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Growing food-safe watercress in Aotearoa

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2020 Unlocking curious minds — is our watercress safe?

The following report provides a summary of knowledge that may be useful to the student as they investigate the watercress growing in their local environment and assess its safety.

Watercress grows wild and continues to be the staple in households and marae of the Hauiti people in Uawa/Tolaga Bay, used on a regular basis in meals, and often collected by the local children as part of their training by community elders. The aim of this project is to increase school children's knowledge and understanding of the importance of the local environment's water quality for safe watercress production.

This project will educate children on the impact of bacteria (*Escherichia coli*) in the local water catchment, and help them understand how detrimental bacteria (pathogens) can be taken up by plants and affect human health; encourage children to observe the growth patterns of watercress – where it grows well, where it grows poorly – and delve into some of the scientific reasons why this might be so. This will build the children's knowledge of what certain plants need to grow. The project exposes children and their whanau in the isolated Uawa community to the science of ecology and teaches them how analytical testing can help assess food safety.

Watercress

Watercress, also called wātakirihi or kōwhitiwhiti, is a highly prized food source for tangata whenua in Aotearoa New Zealand.

Watercress is a perennial plant of the mustard family (all grouped under the name Brassicaceae), which is native to Eurasia and now naturalised throughout the world, including New Zealand. Watercress is a sun-loving plant that grows along running waterways, such as drains, small creeks, wetland streams and the calmer edges of rivers. It grows submerged, floating on the water, or spread over mud surfaces. The plant has white flowers with four petals and delicate, light green, peppery-flavoured leaves. Seed pods are small and bean-like, with two rows of seeds.

Native cress

Among the earliest botanical surveys conducted by the first settlers are references to a 'native cress' – probably the plants known by the scientific names of *Rorippa palustris* and *R. divaricata* (now a threatened plant). *Rorippa palustris* is the more widespread cress found in repo (wetlands) across the motu. These native watercress were identified as wātakirihi or kōwhitiwhiti, but may also be known as panapana, ponui, and matangaoa by different iwi. They can colonise similar habitats to the more common introduced wātakirihi.

Introduced watercress

Watercress from Eurasian origins were introduced to Aotearoa from England in about 1850[1]. These were the green watercress (with the scientific name *Nasturtium officinale*) and brown watercress (with the scientific name *Nasturtium microphyllum*), and a hybrid (*N. officinale* x *N. microphyllum*). A large leaf, higher-yielding variety called *Aqua Large Leaf* is currently available from Kings Seeds, and there is also a bronze-leaved variety of *Nasturtium microphyllum.*

Since the onset of intensified land use, such as farming, and associated practices of draining, harvesters of watercress have noticed the quality has fluctuated dramatically at most sites. Drains associated with farming where the plant grows are at higher risk of pollution and bacterial infection (such as *Escherichia coli*), which can make the plants unsuitable for consumption.

Watercress is also a very good accumulator of nitrogen, and has been used in some instances for nitrogen 'scrubbing' (removal of nitrogen from stream water *via* plant uptake into roots and leaves) in freshwater creeks and drains adjacent to farmland. Sedimentation of habitat reduces harvestable areas. Sedimentation is where high loads of soil (including silt, clay, and other soil components), which are often loaded with high concentrations of nitrogen, phosphorus, other nutrients and potentially harmful microbes, are deposited on the plants as the waterbody settles out in the calmer areas. Like other plants, watercress makes its food *via* photosynthesis in leaf cells, and heavy sediment deposits affect this process by smothering leaves and blocking sunlight.

Pugging is caused by the movement of stock along a riparian margin, which can also create small slips that fall onto watercress beds and smother them.

Environmental measures & growth rates – how does your watercress compare?

Field growth rates for watercress have been previously measured alongside the Whangamata Stream - a spring-fed stream draining into Lake Taupo[2]. The catchment of the stream is yellow-brown pumice soil. Watercress (*Nasturtium officinale*) is dominant in summer, and tends to die back in winter leaving other water plants (e.g. blue sweet grass, jointed rush, water-starwort and yellow monkey flower). The watercress grew in the following environment:

- Reasonably constant base flow of water: 0.1 $m^3.s^{-1}$
- Midday water temperatures: 9–14ºC
- Mean daily solar radiation: 225–800 mW cm^{-2}
- Stream water pH: 7.5
- Ammonium-N values: <10 $ug.L^{-1}$
- Soluble reactive phosphorus: 10–80 $ug.L^{-1}$
- Biomass changes: 5.7% per day (337 $g.m^2$ year)

Cultivation

Consistent water availability is the number one concern in the care of watercress. Although watercress likes to grow with its roots in mud, or under water, it can be cultivated in rich moist garden soil, with frequent watering. Watercress plants need to have available water all year round. While watercress will do well in a variety of soil conditions, the ideal pH range is between 6.5 and 7.5 (i.e. very close to

[1] Palaniswamy UR, McAvoy RJ. 2001. Watercress: a salad crop with chemopreventive potential. Crop Reports, HortTechnology 11(4): 622-626.

neutral). Watercress prefers a position of light shade, but will grow well in a sunny position, providing it remains wet.[2]

In the garden proper, you can dig out a 15 cm furrow, line it with polyethylene and then fill with 5 cm of composted soil.

Natural conditions can be mimicked by growing watercress plants in a bucket or other container. The key is to keep the roots submerged under water. When grown in a container, the plants can be placed in a bucket filled with 5 cm of water so the roots stay submerged. Plants need constant fresh water. The water should be changed once or twice a week.

Propagation

Watercress can be propagated by stem or root cuttings taken at any time and rooted in water. Alternatively, plants may be grown from seed. Seeds are tiny, so they need to be lightly spread over the prepared site. Seeds will germinate in 5–10 days. They are best sown in spring or autumn as plants tend to run to seed in mid-summer, the small seedlings are also frost sensitive. The seeds germinate best in cool conditions (10–15^{o}C). The planting area must be moist but not covered with water. Containers placed in a saucer filled with water will retain moisture. When the seedlings are large enough to handle, they can be transferred to a larger growing bed or trough.

A quick way to grow watercress is to place stalks in a jar of water, changing the water every few days. Fine roots will quickly appear and the rooted plantlets can be transplanted into containers. Growing watercress using cuttings increases the risk of transmitting plant viruses, so cuttings should be taken from healthy plants.

Mature watercress is surprisingly hardy and tolerates being frozen.

Why is pH of soil and water important to plants?

Soil pH is a measurement of the alkalinity or acidity of the soil. The soil pH range is measured on a scale of 1 to 14, with 7 as the neutral mark — anything less than 7 is acidic soil and anything greater than 7 is alkaline soil.

The importance of soil pH for plants is two-fold. Soil fertility depends on pH. Soil pH affects the availability of nutrients to plants. The most nutrients are available for plants to use between pH 6 and 7. The middle of the range on the soil pH scale is also the best range for bacterial growth in the soil to promote decomposition. The decomposition process releases nutrients and minerals into the soil, making them available for the plants to use. The mid-range is also perfect for micro-organisms that convert the nitrogen in the air into a form that the plants can readily use.

When the pH rating is outside the mid-range, both of these extremely important processes become more and more inhibited, locking up the nutrients in the soil such that the plants cannot take them up and use them to their full advantage.

[2] Howard-Williams C, et al., 1982. The dynamics of growth, the effects of changing area and nitrate uptake by watercress *Nasturtium officinale* R. Br. in a New Zealand Stream. Journal of Applied Ecology 19: 589-601.

Growing watercress

Watercress grown in natural waterways gets its nutrients from the water and the soil it is growing in. Watercress grown in farmland is likely to have all the nutrients it needs for rapid growth. Watercress grown in streams in the forest may grow more slowly, but is likely to be of good quality in terms of food safety.

Care of potted watercress is fairly simple, provided the soil is kept wet. Watercress doesn't have high nutrient needs, although it may become deficient in phosphorus, potassium or iron. Phosphate deficiencies appear as stunted and dark coloured foliage, while potassium deficiencies create scorching on older leaves. Yellowing, often in winter, may indicate an iron deficiency. To combat these, mix a water-soluble fertiliser in with the water according to the recommended rates.

In the garden, mulch and keep the area around the plants free from weeds to aid in water retention. Snails love watercress and should be removed by hand or trapped. Whiteflies also like the plant and can be controlled by spraying with soapy water or insecticidal soap. Spider mites cause leaf discoloration and general deterioration of the plant. Natural predators such as ladybirds (also known as ladybug), predatory mites or lacewings can help control these pests.

Insect pests and preditors. Pests include whitefly (left), spider mite (middle), and predators may include lacewings (top right), ladybirds (middle right) and predatory mites (bottom right).

Watercress harvesting and storage

Watercress harvesting can commence about 3 weeks after emergence (from seed). Cutting or pruning the plants will encourage them to branch. Never take more than a third of the plant at any one time. Do not pull on stems as the whole plant may come out.

Wash the cuttings thoroughly and store in a plastic bag in the refrigerator for as long as a week. Watercress can be held in a jar in the sun and used the same day. Harvesting can continue year-round.

Food safety

Our chance of becoming ill after eating plant foods is related to a number of risk factors:

1. Contamination from the environment
2. Pest and disease sprays
3. Chemistry of the plant
4. Contamination after harvest
5. Our own level of immunity – allergens.

Potential sources of microorganism and chemical contamination of watercress include sewage outlets, runoff after heavy rain, and animal-derived contamination. Campylobacter has been discovered on watercress growing in the Wharemauku Stream, Kapiti Coast.

In New Zealand, there are three main types of waterborne pathogens that may cause stomach problems (referred to as gastroenteritis) – bacteria (e.g. Campylobacter, Salmonella, Shigella, Yersinia, *Escherichia coli*), protozoa (e.g. Giardia, Cryptosporidium) and viruses (e.g. enteroviruses, noroviruses, and Hepatitis A virus, although the latter does not cause gastrointestinal disease). If there is animal manure in the water where watercress is grown, then it can become an environment for parasites such as the liver fluke (*Fasciola hepatica*).

Geothermal activity may result in elevated arsenic concentrations in some lakes and rivers, like the Taupo Volcanic Zone. Arsenic is a toxic semi-metal so the consumption of aquatic plants, like watercress, taken from waters with geothermal inflows may present a human health risk. Arsenic gets stuck to the outside of the watercress, although it is not transported from the underwater parts of the plant to

Flavour Compounds

Watercress has a characteristic peppery-hot taste. This taste is due to a chemical in the plant called 2-phen(yl)ethyl isothiocyanate or PEITC for short. PEITC is a sulfur-containing glucosinolate.

This flavour compound, and subsequent flavour profile of watercress changes when the plants flower. The flavour of watercress may also differ in plants grown at different times of the year, in hydroponic systems, and in plants grown in garden beds as opposed to streams or ponds.

Glucosinolates are a family of compounds that plants use for chemical defence against pests. They are toxic to non-adapted herbivores and their presence in the leaves reduces herbivore damage.

those above the water. It is also rapidly released from the surface of the plant when it is placed in water containing no arsenic[3].

A healthy food

Watercress is a good source of folate (vitamin B9), vitamin C and vitamin A (from beta-carotene). The glucosinolates in watercress, including PEITC, give it a distinctive flavour. They also have an antioxidant activity that has been linked to health and wellbeing.

Watercress can be eaten raw in salads and sandwiches, used as a garnish, added to soups and sauces, and used instead of spinach in omelettes, quiches and pancake fillings. If eating raw watercress, make sure it is washed very carefully, and it is safest if collected from a stream or area where animals cannot enter. Watercress may be cooked by boiling, microwaving and steaming, although compounds such as PEITC are partly destroyed by boiling. Steaming or microwave cooking watercress retains these health-promoting compounds.

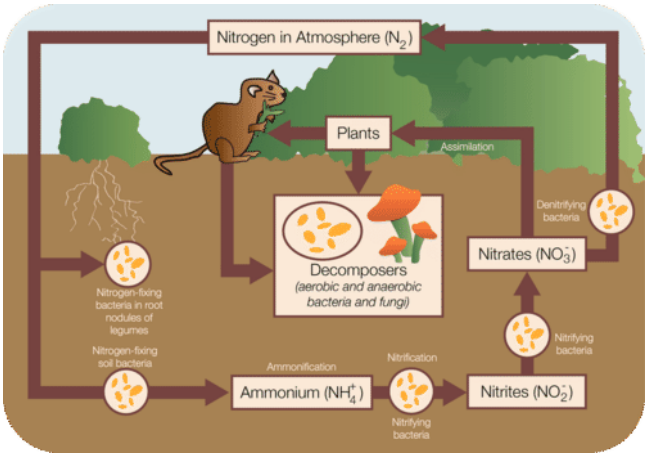
Streams may have high nitrogen concentrations if they run through market gardening areas or through farms that use a lot of nitrogen fertiliser, or if effluent or urine gets into the stream. Watercress from streams with high nitrogen concentrations may contain a lot of nitrate and may not be safe to eat.

The dark green leaves have a peppery flavour. To prepare watercress, firstly wash it well. Remove woody stalks and discoloured leaves. Use the medium to thin stalks and the leaves. Discard only the very coarse stalks; add these to stocks and soups for extra flavour.

High nitrate in streams may make watercress unsafe to eat

Information on exactly what concentration of nitrate (NO_3^-) in the water is too high is very scarce, but one study found that 750 ppm NO_3^- may produce watercress with concentrations near the maximum recommended daily limit for a 60 kg man (this assumes he eats 1 cup (50 g) of watercress a day). Most rivers in New Zealand have much lower NO_3^- concentrations than 750 ppm (mg NO_3^-/L).

Stream nitrate concentrations may change a lot throughout the year, so watercress may be safer at some times of the year than others**. Can you think of reasons why this may be the case?**



Jodi So, CK-12 Foundation. License: CC BY-NC 3.0

[3] Robinson B, et al. 2006. Arsenic hyperaccumulation by aquatic macrophytes in the Taupo Volcanic Zone, New Zealand. Environmental and Experimental Botany 58: 206-215.

Nutrition information

A standard serving size of raw watercress (1 cup of chopped watercress) weighs 40 g. Fresh watercress is a good source of vitamin C (ascorbic acid 30 mg/100 g) folate (280 µg/100 g) and a source of vitamin A (412 µg/100 mg).

Nutrient	Quantity per serve	Dietary Intake per serve	Quantity per 100g	Potential claim
Energy, FSANZ[4]	37 kJ	0%	92	Low energy
Protein	1.1 g	2%	2.8	
Fat, total	0.2 g	0%	0.4	
Fat, saturated (SFA)	0.05 g	0%	0.13	
Carbohydrate, available	0.1 g	0%	0.2	
Sugars, total	0.0 g	0%	0.1	Low sugar
Dietary fibre	1.3 g	4%	3.3	
Sodium	7 mg	0%	17	
Folate	112 µg	56%	280	Good source
Vitamin A, FSANZ	165 µg	22%	412	Source
Vitamin C (ascorbic acid)	30.0 mg	75%	75.0	Good source

[4] FSANZ – Food Standards Australia New Zealand

Glossary

Allergens Compounds that may cause an allergic reaction.

Escherichia coli A potentially nasty bacteria that can give you food poisoning (bad diarrhoea, vomiting and a gut ache).

Gastroenteritis Diarrhoea, vomiting and a gut ache.

Glucosinolates A group of compounds that plants from the cabbage family use for chemical defence against pests. They contribute to the flavour of these vegetables.

Habitat The natural home or environment of an animal, plant or other organism.

Liver fluke A parasitic flatworm that causes liver damage in various mammals, including humans.

Non-adapted herbivores
There is always a silent war between plants and herbivorous insects. In this silent war, chemicals act as both weapons and messengers. Plants evolve new strategies to avoid insect pests eating them, and insects in turn are developing counter adaptions that allow them to eat the plants without becoming sick.

Pathogen A microscopic organism or virus that can cause disease.

PEITC 2-phen(yl)ethyl isothiocyanate – a type of glucosinolate that gives watercress its distinctive peppery-hot taste.

Perennial A perennial plant is one that lives more than 2 years, as opposed to an annual plant that dies after 1 year.

pH A measure of the acidity or alkalinity of a solution. pH is measured on a logarithmic scale on which 7 is neutral, lower values are more acid and higher values are more alkaline.

Photosynthesis A chemical reaction that takes place inside a plant, producing food for the plant to survive. Carbon dioxide, water and light are all needed for ***photosynthesis*** to take place. ***Photosynthesis*** happens in the leaves of a plant.

Propagated The process that grows new plants from a variety of sources: seeds, cuttings, and other plant parts.

Protozoa A type of microscopic organism, different to bacteria and fungi.

Pugging When stock intensively trample wet soil, the soil aggregates are broken down, and spaces (pores) in the soil are reduced.

Sedimentation The process of particles settling to the bottom of a body of water.

Silt Fine sand, soil, or mud that is carried along by a river.

References and teaching resources

Awawhiti Cress grow and sell hydroponic watercress and micro salad cress. Awawhiti Cress is situated in the Ruapehu District and their water is sourced from the Whanganui River headwaters in the Tongariro National Park. http://www.watercress.co.nz/

Ball A. 2006. Estimation of the burden of water-borne disease in New Zealand: Preliminary Report. https://www.health.govt.nz/system/files/documents/publications/water-borne-disease-burden-prelim-report-feb07-v2.pdf

Beneficial Garden Pests – Jim's Mowing
https://www.jimsmowing.co.nz/blog/beneficial-garden-pests/

Commercial watercress production in Hampshire, United Kingdom, where the water comes directly from an aquafer. In these videos, you can see how watercress is produced, including sowing the seed, planting, pest management, harvesting, transport, and marketing.

https://www.youtube.com/watch?v=2eVuDnPMUPA
https://www.youtube.com/watch?v=dggrz21ISBQ
https://www.youtube.com/watch?v=Md2h9FsLjKY
https://www.youtube.com/watch?v=OKBsbk2ImTc
https://www.youtube.com/watch?v=ZrZU6OoY-bE

Howard-Williams C, Davies J, Pickmere S. 1982. The dynamics of growth, the effects of changing area and nitrate uptake by watercress *Nasturtium officinale* R. Br. in a New Zealand stream. Journal of Applied Ecology 19: 589-601.

Gardening Know How - https://www.gardeningknowhow.com;
https://www.gardeningknowhow.com/edible/herbs/watercress/growing-watercress-in-gardens.htm

Growing watercress plants in a bucket or other container
https://www.gardeningknowhow.com/edible/herbs/watercress/growing-watercress-in-pots.htm

Maori Television (Friday 26 October 2018) Rahui placed on Wharemaku Stream
https://www.teaomaori.news/rahui-placed-on-wharemauku-stream

Matakana Watercress is a family run business located in Matakana, an hour north of Auckland. Matakana Watercress have been producing *Nasturium officinale* since 2010. [see video]
http://www.matakanawatercress.co.nz/
New Zealand Food Composition Database
https://www.foodcomposition.co.nz/search/food/X131/claimable

Nitrogen Cycle in Ecosystems
https://www.ck12.org/earth-science/Nitrogen-Cycle-in-Ecosystems/lesson/Nitrogen-Cycle-in-Ecosystems-HS-ES/

Robinson B, et al. 2006. Arsenic hyperaccumulation by aquatic macrophytes in the Taupo Volcanic Zone, New Zealand. Environmental and Experimental Botany 58: 206-215.

Palaniswamy UR, McAvoy RJ. 2001. Watercress: a salad crop with chemopreventive potential. Crop Reports, Horttechnology 11: 622-626.

Pot grown watercress – Marty will show you how to grow watercress in a pot, when your home garden is small scale
https://www.youtube.com/watch?v=Md2h9FsLjKY

Sustainably grown local food. The 2019 Kai Ora Fund is a partnership between Te Tai Tokerau Primary Health Organisation, The Far North District Council, Te Puni Kōkiri, Northland Inc., Kaipara District Council, Northland District Health Board, Whangārei District Council and Manaia Health PHO. The purpose of the Kai Ora Fund is to enable Northlanders to grow and eat nutritious and sustainably grown local food. The small community grants process supports projects that address food security, benefit the wider community and encourage employment and economic development in the region. The Kai Ora Fund has supported watercress projects and may be a useful link to the Northland communities who are interested in watercress.
https://www.tttpho.co.nz/health-services/kai-ora-fund/

Take a tour of the Waikawa Fresh farm watercressto see a in a hydroponic growing systems in action. This video shows the Waikawa Fresh farm operations from – propagating from seedlings to full grown plants, hydroponic systems, management and harvesting of leavy green vegetables including watercress.
https://waikawafresh.co.nz/home/tour/

Watercress harvesting technology. A Feilding company has developed a machine for harvesting of water cress.
http://harvesterconcepts.co.nz/products/show/ht-cress

Watercress Watchers. Students from the Waitara school and local hapū in Taranaki learned how to check the streams' temperature, depth, flow speed, clarity, dissolved oxygen, mineral content, different types of wildlife, and pollution sources.
https://www.curiousminds.nz/stories/watercress-watchers-securing-wild-food/

Report for:

Unlocking Curious Minds Project – Uawa/Tolago Bay School

DISCLAIMER

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