New Zealand Institute for Crop & Food Research Ltd
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CROP & FOOD RESEARCH
Mana Kai Rangahau

Essential oil production from manuka & kanuka

Manuka on the Borland Flat

Manuka and kanuka belong to the family Myrtaceae, a family rich in leaf oils, which also includes the Eucalypts. Essential oil can be extracted from both manuka (*Leptospermum scoparium*) and kanuka (*Kunzea ericoides*) leaves by steam distillation. These oils are very different in their chemical composition, aroma, and biological activity. The characteristics of manuka and kanuka oils from different areas of New Zealand also vary and it is important to recognise the differences. Essential oils from both plants are used in cosmetics, hygiene and aromatherapy products, and herbal medicines.

Introduction

Manuka is the most abundant New Zealand shrub. In favourable open conditions it is a fast growing, conical-shaped bush that reaches about 4 m high, but local varieties vary in leaf form, flower size and colour. They can range from creeping matted plants to small trees, reaching 8 m high.

Kanuka is less variable in plant form, and is often called — or mistaken for — manuka. For example, most of the manuka firewood sold in New Zealand is kanuka. Kanuka can co-dominate with manuka in shrub land but becomes a tree up to 20 m tall in forest associations.

Today manuka oil is used topically as an external antiseptic, and the East Cape ecotype has particularly strong antibacterial activity. Maori had traditional uses for both manuka (kahikatoa, pata) and kanuka. The leaves were used in vapour baths and to scent toilet oils. Pulped seed capsules were applied as wound dressings. Infusions from the leaves were drunk as a tea supplement or for various internal complaints.

Manuka flowers

Kanuka flowers

How to tell the difference

Manuka and kanuka look similar, but there are quick field methods to identify them.

- When the plants are young, before flowering and seeding, a good method is to grasp a bunch of leaves. Manuka leaves are sharp or rough to the touch because of their needle-like leaf tips whereas kanuka leaves are soft. The more mature the leaves, the sharper the difference.
- When the plants have flowered, the seed capsules on manuka are much larger (5–10 mm) and are retained for some years, while kanuka seed capsules are small (2–4 mm) and generally fall soon after flowering.
- Manuka flowers, which are about three times the size of kanuka flowers, are scattered singly over the plant whereas kanuka flowers occur in dense clusters towards the end of the branchlets.
- Manuka is particularly susceptible to invasion by scale insects and consequent sooty mould growth. Kanuka is more resistant and therefore less likely to be affected.
- Manuka leaves are often a bright, shiny green while kanuka leaves have a dull sheen.
- Manuka is smaller, often shrubby and multi-stemmed, with stem diameters of 10–15 cm whereas kanuka is commonly a tree up to 15 m tall with stems 30–60 cm in diameter.

Botany

Manuka is a shrub or tree of diverse habit, often 2–4 m tall, but in forests it may grow as high as 8 m as a spindly, naked-stemmed plant. Manuka is present throughout New Zealand from the lowland to sub-alpine areas, in a variety of habitats, and it sometimes acts as a nursery crop to re-establishing forest. It is a small-leaved plant and the silky hairy leaves are typically 4–12 mm in length and 1–4 mm wide. They may be lance-shaped or oval. Manuka flowers from September to February with peak flowering from November to January. The flowers are usually white, solitary and 8–12 mm in diameter. The woody seed capsules (five-valved) which contain the seed remain persistently on the plant. The brown bark sheds in long strips.

Kanuka is also a shrub as a juvenile, but becomes a tree up to 20 m tall. The trunk can reach more than 60 cm in diameter. Kanuka prefers dry, semi-fertile sites, intermediate between warm-temperate and sub-alpine zones, and is not found in South Westland, Fiordland, Southland or Stewart Island. The leaves can be bunched or solitary and are a similar size to those of manuka. Kanuka flowers from September to February; peak flowering is from November to December. The flowers are smaller than those of manuka (3–5 mm in diameter) and occur in clusters. The seed capsules, which are 2–4 mm in diameter, are smaller and less persistent than those of manuka.

Manuka seed capsules

Kanuka seed capsules

Essential oil production

Oil sacs, known as schizogenous secretory cavities, occur in the leaves of manuka and kanuka and appear as translucent points on the leaf surface. The oil is extracted from the leaves by heating them to vaporise the oil, which is then distilled off. Green leaves and small branches (less than 10 mm in diameter) are cut from the bushes and left to wilt before distillation. The wilted material has a lower moisture content, making distillation more efficient. The harvested material is chopped through a cutter into short lengths (less than 100 mm long) and this mixture of leaves and stems is packed evenly into a sealed distillation vessel. Even packing ensures that the steam can penetrate all the material equally and prevents 'rat holing' (i.e. the steam bypassing the bulk of the charge vessel through vent holes).

A boiler is used to supply the steam. The distillation can be done at atmospheric pressure although a slight lift in pressure will occur as the steam moves through the plant material. The internal vat temperature should be 101–103ºC. The ideal steam flow and the volume of the charge vessel or vat will depend on many variables, and producers should consider having a distillation plant designed to meet their own particular requirements.

Distillation times differ for manuka and kanuka. Between 2 and 6 hours distillation time is required to extract 80–90% of the oil from manuka because of the heavy oil components (sesquiterpenes). Kanuka, which contains mainly light oil components (monoterpenes), can be distilled in 20–40 minutes.

The oil from the leaf volatilises into the water vapour flow passing through the distillation vessel. This mixture is then cooled in a water-jacketed condenser, returning it to liquid water and oil. The oil, which is lighter than water, floats on the surface, enabling it to be collected in a separating vessel. The temperature of the water exiting from the condenser and in the separator are important considerations in ensuring that a high proportion of the oil separates from the water/oil mixture. A relatively high decanter temperature of 50ºC is needed for manuka distillation to ensure a good water/oil separation.

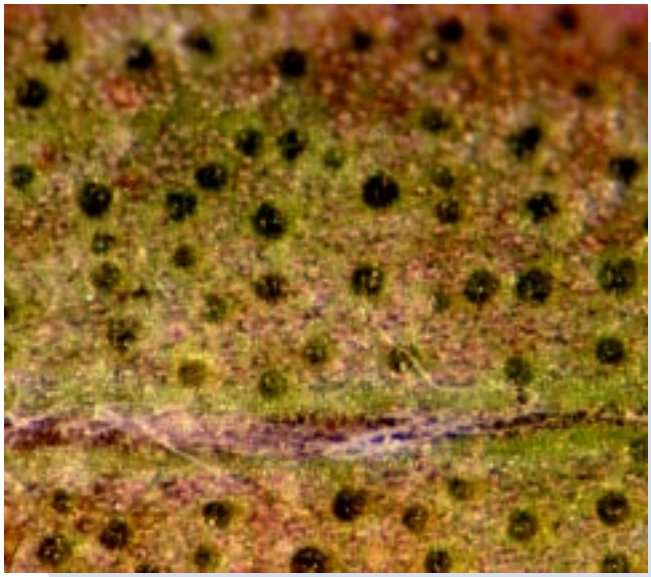
Manuka essential oil

The chemical composition of manuka oil depends on several variables. The first of these is the ecotype harvested, which is affected by the locality of the harvesting site, which in turn affects the aroma and biological activity of the oil. We have defined three predominant manuka oil chemotypes (races of plants with different chemistry) throughout New Zealand:

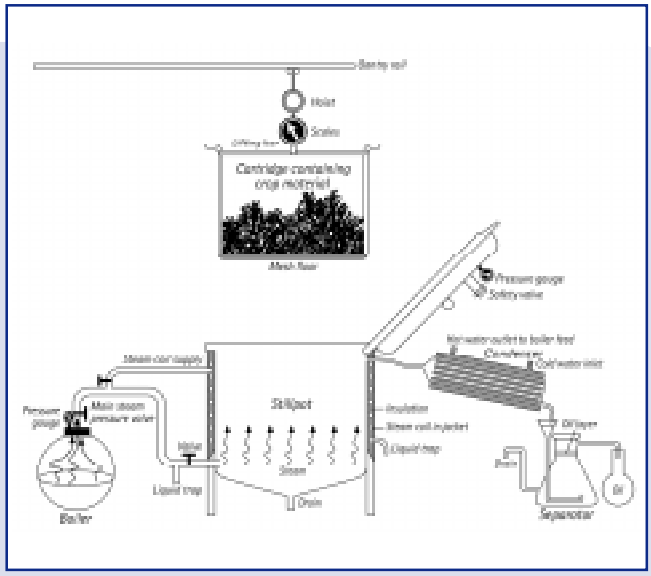
1. In the far north, the oil has a high pinene content.
2. In the East Cape and Marlborough Sounds regions, a high triketone chemotype is found,
3. Oils containing a complex of sesquiterpenes are found over the rest of New Zealand (Table 1). The antimicrobial activity of manuka oil is determined largely by the proportion of triketones in the oil.

Table1: *The proportion of chemical components in the three regional chemotypes of New Zealand manuka.*

Oil components (%)	Location		
	North	East Cape	Southern
Monoterpenes	*40*	*3*	*12*
Sesquiterpenes	*42*	*54*	*65*
Triketones	*1*	*33*	*2*



Oil glands in the manuka leaf



Schematic layout of steam distillation

In a survey of 43 South Island manuka sites there was much variability both within and between sites, due principally to differences in the ratio of total monoterpenes to total sesquiterpenes.

A 12 month seasonal study of the triketone-rich East Cape manuka oils showed there were no significant seasonal changes in triketone levels.

In a Nelson population of manuka it was found that monoterpene components were the dominant contributors to seasonal variation in the essential oil, with the levels peaking in summer.

The oil yield, based on a standard dried sample, can vary between 0.2 and 1%, with 0.5% being typical. Oil yield will change throughout the year, but its composition remains relatively stable. At Waiora, near Dunedin, oil yields were low in the winter and early spring but then rose to between 0.6 and 0.7%. This level was maintained until a rapid decline for a short period after flowering (mid to late February) when new shoot growth was occurring. Except for the period from mid to late February, oil content would appear to be relatively stable (mean 0.5%).

Biological activity of manuka oil

Manuka oil, particularly the triketone-rich chemotypes, has activity against pathological bacteria, e.g. *Staphylococcus, Listeria,* and *Streptococcus,* and against some fungi, e.g. *Trichophyton* and *Microsporum.* Oil from the East Cape chemotype, sold under the trade name "Manex", is a triketone-rich selection, and the unique strong activity of this oil against Gram positive bacteria—for example, *Staphylococcus aureus* and its antibiotic restant strain MRSA—has been conclusively proven to be due to the presence of triketones.

Kanuka oil

The chemical composition of kanuka oil remains much the same throughout New Zealand but two chemotypes have been recognised. The most common is low in the chemical component, p-cymene, while the less common has high levels of (>5%) p-cymene. These chemotypes co-occur in kanuka populations, but as yet the chemotypes have not been grouped into regional ecotypes. Kanuka oil is high in monoterpenes and our survey showed a high (68%) level of a-pinene. Levels of a-pinene were higher (77%) in kanuka from northern New Zealand and lower (52%) in the south. Kanuka yields more oil than manuka. The range in oil yield between kanuka plants is high (0 3%–2.1%) but the mean yield (0.9%) in terms of foliage dry matter is significantly higher than the yields from manuka (0.5%). Kanuka oil has low biological activity.

Harvesting

Wild manuka or kanuka stands can be harvested on a sustainable basis. As noted, the harvest period is probably best from mid spring to late autumn, which avoids the new growth phase in late summer. Juvenile bushes are trimmed by mechanical cutters and the cut material gathered and delivered to the distillery. The trimmed bush will regrow and can be harvested again in 3–5 years. In the long term, developing plantations with selected high quality plants and using mechanical harvesting would be a more cost-effective and efficient system of production. Establishing such a plantation would require the identification and multiplication of improved lines with superior habit, foliage production, levels of bioactivity and resistance to the scale insect (*Eriococcus*) and manuka giant scale (*Coelostomidia* species), which are responsible for the black sooty mould most often seen on manuka.

Market for manuka and kanuka oils

There are markets for non-antibiotic manuka and kanuka oils as well as specialist markets for the biologically active manuka oils. These markets can be arranged by direct contact with brokers or end users.

Research publications

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