

Method 1: Boiling Water Canning

Name _____



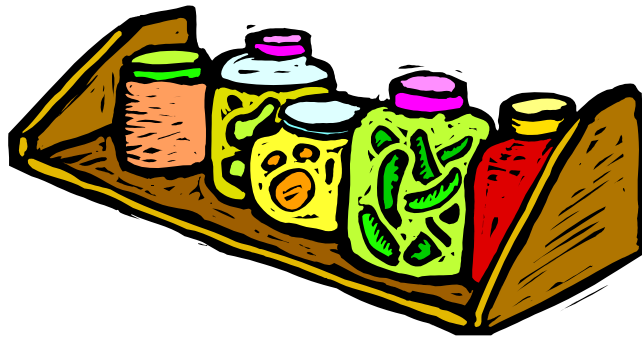
Can My Tomatoes



Brought to you by the
National Center for Home Food Processing and Preservation,
University of Georgia Cooperative Extension and Clemson Cooperative Extension

PUT IT UP!

The *PUT IT UP!* series of lessons in home food preservation includes six different food preservation methods: boiling water canning, making jam, pickling, freezing, drying, and pressure canning. Each method is divided into a beginning hands-on activity and an advanced hands-on activity. Activities may stand alone or be sequenced for cumulative learning. In addition to step-by-step procedures, reflection questions, and ideas for experimentation, each method also includes additional activities: a science-based fill-in-the blank challenge, a history-based word search, a glossary, a resource list, a knowledge test, and more.



On the following pages, *PUT IT UP! Can My Tomatoes* contains:

- ◇ Beginning Activity: Can My Crushed Tomatoes
- ◇ Advanced Activity: Can My Salsa
- ◇ Additional Activities: Can My Tomatoes



Name _____

Date _____

Teacher _____

Can My Crushed Tomatoes



Credits and Acknowledgments

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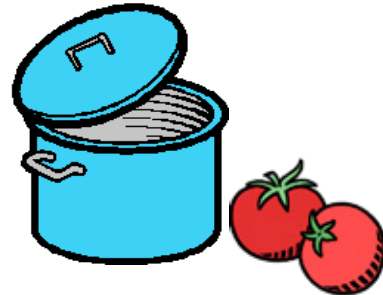
Special thanks to:

Pilot Program Leaders (and youth participants!)

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and Advisory Committee members



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Boiling Water Canning: A Preservation Exploration

Have you ever used crushed tomatoes as a base for spaghetti sauce or chili? You might have made your own pizza sauce with crushed tomatoes? In this food science exploration, you'll get to learn how to can your own crushed tomatoes at home, using just a few simple ingredients.



Let's start with some basics of food science and preservation:

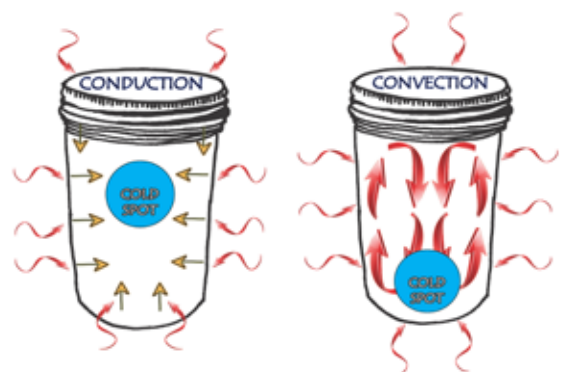
Preservation means to prevent decay, or in other words to stop a food from breaking down and spoiling. Rotten tomatoes, moldy bread, and stinky old milk are all examples of spoiled foods. Refrigeration and freezing are very common preservation methods used in modern households to extend the shelf-life of foods. Other home food preservation methods are pickling, drying (or dehydrating), making jam, and canning.

Canning is the process of putting jars of food in a canner and heating those jars in the canner on a stovetop. **Boiling Water Canning** is when this process is done in a boiling water canner, which is basically a large stockpot with a rack in the bottom and a loose-fitting lid resting on top.



Boiling water canning is simple, but it's important that you follow the detailed directions in the procedure to do it correctly. As you'll see, you will fill a large stockpot about half full with water and heat it while you prepare tomatoes and fill jars. Then you will lower the filled jars into almost boiling water, submerging them completely so that hot water surrounds them on all sides. Once the water comes to a full boil, you'll set a timer.

How does heat move through the food? As heat moves into the jars from the hot water, the food gets heated evenly. If there is enough liquid in a jar for fluid to flow, then a convection pattern will form, circulating heat in loops. If the food in the jar is more solid, then the heating pattern is called conduction, and it moves in a straight direction, inwards. Even the coldest spot in the jar must be heated in order for the canned food to be safe to eat.



Beginning Boiling Water Canning Activity: Crushed Tomatoes

Time required:

1 to 1½ hours procedure + 1 to 1½ hours additional processing time
= 2 to 3 hours total (+ 12 hour minimum cooling time)

Ingredients:

For a canner load of about 9 pint jars

(canner size may vary, so check capacity ahead of time and adjust accordingly)

- 14 to 16 pounds of tomatoes (1½ to 1¾ pounds per pint)
- 9 tablespoons bottled lemon juice (or 2¼ teaspoons citric acid)
- 4½ teaspoons canning salt (optional)
- Any additional ingredients from 'Want to Experiment?' (optional)

Equipment needed:

- Gas or electric stovetop range with four burners
- Boiling water canner (or large stockpot) with rack
- Pint canning jars, regular or wide mouth
- Two-piece metal canning lids and ring bands, regular or wide mouth
- Permanent marker, or labels and pens
- Medium saucepan for boiling water to be added to canner
- Large colander or bowl for washing tomatoes
- Paring knife(s)
- Cutting board
- Large stockpot, 8-10 cup capacity
- Slotted spoon
- Large wooden spoon or mallet
- Large mixing bowl for ice/cold water
- Ice (optional; for cooling tomatoes)
- Jar lifter
- Liquid measuring cups
- Measuring spoons
- Large ladle
- Jar funnel
- Headspace tool
- Bubble freer or narrow spatula
- Spoon
- Paper towels
- Thermometer
- Kitchen timer (may be on oven)
- Towel or cake-cooling rack

If range is a smooth-top, boiling water canner must have a flat-bottom.

Select disease-free, preferably vine-ripened, firm tomatoes. Do not make salsa with tomatoes from dead or frost-killed vines.

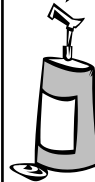
The Procedure:

Just Follow These Steps...

Part One: Preparing the Canner and Jars

1. Wash hands thoroughly with soap under running water for at least 20 seconds, rinse well, and dry.
2. Assemble equipment and ingredients.
3. ★ Fill boiling water canner half full with clean, hot water. Turn heat on medium-high to heat water in canner to just under boiling (simmering, 180°F.)
4. Examine ring bands and discard any with rust or bends. Examine jars carefully. Discard any with cracks or chips in the rim.
5. ★ Wash jars thoroughly in warm soapy water, rinse well, and then place them in the canner to stay warm until ready to use.
6. Wash ring bands if necessary; otherwise, keep them dry until use.
7. Use a permanent marker to label lids with your name, the name of the product and the date. If using labels and pens, then wait until after processing, when jars have cooled.
8. Prepare lids as instructed by manufacturer.
9. ★ Heat 3-4 cups water to a simmer in a saucepan for adding to canner, if needed.

★ = Be Extra Careful!



Fun Fact!



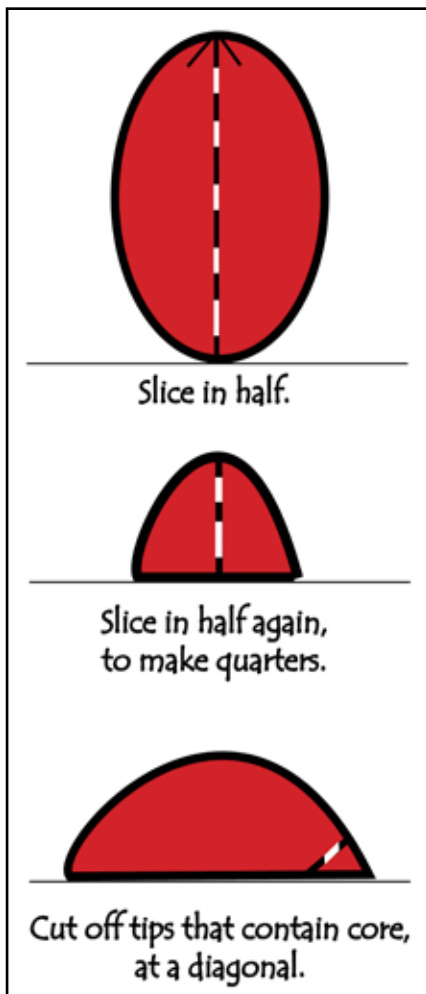
Think About It: Vacuum Seals

Vacuum seals form as jars cool, keeping air out of jars so that the food inside is less likely to spoil. Could a vacuum seal keep air out if there were cracks and chips in the jar?

Feeling creative?

Make up a company name for your product.





Part Two: Preparing the Tomatoes

10. ★ Fill a stockpot with enough water to cover several tomatoes at a time. Bring water to a boil while preparing tomatoes.

Leader Demonstration: Basic knife skills. Grip the knife handle with your dominant hand, wrapping fingertips behind knuckles for tight grip. When slicing, use a rocking motion, not just downwards. Always pay attention and keep your hands and fingers away from the blade.

11. ★ Wash tomatoes. Carefully cut an "x" in the non-stem end of each tomato with the tip of a paring knife.

12. Fill a large bowl with ice (if you have it) and cold water.



13. ★ Place 2 to 3 tomatoes at a time in the boiling water for 30 to 60 seconds, until skins split, then quickly remove them with a slotted spoon and place in the cold water. Slip off and discard tomato skins. Repeat and continue peeling all tomatoes.

14. ★ Place four tomatoes on a clean cutting board and quarter then core them: carefully use a paring knife to remove the more firm inner core. Trim off any bruises.

15. ★ Have somebody put these quarters in a large stockpot, turn burner heat to high, and crush the tomatoes using a large mallet or spoon. At the same time, have someone else continue quartering, coring, and adding quartered tomatoes while keeping the tomatoes in the stockpot boiling. Stir, but do not crush anymore.



16. ★ After you add all the tomatoes, simmer (gently boil) for 5 minutes.

Part Three: Packing the Tomatoes

17. ★ Slowly remove jars from hot water with jar lifter. Carefully empty any water back into the canner. Place jars upright on a towel-covered countertop or rack.

18. Measure and add 1 Tbsp. bottled lemon juice or $\frac{1}{4}$ tsp. citric acid to each pint jar.

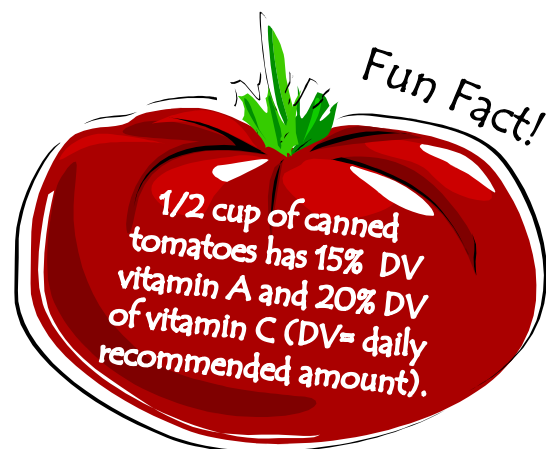
19. If desired, measure and add $\frac{1}{2}$ tsp. salt to each pint jar.

20. ★ Rest funnel in jar opening and ladle tomatoes into hot pint jars leaving $\frac{1}{2}$ -inch from the top of the tomatoes to the top of the jar rim. This gap is called headspace. Measure headspace with headspace tool to ensure it is $\frac{1}{2}$ -inch.

21. Remove air bubbles by moving bubble freer or spatula gently in and out around the inside edge of each jar. Check the headspace of each jar again, using a spoon to remove or add small amounts if needed to make it $\frac{1}{2}$ -inch.

22. Wipe jar rims with clean, damp paper towel, then apply lids according to manufacturer's directions. Turn bands onto jars until fingertip tight. Fingertip tight is when you meet firm resistance as you turn the band with your thumb and two fingers onto the jar.

23. ★ Use a thermometer to check the temperature of water in canner is 180°F. Adjust burner higher or lower, if necessary.



Think About It: Wiping the Jar Rim

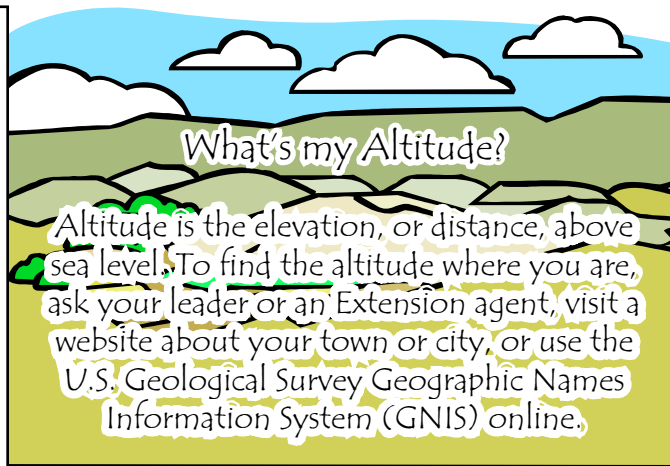
If a bit of tomato were left on the rim, could a tight seal form?

Think Again! Fingertip Tight

Why do you think it is important that lids are tightened just right? Hint: If a band is too tight, could air escape? If a band is too loose, could liquid get out?

Part Four: Boiling Water Processing

24. ★ Use jar lifter to carefully place jars of tomatoes one at a time on the rack in the canner. Keep jars upright at all times. Make sure water is 1-2 inches above tops of jars. Add hot water from the saucepan if needed, pouring between jars rather than directly on top of jars.
25. ★ Place lid on canner and turn heat to high. Bring water in canner to a strong boil before timing.
26. Set timer using the times recommended on the table to the right. Maintain a steady, strong boil throughout the entire timing process.
27. ★ When the timer goes off, turn off heat then remove canner lid with lid pointed away from you. Wait 5 minutes for contents to settle in jars.
28. ★ After 5 minutes of cooling, keep jars straight up as you remove jars one at a time with jar lifter. Be careful not to tilt them. Place jars at least 1 inch apart on dry towels or cake-cooling rack. Place away from drafts of moving air.
29. Let jars cool, undisturbed 12 to 24 hours. Check jars for vacuum seals. If jars are taken home before cooling completely, keep in a refrigerator.
30. Remove ring bands from sealed jars and wipe jars. Store in a cool, dark, dry place. Enjoy with family and friends within one year for best quality. Store unsealed or opened jars in the refrigerator and eat within one week.



Altitude Adjustments and Processing Times for Hot Packs of Crushed Tomatoes in Pint Jars:

Altitude	Process Time
0-1,000 feet	35 minutes
1,001-3,000 feet	40 minutes
3,001-6,000 feet	45 minutes
above 6,000 feet	50 minutes

Chart from: *USDA Complete Guide to Home Canning*

Listen for lids to "pop!" as the vacuum pulls them down.

How to Test for a Vacuum Seal



Fun Facts from: USDA. (2012). *Household USDA Foods Fact Sheet: Tomatoes, Diced, Low-Sodium, Canned.*

University of Arkansas Division of Agriculture. (2006). *Tomato: Fruit or Vegetable?*
http://www.kidsarus.org/kids_go4it/growit/plantit/tomatoes.htm.

Time to Reflect...

Write your responses to these questions.
Then, share your reflections with someone else.

What was your favorite part of canning crushed tomatoes?

For you, what was the most challenging part of canning crushed tomatoes?

What surprised you most in this activity?



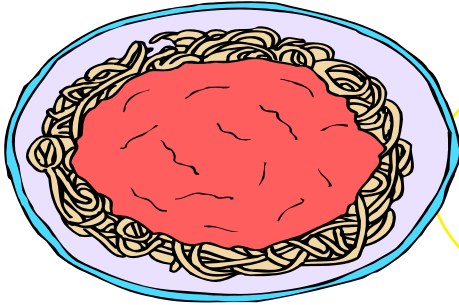
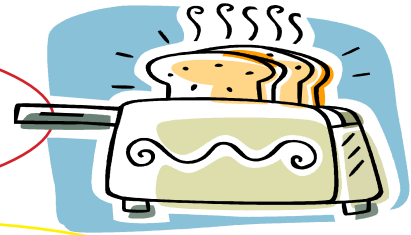
If you could do this activity again, what is one thing you would change?
Why?

Do you think that canning tomatoes is a useful skill?
Why or why not?

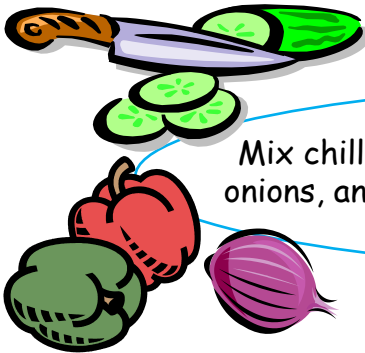
How will you use what you have learned about canning tomatoes?

Want to Experiment?

Scoop a spoonful of crushed tomatoes onto crispy toasted pieces of bread, then top with basil and maybe even parmesan cheese.
Yum!



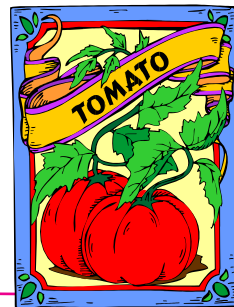
Make spaghetti sauce with your canned crushed tomatoes by adding Italian seasonings like oregano, basil, rosemary, and thyme after opening. These flavors are strong, so stir in a few shakes and then taste before adding more. You may also like to mix in roasted vegetables or cooked ground beef.



Mix chilled tomatoes with tomato juice, chopped peppers, cucumbers, onions, and cilantro (if you like) for a popular cold soup called gazpacho!

Ask for help to follow directions for canning a fruit product such as peaches or peach salsa. Recipes are in *So Easy to Preserve* and on the National Center for Home Food Preservation website (homefoodpreservation.com). How is canning fruit similar to canning tomatoes? How is it different?

Compare home-canned tomatoes with store-bought tomatoes. How do tastes, textures, and appearances differ? Do you prefer one more than the other? Why?



Plant tomato seeds! Make sure the plants have enough space, sun, and water.

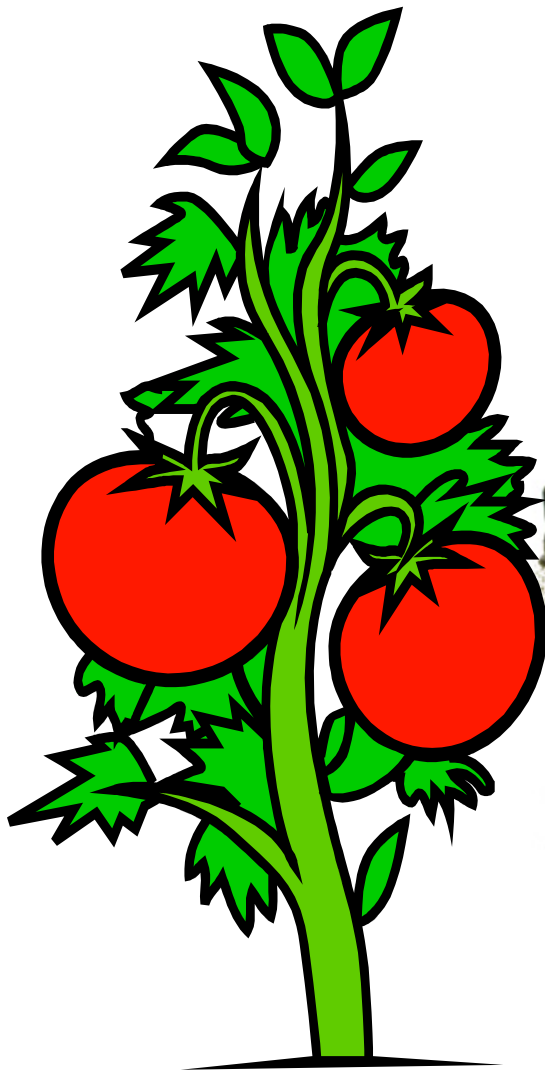


Did you really like canning? Brainstorm, research, or just ask your leader about careers in which you get to play with food, like food science, cooking, or catering.



Name _____
Date _____
Teacher _____

Can My Salsa



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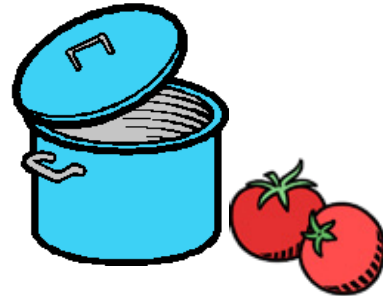
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Boiling Water Canning: A Preservation Exploration

Have you ever crunched into chips and salsa for a snack or appetizer? You might have added salsa to a burrito, taco, or quesadilla? In this food science exploration, you'll get to learn how to can your own salsa at home, using just a few simple ingredients.



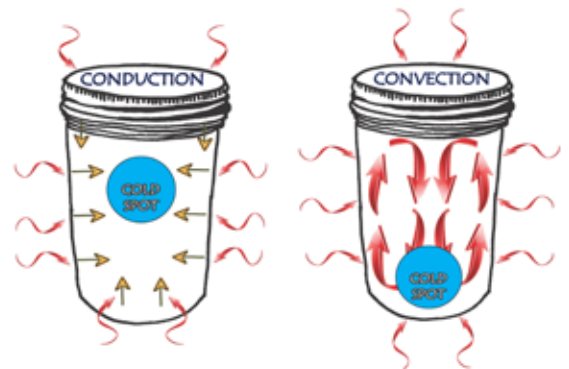
Let's start with some basics of food science and preservation:

Preservation means to prevent decay, or in other words to stop a food from breaking down and spoiling. Rotten tomatoes, moldy bread, and stinky old milk are all examples of spoiled foods. Refrigeration and freezing are very common preservation methods used in modern households to extend the shelf-life of foods. Other home food preservation methods are pickling, drying (or dehydrating), making jam, and canning.

Canning is the process of putting jars of food in a canner and heating those jars in the canner on a stovetop. **Boiling Water Canning** is when this process is done in a boiling water canner, which is basically a large stockpot with a rack in the bottom and a loose-fitting lid resting on top.

Boiling water canning is simple, but it's important that you follow the detailed directions in the procedure to do it correctly. As you'll see, you will fill a large stockpot about half full with water and heat it while you prepare tomatoes and fill jars. Then you will lower the filled jars into almost boiling water, submerging them completely so that hot water surrounds them on all sides. Once the water comes to a full boil, you'll set a timer.

How does heat move through the food? As heat moves into the jars from the hot water, the food gets heated evenly. If there is enough liquid in a jar for fluid to flow, then a convection pattern will form, circulating heat in loops. If the food in the jar is more solid, then the heating pattern is called conduction, and it moves in a straight direction, inwards. Even the coldest spot in the jar must be heated in order for the canned food to be safe to eat.



Advanced Boiling Water Canning Activity: Choice Salsa

Time required:

1½ to 2 hours procedure + ½ to 1 hour additional processing time
= 2 to 3 hours total (+ 12 hour minimum cooling time)

Ingredients:

For a canner load of about 6 pint jars or 12 half-pint jars
(canner size may vary, so check capacity ahead of time and adjust accordingly)

- 6 cups (about 5 pounds) tomatoes
- 9 cups (about 3 pounds) onions and/or peppers of any variety
- 1½ cups commercially bottled lemon or lime juice
- 3 teaspoons canning or pickling salt
- Any additional ingredients from 'Want to Experiment?' (optional)

Equipment needed:

- Gas or electric stovetop range with four burners
- Boiling water canner (or large stock pot) with rack
- Pint or half-pint canning jars, regular or wide mouth
- Two-piece metal canning lids and ring bands, regular or wide mouth
- Jar lifter
- Jar funnel
- Headspace tool
- Bubble freer or narrow spatula
- Medium saucepan
- Large stockpot
- Large colander or bowl
- Large mixing bowl
- Ice (optional; for cooling tomatoes)
- Small paring knives
- Cutting boards
- Large ladle
- Chef's knives
- Slotted spoon
- Dry and liquid measuring cups
- Measuring spoons
- Large spoon for stirring
- Permanent marker, or labels and pens
- Food-handling gloves (if using hot peppers)
- Paper towels
- Thermometer
- Towel or cake-cooling rack
- Timer (may be on oven)

Peppers
may be any
color, sweet
or hot.

Paste
tomatoes like
Roma's make thicker
salsa. Slicing tomatoes
make watery salsa.

If range is a
smooth-top,
boiling water canner
must have a flat-
bottom.

The Procedure:

Just Follow These Steps...

Part One: Preparing the Canner and Jars

1. Wash hands thoroughly with soap under running water for at least 20 seconds, rinse well, and dry.
2. Assemble equipment and ingredients.
3. ★ Fill boiling water canner half full with clean, hot water. Turn heat on medium-high to heat water in canner to just under boiling (simmering, 180°F).
4. Examine jars carefully. Discard any with cracks or chips in the rim. Examine ring bands and discard any with rust or bends.
5. ★ Wash jars thoroughly in warm soapy water, rinse well, then place them in the canner to stay warm until ready to use.
6. Wash ring bands if necessary; otherwise, keep them dry until use.
7. Use a permanent marker to label lids with your name, the name of the product and the date. If using labels and pens, then wait until after processing, when jars have cooled.
8. Prepare lids as instructed by manufacturer.
9. ★ Heat 3-4 cups hot water in a medium saucepan for adding to canner, if needed.



Think About It: Vacuum Seals

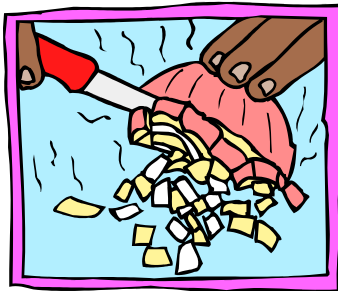
Vacuum seals form as jars cool, keeping air out of jars so that the food inside is less likely to spoil. Could a vacuum seal keep air out if there were cracks and chips in the jar?

Feeling creative?

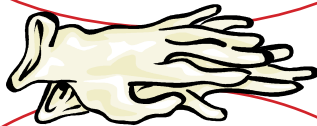
Make up a company name for your product.



Leader Demonstration: Basic knife skills. Grip the knife handle with your dominant hand, wrapping fingertips behind knuckles for tight grip. When slicing, use a rocking motion, not just downwards. Always pay attention and keep your hands away from the blade.



Safety tip: Do not touch your face, particularly the area around your eyes, when you are handling hot chiles.



Tasty tip: Do you like spicy salsa? Much of the spicy heat of peppers is in the seeds. If you want less spicy salsa, remove all seeds!

Part Two: Preparing the Salsa

10. ★ Fill a stockpot with enough water to cover several tomatoes at a time. Bring water to a boil while preparing tomatoes.
11. Fill a large bowl with ice (if you have it) and cold water.
12. Wash tomatoes.
13. ★ Cut an "x" in the non-stem end of tomatoes with the tip of a small knife.
14. ★ Place 2 to 3 tomatoes at a time in boiling water for 30 to 60 seconds or until skins split. Remove tomatoes with a slotted spoon and place in cold/ice water. Slip off tomato skins and discard them. Place tomatoes on a clean cutting board.
15. ★ Carefully use a knife to remove the firm inner core from tomatoes, then coarsely chop (blueberry-sized pieces).
16. ★ Peel, rinse, trim and dice onions into 1/4-inch pieces (pencil eraser-sized).
17. ★ Rinse bell peppers, remove stems, seeds and membranes, then dice.
18. ★ If using hot peppers, place food-handling gloves on both hands. Rinse and dry hot chile peppers. Remove stems, and remove the seeds and membranes unless you want more spicy heat. Dice chile peppers into very small pieces. Remove and discard gloves, then wash hands well.
19. Measure and combine 9 c. of peppers and onions with 6 c. of tomatoes in a large stockpot. Measure and add 1½ c. lemon or lime juice and 3 tsp. salt. Stir to mix ingredients evenly.
20. ★ Heat to boiling over high heat, then reduce heat to a simmer for 3 minutes, stirring as needed to prevent scorching.



Part Three: Packing the Salsa

21. ★ Slowly remove jars from hot water with jar lifter. Carefully empty any water back into the canner. Place jars upright on towel-covered countertop or rack.

22. ★ Rest funnel in jar opening and ladle hot salsa into hot pint jars leaving $\frac{1}{2}$ -inch from the top of the salsa to the top of the jar rim. This gap is called headspace. Measure headspace with headspace tool or ruler to ensure headspace is $\frac{1}{2}$ -inch.

23. Remove air bubbles by slowly moving bubble freer or spatula gently in and out around the inside edge of each jar. Check headspace of each jar again and gently add or remove salsa with a small spoon, if needed.

24. Wipe jar rims with a clean, damp paper towel.

25. Apply lids according to manufacturer's directions. Turn bands onto jars until fingertip tight. Fingertip tight is when you meet firm resistance as you turn the band onto the jar using your thumb and two fingers.

26. ★ Use a thermometer to check that the temperature of the water in the canner is 180°F. Adjust burner higher or lower, if necessary.



Think About It: Freeing Bubbles

What could happen to your final product if air bubbles remain trapped during processing in the canner?

Think Again! Fingertip Tight

Why do you think it is important that lids are tightened just right?
Hint: If a band is too tight, could air escape? If a band is too loose, could liquid get out?

Fun Fact!

Capsaicin (cap-say-ah-sin) is what makes hot peppers hot. Its intensity is not affected by heat or freezing, and it does not have any scent or flavor of its own.





Salsa is fat-free and low in calories, but rich in flavor. Homemade salsas tends to be more nutritious and less salty than commercial salsas.

Altitude Adjustments and Processing Times for Hot Packs of Choice Salsa in Pint Jars:

Altitude	Process Time
0-1,000 feet	15 minutes
1,001-6,000 feet	20 minutes
above 6,000 feet	25 minutes

Chart from: *USDA Complete Guide to Home Canning*



Listen for lids to "pop!" as the vacuum pulls them down.

How to Test for a Vacuum Seal



Fun Facts from:

Dewitt, D. (1999). *The Chile Pepper Encyclopedia*. New York: William Morrow and Company, Inc.
 Anderson, J. and Deskins, B. (1995). *The Nutrition Bible*. New York: William Morrow and Company, Inc.

Part Four:
Boiling Water Processing

27. ★ Use jar lifter to carefully place jars of hot salsa one at a time on the rack in the canner. Keep jars upright at all times. Make sure water is 1-2 inches above tops of jars. Add hot water from the saucepan if needed, pouring between jars rather than directly on top of jars.

28. ★ Place lid on canner and turn heat to high. Bring water in canner to a strong boil, then start timer using the times recommended on the table to the left. Maintain a steady boil throughout the entire timing process.

29. ★ Once the timer goes off, turn off heat. Remove canner lid, lifting the underside of the lid away from you to direct the steam away from your face. Wait 5 minutes for the salsa to settle in the jars.

30. ★ After 5 minutes of cooling, keep jars straight up as you remove jars one at a time with jar lifter. Be careful not to tilt them. Place jars at least 1 inch apart on a dry towel or cake-cooling rack. Place away from drafts of moving air.

31. Let jars cool, undisturbed, for 12 to 24 hours. Check jars for vacuum seals. If jars are taken home before cooling completely, keep in a refrigerator.

32. Remove ring bands from sealed jars and wipe jars. Store in a cool, dark, dry place. Enjoy with family and friends within one year for best quality. Store unsealed or opened jars in the refrigerator and eat within one week.

Time to Reflect...

Write your responses to these questions.
Then, share your reflections with someone else.

What was your favorite part of canning salsa?

For you, what was the most challenging part of canning salsa?

What surprised you most in this activity?



If you could do this activity again, what is one thing you would change?
Why?

Do you think that canning tomato products is a useful skill?
Why or why not?

How will you use what you have learned about canning tomato products?

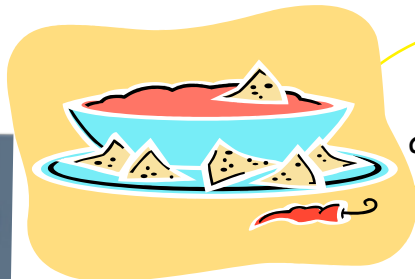
Want to Experiment?

Try different varieties and colors of tomatoes. You may use green, yellow, or orange tomatoes.



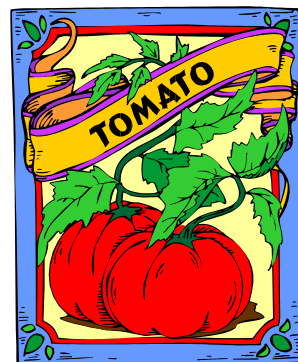
Try different ratios and types of peppers and onions. More bell peppers make a milder salsa, while chile peppers make a spicier salsa. Red, yellow, or white onions may be used, and will slightly alter the overall flavor. Remember that it is important to the safety of the salsa that you DO NOT alter the overall quantity of onions and peppers (9 cups total per batch).

Check grocery store shelves for salsa mixes in the home canning products. Follow package directions to try one of them!



Compare home-canned salsa with store-bought salsa. How do tastes, textures, and appearances differ? Do you prefer one more than the other? Why?

Ask for help to follow directions for canning another salsa product such as peach salsa. Recipes are in *So Easy to Preserve* and on the National Center for Home Food Preservation website (homefoodpreservation.com). How is canning fruit salsa similar to canning tomato salsa? How is it different?



Plant tomato seeds! Make sure the plants have enough space, sun, and water.



Did you really like canning? Brainstorm, research, or just ask your leader about careers in which you get to play with food, like food science, cooking, or catering.



Name _____

Date _____

Teacher _____

Can My Tomatoes



Brought to you by the
National Center for Home Food Processing and Preservation,
University of Georgia Cooperative Extension and Clemson Cooperative Extension

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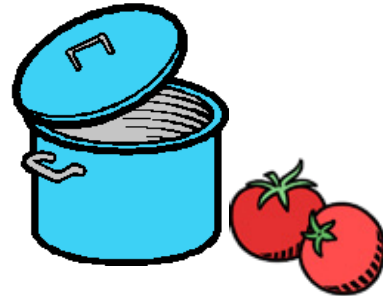
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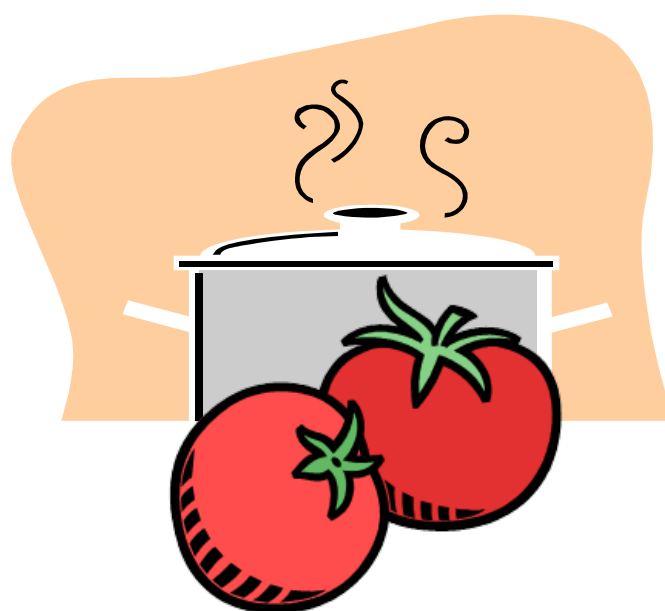
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All About Boiling Water Canning

	<u>Pages</u>
FUNdamentals of Boiling Water Canning.....	A.A.4
Boiling Water Canner and Mason-Style Jar Anatomy.....	A.A.5
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What's the Story of Boiling Water Canning?.....	A.A.7
Who Are You Calling Spoiled?!.....	A.A.8
Glossary, Sources, and Resources.....	A.A.9
What Do You Know About Boiling Water Canning?.....	(A.A.10)



Boiling water canning is a science, so there are important facts and concepts at play. These FUNdamentals will help you understand the steps of the canning procedure.



FUNdamentals of Boiling Water Canning

Use the word bank at the bottom of the page to correctly fill in the blanks.
(Hint: The answers can be found in the pages of this activity book.)

_____ is a method of food preservation that raises the temperature so high that spoilage microorganisms like molds and yeasts are destroyed by the heat.

_____ is measured by pH value. Acid foods have a pH value of 4.6 or lower, low-acid foods have a pH higher than 4.6. Borderline foods sit on the border between acid and low-acid, with a pH range close to 4.6 in either direction.

Adding a proper amount of _____, vinegar, or citric acid to tomatoes adds enough acid that the resulting product can be safely canned in a boiling water canner.

_____ are acidic enough to prevent dangerous bacteria from producing poison. They can be safely canned in a boiling water canner.

A _____ is created when air is pushed out and unable to re-enter a closed system (like a sealed jar).

Microorganisms (bacteria, molds, and yeasts) sometimes cause food to _____. Low temperatures slow the growth of microorganisms; high enough temperatures kill them.

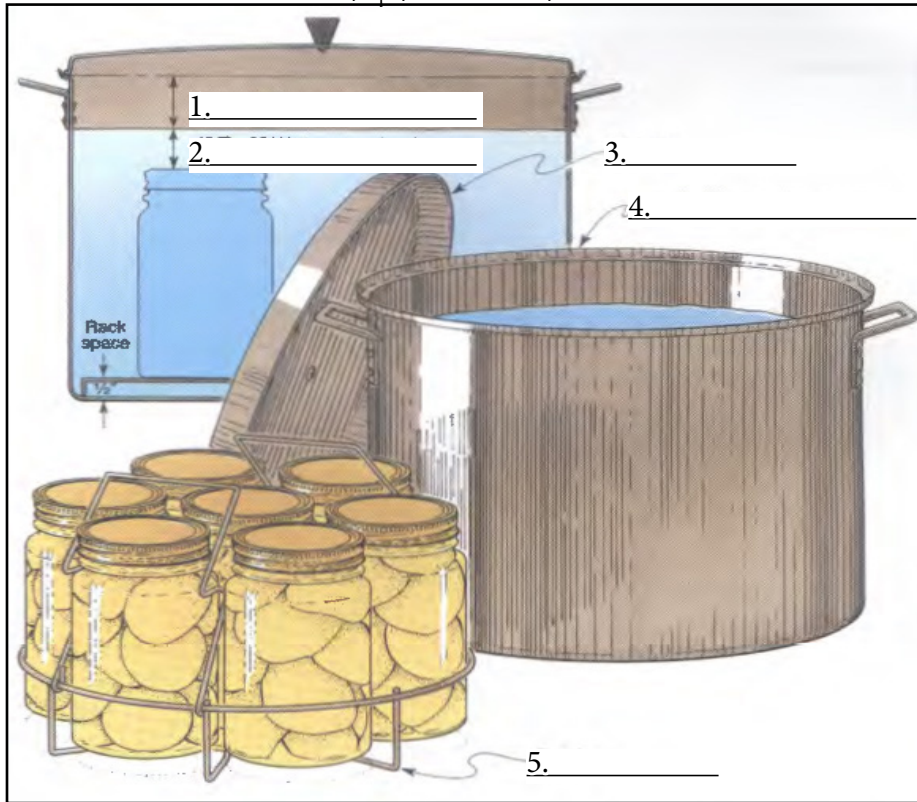
_____ is a form of energy that can travel through solids, liquids, and gases.

_____, Cooperative Extension, and the National Center for Home Food Preservation have science-based recipes for canning, like the recommendations in the books *So Easy to Preserve* and *Complete Guide to Home Canning*.

Word bank: ACIDITY, SPOIL, USDA, BOILING WATER CANNING, ACID FOODS, HEAT, VACUUM, LEMON JUICE

Boiling Water Canner Anatomy

Fill in each blank with the term to the right that describes that part of the canner.



AIRSPACE allows room for water to boil.

WATER must cover 1 to 2 inches above jars so that the jars will be completely surrounded by boiling water, even if a small amount evaporates.

LID/COVER of the canner prevents heat from escaping and reduces water loss from evaporation.

CANNER or **STOCKPOT** contains water so that it can heat to boiling.

RACK prevents jars from cracking due to high heat from the burner and allows water to circulate underneath the jars so that they are heated evenly on all sides.

A _____ can be used again and again until cracked or chipped.

_____ on top of jar allow ring band to twist on tightly.

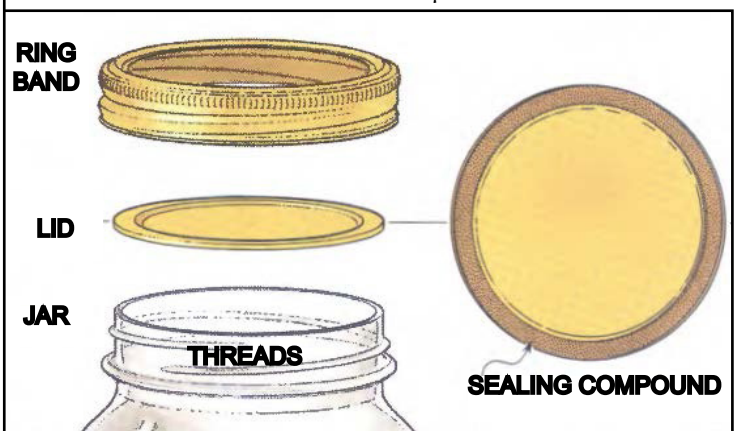
A _____ secures lid to jar, and can be reused if not bent or rusty.

A _____ has a springy center that dips down when pulled by a vacuum. After jars cool, gently rub the center of the lids with your fingertip; you have evidence that a vacuum has formed if you feel an indent.

_____ is a soft plastic in the bottom-edge groove of lids that softens when heated and forms an airtight seal around the lid when cooled.

Mason-Style Jar Anatomy

Use the labels in the illustration below to correctly fill in the blanks of the descriptions to the left.



Illustrations from: USDA. (2009). *Complete Guide to Home Canning*. Agriculture Information Bulletin No. 539. Washington, DC: USDA National Institute of Food and Agriculture.

pH Power

What is pH?

pH is a measure of acidity, on a scale from 0 to 14.

Acid must be added to borderline foods to make sure they are acidic enough to be safely canned in a boiling water canner.

Foods are classified as Acid or Low-Acid according to their pH value. Acid foods have a pH of 4.6 or less; Low-Acid foods have a pH above 4.6. Foods that range close to pH 4.6 are called Borderline foods.

use a boiling water canner

use a pressure canner

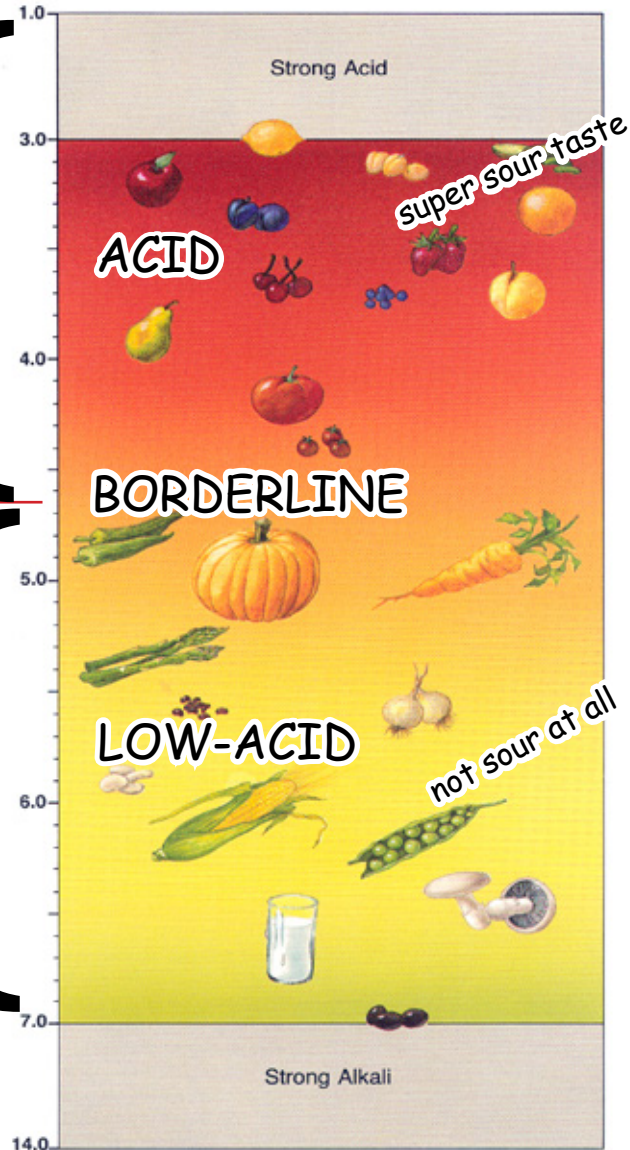


Illustration from: *USDA Complete Guide to Home Canning*

Acid foods can be safely canned in a boiling water canner, but low-acid foods must be pressure canned. So **how do you safely can borderline foods like tomatoes?** Add bottled lemon juice, vinegar or citric acid to tomatoes to make them more acidic. Use amounts from recipes recommended by USDA.

The table below shows pH values of several common foods. Under the "Acid, Low-Acid, or Borderline" column, write how that food is classified based on its pH.

Food	pH Value	Acid, Low-Acid, or Borderline?
Vinegar	2.0-3.4	
Lemon Juice	2.3	
Tomatoes	4.2-4.9	
Peppers	5.1	
Onions	5.3-5.8	



What's the Story of Boiling Water Canning?

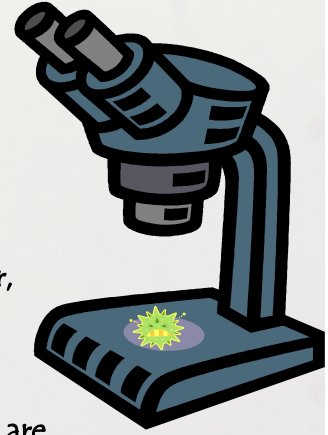


Search the puzzle for the 14 UPPERCASE, UNDERLINED words from the history notes below and circle them!

J	A	E	T	W	S	W	W	J	X	Z	Y	A	R	P
W	C	D	E	C	N	D	F	O	H	F	X	I	U	R
M	I	C	R	O	O	R	G	A	N	I	S	M	S	O
S	D	Q	V	H	I	M	N	S	X	D	B	V	O	C
Y	W	X	T	T	T	B	M	M	E	L	L	J	O	E
H	U	E	A	C	A	R	X	E	B	M	D	M	Z	S
L	M	Z	V	O	D	K	Q	V	R	W	Y	A	N	S
M	H	W	U	V	N	L	S	U	L	C	C	Z	U	E
S	O	F	F	S	E	A	L	E	D	I	I	B	N	S
T	T	L	A	E	M	O	H	R	D	D	F	A	V	E
S	B	U	D	U	M	D	P	I	I	Q	Z	C	L	V
A	B	Y	S	S	O	W	F	Z	Q	P	D	T	V	L
E	V	D	H	X	C	I	E	G	A	L	I	O	P	S
Y	A	Y	B	H	E	E	J	J	T	Z	M	S	E	V
J	G	F	K	D	R	P	V	C	B	O	G	H	K	E

- Boiling water canning PROCESSES for preserving foods were developed at the end of the 1700s.
- In boiling water canning, ACID foods or ACIDIFIED foods such as fruits, tomatoes, salsas, pickles, jams, jellies or preserves are put in jars, lowered into a canner full of hot water, and then that water is brought to a boil (212°F at sea level).
- This METHOD of preserving food is also called “water bath process” and “boiling water bath canning”, but we’ll use the term “boiling water canning”.
- Have you ever discovered something new without understanding how it works? In the 1790’s, Nicolas Appert discovered that heating foods in SEALED glass jars prevents SPOILAGE, though he did not understand why.
- Louis Pasteur investigated Appert’s question “why?”. In 1864 Pasteur discovered important relationships: MICROORGANISMS cause food to spoil and heat kills microorganisms, preventing them from being able to spoil food.
- The heat from the boiling water prevents food spoilage by killing the microorganisms MOLDS and YEASTS and also destroying molecules called ENZYMES which cause chemical change.
- In the late 1800s and early 1900s much work was done to develop COMMERCIAL processes (in big factories) for canning foods. Little attention was paid to home canning.
- It was not until 1917 that the United States Department of Agriculture (USDA) made the first RECOMMENDATIONS using a boiling water process in HOME canners for fruits and tomatoes.

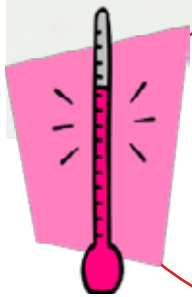
Who Are You Calling Spoiled?!



You can't see it with your bare eyes, but inside a boiling water canner, enzymes and microorganisms are destroyed by the high heat. Both are microscopic, so you would need a microscope to look at them.

Enzymes are actually a part of the basic structure of living things and are necessary for life and growth. Enzymes activate change in fruits and veggies that lead to ripeness, but over time they cause foods to over-ripen and spoil. High temperatures inactivate enzymes and stop them from spoiling foods.

Microorganisms are tiny creatures that live everywhere on earth that there is water, including oceans, streams, and even in your body! Many types of these little critters are harmless and even necessary for life, but certain kinds cause food spoilage or food poisoning. Bacteria, yeast, and mold are the types of microorganisms which commonly cause food to spoil. You may have seen masses of mold as fuzzy spots on spoiled bread; pink shiny spots on spoiled cream cheese may be thousands of yeasts; slime on spoiled ground beef is caused by bacteria. Microorganisms that cause food poisoning are called pathogens.



What does your body do when you get a "bug"?
(A "bug" is another term for a pathogen.)

You might get a **fever!**

Why?

The increased heat in your body helps kill the pathogens making you feel sick. In the same way, the heat of boiling water in a canner transfers into the food inside the jars and destroys pathogens living there.

Danger! Beware of C. bot!



Pathogens can be very dangerous. For example, the bacteria called *Clostridium botulinum* (*C. bot.*) is deadly. This bacteria is harmless when in soil or water, but when it is sealed in a jar with moist, low-acid food stored at room temperature, it can produce a toxin that causes botulism, a potentially deadly food poisoning. *C. bot.* is difficult to detect, like a secretive villain that leaves no sign of being there. It's important to use only tested canning recommendations and follow them exactly to be sure that canned foods do not have any pathogens that would make you sick.

Glossary

Acid foods are foods with a pH value at or below 4.6; they taste sour.

Acidified foods are foods that acid is added to in order to lower the pH to 4.6 or below.

Bacteria are a type of microorganism that grow on food and can cause spoilage or sickness.

Boiling water canning is the process of filling jars with food then processing the closed jars in a boiling water canner for a long enough time to heat the product and destroy microorganisms.

Enzymes are natural proteins that speed up the rate of reactions necessary for life.

Food preservation protects food from spoilage by microorganisms and enzymes.

Low-acid foods are foods with a pH value above 4.6.

Microorganisms are creatures so small they cannot be seen except with a microscope.

Mold and Yeast are types of microorganisms that grow on food and can cause spoilage.

pH is a measure of acidity, on a scale from 0 to 14.

USDA is the acronym for the United States Department of Agriculture; a reliable source for scientifically tested home food preservation recommendations, including canning.

Vacuum is empty space created when air is pushed out of a container and is unable to re-enter.

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Name: _____

Date: _____

What Do You Know About Boiling Water Canning?

If you think the statement is true then circle "True",
and if you think the statement is not true then circle "False".

Boiling water canning is based on science. True False

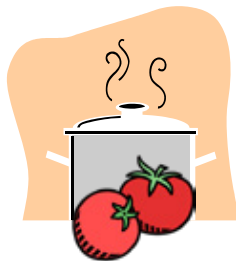
Canned tomatoes last longer than fresh, uncanned tomatoes at room temperature. True False

Low temperatures (like in refrigerators) and high temperatures (like in canners) speed up the growth of microorganisms (like bacteria, molds, and yeasts) that spoil foods. True False

Most microorganisms grow best in very acidic conditions. True False

It is not safe to can low-acid foods in a boiling water canner. True False

When filling jars for canning, it is a good idea to fill the jar with food product all the way up to the lid. True False



If you agree with a statement below then circle "I agree",
and if you don't agree with the statement then circle "I disagree".

There are no correct answers, just answer honestly with what is true for you.

I like to make my own snacks and other foods at home. I agree I disagree

It's fun to prepare and preserve food. I agree I disagree

I know how to can tomatoes (with the help of an adult). I agree I disagree

I can get everything I need to can tomatoes at home. I agree I disagree

I will use canning recipes and instructions from USDA or other science-based sources. I agree I disagree

Sometime when I am at home, I will try to can tomatoes (with the help of an adult). I agree I disagree