mystery science

Lesson: “How can you tell if acids are hiding in your fridge?”

VIDEO TRANSCRIPT

EXPLORATION VIDEO 1

Hi. It's Esther from the Mystery Science team. Take a look at these people's faces and see if you can guess what's going on. Here comes some more. Got any ideas? If you need a hint, these people are all tasting a particular flavor. And from their expressions, maybe you can guess what that flavor is. It's sour. There's something about sour flavors that can make faces scrunch and mouths pucker. Even babies tasting sour for the first time will pucker up, and scientists aren't sure why. We seem to make this sour expression automatically. You've probably tasted sour foods before, but what is it that makes something sour? I mean, salt obviously gives things a salty taste, and sugar gives things a sweet taste. But sour. What is it that gives foods a sour taste? Think of sour things you've tasted. What do you think they might have in common?

EXPLORATION VIDEO 2

I've tried some sour candy before. Maybe you have too. It has this powdery stuff all over it that definitely tastes sour. But what exactly is in that stuff? Other foods don't have that powder, but they seem to naturally taste sour, like lemons. Then there are foods like these pickles. No mystery powder, no lemon, but they still taste sour. It's tricky to figure out where sour comes from, but it turns out there is something that lemons, pickles, and sour candy all have in common. Lemons get their naturally sour taste from something called citric acid. Pickles get

their sour taste from soaking in vinegar, which is also called acetic acid. And if you check the ingredients of sour candy, you'll likely see acids listed there too. Notice a pattern here? All these sour things contain some kind of acid. If you've heard of acids before, you might imagine the oozing, burning goo they show in cartoons. Or maybe you've seen a warning sign like this from a science lab. Is that a hand with a hole in it? Yikes. There's a reason some acids come with a warning, like this one here. It's a laboratory acid called sulfuric acid. Watch what happens when someone pours it over a cheeseburger and lets it sit for a while. Wow. That is a big change. Just imagine if that was your hand. Let's see what another kind of lab acid called hydrochloric acid can do to a metal soda can. Woah. It's like the hydrochloric acid has eaten away the metal. You can see that part of the can is gone. Here's another acid called nitric acid. Watch as a shiny copper penny is carefully lowered into it. See that? Another big change. Clearly, the acids that scientists work with are serious stuff. But we started out talking about foods. Acids in foods give them a sour taste. But are those food acids somehow similar to lab acids like this? Can food acids cause changes too? That might seem hard to believe, but if you've ever gotten lemon juice in a cut, you know it can really sting. It's not hole-in-your-hand bad, but it does hurt. So maybe these acids have more in common than you think. This is a glass of citric acid, like what's naturally in lemons. An old metal nail has been sitting in it for a few days. See that? There are bubbles and flakes of brown stuff coming off. Some kind of change is going on. That's not all. Check out what the acetic acid in plain old vinegar can do to a couple of eggs. Here's what the eggs look like after a few days soaking in the vinegar. Notice all the bubbles? And here are the eggs after one whole week in vinegar. Just watch. Weird. Right? Somehow, they're bouncy now, and their hard shells are gone. Something is happening with these food acids. They can make other things change. It's a bit like those really big changes you saw with laboratory acids. Look again at the way these two different kinds of acid, a lab acid and a food

acid, can change other things like metal. What similarities do you notice? What are some differences?

EXPLORATION VIDEO 3

All acids, whether used in science labs or in food we eat, do have some things in common. For instance, put an acid and metal together, and you can observe some changes. You can say they react together. Acids also react with materials like our skin, but there's a pretty big difference between the stinging sensation of a food acid like lemon juice and the burger-melting burn of a laboratory acid. That's because acids have different strengths. The acids used in labs are often called strong acids. Strong acids cause bigger, faster reactions, like with this metal can. Hydrochloric acid broke down most of the can in just a few hours. The acids in foods are not as strong, so you can call them weak acids. They cause smaller, slower reactions, like with this metal nail. It took days for citric acid to eat away just a little bit of the rusty metal. Acids have another thing in common that you already know about. They taste sour. And if a weak acid can make your mouth pucker, I hate to imagine what a strong acid would taste like. Obviously, eating acids that do damage like this would be unsafe. But safer, weaker acids are found in lots of foods, like lemons, pickles, and sour candy. When you taste sour, you're noticing something about these foods. You can call that a property. And those foods, as different as they seem, have the same property. They're acidic. Let's say you want to avoid that acidic taste. Some foods are famously sour, like lemons, but others are trickier. In the fridge right now, there are probably foods that you don't know contain hidden acids. Those foods are secretly acidic. If you want to avoid a sour surprise, maybe you could figure out if a food is acidic before tasting it. What do you think? What could you do to test if a food is acidic without tasting it?

ACTIVITY INTRODUCTION VIDEO

In today's activity, you're going to figure out which foods from the fridge are acids without tasting them. You need a test, an acid detector that can tell you if a substance has the property of being acidic. Just like when a metal detector beeps when it finds a hidden piece of metal, you need a test that will tell you acid, acid, acid when it finds a substance that is secretly acidic. Once you have your acid detector, you'll be given three different surprise substances. These are everyday substances that you might find in your home or kitchen. Your challenge is to use your detector to figure out which of these substances from your refrigerator might actually be acids. Will you reveal their true acidic identities? We'll show you how to get started, step by step.

ACTIVITY STEP 1

In today's activity, you'll work with a partner. Decide who will be Scooper and who will be Mixer. If you're working alone, that's okay too. When you're done with this step, click the arrow on the right.

ACTIVITY STEP 2

Get your starting supplies. You'll get more supplies later.

ACTIVITY STEP 3

In the first part of this activity, you're going to determine if baking soda can be used as your acid detector, something that can tell you which substances are acidic and which are not. So first, you'll combine baking soda with water, a substance that we know is not acidic. Scooper, find the cup labeled B. That's baking soda. Mixer, find the cup labeled W. That's water. Scooper, add

one scoop of baking soda to the water cup, like this. Then, Mixer, use a clean mixing stick to slowly stir the baking soda with the water. Make sure you both look carefully to see what happens.

ACTIVITY STEP 4

What happened when you mixed baking soda with water? Go ahead and record anything that you noticed here in Question 1 of your worksheet. If you didn't see anything happen, that's important to record too.

ACTIVITY STEP 5

Now you'll add baking soda to vinegar, a substance that we know is an acid. Mixer, find the cup labeled V. That's vinegar. Scooper, add one scoop of baking soda to the cup with vinegar. Then, mixer, you'll slowly stir them together. Make sure you both make observations of what happens.

ACTIVITY STEP 6

What happened when you mixed baking soda with vinegar? Go ahead and record anything that you noticed here in Question 2 on your worksheet.

ACTIVITY STEP 7a

We noticed that when we mixed baking soda with water, a substance that is not an acid, nothing much happened. But when we mixed baking soda with vinegar, a substance that is an acid, something did happen. A bubbly, fizzy reaction. At Mystery Science Labs, we tested other substances that we already know are acids. When we mixed them with baking soda, here's what happened. So for the rest of the activity, we're going to use baking soda as our acid

detector. Discuss this question as a class, then answer question three on your worksheet. When you mix your acid detector, baking soda, with an acid, what will you notice?

ACTIVITY STEP 7b

Here's what we thought. When your acid detector mixes with a substance that is an acid, you'll see bubbles, and you might even hear some fizzing, just like the bubbles and fizzing that happen when baking soda mixed with vinegar. The bubbles might be slow or small, but if you notice any bubbles or fizzing, that's an acid. Those bubbles are telling us acid, acid, acid. But when baking soda mixes with a substance that is not an acid, we won't see bubbles, just like we saw with the water. No bubbles, not an acid. Go to the next step to start testing.

ACTIVITY STEP 8

Your teacher will have three substances for you to test. Your job is to figure out if any of them are secretly acids. If you're working at home, you can check the refrigerator for possibilities. In a moment, you will get cups labeled 1, 2, and 3. Your teacher will tell you what's in each cup. Write the name of each substance on your worksheet here, here, and here.

ACTIVITY STEP 9

Get the rest of your supplies.

ACTIVITY STEP 10

We suggest that you watch this whole step first so that you'll know what to do. Starting with substance number 1, Scooper, you'll add one scoop of baking soda. Then, Mixer, you'll use a clean mixing stick to slowly stir the baking soda with the substance. Be sure to mix it slowly and

observe carefully to see what happens. Remember, if you see any bubbles, that tells you the substance is acidic. You'll repeat this for substance 2 and then substance 3. Make sure to use a new, clean mixing stick to stir each substance. As you work together, make sure to write down anything that you notice, recording your observations here, here, and here on your worksheet. Okay. Go ahead and work with your partner to test each of your substances one by one.

ACTIVITY STEP 11

Make sure to finish recording all of your observations on your worksheet. Once you've done that, it's time to reveal the true acid identities of these substances. Do you think any of these substances 1, 2, or 3 are acids? Why do you think that? What's your evidence? Discuss and then answer question 4 on your worksheet. If you're not sure about some of them, that's okay. Just make sure to describe what you noticed.

ACTIVITY STEP 12

Now that you've recorded all your observations, discuss your results and these questions as a class. Which substances, 1, 2, or 3, have the property of being acidic? Why do you think that?

WRAP-UP VIDEO 1

Some foods have the property of being acidic, and they taste sour. But in the activity, you needed a way to test if a substance is acidic without tasting it. To do this, you used an acid detector: baking soda. Mix baking soda with something acidic, such as vinegar, that's acetic acid, and you'll get a reaction, usually bubbling and fizzing, like this. We tested some foods at the Mystery Science Lab to see if they're acidic. Your results may have looked a bit different, but check out what we found. Like, watch what happens when we mix mustard with baking soda.

See that? That's definitely a reaction. So mustard must be acidic. How about orange juice? Mix it with baking soda and yep. It's acidic. Up next is egg white. That's the clear runny stuff you get when you crack an egg. Mix it with baking soda, and not much happens. No reaction means no acid. A few times, it was hard to tell if we were seeing a reaction or not. Like, check out what happened when we tested some milk. Maybe there's a little fizzing. You might have had some maybe reactions too. To clear up the maybes, scientists use a variety of detectors that can measure even a small amount of acid. Those detectors show that milk is acidic, but only slightly. That's why you only saw a small reaction with baking soda. It's hard to detect very weak acids this way. Instead of blaring acid, it's more like a whisper. Acid. Acid. Acid. With a substance that's more acidic, like the vinegar you tested, there's a bigger, faster reaction. But even vinegar is weak compared to the acids used in laboratories. Like, remember that hydrochloric acid you saw destroying a soda can? Vinegar can't do that. So if a lab acid can cause a change like this, what do you think would happen if you mix baking soda with a strong lab acid?

WRAP-UP VIDEO 2

Let's see what happens when you mix baking soda with a strong lab acid like hydrochloric acid. Check it out. That's some major bubbling. Your detector is practically screaming acid, acid, acid this time. You've seen before that the acids used in labs and the acids in foods have different strengths. With strong acids, you get bigger, faster reactions. Imagine if you tested a whole bunch of substances with baking soda, then put them in order based on how big the reaction was. Like, hydrochloric acid creates lots of bubbling, so let's put that first. Next might come vinegar, a bit less bubbling, but still lots. Then maybe mustard, which has, like, foamy fizzing. Then maybe orange juice, which had some bubbles. Finally, something like milk, where there was just a little fizzing. Looking at the detector reactions can help you compare the strains of

different acids. The bigger the reaction, the more acidic a substance is. And as the reactions get smaller, the less acidic it is, until finally, no reaction means no acid, like you saw with pure water. Scientists have a similar system for measuring how acidic different substances are. It's often called the pH scale. You'll learn more about this scale as you study chemistry in the future. The bright colors of this pH scale go along with another kind of detector that scientists use. When they test the substance to see how acidic it is, they look for a color change on a special kind of paper, kind of like how you looked for bubbling and fizzing. There's a lot more to discover about acids. For instance, your body relies on a complex balance of weak and strong acids. In your stomach right now is acid just as strong as the ones in labs, and that's a good thing. That acid helps you digest food. And you know how certain foods can make you pucker up? That pucker is like an acid detector. Think about it. Baking soda helped you detect substances with the hidden property of being acidic. And when you taste sour, what you're really doing is detecting acids. Your body has its own acid detector. Have fun, stay curious, and enjoy some acids with your next meal.