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STEM
E-CONTENT
3D VIRTUAL REALTY

The Key To Global Life,
Digital Change Of Nature

Total Duration: 6 hours

Student's Age: 12-18 Years

Application Area:
- chemistry
- design
- technology
- science

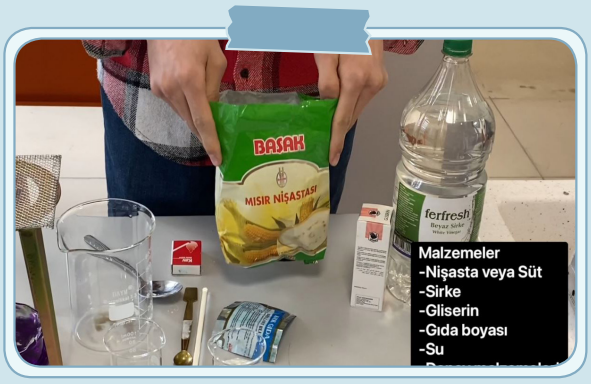
Keywords: Bioplastics, chemistry, polymers, 3D design, data collection, material science.

E2 - Milk jewels! (Bioplastic from milk and vinegar.)

Module
- Environmental pollution
- Global Warming

E2 - English Version

Materials:
- **Milk**
- **Vinegar**
- **Any heat source to warm the milk**
- **Paper towels**
- **Spoons**
- **Coffee filters**
- **Glass jars**
- **3D printer**
- **3D design software: tinkercad (tinkercad.com)**



Notes:
- Students may work in groups
- Students must participate and be active in the preparation for, data collection of, and reporting during the experiment,
- Knowledge of Tinkercad is needed,
- Each group must prepare a short film (1.5 min) after the steps are completed.

@digitalchangeon

Introduction

Bioplastics are plastics that are made from a renewable resource and/or are able to break down naturally. The first-ever man-made (what was the main ingredient?).

Plastic was actually a bioplastic Bioplastics can help reduce reliance on fossil fuels, support sustainability in the industry. The development and production of viable bio-plastics is one of the most competitive and cutting edge areas of research in the plastics industry.

Research is being done to create a range of bioplastics that will be able to replace existing oil based materials in a variety of applications. Ideally, plastic polymers will have natural sources, have a high sustainable content, and will be compostable and biodegradable such that they are recycled back to nature.

How can milk be changed into plastic?

To answer that we need to think first about what plastic is.

The word plastic is used to describe a material that can be molded into many shapes. Plastics do not all look or feel the same. Think of a plastic grocery bag, a plastic doll or action figure, a plastic lunch box, and a disposable plastic water bottle. They are all made of plastic, but they look and feel different. Why?

Their similarities and differences come from the molecules that they, like everything else, are made of. Molecules are the smallest units (way too small to see with your eye!) of any given thing. Plastics are similar because they are all made up of molecules that are repeated over and over again in a chain. These are called polymers, and all plastics are polymers. Sometimes polymers are chains of just one type of molecule. In other cases polymers are chains of different types of molecules that link together in a regular pattern. A single repeat of the pattern of molecules in a polymer (even if the polymer uses only one type of molecule) is called a monomer.

Make the students aware of the lifecycle of bioplastic. The class can be divided into teams. Each team can be asked to design a logo.

Considerations

- Students may work in groups
- Students must participate and be active in the preparation for, data collection of, and reporting during the experiment,
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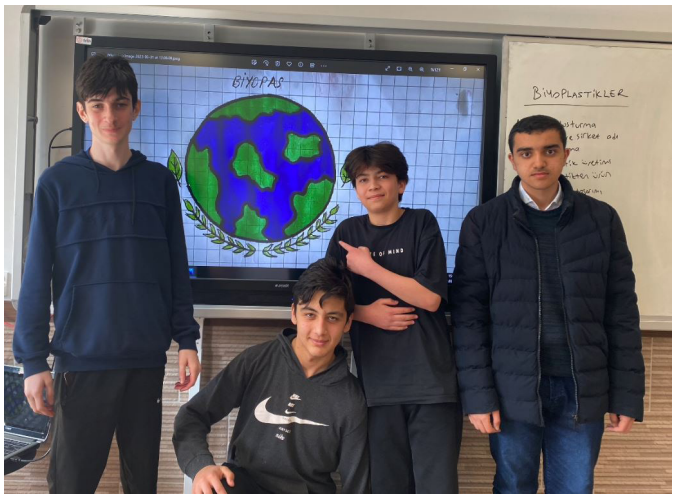
Aim of the Activity

This activity teaches students a number of skills, including the scientific method and communication using 21st century skills such as posting their work online in the form of a video or blog for the consideration of their peers. They will research bioplastics in order to understand why their development could be favorable for society and they will engage in numerous iterations to refine a standard bioplastics procedure to create the best product that they can.

- At least 2 different methods are tested, this template describes the method with milk and vinegar;
- To report results by conducting experiments (students make a movie to promote their final product to potential clients, explaining the motivation behind making bioplastics, the procedure followed, and why their product is worth buying);
- To improve the ability of spatial-visual intelligence when designing jewelry;
- To gain awareness of the concept of bioplastics;
- To use Tinkercad and 3D printing (the mold to make the product is 3d printed).

Activity Process

Before Activity



Picture 1. Plastic bags

Teacher separates the students into groups (Picture 1; to create groups randomly - https://www.classtools.net/random-name-picker/).

At this stage, the teacher asks the following research questions:

- What are the raw materials of plastic products?
- What is the amount of plastic waste that occurs over a year on earth?
- What is the impact of plastic waste on the ecosystem?
- What are bioplastics? What are the production stages?

Let's Start

1 Experiment: Making plastic with milk

1. Heat 1 cup of milk to about 50 degrees C and store in a thermos flask if necessary.
2. Add 4 teaspoons (tsp) white vinegar to a mug or heat proof cup.
3. Pour 1 cup of warm milk into the mug with the vinegar. What do you see happening? You should see the curds forming.
4. Mix with a spoon for a few seconds (Picture 2)

Picture 2. Mix with a spoon

5. Stack four layers of paper towels on a hard surface that can get damp.
6. Once the mixture has cooled slightly, scoop the curds onto the paper with a spoon. Collect as much curd as possible.
7. Try to get as much excess moisture out of the curds as possible (Picture 3).

Picture 3. Boil

8. Knead well and make a ball of all curds . This is the casein plastic (Picture 4).
9. You now only have 1 hour to make something with your plastic!
10. Get started as an artist or jewelry designer. Let your imagination run wild. You can shape, color, and so on your plastic. For example, use cookie cutters, add food coloring, glitter or other decorative pieces.
11. Your creation must then dry for 48 hours. Once dried, you can still paint your creation if necessary.

Picture 4. Make samething

2 Make it your own

We investigate how the amount of vinegar influences the yield of casein plastic.

You can experiment with proportions (more milk or more vinegar) and temperature. Can you set up an experiment to see what makes the most plastic, e.g. with the same amount of milk but different amounts of vinegar? How would you handle this?

Test and compare (Picture 5):

1. 4 tsp white vinegar with 1 cup warm milk
2. 1 tsp white vinegar with 1 cup warm milk
3. 2 tsp white vinegar with 1 cup warm milk
4. 8 tsp white vinegar with 1 cup warm milk

Picture 5. Test and compare

To collect the curds and thus get a good idea of the yield of the casein plastic, you can filter the milk-vinegar mixture through a cotton cloth secured with rubber bands on a cup instead of using a spoon. Make a plan/design for your experiment, discuss it with your supervisor and then implement it (see an example below). Accurately track data and analyze it afterwards. Can you think of other possible factors that can influence the outcome? Set up an experiment.

Amount of vinegar (tsp)	Is the plastic curved?		Weight of casein plastic	Liquid definition (excess moist)	Other observations
	Yes	No			
1			(.....)	(.....)	(.....)
2			(.....)	(.....)	(.....)
4			(.....)	(.....)	(.....)
8			(.....)	(.....)	(.....)

Note: Please take this information while researching. Evaluate afterwards.

3 Design: Create your own cookie cutter via 3D-printing

Picture 6. Make samething

Use for example the scribble tool in tinkercad to create your cookie cutter (Picture 6).

4 Evaluation

Discuss the results:

In this chemistry science project, you will investigate what is the best recipe for making casein plastic by making batches of heated milk with different amounts of vinegar.

Without enough vinegar the casein molecules do not unfold well, making it difficult for them to link together into a polymer. Of course, if you were manufacturing you would be thinking about both the amount of plastic you can make and the cost. The more of any ingredient you use the more expensive the end product is. The "best" recipe will have the highest yield (make the most plastic) for the smallest amount of vinegar (Picture 7).

How much vinegar is needed to give you the most plastic?

Picture 7. Discuss the results

Short video of results and failures:

The designs are completed and a short film is prepared to describe the process. Students are asked to imagine themselves as an artist or a jewelry designer. At this stage, they are given time to challenge their imagination. Shape, color plastics, etc. for example, use a cookie cutter, you are asked to add food paint, glitter or other decorative parts. Designs are held for 48 hours to dry. After drying, the painting can be performed.

Closure

- At the end of the study, these outputs could be obtained. Here is examples for you

Check the goals:

21st Century Skills :

- Inquiry Questions: Sample questions intended to promote deeper thinking, reflection and refined understandings precisely related to the grade level expectation.
- Relevance and Application: Examples of how the grade level expectation is applied at home, on the job or in a real-world, relevant context.
- Nature of the Discipline: The characteristics and viewpoint one keeps as a result of mastering the grade level expectation.
- Share experimental data, and respectfully discuss conflicting results (CDE : Comprehensive Diagnostic Evaluations).
- Critically evaluate scientific explanations in popular media to determine if the research methodology and evidence presented are appropriate and sufficient to support the claims (CDE).

Possible extension:

- Create standards and establish precedent for testing plastic products.
- Refine and improve a bioplastics procedure based on standards created in order to produce the best possible product.

Assesment

Evaluation

- The design of students can be displayed within the school. Different products can be created by diversifying waste materials used.

Goals	Must be Improved (1)	Medium (2)	Good (3)	Very Good (4)
Appropriate reporting in practice,	(.....)	(.....)	(.....)	(.....)
Appropriate use of digital tools in the process (use of Web 2.0 tool),	(.....)	(.....)	(.....)	(.....)
Having high team-work skills, high communication skills,	(.....)	(.....)	(.....)	(.....)
Success in Tinkercad and jewelry design,	(.....)	(.....)	(.....)	(.....)
Managing the planning, execution, problem solving and decision making processes in the best way,	(.....)	(.....)	(.....)	(.....)
Well designed process video (at this stage, those who use the web 2.0 tool will be more advantageous)	(.....)	(.....)	(.....)	(.....)
Total				

Creativity and Innovation
- Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.

Communication and Collaboration
- Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

Research and Information Fluency
- Students apply digital tools to gather, evaluate, and use information

Critical Thinking, Problem Solving, and Decision Making
- Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

- **Useful Links and Background**
- *lesson plan and background info: https://www.sciencebuddies.org/stem-activities/milk-into-plastic*
- *https://www.bioplasticsmagazine.com/en/index.php*
- *https://thisisplastics.com/plastics-101/what-are-bioplastics-and-why-are-they-important/*

Links

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