

SALTINES , SALIVA, and the STARCH REACTION

...turning a " classic" failure into a successful exploration

Introduction to "the myth"

Here's how it goes - give students saltine crackers. Put a drop of iodine on a cracker. See the cracker turn blue-black. The reaction indicates the presence of starch. Instruct the students to choose a fresh cracker and chew it, **NO SWALLOWING ALLOWED!** Chew and observe taste sensations for at least 5 minutes (maybe ten minutes). Tell them to notice the taste changing from bland to sweet (it actually happens, but the mush in your mouth at this point is way too distracting to focus on the subtle change in taste. Spit out the chewed cracker mush into a dish. Add iodine. Behold! The cracker much is now.....blue black!

The expectation is that the cracker would no longer show the starch reaction with iodine. This is nearly impossible to see with the "chew a cracker" procedure.

What follows is one example of a successful way to conduct this experiment.

What you need:

Saltine crackers

Test tubes and racks

Small cups/containers

Water

Droppers

Graduated plastic pipette or teaspoon

Waxed paper

Iodine

What to do:

Do the chew a cracker experiment described above. Note the taste change (subtle) and lack of change in the iodine test after chewing the cracker. Spit into a cup. You must collect at least 5 ml (one teaspoon) of saliva. Obtain two test tubes. Break off two pieces of cracker approximately the same size -- about the size of a small pea. Place the cracker pieces in separate squares of waxed paper. Fold the waxed paper over the cracker and crush each piece of cracker into oblivion. Place each crushed cracker bit into separate test tubes. To one tube add 5 ml of water. To the second tube add 5 ml of saliva. Mix each tube thoroughly, and allow to sit at room temperature for at least 5 minutes.

Add one drop of iodine to each tube. Mix. What do you see?

What's going on?

Starch is a long polymer of glucose molecules. There are three forms of starch - amylose, amylopectin, and and "animal" starch or glycogen. Amylose is the form found in crackers. Amylose is a linear chain of 200 - 2000 glucose subunits bonded together that forms a long helical structure.

Iodine molecules fit tightly inside the helix, and consequent changes in the electron configuration of the iodine molecules cause the starch/iodine complex to turn the diagnostic blue-black color. This color reaction is reversible and is specific to the helical forms of glucose polymers found in starch. Amylase, an enzyme found in saliva, breaks down amylose into, ultimately, it's individual glucose subunits. As amylose is broken apart and the remaining sections grow shorter, at some point they can no longer accommodate the iodine molecules. The color reaction does not occur and iodine remains its normal brownish color (or the color reverses, if the reaction has already occurred).

As the cracker is chewed, salivary amylase starts breaking down the amylose into shorter glucose polymers. Some will be converted into individual glucose molecules that may impart a sweetish taste. (Of note: Glucose is not particularly sweet; fructose very similar in structure to glucose, and is much sweeter. Table sugar - sucrose - is a disaccharide of glucose and fructose.) Because there is so much starch in a cracker, there is not enough amylase in the saliva to break down all of the starch into glucose. There is plenty of starch left, after chewing, to give a positive reaction with iodine. Using a very tiny piece of ground up cracker in a large volume of saliva provides enough amylase to digest all of the starch in a few minutes, thus resulting in a negative reaction in the starch test.

Thank you! *Karen Kalumuck Exploratorium Teacher Institute*