Utilising the natural environment: Making bush soap

Introduction

The various Aboriginal populations of Australia have been living on the Australian continent for at least 50,000 years (1). During this time, Aboriginal people have developed extensive knowledge systems that have allowed for sustained occupation across the continent, including some of the harshest desert environments found on the planet. This has led to Aboriginal people being the oldest living continuous culture in existence (2).

Aboriginal knowledge systems extend to the use of native plants that can be found across the continent. These plants have not only provided a source of food for Aboriginal people but have also provided medicines and tools. Aboriginal people also discovered that they could use native plants to help maintain cleanliness, which helped to ensure ongoing health and wellbeing. Just like the soaps and detergents we use today, Aboriginal people discovered that leaves from particular trees would foam up into a soapy lather that could be used as a cleaning agent (4).

A video showing the production of soap lather from the green seed pods of the ‘elkerte’ wattle tree can be seen at [Science In First Language – Bush Soap – YouTube](https://www.youtube.com/watch?v=Kl0HWvfoqqo).

The chemistry of bush soap

Plants produce a range of organic chemical compounds that are collectively referred to as phytochemicals. These chemicals help the plant survive by acting as defence mechanisms against insect, fungal and bacterial pathogens, and to also deter hungry plant eaters like humans and animals (5). One of the phytochemicals that are produced by plants are called saponins (Latin ‘sapon’, soap + -in). Saponins are found in the leaves, seeds, bark, roots and stems of more than 500 plant species, where they may comprise up to 10% of dry matter (6).

Aboriginal people discovered that they could use native plants as soap. By scrubbing their hands with plant material that contains high levels of saponins, such as the leaves or green seed pods of certain native plant species, Aboriginal people were able to be able to create a soapy lather that could be used to clean hair and body. This is achieved by crushing the leaves to release the saponin from the leaves, and then agitating the broken leaves in water. Just like the soaps we use today, the crushed leaves produce a soapy lather that can be used as a cleaning agent.

So how do these soaps work?

If we first look at the structure of a saponin compound, we can begin to see how these phytochemicals that are produced by the plant can act as a cleaning agent. Structurally, saponins contain a carbohydrate unit attached to an aglycone unit (usually a triterpene or steroid group) (see Figure 1) (7). The carbohydrate unit acts as the polar head of the saponin compound. Since polar molecules freely interact with water, the carbohydrate portion of the saponin compound is known to be hydrophilic (Greek ‘hydro’, water + ‘philic’, affection). On the other hand, the aglycone unit on the saponin compound acts as a non-polar tail. Non-polar compounds do not freely interact with water, and are therefore, known to be hydrophobic (Greek ‘hydro’, water + ‘phobic’, fear).

Diagram

Description automatically generatedCompounds, such as saponins, that have both hydrophilic and hydrophobic parts are described as amphiphilic.

Figure 1: The structure of a saponin unit

Figure 1: The structure of a saponin unit

Diagram

Description automatically generatedBecause of their amphiphilic nature, when saponin compounds are introduced into water they form structures called micelles (see Figure 2). This occurs because the hydrophilic (water-loving) head is happy to interact with the surrounding water, but the hydrophobic (water-hating) tail tries to escape the water. This results in the saponin units orientating themselves so that the hydrophilic heads all face out into the water, while the hydrophobic tails face inwards towards each other to exclude themselves from the surrounding water.

Figure 2: Saponin units form a micelle structure in water

Diagram

Description automatically generatedAs shown in Figure 3, by scrubbing your hands with saponins in the presence of water, you are able to lift dirt, oils and fats from your hands and into solution with the saponins. This agitation causes the single saponin units to dissociate from their micelle structure and interact with the grime on your hands. Once agitation stops, the micelles reform, trapping dirt, oils, and fats within their structure before they are then washed away by excess water.

Figure 3: Micelles form in water. Once agitated they dissociate from their micelle structure before reforming. When reforming, they trap dirt that can then be washed away. They also have a surfactant effect that allows for the formation of bubbles.

Just like the modern soaps we use today, saponins also produce a foaming effect in the water. This is because the formation of the micelle stabilises the liquid-gas interface at the water’s surface and prevents the air from immediately escaping into the open atmosphere, which results in the formation of the bubbles above the liquid surface.

To understand this more you need to consider the liquid-gas interface. To easily demonstrate this, students can blow bubbles into a relatively pure liquid, such as tap water, and observe the speed in which the bubbles rupture. In doing this, students will notice that the bubbles rupture as soon as they break the surface of the liquid. This is because as the gas bubbles rise above the water surface, the liquid film that surrounds the gas bubble thins out, which rapidly causes the bubble to rupture.

Adding saponins to the water has a surfactant effect, which acts to lower the permeability of the liquid-gas interface and prevent the gas from immediately escaping into the open atmosphere (8). This stabilisation is a result of the micelles trapping air above the surface of the water, which results in the formation of the bubbles above the liquid surface.

Practical investigation

Materials needed

* 3–5 leaves or green seed pods from an acacia tree
* 2 x beaker
* tap water
* drinking straw

This practical investigation can be performed outdoors or in the laboratory. Ideally, an acacia tree will be located on the school grounds. If not, the teacher may need to collect the leaves or seed pods prior to the lesson. If collecting samples prior to the lesson, ensure the leaves are stored in an airtight container until ready for use as this will prevent the degradation of saponins.

Various acacia species can be used for this experiment. However, some species contain more saponin content than others. It may be best for the teacher to first try some samples. Alternatively, different acacia species could be investigated and compared.

If an appropriate acacia species is on the school grounds, this is a good opportunity to explain to students that Aboriginal people learnt their skills from interacting with the natural environment and that science does not only occur in the laboratory.

Students should collect or be given 3–5 leaves or seed pods from an acacia tree. The more the better. However, care should be taken to ensure that not too many leaves are taken from any single tree. If only a single tree is available, make sure leaves or seed pods are collected from different parts of the tree. Ideally, sample collection will be taken from multiple trees.

Method:

Making the bush soap

1. Take leaves or seed pods and scrunch them into your hands before rubbing the leaves between your hands for a couple of seconds.

2. Apply water to hands by either dipping in a basin of water or pouring water over hands. Not too much water is needed.

3. Vigorously scrub hands until soap-like foam is formed.

4. Wash away soap.

5. Leaves or seed pods can be reused to examine the foaming action.

Foaming action

To demonstrate the foaming action caused by saponins, the saponins can be extracted from the leaves through a simple water extraction.

1. Add the previously used leaves or seed pods to a beaker of water and let them soak for a few minutes.

2. Taking a drinking straw, blow bubbles into a beaker containing tap water. This will demonstrate how bubbles act in a relatively pure liquid (i.e. bubbles rupture when leaving water surface).

3. Next, blow bubbles with the straw into the water containing the extracted saponins. A foaming effect should result.

***4. Extension***: Students could design and conduct an experiment to quantitatively compare the foaming capacity of different acacia species.