

DESCRIPTION

This lesson should take place two weeks after Lesson 3. In this lesson students will review bokashi composting and discuss the nutrient cycle. They will dry the bokashi they made during Lesson 3 for later use, and bury the fermented food waste created during Lesson 3 in the garden soil or aerobic compost pile in order to complete the bokashi composting process.

TIME: 60 minutes

SUBJECTS: Language Arts, Science

LEARNING OBJECTIVES

After this lesson students will be able to:

- Understand and describe the nutrient cycle, through which plants are fertilized naturally.
- Understand the importance of microorganisms and how they help us reduce waste, recycle nutrients, and nourish the garden soil and plants.
- Complete the process of making and using bokashi and explain how the process works and why composting is important.



ACADEMIC STANDARDS*

CCSS, Language Arts: 3.RF.3, 3.W.1, 3.W.2, 3.W.8, 3.W.10, 3.SL.1 **NGSS:** 3-LS4-3, LS4.C, Influence of Science, Engineering and Technology on Society and the Natural World, Patterns, Systems and System Models **Lesson Extensions:** 3.W.1, 3.W.7, 3.SL.4

*A detailed list of the Academic Standards can be found in the Unit Overview document.

LESSON OUTLINE

- I. Introduction (15 minutes)
 1. Compost Check-In
 2. Bokashi Review
 3. Nutrient Cycle
 4. Group Activities Overview
- II. Group Activities (30 minutes)
 1. Drying The Bokashi (15 minutes)
 2. Completing The Process (15 minutes)
- III. Closing and Snack (15 minutes)

KEY TERMS AND CONCEPTS

Bokashi - A Japanese term meaning 'fermented organic matter'; a material typically made with beneficial microorganisms, molasses, water, and wheat mill run or bran; a method of composting that uses beneficial microorganisms to ferment and accelerate the breakdown of organic matter

Beneficial Microorganisms - Naturally-occurring plant and soil microorganisms that can be cultivated and applied to improve plant health and the recycling of soil nutrients

EM® - Effective Microorganisms™; a formulated product of specific naturally-occurring microorganisms including lactic acid bacteria, yeast, and phototrophic/ photosynthetic bacteria (which utilize solar energy to metabolize organic and inorganic substances); a technology pioneered by Dr. Teruo Higa, a scientist from Japan

Nutrient Cycle - The movement and exchange of organic and inorganic matter (e.g., minerals) back into the production of living matter

LESSON MATERIALS

Lesson Supplies:

- Nutrient Cycle Sign
- Garden Agreements Sign
- Compost Map Answer Cards: Beneficial Microorganisms; Wheatmill Run; Molasses; Water; Decomposers (F.B.I.)
- Tarp
- Bokashi Compost Bucket with fermented food waste from Lesson 3
- Bokashi made during Lesson 3 (inside Bokashi Storage Bucket)
- Student Workbook

Teaching Team to Provide:

- Fruit and/or vegetable snack (from the school garden/orchard if available and if approved by the school's garden leaders)

School to Provide:

- Compost/Garden/Science Journals (1 per student if not using Student Workbooks)
- Shovels (if digging trench in garden soil)
- Hand trowels
- Buckets and/or garden hose
- Wood chips or other large quantity of brown/carbon materials (e.g., leaves; for placing over fermented food waste in the aerobic compost pile).

ACCOMPANYING DOCUMENTS

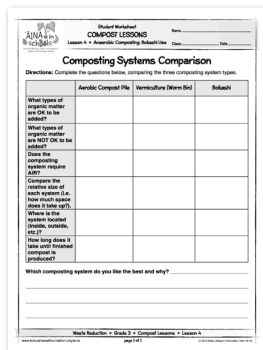
- Guided Notes
- Kōkua Compost Song Mad Lib
- Student Worksheet: Composting Systems Comparison

ADVANCE PREPARATION

- Discuss lesson preparation and presentation plans with your teaching team.
- Make copies of the Guided Notes and Composting Systems Comparison Student Worksheet, one per student if not using the Student Workbook.
- Decide whether the fermented food waste from the Bokashi Compost Bucket will be buried in the garden soil or layered under wood chips in an "active" aerobic compost pile (see Group Activities: Completing The Process for details).
- Harvest or purchase and prepare the fruit and/or vegetable snack.
- Lay out the tarp in a dry, protected area and anchor the corners and edges with heavy objects.
- Have students ready to take notes in their Compost/Garden/Science Journals if not using Student Workbooks.



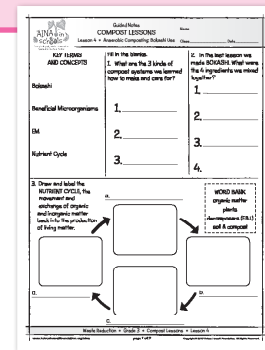
A fresh, healthy snack harvested from the school gardens.



Student Worksheet: Composting Systems Comparison



Compost Map Answer Cards



Guided Notes: Anaerobic Composting: Bokashi Use

INTRODUCTION

15 MINUTES

“Aloha! Today is our fourth ĀINA In Schools lesson on composting and the last lesson of the semester.” During the discussion, write key terms on the board and have students take notes in their journals or Student Workbooks. **Use the Compost Map Answer Cards during the discussion.**

COMPOST CHECK-IN

“What are the three compost systems we learned about?”
Desired Answers: Aerobic Composting, Vermicomposting, and Bokashi. Write the three composting systems on the board. **Workbook Question #1:** Have students write in the three composting systems. Ask students to share about the status of their aerobic compost pile, worm bin, and bokashi bucket, and their experiences and observations in caring for their composting systems.

BOKASHI REVIEW

“In our last lesson, we made BOKASHI by mixing four things together. What are the ingredients in our BOKASHI recipe?” If using beneficial microorganisms: Desired answer: LAB, IMO, wheat mill run, and water. If using EM-1®: Desired answer: EM-1®, molasses, water, wheat mill run. **Workbook Question #2:** Have students write in the desired answers on #2 of the Guided Notes.



“Our BENEFICIAL MICROORGANISMS have been multiplying for two weeks, and now our bokashi is ready to use, or to be dried for storage and later use. Today we will dry the bokashi that we made and use it next semester for more bokashi composting!”

“What is the third step in the bokashi composting process?” Desired answer: To complete the composting process by burying the fermented food waste in the garden soil or layering it under wood chips (carbon) in an aerobic compost pile.

“This final step relies on the decomposers (the soil F.B.I.) that are present naturally in the garden soil or compost

pile to finish the breakdown of the fermented food waste into finished compost, which will then feed our garden soil and plants.”



Nutrient Cycle Sign

NUTRIENT CYCLE

“How can we tell when the composting process is complete and we have finished compost?” Accept a few student answers. “Compost is finished when you can no longer recognize what is in it. It will also smell earthy and fresh, with a rich, dark color. This is true for aerobic compost piles, worm bins, and bokashi composting systems...and even forests!”

“Do forests need to be fertilized? Not by people! In nature, plants receive all the nutrition they need through the NUTRIENT CYCLE, where organic matter and inorganic matter (e.g., minerals from the earth) are cycled around and around, thanks to the work of decomposition. All materials are recycled and there is no waste! Decomposers such as microorganisms and invertebrates make this possible.” **Workbook Question #3:** Show the Nutrient Cycle Sign and have students draw and label a simple version in their Guided Notes.

GROUP ACTIVITIES OVERVIEW

“Today we will work with decomposers to complete the bokashi composting process. We will also dry our bokashi so that it can be stored for use next semester!”

Garden Agreements

Have students take a deep breath, then repeat and discuss the Garden Agreements as listed on the Garden Agreements Sign:

- I will be SAFE
- I will be KIND
- I will have an OPEN MIND
- I will use my TIME WELL



Divide the students into two groups before going outside. Rotate the groups after 15 minutes. Regroup for closing and snack.

GROUP ACTIVITIES

30 MINUTES

DRYING THE BOKASHI

(15 minutes, outside in a dry protected area)

Lay out the tarp over the grass or sidewalk (in a protected area in case of wind). Roll the edges inward a few times to create a barrier to prevent the loss of bokashi around the edges of the tarp. Anchor the corners and edges with heavy objects. The drying area where the tarp is laid should be in a covered space unless there is no chance of rain.

Open the Bokashi Storage Bucket and have students carefully spread the bokashi from the Bokashi Storage Bucket over the entire tarp, using their hands to break up clumps completely (and mindfully). The material needs to be completely dry before long-term storage (or it may be used in this form immediately).



The bokashi will need to dry for several hours and be collected at the end of the school day, or the tarp may be moved into a classroom overnight if necessary especially during rainy seasons. When dry, it can be stored within the Bokashi Storage Bucket, tightly sealed and kept in a dry place.

COMPLETING THE PROCESS *(15 minutes)*

The bokashi composting process may be completed by either burying the fermented food waste in the garden soil or layering it under wood chips in an “active” aerobic compost pile, as described in the following instructions.

Burying in the Garden Soil:

- Prepare the garden soil by using shovels to dig a trench, approximately 8 inches wide, 8 inches deep, and 8 feet long (this may be done before the lesson).
- Have students take turns using the hand trowels

to spread the fermented food waste evenly inside the trench.

- Have students place soil over the fermented food waste and mix lightly, making sure soil comes into direct contact with all the food pieces.
- Have students fill the trench with soil and smooth out the soil surface.



Layering in the Aerobic Compost Pile:

- Have students bring their Bokashi Compost Bucket to the aerobic compost pile. Have students use hand trowels to spread the fermented food waste in an even layer on top of the “active” compost pile. All classes will be composting the contents from the same Bokashi Compost Bucket, so be sure that enough fermented food waste is left for the remaining classes.
- Use shovels to evenly add several scoops of soil over the fermented food waste to help inoculate it with beneficial microorganisms and invertebrates.
- Have students take turns using the hand trowels to fill buckets with wood chips, then place the wood chips in a thick, level layer (4 to 6 inches) over the fermented food waste. Be sure that food waste is completely covered and not left exposed.
- Have students take turns watering the aerobic compost pile thoroughly.

All students must wash their hands thoroughly with soap and water.

CLOSING AND SNACK

15 MINUTES

Gather all the students in the garden/compost area. Have students refer to their Guided Notes and ask them to share about their experience.

Discuss with students:

- What did the fermented food waste look like when we buried it in the garden/compost pile?
- What do you think it will look like in two weeks?
- Describe the NUTRIENT CYCLE and explain its importance.
- How can you tell when the composting process is complete?

Be sure that students have washed their hands thoroughly with soap and water, then share the fruit and/or vegetable snack with students. Ask them to share what they are thankful for before enjoying the snack, and reflect on the nutrient cycle that has contributed to the growth of these healthy fresh fruits and vegetables and all of the plants and foods that we eat, as well as our role in working with nature to continue the nutrient cycle through composting!

Workbook Question #3: If time permits, have students add detail to their NUTRIENT CYCLE drawing in their Guided Notes.

FOLLOW UP BOKASHI/COMPOST/GARDEN CARE

Follow Up Bokashi/Compost/Garden Care is the responsibility of the classroom teacher and students.

- Thoroughly wash the Bokashi Compost Buckets with soap and water. Allow to dry thoroughly before reassembling, closing the lid, and storing.
- Allow the bokashi to dry for several hours on the tarp, then have students collect it and clean up the area at the end of the school day, or move the tarp into a classroom to continue drying overnight if necessary. When dry, store the bokashi in the same plastic bags within the Bokashi Storage Bucket, tightly sealed and kept in a dry place. The bokashi may be used at any time to begin another cycle of bokashi composting.
- When 2 weeks have passed, take students to the garden or compost pile and dig in the area where the fermented food waste was buried. Take photos and have students discuss and write in their journal about what they discover!
- Students must wash their hands thoroughly with soap and water after working in the garden.



FOLLOW UP ACTIVITIES

Follow Up Activities are the responsibility of the classroom teacher.

- Review this semester's composting experience, including the key concepts for the unit.
- Have students complete the Guided Notes: Anaerobic Composting: Bokashi Use and Composting Systems Comparison Student Worksheet. Review together as a class.



- Have students create a final journal entry about their composting experience this semester. Have them share their work with the class.
- Save and submit examples of student work to Kōkua Hawai'i Foundation.
- Continue to have students care for the aerobic compost pile(s) and worm bin(s) as described in the Follow Up sections of Lessons 1 and 2. Be sure that a plan is in place for care of the composting systems over winter break.

LESSON EXTENSIONS

Fermentation

(3.W.1, 3.SL.4)

1. Explore the important process of fermentation further with students:
 - Fermentation is a type of decomposition carried out in anaerobic conditions. In contrast, respiration occurs in aerobic conditions (in the presence of oxygen). Both processes are carried out by microorganisms in order to obtain energy for life.
 - In addition to bokashi composting, fermentation is used to make pickles, sauerkraut, soy sauce, kim chee, wine, beer, sourdough bread, and many other foods.
 - Fermented foods contain probiotics and are recognized as having numerous of health benefits, including strengthening and supporting our digestive and immune systems, thereby helping our bodies to fight off and prevent diseases, like cancer.
2. Share a tasting of fermented foods with the students.
3. Have students write opinion pieces on the topic and share about their tasting experience.



Microorganisms Make It Happen

(3.W.7)

1. Help students strengthen their understanding of the fact that microorganisms are doing most of the work of decomposition in all three types of composting systems that the students have experienced.
 - Aerobic Compost: Bacteria primarily decompose nitrogen rich materials (green waste and food waste), while fungi are the primary decomposers of carbon rich materials (brown waste).
 - Vermiculture: Bacteria on the food waste and in the guts of the composting worms do the work of decomposition.
 - Bokashi: EM® (Effective Microorganisms™, including yeasts, lactic acid bacteria, and phototrophic/photosynthetic bacteria) do the main work of decomposition during the fermentation process, followed by the soil F.B.I. (fungi, bacteria, and invertebrates) in the garden soil or compost pile.
2. Have students do research to further explore the world of microorganisms and other important roles they play in our lives and on Earth (e.g., digestion, water purification).