

BEYOND THE REFERENCE RANGE

THE APPLE BROWNING BENCH TEST

An Enzymatic Browning + Treatment Investigation

Wonder 030 • Why does an apple turn brown after it is cut?

ACCESSION BRR-WJ-030-ACT-01	SETTING INDOOR
AGE 2+ participating; adult handles all cutting	TIME 35-60 min
CONTAINMENT LEVEL LOW - fruit juice + citrus + sticky fingers	VERSION 1.0 • 2026-09-10

ACTIVITY INTENT

Use equal slices from one apple to compare how four treatment conditions affect visible browning over time. The investigation introduces a control, treatment variables, timed observations, scoring, and the idea that a visible change can be evidence of an underlying chemical process.

PURPOSE + SCIENCE BACKGROUND

The American Chemical Society explains that cutting fruit exposes enzymes in plant tissue to oxygen. Enzyme-driven reactions then form brown products. Acidity, salt concentration, water, temperature, and oxygen contact can change the visible rate. This kitchen-table investigation keeps the useful bones of an experiment: one apple, comparable slices, one untreated control, defined treatments, fixed observation times, and recorded results.

NON-NEGOTIABLE SAFETY RULE

An adult performs all knife work. Lemon juice and salt solution are experiment reagents here, not tasting samples. Keep liquids away from eyes, supervise small children closely, and discard the handled test slices when the investigation ends.

MATERIALS

- 1 fresh apple
- Cutting board + adult-use knife
- 4 small plates or sections labeled CONTROL, WATER, LEMON, and SALT
- Water
- Lemon juice
- Salt solution: 1 teaspoon table salt mixed into 1/2 cup water
- 4 clean spoons, droppers, or food-safe brushes
- Timer
- Field Notes Binder or observation sheet
- Pencil/crayon/marker
- Optional: phone camera for one no-face time-series photo set

PRE-ANALYTICAL SETUP

- Label all four treatment stations before cutting the apple.
- Prepare the salt solution before the timer begins.
- Cut four slices from one apple as similar in thickness and exposed surface area as practical.
- Decide observation times before starting: T0, 10, 20, and 30 minutes. Extend to 45-60 minutes only if differences are subtle.
- Keep all samples in the same location and lighting.

Browning score: 0 = none • 1 = barely visible • 2 = light • 3 = moderate • 4 = dark/obvious

PROCEDURE

01 • Establish the control. Place one apple slice on the CONTROL plate and add nothing.

02 • Apply treatments. Lightly coat WATER with water, LEMON with lemon juice, and SALT with salt solution. Use separate clean tools.

03 • Start T0. Record appearance and assign each slice a 0-4 browning score immediately.

04 • Predict. Circle which sample is expected to brown first and which is expected to brown least. Do not rewrite the prediction later.

05 • Observe at 10 minutes. Score and note every sample at the same time.

06 • Observe at 20 minutes. Repeat without changing the sample order or lighting.

07 • Observe at 30 minutes. Record the planned final scores. If differences are still subtle, document that and optionally extend to 45-60 minutes.

08 • Interpret. Identify which treatment slowed visible browning most in this run by comparing it with CONTROL.

09 • Close the run. Photograph the final lineup if desired, record one new question, and discard the handled slices.

FIELD NOTES BINDER - MINIMUM DATA SET

TIME	CONTROL	WATER	LEMON	SALT
T0	_____	_____	_____	_____
10 min	_____	_____	_____	_____
20 min	_____	_____	_____	_____
30 min	_____	_____	_____	_____

Prediction - browns first: _____ Prediction - browns least: _____

Observed browns first: _____ Observed browns least: _____

New question created: _____

QUALITY CONTROL (QC)

The run is acceptable when:

- All slices come from the same apple.
- Slice size/thickness is reasonably similar.
- CONTROL receives no treatment.
- Separate tools are used for treatment application or rinsed thoroughly between treatments.
- All samples are observed at the same planned time points under the same lighting.
- A score is recorded even when there is little or no visible difference.
- The conclusion compares each treatment against CONTROL.

QC NOTE: If the slices do not separate dramatically, the experiment has not failed. Apple variety, freshness, temperature, slice thickness, treatment amount, and elapsed time can all change the visible rate. Record the boring result. Boring results still count.

QUALITY ASSURANCE + SAFETY

- **Knife safety:** adult cutting only.
- **Eye/skin:** avoid splashing lemon juice or salt solution.
- **Young observers:** pointing, choosing a prediction, brushing treatment with help, matching colors, or stickers all count.
- **Food handling:** discard experiment slices after the run.
- **Data integrity:** do not change scores to match the expected mechanism.

PROCEDURAL DEVIATIONS

DEVIATION	ACCEPTABLE RESPONSE
Slices noticeably different thickness	Document it; thickness/exposed area may affect visible browning.
One treatment applied late	Record the delayed start time rather than pretending T0 was identical.
Different apple used for one sample	Mark as exploratory only; do not include in the main comparison.
Lighting changed	Return samples to one consistent location and note the deviation.
Toddler rearranged specimens	Re-identify only if labels remain certain. If not, invalidate the affected comparison. Tiny auditor wins.

ROOT CAUSE ANALYSIS (RCA)

- Was the apple very cold when cut?
- Was the variety naturally slow to brown?
- Were slices unusually thick or minimally exposed?
- Were treatments applied so heavily that oxygen contact was limited across several samples?
- Was the observation window too short?
- Did lighting hide small color differences?

CORRECTIVE + PREVENTIVE ACTION (CAPA)

- Extend observation to 45-60 minutes before repeating the entire activity.
- On a repeat run, standardize slice thickness and apple variety.
- Photograph all samples in one frame at each time point.
- For older learners, use a fixed treatment volume such as 1 teaspoon per slice.
- Keep the untreated control unchanged in every repeat. The control is the anchor, not decorative fruit.

VARIATIONS

- **Toddler / early childhood:** compare CONTROL and LEMON only; focus on lighter/darker and change over time.
- **Elementary:** keep all four conditions and use the 0-4 scale.
- **Older learners:** run duplicate slices for each treatment and average scores.
- **Temperature study:** compare matched controls at room temperature and refrigerated conditions.
- **Surface-area study:** compare a thick wedge with thin slices from the same apple.
- **Apple-variety study:** repeat with two varieties while keeping treatment and timing the same.

BONUS ROUND

- Build a four-frame time-lapse: T0, 10, 20, 30 minutes.
- Hide labels at the end and ask a new observer to rank samples least to most brown.
- Turn scores into a tiny line graph.
- Repeat the winning treatment on a second apple and see whether the result survives replication.

FURTHER INVESTIGATION

The ACS activity extends this same idea across acidity, salt, sugar, water, and an untreated control. A future run can change one variable at a time - apple variety, temperature, surface area, treatment concentration, or time - while keeping the rest fixed.

INTENTIONAL MEMORY PROMPT

Take one photo of the four labeled apple samples beside the Field Notes page - no faces needed. Caption it: **APPLE BROWNING BENCH TEST • 2026 • Case status: fruit remains suspicious.**

BENCH NOTES

- Cutting the apple changes what its enzymes can contact.
- Oxygen is part of the reaction environment.
- The control tells us what happened without a treatment.
- A treatment that slows browning changes the reaction conditions; it does not make the apple immune to time.
- One run is a clue. Replication is where the gossip gets interesting.

REFERENCES • GO DOWN THE RABBIT HOLE

American Chemical Society. *Activity - Slowing Apple Browning*. Open verified ACS Rabbit Hole

Source verification completed September 10, 2026.

REVISION HISTORY

VERSION	DATE	CHANGE
1.0	2026-09-10	Initial BRR Full SOP + Quick SOP package created for Wonder 030.