Sweet potato indicator

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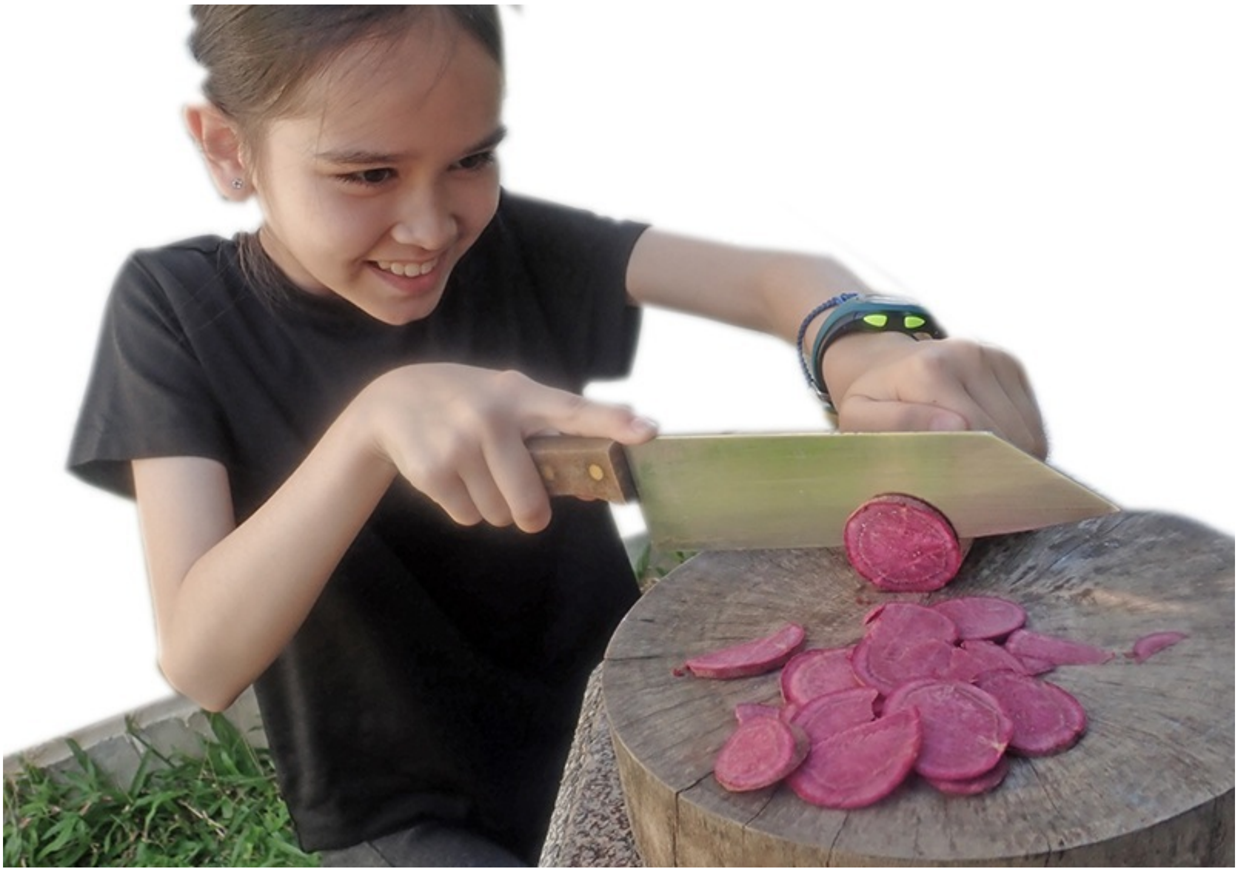
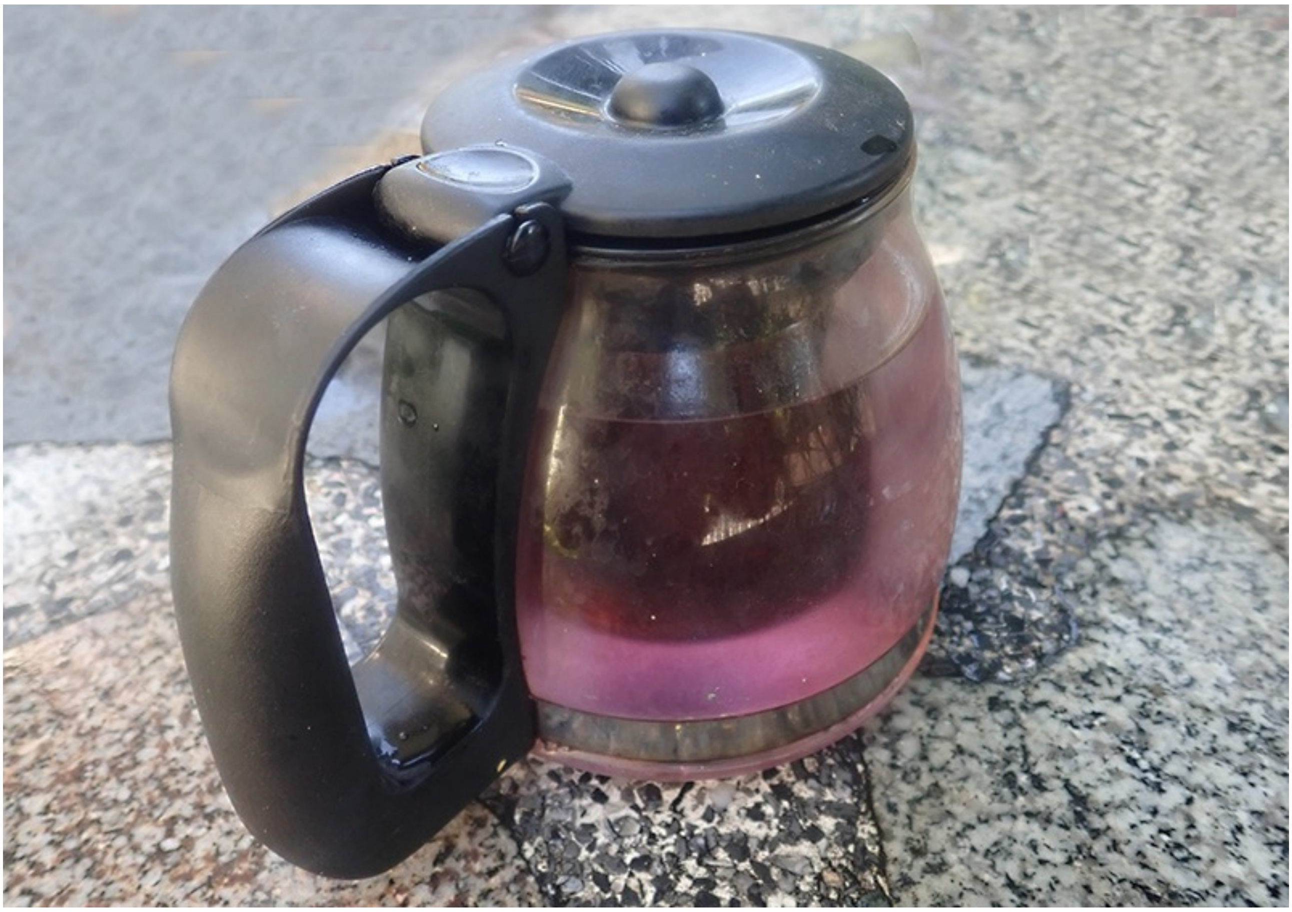
Blue Unchun dye in water changed to purple when lime juice was added to make the water acidic, but blowing bubbles with a straw to dissolve CO_2 in the blue water did not change its colour. To demonstrate that dissolved CO_2 does make water slightly acidic we need to find a more sensitive dye. Dad tried several things some time ago when he worked at NSM Thailand. He remembers finding one dye that did change colour with CO_2 in water

To make this indicator I cut a purple sweet potato into thin slices, chopped them up and put them in a Chinese tea pot. If you don't have a Chinese tea pot whole potatoes could be boiled in a pot of water, but a teapot is more convenient and gives a better coloured dye solution.



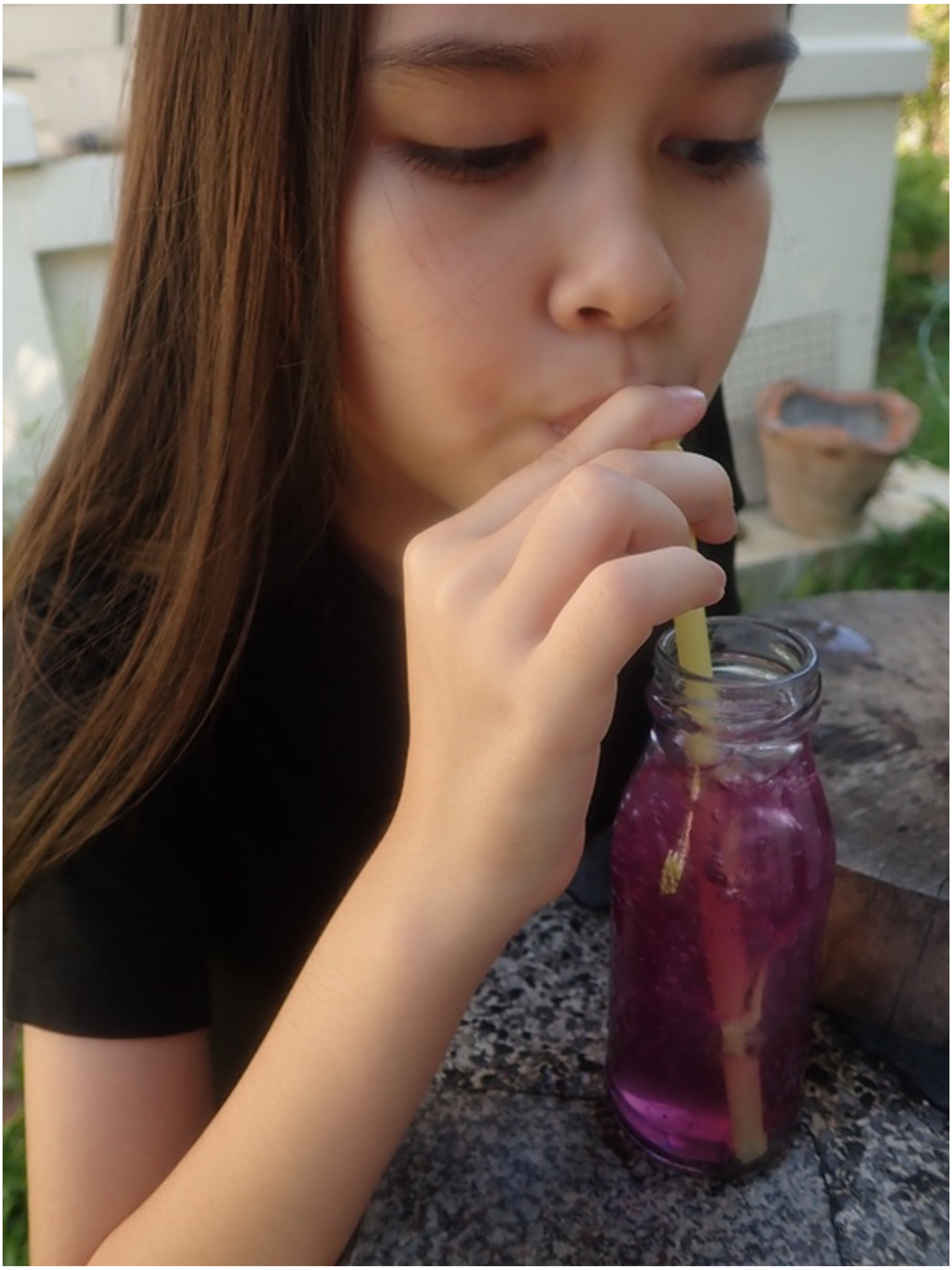
Cutting the sweet potato.



After five minutes the water had turned pale purple …

… and the potato chips in the pot had lost most of their purple dye.

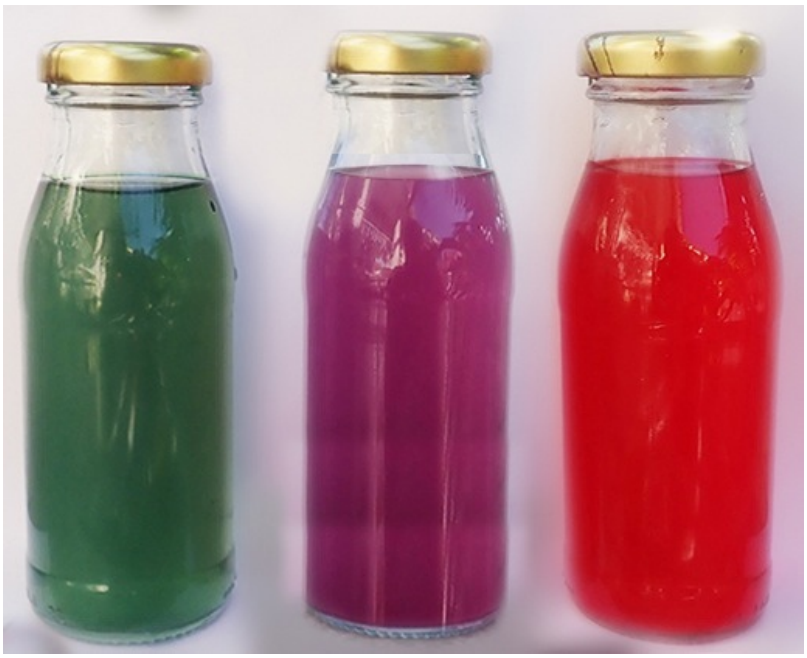
The purple water was poured into glass bottles. I took a straw and blew bubbles into one bottle for a whole minute, being careful not to splash water over the top.



A minute is a long time when you're blowing bubbles. I looked carefully at the colour of the water. It didn't seem to have changed much so I blew bubbles for another minute.

Two bottles are shown below close together in sunlight against a white background. If your sweet potato dye behaves like ours, the colour in water (left) after you blow into it, will change from purple to pinkish as shown (right) showing that dissolved CO_2 mades water more acidic.

The pink tinge with dissolved CO_2 (on the right above) became more intense when I added a few drops of lime juice, confirming that the initial colour change from purple towards pink is due to increasing acidity.



Our sweet potato indicator in dilute NaOH solution (left) tap water (centre) and dilute HCl solution (right).

When CO_2 dissolves in water it forms carbonic acid in solution.

$$CO_2 + H_2O \longrightarrow 2H^+ + CO_3^{2-}$$

Isolated protons (H^+ ions) attach themselves to water molecules so the reaction is better written as …

$$CO_2 + 3H_2O \longrightarrow 2H_3O^+ + CO_3^{2-}$$

The details are obscure. We will leave that for another time. Of more importance are the consequences of rising CO_2 levels in the atmosphere, oceans and freshwater systems for the earth's ecosystems.

Calcium carbonate is white but this land-snail shell is brown. The brown is due to a tough acid-resistant outer skin called the *peiostricum*, that protects calcium carbonate shells from damage in acidic conditions. Many marine, land and fresh water molluscs have this protective layer on their shells, but as more and more CO_2 dissolves in the sea the acidity rises and calcium carbonate dissolves, endangering coral reefs and shellfish.

Notes:

Like the Unchun dye I used before as an indicator (see the index) the green dye was unstable in alkaline solution. The green faded to yellowish brown over a few hours and after two weeks the alkaline solution was orange.

The purple-potato dye in alkaline solution after two weeks is on the left. The dilute lime juice solution (centre) and the dilute acid solution (right) are shown (largely unchanged) after the two weeks.

Like Unchun dye, this indicator must be made fresh each time it's used. To make a useful commercial indicator the colour changes need to be well defined and the dyes must be stable over time, at least in dilute solutions.

Litmus

The vegetable dye that became the standard acid/alkali indicator a century ago and is still used in schools is Litmus, a stable dye that is red in acid and blue in alkali. "Litmus" has come into the English language in the expression "*Apply the Litmus test*", meaning to do something that cannot be faked, to show everyone what has really happened.