Grain Science

KANSAS STATE UNIVERSITY

Grain Science and Industry

Lesson 9: Value-Added Products

Unit:	Grain Science
Estimated Time:	50 Minutes
Age of Learners:	9th-12th Grade

Equipment, Supplies, References, and Other Resources:

- Glue and Extrusion worksheet
- Flour vs. Name Brand Glue: Flour, water Styrofoam bowls, spoons, name brand glue (like Elmer's), several small objects (buttons, pennies, paper clips, etc.), scrap paper,
- Value-Added Yes or No Powerpoint
- Extrusion Activity: Play-Doh, Plastic syringes (without needles), Plastic tubing or straws, Scissors, Ruler or measuring tape, Plastic trays or plates

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Objectives	1. Compare the effectiveness of homemade flour glue with commercial glue by conducting a hands-on experiment to assess consistency and strength, fostering skills in observation, experimentation, and data recording. 2. Explore the concept of value-added products in the context of grain science, identifying examples of value-added products and their significance in enhancing product utility and marketability. 3. Investigate the extrusion process as a value-added technique in food processing, examining its applications, advantages, and effects on product characteristics, promoting understanding of food technology principles and their practical implications. 4. Engage in a simulated extrusion activity to illustrate the extrusion process, experimenting with different variables to observe their impact on the final product, and facilitating comprehension of extrusion mechanics and related factors.
Interest Approach ~15 minutes *Divide students into groups of 3-5. The initial portion of the interest approach will take about 10 minutes. Students will complete the activity after 30 minutes.*	**Flour vs. Name Brand Glue** **Materials per Group** • ½ cup flour • ½ cup water • Styrofoam bowl • Spoon • Elmer's/Name Brand glue • Several small objects that can be glued (e.g. buttons, pennies, paper clips, etc.) • Scrap paper **Directions** Mix ½ cup flour with ½ cup of water until you get a thick glue-like consistency. Add a bit more water if it's too thick. Mix well with a spoon to get rid of all the lumps. When you have finished mixing the flour glue, select a small object like a button and glue it onto a piece of scrap paper. Repeat this step with Elmer's or another name brand glue. Wait 30 minutes and try to remove your object from the paper then record your observations below. 1. Which glue had the best consistency? 2. Which glue was the strongest 30 minutes?

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Value-Added Products ~ 5 minutes	Value added is a change in the physical state or form of the product (such as milling wheat into flour or making strawberries into jam). The production of a product in a manner that enhances its value. Show the Value Added Yes or No PowerPoint to students. Students will guess if the six pictures are value added products or not. 1. Field corn – no 2. Wheat – no 3. Flour – yes 4. Corn syrup – yes 5. Cracked corn feed – yes 6. Ethanol – yes Ask students: Is glue made from flour a type of value-added product? Yes!
Extrusion ~ 20 minutes *Students can read about extrusion individually or can take turns reading it together in class.* *Divide students into groups of 3 to 5 to complete the Simulation of Extrusion activity.*	An example of Value-Added Products is extrusion. Extrusion is simply the operation of shaping a plastic or dough-like material by forcing it through a restriction or die. A food extruder is a device that expedites the shaping and restructuring process for food ingredients. Extruders can be used to cook, form, mix, texturize and shape food products under conditions that would favor quality retention, high productivity, and low cost. Applications include ready-to-eat snacks, cereal, plant-based meat, pet food, aquatic feed, etc. **Cereal extrusion** Most cereals contain a large amount of starch. In its natural form, the starch is insoluble, tasteless, and unsuited for human consumption. To make it digestible and acceptable, it must be cooked. The most common cereals used daily for making breakfast cereal and snack foods are corn, wheat, rice, oats, barley, and sorghum. **Advantages of extrusion** Extrusion technology provides several different advantages over the traditional methods of breakfast cereals and snack food processing. Some of these advantages include the following: • Product characteristics: a variety of shapes, texture, color, and appearances can be produced, which is not easily formed using other production methods. • Energy efficiency: extruders operate at relatively low moisture while cooking food products, so less re-drying is required. Show video of extrusion: **CigiTV - Cooking Extrusion** (4:13) Shows the machinery and process used to make products ranging from breakfast cereal to pet food. https://www.youtube.com/watch?v=TiaCrn23g1k *continued on next page*

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Extrusion, continued	**Extrusion Activity** **Materials per Group** • Play-Doh • Plastic syringes (without needles) • Plastic tubing or straws • Scissors • Ruler or measuring tape • Plastic trays or plates **Simulation of Extrusion** 1. Flatten the lump of Play-Doh on the tray to create a rectangular shape. 2. Using the ruler, cut the Play-Doh into smaller pieces of equal width (about 2-3 cm wide) and length. 3. Take one of the smaller Play-Doh pieces and insert one end into the plastic tubing or straw. Make sure the Play-Doh extends beyond the tubing/straw. 4. Holding the tubing/straw, push the Play-Doh through using the syringe, simulating the extrusion process. Observe the changes in shape and texture as the Play-Doh is forced through the tubing/straw. 5. Once the Play-Doh is extruded, cut the extruded clay into smaller sections using scissors. 6. Compare and discuss the shapes and textures of the extruded Play-Doh pieces with the original Play-Doh pieces. Repeat the above steps with the following amendments: 7. Modify the shape of the tubing or straw observe the impact on the extruded Play-Doh. 8. Experiment with different Play-Doh formulations by adding additional ingredients like water or food coloring to observe the effects on extrusion. **Reflection and Discussion** 1. Explain how the pressure exerted by the syringe and the shaping effect of the tubing/straw affected the clay. 2. Discuss the similarities and differences between the simulated extrusion activity and the actual grain extrusion process. 3. Reflect on the challenges and considerations that food technologists face when designing and operating extrusion processes.

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Supplemental Activity: Value-Added Research ~ 15 minutes *Divide students into groups.*	Students will select one value-added product from the list below or choose one of their own to research in more detail. They will explore the production process, nutritional benefits, market demand, and any challenges associated with the product. They will take notes and gather relevant visuals to create a two-minute presentation to share with the class. **Challenge:** Brainstorm a value-added product that you would create to meet the needs or wants of your group. **Wheat:** 1. Flour: Used to make bread, pasta, cakes, pastries, and more. 2. Soft wheat flours: Used to make cookies, crackers, pretzels, and cakes. 3. Durum wheat: Used to make pasta, such as spaghetti and macaroni. 4. Starch, paste, malt, dextrose, gluten, alcohol, and other products: Produced by industry using wheat. 5. Additional value-added compounds: Such as glycerol, succinic acid, acetic acid, lactic acid, and α-glycerylphosphorylcholine, produced during fermentation of wheat grain. **Corn:** 1. Cornstarch: A derivative of corn, it's a common ingredient in hygiene products, matchsticks, and many medications and vitamins. 2. Corn: Used to make ethanol gas, batteries, plastics, crayons, whiskey, glue, and cough drops. 3. Corn flakes: A corn product. 4. Corn syrup: A corn product. 5. 5.Corn oil: A corn product. 6. High fructose corn syrup: A corn product. 7. Corn meal: Used in bakery mixes, cereals, corn bread, and corn meal mixes. 8. Corn steep liquor: A by-product of corn. 9. Corn fiber: A by-product of corn. 10. Corn gluten: A by-product of corn. 11. Toothpaste: Corn is used in toothpaste as a gentle abrasive to help clean your teeth. 12. Beverages: Corn is used to produce beverages, such as beer and ale. 13. Food acids: Corn is used to produce food acids, such as citric acid. *continued on next page*

Instructor Directions & Estimated Time	Content Outline and/or Procedures
Value-Added Research, continued	**Sorghum:** 1. Bran, brewer's grains, and other by-products: Such as sorghum bran, malted sorghum sprouts, and sorghum wine residue. 2. Enjera, porridge, and local drinks: Such as enjera, tella, and arekie. 3. Bread: Both leavened and unleavened. 4. Couscous: Used primarily in Sahelian Africa. 5. Syrup: Used as a sweetener. 6. Natural fuel source: Used as a natural fuel source. 7. Animal feed: Used for animal feed in the U.S. 8. Ethanol production: Used for ethanol production in the U.S. 9. Bakery products: Such as dishes, recipes, and bakery products. 10. Noodles and pasta: Such as noodles and pasta.

	State Standards
Language Arts	• **RI.9-10.11.a.** Use context to determine the meaning of a word or phrase • **RI.9-10.11.** Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9–10 reading and content. • **W.9-10.3.e.** Provide a conclusion that follows from and reflects on what is experienced, observed or resolved over the course of the narrative.
Science	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. (**HS-LS2-5**) • Modern civilization depends on major technological systems. (**HS-ESS3-1**), (**HSESS3**-3) • Engineers continuously modify these systems to increase benefits while decreasing costs and risks. (**HS-ESS3- 2**), (**HS-ESS3-4**)
Math	• **(S.IC) B.** Make inferences and justify conclusions from sample surveys, experiments, and observational studies. • **G.MG.1. (9/10).** Use geometric shapes, their measures, and their properties to describe objects. • **G.MG.2. (9/10).** Apply concepts of density and displacement based on area and volume in modeling situations.

Lesson 9: Flour vs. Name Brand Glue Worksheet

Materials

- ½ cup flour
- ½ cup water
- Styrofoam bowl
- Spoon
- Elmer's/Name Brand glue
- Several small objects that can be glued (e.g. buttons, pennies, paper clips, etc.)
- Scrap paper

Directions

Mix ½ cup flour with ½ cup of water until you get a thick glue-like consistency. Add a bit more water if it's too thick. Mix well with a spoon to get rid of all the lumps.

When you have finished mixing the flour glue, select a small object like a button and glue it onto a piece of scrap paper. Repeat this step with Elmer's or another name brand glue. Wait 30 minutes and try to remove your object from the paper then record your observations below.

1. Which glue had the best consistency?

2. Which glue was the strongest after 30 minutes?

Lesson 9: Extrusion Worksheet

Extrusion

Extrusion is simply the operation of shaping a plastic or dough-like material by forcing it through a restriction or die. A food extruder is a device that expedites the shaping and restructuring process for food ingredients. Extruders can be used to cook, form, mix, texturize and shape food products under conditions that would favor quality retention, high productivity, and low cost.

Applications include ready-to-eat snacks, cereal, plant-based meat, pet food, aquatic feed, etc.

Cereal extrusion

Most cereals contain a large amount of starch. In its natural form, the starch is insoluble, tasteless, and unsuited for human consumption. To make it digestible and acceptable, it must be cooked. The most common cereals used daily for making breakfast cereal and snack foods are corn, wheat, rice, oats, barley, and sorghum.

Advantages of extrusion

Extrusion technology provides several different advantages over the traditional methods of breakfast cereals and snack food processing. Some of these advantages include the following:

- Product characteristics: a variety of shapes, texture, color, and appearances can be produced, which is not easily formed using other production methods.
- Energy efficiency: extruders operate at relatively low moisture while cooking food products, so less re-drying is required.

Extrusion Activity

Materials

- Play-Doh
- Plastic syringes (without needles)
- Plastic tubing or straws
- Scissors
- Ruler or measuring tape
- Plastic trays or plates

Simulation of Extrusion

1. Flatten the lump of Play-Doh on the tray to create a rectangular shape.
2. Using the ruler, cut the Play-Doh into smaller pieces of equal width (about 2-3 cm wide) and length.
3. Take one of the smaller Play-Doh pieces and insert one end into the plastic tubing or straw. Make sure the Play-Doh extends beyond the tubing/straw.
4. Holding the tubing/straw, push the Play-Doh through using the syringe, simulating the extrusion process. Observe the changes in shape and texture as the Play-Doh is forced through the tubing/straw.
5. Once the Play-Doh is extruded, cut the extruded clay into smaller sections using scissors.
6. Compare and discuss the shapes and textures of the extruded Play-Doh pieces with the original Play-Doh pieces.

Repeat the above steps with the following amendments:

7. Modify the shape of the tubing or straw observe the impact on the extruded Play-Doh.
8. Experiment with different Play-Doh formulations by adding additional ingredients like water or food coloring to observe the effects on extrusion.

Reflection and Discussion

1. Explain how the pressure exerted by the syringe and the shaping effect of the tubing/straw affected the clay.

2. Discuss the similarities and differences between the simulated extrusion activity and the actual grain extrusion process.

3. Reflect on the challenges and considerations that food technologists face when designing and operating extrusion processes.

Lesson 9: Value-Added Products Research

Value-Added Products

Value added is a change in the physical state or form of the product (such as milling wheat into flour or making strawberries into jam). The production of a product in a manner that enhances its value.

Value-Added Research

Select one value-added product from the list below and research the following:

1. production process
2. nutritional benefits
3. market demand
4. any challenges associated with the product.

Take notes and gather relevant visuals to create a two-minute presentation to share with the class.

Wheat:

1. Flour: Used to make bread, pasta, cakes, pastries, and more.
2. Soft wheat flours: Used to make cookies, crackers, pretzels, and cakes.
3. Durum wheat: Used to make pasta, such as spaghetti and macaroni.
4. Starch, paste, malt, dextrose, gluten, alcohol, and other products: Produced by industry using wheat.
5. Additional value-added compounds: Such as glycerol, succinic acid, acetic acid, lactic acid, and α-glycerylphosphorylcholine, produced during fermentation of wheat grain.

Corn:

1. Cornstarch: A derivative of corn, it's a common ingredient in hygiene products, matchsticks, and many medications and vitamins.
2. Corn: Used to make ethanol gas, batteries, plastics, crayons, whiskey, glue, and cough drops.
3. Corn flakes: A corn product.
4. Corn syrup: A corn product.
5. Corn oil: A corn product.
6. High fructose corn syrup: A corn product.
7. Corn meal: Used in bakery mixes, cereals, corn bread, and corn meal mixes.
8. Corn steep liquor: A by-product of corn.
9. Corn fiber: A by-product of corn.
10. Corn gluten: A by-product of corn.
11. Toothpaste: Corn is used in toothpaste as a gentle abrasive to help clean your teeth.
12. Beverages: Corn is used to produce beverages, such as beer and ale.
13. Food acids: Corn is used to produce food acids, such as citric acid.

Sorghum:

1. Bran, brewer's grains, and other by-products: Such as sorghum bran, malted sorghum sprouts, and sorghum wine residue
2. Enjera, porridge, and local drinks: Such as enjera, tella, and arekie
3. Bread: Both leavened and unleavened
4. Couscous: Used primarily in Sahelian Africa
5. Syrup: Used as a sweetener
6. Natural fuel source: Used as a natural fuel source
7. Animal feed: Used for animal feed in the U.S.
8. Ethanol production: Used for ethanol production in the U.S.
9. Bakery products: Such as dishes, recipes, and bakery products
10. Noodles and pasta: Such as noodles and pasta

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Grain Science lessons are posted at:
https://www.grains.k-state.edu/educator-resources/untitled.html

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