MĀORI TEXTILES AND DYES AS A CONTEXT FOR TEACHING SCIENCE

Photo from Wikimedia Commons of Māoris weaving tāniko in 1981.

*Charmaine Russell, Ngāti Ranginui and Ngāi Te Rangi, was looking for opportunities to weave together rāranga and the chemistry of traditional dyes. She shares her experience with **NZASE Science Communicator Heather Goodey**, providing a context that could be used for Level 1 assessments or adapted for use in the classroom at multiple levels.*

Māori people arrived in Aotearoa with knowledge of Pacific plants that were not present in New Zealand. With no fur-bearing animals except kuri, finding an alternative fibre for textiles and clothing present in Aotearoa was pivotal to survival. Having discovered harakeke and developed a method for its' preparation for textiles, considerable endeavour must have taken place to develop dyes in a new country. The discovery and science of creating dyes that would stick on fibres and not wash off, a process called 'fixing,' is an impressive feat.

Harakeke
Courtesy: Mike Stone

The Tradition

Harakeke was prepared through harvesting traditions to preserve the plants for future use. A mussel shell was used to strip the green epidermal outer layer leaving the white fibres known as muka. Creating dyes that fix to cellulose is a much more difficult achievement than creating dyes that fix to animal skins and fibres which can utilise a metal mordant (a substance that combines with a dye and fixes it in a material.

Māori were able to create 3 dyes that were adequately colour-fast giving 4 colours - Undyed muka, yellow to white depending on the harakeke plant variety; hīnau, black; tanekaha, reddish brown; and raurēkau, yellow.

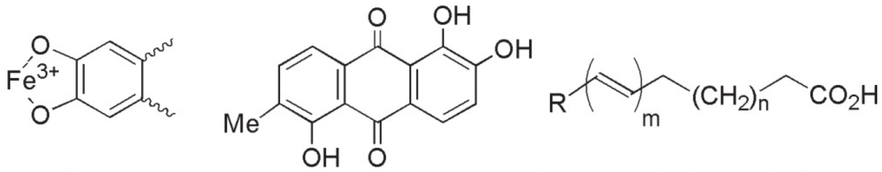
The image of a Piu-piu, a dance waist skirt worn by the Māori people, from the Honolulu Museum of Art. | Courtesy: Wikimedia

Black: The muka was soaked in a solution of hīnau bark that had been simmered in water for several hours. The fibres were dried without rinsing leaving a coating of tannin. The paru, a fine mud high in iron (III) content, covered the fibres and was left for several hours. The excess mud was removed, and the fibres washed in cold water and left in the sunlight to develop the black colour. The bark of manuka and kanuka is an alternative source but the type of tannin they contain are the condensed tannins give a less intense black colour with a green tinge. Hīnau contains a similar class of compound, gallotannins, which results in the deep bluish-black colour.

Unfortunately, over time the hīnau dye degrades the cellulose leaving it brittle and likely to break because of the acidic nature of the dye. Scientific investigations are being undertaken to preserve taonga that has hīnau dyed.

Red/Brown: The bark of tanekaha produces a red/brown coloured dye. The muka is soaked in a solution of tanekaha bark for a day turning them brown/red. On removal they are rubbed in a hot white wood ash (alkaline potassium compounds like potassium carbonates), then exposed to sunlight for an hour before being washed and left to dry. The bark of tanekaha is rich in another class of water-soluble phenolics called proanthocyanidins. This chemical is found in many plants, in the bark, nuts, and fruit such as cranberry, grape seed, cinnamon bark, and red cabbage amongst others. The change in colour from brown to red/brown with hot alkali suggests that the proanthocyanidins are converted to red anthocyanidin. Red anthocyanidin is the chemical responsible for the red colour in flowers and for the blue and purple colour in red cabbage. Anthocyanidin changes colour depending on pH; it is often used as a natural indicator. The treatment with hot alkali may decrease the water solubility of the initial condensed tannins making the dye more colour fast and initially adds a red/orange hue to the dye that then fades to brown.

Yellow: Using the bark of raurēkau and heating in water with muka for hours produces a rich yellow colour. The dye molecules are water soluble but because of their structure and functional groups, they can form hydrogen bonds with the cellulose of the muka locking the dye in place. This is called a direct dye.



5, Maori black dye

6, morindone

7, generic formula for weka and shark liver oils

The chemical composition of dyes, paints and pigments used in the Māori culture. | Courtesy: Gerald Smith and Rangi Te Kanawa

Paints and pigments: Māori used soot from burning resinous wood like rimu mixed with shark liver oil or weka oil. This is similar to the black pigments made by other cultures using linseed oil and soot (carbon). Evidence of this pigment from rock art in the limestone caves dates to 15th century. Other pigments utilised iron ores (ochre) and fungi like āwheto (vegetable caterpillar fungus) which was used as an ink for creating moko.

A Science Unit

The chemistry involved in dyeing using traditional Māori methods is complex which makes this a challenge to incorporate in a science unit. Charmaine Russell of Wainuiomata High School has been pondering this idea. She sought the advice of experts.

To begin with the class, she **explored and observed** harakeke variations and identified different physical features, learning the correct tikanga and times of year to harvest harakeke. Learning about **precipitation reactions** helped students connect with the way phosphates can be removed from waterways to protect the environment. Students created tīpare (headbands) by weaving the harakeke. Using a commercial dye, the students dyed their harakeke. They used **fair testing** to compare the qualitative differences of dye uptake for each variable and if and how they were correlated. Variables included the length of time in the dye, temperature of the dye and the extent of hāpine (stripping the outer surface of the harakeke). In part, this investigation was inspired by the actions of one student who skipped the hāpine step which resulted in poor dye uptake, says Charmaine.

The class are now looking into the chemistry of the dyes. They started with **classifying and identifying** the plants used in traditional Māori dyes and creating a key of native species. Secondary data on climate and conditions are used to **pattern seek** the distribution of these plants.


Students learning to weave using harakeke in Charmaine's class. Courtesy: Charmaine Russell

Modelling is used for the traditional dyeing process. Charmaine notes using traditional resources would require permission from local hapu. By modelling the ideas with available chemicals, the predictable patterns of the reactions are explored, and the context remains authentic while scarce and precious resources are protected.

For the black dye, a **combination reaction** between strong tea solution represents the tannin from the bark and crushed iron tablet represents the iron from the paru making the black dye iron tannate. Cotton is used in the dying process as a model for muka as it is also a cellulose-based material. "Just make sure any chemicals used in manufacture are washed off before the dyeing process." advises Charmaine.

The Onion skins are used in place of raurēkau for the yellow dye. The red/brown colour of tanekaha can be replaced with cinnamon sticks boiled in water and applied to the cotton and then rubbed in sodium carbonate or sodium hydrogen carbonate (baking soda). Charmaine has not tried this yet with her class.

For **combustion reactions**, the class will compare products from the complete combustion used to make potash (wood ash) for tanekaha dye and incomplete combustion creating soot for pigments. This is an opportunity to look at **mass conservation**. Exploring **neutralisation reactions**, the class will learn about how neutralisation is used in the protection of woven taonga being degraded by the acidic products from the black hīnau dye.

This is an ambitious unit of work but to date the students have enjoyed the experience and are feeling engaged in their learning journey. Not every activity has to fit neatly into the standards. It is interesting to see how not everything is known and how science is still trying to understand processes that Māori have used for hundreds of years.

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Resources and references

Exploring Dyes -TKI: https://eng.keitemohiokoe.tki.org.nz/Overview-of-Chemistry/Dyeing-3/Activity-Exploring-Dyes-Levels-3-and-4

Preserving harakeke taonga - Science Learning Hub: https://www.sciencelearn.org.nz/resources/1271-preserving-harakeke-taonga

Black is back - Connected Series: https://instructionalseries.tki.org.nz/Instructional-Series/Connected/Connected-2014-level-4-What-s-the-Evidence/Black-is-Back

Vegetable Caterpillar - Science learning hub: https://www.sciencelearn.org.nz/resources/1435-vegetable-caterpillar

Harakeke - Royal Society: https://www.royalsociety.org.nz/assets/127-Alpha-Series-Harakeke-Flax.pdf

G. Smith & R. Te Kanawa. 2008. Some Traditional Colourants of Māori and other Cultures. Vol72. NZIC: https://www.dominikmatus.cz/files/Some%20Traditional%20Colourants%20of%20Maori%20and%20other%20Cultures.pdf

Ngā Kupu *(Source: Maori Dictionary)*
Kurī: Dog
Harakeke: NZ flax
Muka: The inner fibre of the flax plant
Hīnau: Tall forest tree with long leaves; sometimes referred to as NZ olives
Tanekaha: Celery pine
Raurēkau: Large-leaved coprosma
Rimu: Red pine
Taonga: Treasure
Tikanga: Customary values and practices
Tāwai: To dye
Paru: Mud