables – several days (ideally, 1 week)

To observe preserved selected fruits or vegetables – several days (ideally, 1 week)

Required materials

Selected seasonal food, material based on students' suggestions

Possible teaching sequence

1. Students observe selected seasonal fruits or vegetables for several days and record observable changes (change in colour, size, odour; change in surface texture as a consequence of water loss; softening/hardening; the growth of mould, etc.). They can also draw and take pictures of what they observe.
2. The teacher must be aware of potential allergies among pupils. They need to be aware of any students who might have health issues, especially allergies to mould spores.
3. Students suggest different ways to preserve selected fruits and vegetables. We propose that you choose one or two kinds of fruits or vegetables in a group and conserve it several ways. This way, pupils can answer the research question about the most appropriate conservation method. If other groups work with different kinds of fruits and vegetables they might even find out that not every method is suitable for every kind of fruit or vegetable because of the change in taste (we do not put sweet fruit into a salty solution), the change in consistency (we do not freeze the cucumber), etc. Pupils suggest conservation methods mostly based on their everyday experience. A teacher might expect suggestions like lowering or raising the temperature, removing "air", or using salt. Students can try various techniques: boiling, freezing, refrigeration, keeping it cool, placing in a very sweet or salty solution, adding osmotic active substances. It is also possible to place it into a plastic bag or glass bottle, close tightly, and vacuum out the air with a syringe.
4. The teacher might want to investigate, demonstrate or discuss principles of used conservation methods. The effect of osmotic active substances can be demonstrated using a potato (see the picture). Make 3 holes in a potato and put salt into one, pour water into the second and isotonic solution into the third. After approximately 30 minutes, pupils can observe that the first hole contains water (which comes from the cells), the second hole has lost all its water (they entered the cells), and the third hole looks the same as it did before (the volume of the physiological solution has the same water concentration as the water content in the cells so nothing changes).

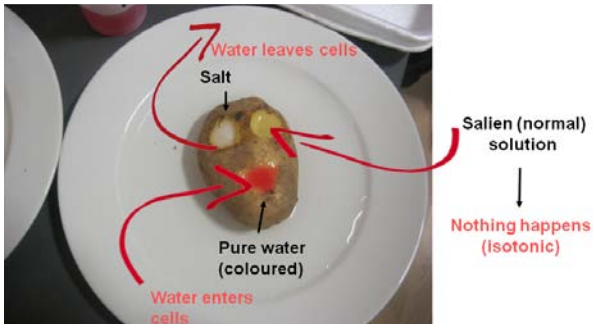


Photo: Dragana Miličić

Background information

Most fruits and vegetables go bad because of damage caused by microorganisms (such as bacteria and mould), enzymatic processes, or bruising. Microorganisms facilitate deterioration through structural decay. Microorganisms, such as bacteria and moulds, release their own enzymes as they grow, speeding up the spoiling process. Enzymes, which occur naturally in live fruits and vegetables, are part of the natural aging process. Enzymatic browning leads to discoloration and, later, spoilage. Bruising physically alters the exterior of fruits and vegetables, triggering enzymatic reactions.

In order to preserve food, we have to limit enzyme activity, killing or slowing down the growth of microorganisms. Microorganisms are killed directly by thermal treatment. They are killed indirectly by drying them out or by the application of osmotic active substances, such as salt, sugar, etc. Some microorganisms produce substances which work as preserving compounds (alcoholic fermentation – alcohol is produced, lactic acid fermentation – lactic acid is produced).

All biochemical reactions in living organisms take place in some kind of water solution. Therefore, there has to be a sufficient amount water in a liquid state. Freezing food slows down or completely stops biochemical reactions. Decreasing the amount of water can be done by drying the fruit or vegetable – evaporating the water in it – and by adding osmotic active substances, for example salt or sugar. Food and microorganisms both consist of cells with membranes. The process of osmosis operates across these membranes to draw water out. Osmotic active substances affect the internal fluid in microorganisms, causing them to shrivel up and die. Osmosis ensures that it is difficult or impossible for microorganisms to reproduce or survive. Dried fruits and vegetables still contain some microorganisms in a latent state which can resume their activity with a rise in humidity.

Cold temperatures slow down respiration but storing produce inside airtight containers leads to the total lack of respiration and that speeds decay. Exceptions to this are onions, garlic, and potatoes, which are best stored in a cool, dark, dry place outside the refrigerator.

Boiling or just raising the temperature will inactivate enzymes and even kill microorganisms.

Storage compatibility needs to be taken into consideration. Fruits emit ethylene gas, which speeds ripening, and some vegetables are more sensitive than others. Incompatible combinations include apples and apricots stored with spinach, lettuce, or other leafy greens.

Research question 1: What happens to fruits or vegetables when left on the kitchen table for several days?

Task 1:

Choose at least two fruits or vegetables. Observe them for several days. Record your observations. The fruit or vegetable you have chosen might change in texture, taste, or colour. What other changes do you observe?

Research question 2: How can we keep seasonal food from spoiling?

Task 2:

- Suggest two ways to keep seasonal food from spoiling. Try them with your fruit or vegetable.
- How much longer does that fruit or vegetable stay eatable (without any observable changes) compared to the fruit and vegetable you observed in Task 1?
- Record your observations.

Preserving seasonal food

	Preserved Food	
Way of preservation		
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		

What do you think would be the best way to preserve your fruit or vegetable?

3.4 Read labels and logos

Objectives

- Pupils identify various sustainable food labels and learn about their meanings.
- Pupils design their own labels and packaging for homemade seasonal products.

Research questions

- What logos are on fruit and vegetables we buy at the store?
- What do logos placed on food mean?
- What food label can I place on my product?

Duration

Two lessons – 45 minutes each

Required materials

Produce (fruit and vegetables) and food products with various logos, a camera (optional), internet access, homemade food products, paper, coloured pencils, and other materials needed to design and make a food label.

Possible teaching sequence

1. The teacher provides each group with some products that have various sustainable logos on them. Alternatively, students can be asked to bring the produce themselves or take pictures of such logos at the store where they go shopping (note: tell them to ask permission from the shop owner or a sales clerk). In their groups, students create their own album of logos. They can either draw them or take pictures to print out later and glue into their notebooks.

   Below are two examples of logos pupils will probably find. Most countries also have national sustainability logos and students should be sure to look for these too.

2. Pupils identify the meanings of the logos. If they have difficulties (which they might), help them find the answers by providing resources (e.g. printed materials found in stores, via search engines online using key words, via websites like ECOLABELINDEX[14] and SUSTAINABILITY FOOD LABELS[15], etc.)

3. Pupils discuss which logos are about ethical issues and which are environmental.

4. Ask pupils to bring to school homemade fruit or vegetable preserves (marmalade, jam, jelly, fruit cake, pickles, dried fruit, canned vegetables, etc.). Another option would be to prepare such a product at school. Pupils could also bring a food item from home and try to place as many labels on it as possible based on the information they have about how and where it was grown, how it was processed, etc.

Background information

There is growing public demand for clear information on the impact of food consumption, including its effects on the environment, animal welfare, and the working conditions in developing countries. Information about these issues sometimes appears in the form of labels and logos on food and drink packaging. Such

[14] http://www.ecolabelindex.com/ecolabels/
[15] http://sustainability.tufts.edu/decoding-food-labels/

Logo	Where did you find it?	Meaning / Specific requirements	Remarks (optional)
		This logo guarantees that at least 95% of the product's ingredients of agricultural origin have been organically produced.	This EU logo should be accompanied by the name of the place where the agricultural raw materials were farmed.
		This means that the farmers and workers who grew and produced this product got better terms and a better wage for their work, as well as decent working conditions.	"Fairtrade is a strategy for poverty alleviation and sustainable development. Its purpose is to create opportunities for producers and workers who have been economically disadvantaged or marginalized by the conventional trading system."

environmental and ethical labels are distinct from quality labels (i.e. information about the brand, origin, use-by-date, and nutrition values) and can also play a significant role in influencing purchase decisions. They try to encourage individuals to make choices that are beneficial for society (e.g. choices that are environmentally friendly and/or have an ethical dimension).

Choosing local and seasonal foods means that food does not have to travel so far. Since transportation over long distances is not good for the environment, buying local is good for saving energy, reducing carbon dioxide emissions, and promoting sustainable agriculture. Reducing the distance travelled can also have a dramatic effect on lowering the price of certain seasonal foods and can also mean employment for members of the local community. Processing local fruit and vegetables at home can reduce the amount of packaging used and also save money in the family budget. Recycling and reusing packaging is vital to stopping the destruction of natural resources and protecting the local environment. The role of sustainability labels in consumer choices varies a good deal between countries, but still is in all likelihood low.[16]

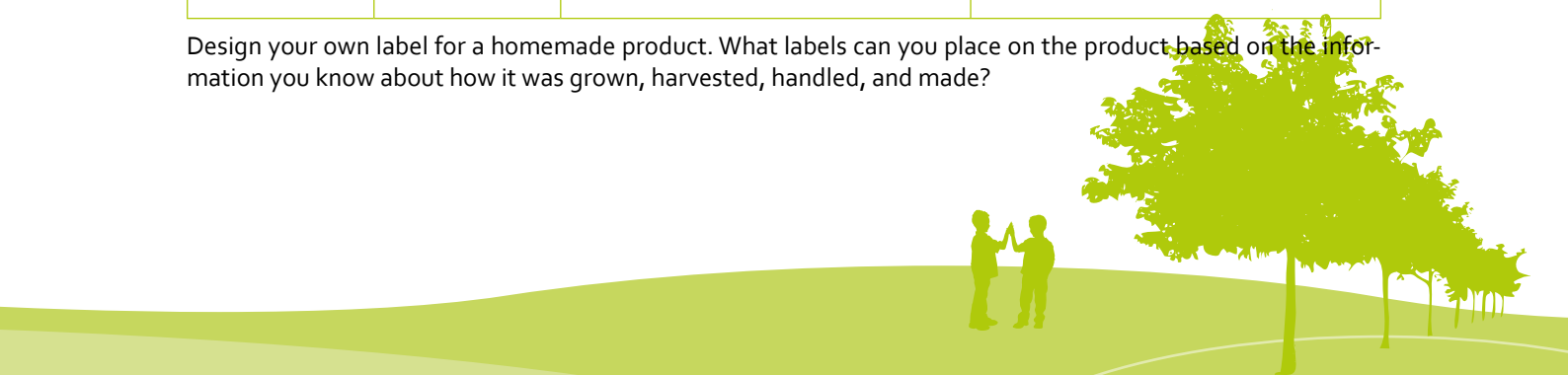
[16] http://www.eufic.org/article/en/expid/EUFIC_FORUM_No6/

Read the labels and logos

Find logos on produce and products. Do you know what they mean? Find out.

Logo	Where did you find it?	Meaning / Specific requirements	Remarks (optional)

Design your own label for a homemade product. What labels can you place on the product based on the information you know about how it was grown, harvested, handled, and made?



4 MILK

4.1 What is milk?

Objectives

- Find out about the composition of milk.
- Compare different kinds of milk.
- Construct a questionnaire and do some social research.

Research questions

- What is the most commonly known fact about milk?
- What kinds of milk are there? What makes them different?

Duration

2 lessons – 45 minutes each

Required material

Internet access, different samples of milk from various stores (optional)

Possible teaching sequence

1. Pupils are asked to do a survey to find out the most commonly known information about milk or to find out what benefits of milk are stressed most often. They can find the information from various milk containers or do a survey among their family members, schoolmates or neighbours. Ask them to present their results.
2. Pupils are asked to find out about the different kinds of milk for sale (e.g. different amounts of fat, different flavours added, lactose free, organic, etc.) on the market. They can take pictures of or notes about the kinds of milk they find at the store. They will discover that some needs to be stored in the fridge while others do not (if they are not opened). Other things that might differ are shelf life and the types containers they are stored and sold in. All findings can lead to new research which helps them understand better. Pupils present their findings and formulate possible questions about the information and differences they do not understand. This might be the starting point for a new study and further research.

Background information

Diary (cow) milk is approximately 3.3% protein, primarily casein and albumin. Milk is slightly acidic with pH 6.8 while casein has an isoelectric point of pH 4.5. When the pH of milk is lowered, casein is denatured. When casein is separated by filtration, the filtrate also contains albumin which denatures by heating to 65 °C. Casein is the main protein in cheese.

One litre of milk contains approximately 30-40 grams of fat in the form of an emulsion. Milk fat consists mostly of glycerol, free fatty acids, phospholipids, sterols, and esters. Fatty acids (more than 140) form around 85% of milk fat. They are mostly in the form of acylglycerols, and only a very small amount is in the form of free fatty acids, dissolving vitamins A, D, E, K and some pigments, for example carotenoids. The primary types of milk sold in stores are whole milk (3.5% fat), reduced-fat milk (2% fat), low-fat milk (1% fat), and fat-free milk which is also called non-fat or skim milk (no more than 0.2% fat). The percentages included in the names of the milk indicate how much fat is in the milk by weight.

After pasteurization, milk undergoes homogenization to prevent the separation of the milk fat from the fluid milk. Homogenization creates a smooth, uniform texture. The size of the fat particles in homogenised milk is around 0.1 µm-10 µm. Larger fat particles have a tendency to rise to the top and form a layer of cream. Technologically, this is done by exerting high pressure on warm milk (55-65°C).

The sugar present in milk is called lactose. Lactose intolerance is an enzymatic disorder due to a lactase deficiency. Lactase is an enzyme that catalyses the hydrolysis of lactose into glucose and galactose. Lactose intolerant individuals have insufficient levels of lactase in their digestive system and so have difficulty digesting lactose.

Milk is a good source of calcium, magnesium, phosphorus, potassium, selenium, and zinc. Many minerals in milk are associated together in the form of salts, such as calcium phosphate. Approximately 67% of the calcium, 35% of the magnesium, and 44% of the phosphate in milk are salts bound within the casein micelle. The remainder are soluble in the serum phase.

Milk contains water-soluble vitamins thiamine (vitamin B1), riboflavin (vitamin B2), niacin (vitamin B3), pantothenic acid (vitamin B5), vitamin B6 (pyridoxine), vitamin B12 (cobalamin), vitamin C, and folate.

Milk is a good source of thiamine, riboflavin and vitamin B12. Milk contains small amounts of niacin, pantothenic acid, vitamin B6, vitamin C, and folate, and is not considered a major source of these vitamins. It also contains the fat soluble vitamins A, D, E, and K. The content level of fat soluble vitamins in dairy products depends on the fat content of the product.

What is milk?

When you look closely at a bottle or box of milk, you find out all kinds of information about the milk on it. What is milk made of? What is it for? Do our bodies need it?

How many different kinds of milk are there? How are they different?

Survey 1

What is the most commonly known fact about milk? What do people know about its composition?

What do you think? Make a prediction about what might people know or think about milk. Come up with ways to find out if you are right.

Plan your survey

- How will you do it? (by studying milk containers, by asking friends or family members, etc.)
- What will you search for? What will you ask?
- How long will it take?
- How will you evaluate it?

Present your results.

Survey 2

Is there only one kind of milk on the market?

How many differences can you find? Make a list of them.

Do you understand those differences? If not, make questions to find out what they mean.

4.2 The production and consumption of milk

Objectives

- Learn about milk production and the production of dairy products
- Learn about the life cycle of a dairy cow and cattle.
- Find out about the relationship between production and consumption.
- Construct a questionnaire and do social research.
- Draw conclusions from gathered information.

Research questions

- What is the average family's weekly consumption of milk and dairy products?
- How much milk is used to make certain dairy products?
- How many cows do you have to keep in order to provide the milk and dairy products used by the average family in a week? / How many average families would the milk production of one cow provide for?

Duration

Several days

Required material

For one group

To make cream: 2000 ml raw milk, a pot, a cooker, a jar, a spoon

To make butter: 200 ml cream, a jar and a manual food processor, cold water, cotton fabric (40×40 cm), a bowl

To make curds: 1800 ml milk (use the rest of milk used to prepare cream), a pot, cotton fabric (40×40 cm), a bowl

To make yoghurt: 250 ml milk, a pot, a cooker, a thermometer, a yoghurt starter (one teaspoon of unsweetened yoghurt with live cultures), a jar with a lid, towels or a blanket.

To make cheese: 2000 ml raw milk, a pot, a cooker, a thermometer, a coagulant (e.g. rennet), room temperature water that has been boiled, a knife, salt, cotton fabric (40×40 cm), a bowl

A PC with an internet connection

Possible teaching sequence

1. Pupils design and run a survey about the consumption of milk and dairy products in an average family. Afterwards, they estimate the amount of milk used to make dairy products.
2. Pupils make some dairy products on their own. The approximate amounts of milk needed to prepare 100 g of a dairy product are presented in the table below.
3. Pupils learn from various resources[17] (or they could visit a farm) how much milk is produced annually by one cow. They calculate how much that would be a week. They need to figure out if that would be enough for their family based on the previous research about their consumption habits of milk and dairy products. Pupils also learn how much milk is needed to make certain amounts of the dairy products they eat.
4. If visiting a farm, pupils learn about livestock and the life cycle of a dairy cow.

[17] http://www.raw-milk-facts.com/dairy_cow_breeds.html
http://farm-animals.knoji.com/top-eighteen-best-milk-producing-cattle-breeds-in-the-world/
http://www.wikihow.com/Choose-a-Good-Dairy-Cow-Breed
http://www.wellfedhomestead.com/choosing-a-dairy-cow-breeds

The amount of milk you need to prepare 100 g of a dairy product

Dairy product	Or.	Amount of milk used	Amount of the finished dairy product	Consumption of milk to make 100 g of the dairy product
butter	1	1 l / 1020 g	45 g	2.2 l / 2267 g
cheese	2	1 l / 1020 g	100 g	1 l / 1020 g
cream	4	1 l / 1020 g	180 g	0.56 l / 567 g
curd	3	1 l / 1020 g	120 g	0.83 l / 850 g
yoghurt	5	1 l / 1020 g	1030 g	0.97 l / 99 g

Background information

Activities use raw whole milk, not processed milk.

Making cream

Milk is heterogeneous mixture even if it doesn't look that way. Cream separates from the rest of the milk in 48 hours. Cream contains mostly fat which has a lower density than water, which is the main part of milk.

Making butter

Skimmed cream from raw milk contains mostly milk fat, water, and proteins. The process of butter making consists of the cream first being concentrated and then the fat globules being broken down mechanically, so that the fat is liberated. This forms a continuous fat phase containing dispersed water droplets which can be separated from the fat phase.

Making curd

The basic principle in making cheese is to coagulate or curdle the milk so that it forms curds and whey. Raw milk left in a fridge for a certain period of time curdles naturally. The milk sours and forms an acid curd.

Curd making starts with acidification. This process is performed by bacteria. Bacteria feed on the lactose in milk and produce lactic acid as a waste product. In time, increasing amounts of lactic acid (lowering the pH of milk) causes the coagulation of the proteins in the milk. It appears as a white lumpy mass – curd.

Photo: Alžbeta Slavkovská

Making yoghurt

The principle of making yoghurt is milk fermentation using bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophilus*, which change the lactose (milk sugar) into lactic acid. The fermentation is also observable by a consistency change: the milk becomes creamy.

Making cheese

Cheese is produced by enzyme coagulating milk proteins (casein). Enzymes used to coagulate milk come from a number of sources: animals, plants, and fungi. The traditional source of enzyme is rennet. Rennet is extracted from the lining of the fourth stomach of suckling calves. The most important enzyme in rennet is chymosin.

Photo: Alžbeta Slavkovská

The production and consumption of milk

Problem: **What is the average family's weekly consumption of milk and dairy products?**

Task: Prepare and run a survey to find out how much milk and how many dairy products the average family consumes in a week.

Discussion: Who should you ask the questions?

How many families should you ask?

Consider units of measurement in order to compare the amount of dairy products.

Are there any extra steps you need to take?

Procedure: Run a survey to obtain the data to fill in the table below.

Table of family weekly consumption of milk and dairy products

Family	Number of members	Milk consumption	Yoghurt consumption	Curd consumption	Cheese consumption	Butter consumption
1.						
2.						
3.						
4.						
5.						
6.						
Mean						

Problem: **How much milk is used to make certain dairy products?**

Try to estimate the amount of milk you need to prepare 100 g of a dairy product.
Try to put them in order according to the amount of milk needed to prepare them.

Task: Find out how to prepare different dairy products.

Find the recipes (the procedure) to make yoghurt, curd, cheese and butter at home.

Follow the instructions and make your dairy products.

Discussion: What kind of milk do you need to prepare dairy products on your own?

What is the relationship between the volume and the weight of milk?

(Do not forget to measure the volume and the weight of milk used for production and to measure the weight of product.)

Amount of milk you need to prepare 100 g of a dairy product

Dairy product	Amount of milk used to produce 100 g of a dairy product		
	Order	Amount of milk you think is needed	Real amount of milk needed
butter			
cheese			
cream			
curd			
yoghurt			

Problem: **How much milk is needed to prepare 100 g of a particular dairy product?**

Task: Find out how much milk is used to make 100 g of specific dairy products (yoghurt, curd, cheese, and butter).

Discussion: Are the prices of dairy products based on the milk needed for their production?

What is the main component of those specific dairy products?

The amount of milk you need to prepare 100 g of a dairy product

Dairy product	Or.	Amount of milk used	Amount of finished dairy product	Consumption of milk to make 100 g of the dairy product
butter				
cheese				
cream				
curd				
yoghurt				

Problem: **How many cows do you have to keep in order to provide the milk and dairy products used by the average family in a week?**

How many average families would the milk production of one cow provide for?

Prediction:

Task: Find out how much milk the average dairy cow produces.

Use the data you gathered in your family survey and production of dairy products.

Use the information sources and visit a farm in your region to learn about the life cycle of a dairy cow and the production of milk.

Discussion: What cattle breeds are raised in your region (dairy, beef or mixed purpose)?

What is the yearly milk production of a specific cattle breed (according to region)?

What conditions is milk production influenced by?

Weekly milk consumption in one family

Family consumption of	Consumption in gram of product	How much milk is needed?
milk		
butter		
cheese		
cream		
curd		
yoghurt		
Summary		

Milk production and consumption

Weekly family consumption of milk	**Yearly milk production of one cow**	**Average weekly milk production of one cow**	**The number of cows needed to cover family consumption**	**The number of average families covered by the milk production of one cow**

4.3 How is milk packaged?

Objectives

- To investigate the properties of materials used to package milk.
- To investigate the waste policy in a family and in a local community.
- To propose and design a new milk container.

Research questions

- What is the best container to sell milk in?
- How much garbage is produced by the consumption of milk?

Duration

Varies. Each partial task can be started in one lesson. The research phase will last several weeks if data about household garbage is collected and material decomposition is investigated.

Required material

Various milk packaging (Petra Pak – one with a cap and one without, various milk bottles – plastic and glass, a milk bag – PP, PE or PVC, etc.), materials suggested by students to test properties, materials to design a container

Possible teaching sequence

1. Pupils work in groups. They investigate the properties of different milk packages. Pupils are asked to suggest how they will test the particular properties of each material. Different packages are provided by the teacher or are collected by the students.
2. Pupils find out how much waste they have in their homes from drinking milk and what that waste is made out of. They use a simple questionnaire to run their survey. Results are discussed in groups and later in the whole class. Pupils are also asked to think about what those results mean for their everyday lives. They are asked if any action is needed. They might find out about the waste policy in their city and suggest even more global solutions.
3. Pupils design new milk packaging taking into consideration all their previous findings: the properties of the materials used and the results of the survey about waste in their household. They label their product according to country legislation[18], come up with an advertising strategy, underline its benefits, etc.

Background information

In the past, milk was sold in glass bottles and later in plastic packaging. Milk has been sold in cartons since September 1952 (Tetra Pak Company, Lund, Sweden). In 1961, the Tetra Pak Company started using a new aseptic filling machine and a new improved aseptic package: Tetra Classic. It uses composite packaging material instead of one, single material. It consists of approximately 75% paper, 20% plastic (polyethylene – PET) and 5% aluminium foil.

Lowering the amount of waste is brought about by decreasing the amount of packaging. This can be done by buying products in larger packages, reusing packages or by choosing recyclable packages. Regular separation of household waste can lower the amount of garbage produced by 80%.

[18] http://ec.europa.eu/food/safety/labelling_nutrition/labelling_legislation/index_en.htm

What is the best container to sell milk in?

Have you noticed that milk is sold in various packages? Those packages are made of different materials, have different designs and different sizes.

- *Does it matter what package or what material is used?*
- *Find out what material is used/was used in milk packaging.*
- ***Find out the properties of the materials used.***
- *Which material is the best for storing and selling milk?*
- *Describe how to test each material and how to quantify/compare it.*

Properties you want to test	Procedure how to test a particular property	How is the property is quantified/ compared
A *Strength*		
B *Saturation (does it go soggy?)*		
C *Degradability*		
D *Storing properties*		
E *Size*		
F		

Test properties of particular packages.

	Package				
Properties you want to test	1 Tetra Pak package with a cap	2 Tetra Pak package without a cap	3 Glass bottle	4 PP, PE or PVC bag	5
A *Strength*					
B *Saturation (does it go soggy?)*					
C *Degradability*					
D *Storing properties*					
E *Size*					
F					
Conclusions					
Suitable for storing milk **because**					
Not suitable for storing milk **because**					

Does drinking milk leave litter?

How much garbage from milk is in your household? What do you do with it? Find out.

Discuss the answers to the following questions in your group:

- How can you find out how much garbage from milk is produced weekly in your households?
- What do we do with garbage in our households?

Plan and run your survey

What do we do?	
How long do we do it?	
Results	

Interpret your results. Do you think we need to take action? Do you think the data are alarming? Or are they okay? How do you know if there is a problem or if you need to take action?

If you decide that your findings show that there is the need to take action, how would you explain the problem to those who you think need to participate (the members of your family, your school principal, etc.?

What should a milk container look like?

Pretend that you and your team are responsible for selling a local farmer's (the members of your family, your school principal, etc.) milk. Your task is to come up with a sales strategy. You also need to design a milk container and think about how to attract potential customers. How do you do that?

Based on your previous knowledge, suggest how your milk is going to be sold. Design a container(s) and come up with ways to get customers. To present the milk from your local farm, consider the material you'll use, the package size, the design, the information provided, etc.

Present your package and your sales strategy to the class.

Consider your classmates' proposed ideas when they're presented and write down at least one strong point and one weak point of each.

4.4 Is local food better?

Objectives

- Pupils learn to work with information and interpret it.
- Pupils identify the relationship between the origin of a product and its social, environmental, and economic impact.

Research question

Is local food better than imported food?

Duration

2 lessons

Required material

A PC with an internet connection, a map

Possible teaching sequence

1. Pupils work in groups. They make a written list of milk and dairy products they usually eat or drink on a daily basis. They then find out where those products come from. They need to search for the brand, the distributor, etc. Afterwards they figure out how many food kilometres have to be driven to supply the milk and dairy products they eat on a daily basis.

   The activity leads to ways to reduce food kilometres by replacing products brought long distances with local products.

2. The second task focuses on the arguments for why local food might be better. Pupils discuss the advantages and disadvantages of various aspects influenced by food origin. They then summarize the pluses and minuses in a table to evaluate which food is better.

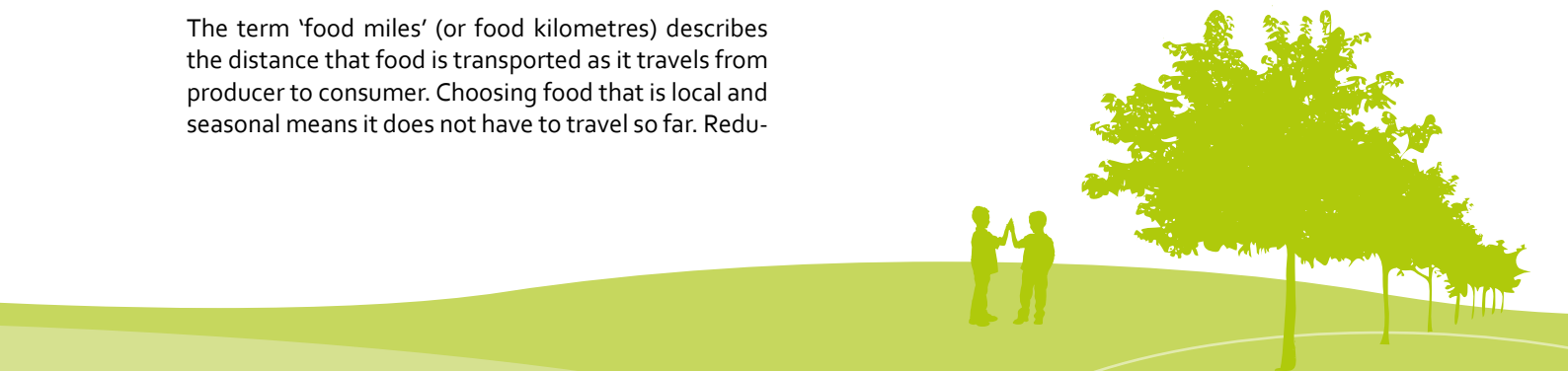
   Pupils should learn to prioritise and decide which aspect is the most important.

Background information

The term 'food miles' (or food kilometres) describes the distance that food is transported as it travels from producer to consumer. Choosing food that is local and seasonal means it does not have to travel so far. Reducing food miles can have a dramatic effect on reducing carbon dioxide emissions, and possibly lowering the price of food.

But there are also other considerations:

- The freshness of local food
- Health concerns
- Contact of the consumer with the producer – the direct responsibility of producer to consumer
- The employment of members of the local community
- Economic growth of the local community/region
- Saving the environment, reducing carbon dioxide pollution (global warming)
- etc.



Is local food better?

Read the article and decide what the main idea is.

"In 1993, a Swedish researcher calculated that the ingredients of a typical Swedish breakfast – apple, bread, butter, cheese, coffee, cream, orange juice, sugar – travelled a distance equal to the circumference of the Earth before reaching the Scandinavian table.

"In 2005, a researcher in Iowa found that the milk, sugar, and strawberries that go into a carton of strawberry yogurt collectively journeyed 2,211 miles (3,558 kilometres) just to get to the processing plant.

"As the local food movement has come of age, this concept of food miles (or food kilometres) – roughly, the distance food travels from farm to plate - has come to dominate the discussion… "

http://www.worldwatch.org/node/6064

- In the table below, list the milk and dairy products you usually eat or drink on daily basis.
- Count how many food kilometres have to be driven to supply you with the milk and dairy products you consume on a daily basis.
- Use Google maps to estimate the distance that has to be driven.

Milk and dairy products you usually drink/eat	Origin of the product or its ingredients (if it is available)	Distance that has to be driven for it to get to your plate
1.		
2.		
3.		
4.		
5.		
6.		
	SUM	km

Questions to answer:

How much fuel (petrol) has to be used (burnt) to supply your daily consumption of milk and dairy products?

What is the environmental impact of burning fuel? List more than one.

Is it possible to shorten food kilometres by choosing different dairy products?

How far is "local"? How many kilometres away could a farm be and you would still say it's local.

Are there any other conclusions you can draw from the data you collected?

Use the table below and think of different aspects of food origin (travelling). Consider what is best for these categories: you, your community, regional development, and the environment.

Use a plus or minus to indicate if you think an aspect is an advantage or disadvantage for each category. Use a "0" if you think there is no impact. Leave the field empty if you do not know.

You can add other aspects.

Different aspects	**Local food**				**Imported food**			
	Good for me	*Good for my community*	*Good for regional development*	*Good for the environment*	*Good for me*	*Good for my community*	*Good for regional development*	*Good for the environment*
Fuel consumption								
Local employment								
Food freshness								
Fair food prices								
Direct contact with producer								
Seasonal food availability								
Food quality guarantee								

Summarize your results. Decide which food is better considering its origin.

Are there many disagreements among your class's groups?

What aspects do you think are the most important and beneficial?

DISCLAIMER:

Please note that this booklet has been developed in the context of a European project, bringing together institutions from ten different countries. As such, there may be no direct link between the class activities proposed and the specific curricula applicable in each European country. Thus, the reader may wish to consult the official documentation of his/her country for reference and appropriate adaptation.

List of Resources/ Bibliography

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Principles and big ideas of science education, Wynne HARLEN, Ed., Association for Science Education, 2010

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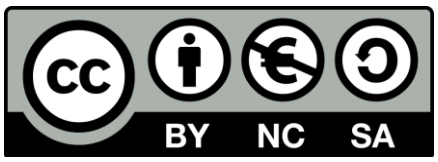
- *Inquiry in science education*, Wynne HARLEN, 2013
- *Tools for enhancing inquiry in science education*, Editorial coordinator: Susana BORDA CARULLA, 2013
- *Assessment & Inquiry-Based Science Education: Issues in Policy and Practice*, Wynne HARLEN, Global Network of Science Academies (IAP) Science Education Programme, 2013

ESD Resources

Education for Sustainable Development, Source book, UNESCO, 2012, available at:

'Teaching and Learning for a Sustainable Future', a free professional development programme of the UNESCO available at: http://www.unesco.org/education/tlsf/index.html



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