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A fresh look at manuka and kanuka essential oils from New Zealand

W. Maddocks-Jennings [a,*], J.M. Wilkinson [b], D. Shillington [a], H. Cavanagh [b]

[a] *Universal College of Learning (UCOL), Private Bag 11022, Palmerston North, New Zealand*
[b] *School of Biomedical Sciences, Charles Sturt University, Wagga Wagga, Australia*

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Summary Essential oil is obtained from manuka, *Leptospermum scoparium* and kanuka, *Kunzea ericoides*, which are indigenous plants to New Zealand. The oil from these plants has been commercially available to aromatherapists for more than a decade. In this time, attention has been given to the antiseptic and antimicrobial actions of the oils. Of most interest to researchers and aromatherapists is the presence of β-triketones, present in the manuka oil. These triketones are believed to significantly contribute to the antimicrobial action. More recently, it has emerged that there are significant geographical variations affecting the composition of these oils. Whilst a full understanding of the therapeutic implications is some way off, it is important for aromatherapists to appreciate that these differences exist and the oils selected may match the intended therapeutic purpose.

Introduction

In recent years, there has been considerable interest in the therapeutic potential of two commercially produced essential oils from New Zealand. These are: manuka, *Leptospermum scoparium* J. R et G. Forst and kanuka, *Kunzea ericoides* (A. Rich Thompson, formerly called *Leptospermum ericoides*). Manuka is also known as kahikatoa, red manuka and tea tree. Kanuka is also known as white or tree manuka as it is larger than the manuka with smaller leaves, flowers and fruit with a white wood (Booker et al., 1987). Of the 79 *Leptospermum* species, manuka is the only one that is native to New Zealand; however, some controversy exists as to whether both manuka and kanuka are also endemic to Australia (Perry et al., 1997). Both

* Corresponding author. Tel.: +64 6 9527000x70821.
E-mail address: w.maddocks-jennings@ucol.ac.nz (W. Maddocks-Jennings).

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manuka and kanuka grow prolifically through both islands of New Zealand. Maori lore attributes the kanuka as being the 'male' tree and the manuka the 'female' (Booker et al., 1987). Aromatherapists and other practitioners need to understand that there are variations in composition, especially of manuka oil, which can influence clinical selection. This discussion will outline the differences and propose some potential therapeutic applications.

Historical uses

As with the Australian tea tree *Melaleuca alternifolia*, the common name relates to the uses that Captain Cook had for the dried leaves when he was exploring New Zealand in the eighteenth century. History records a diverse range of uses by both indigenous Maori and early European settlers. These include infusions for 'immoral people', urinary and intestinal complaints, as a febrifuge, sucking the gum for coughs, vapour inhalations for colds, poultices for back pain and skin conditions, inflamed breasts, burns and scalds, mouthwashes and gargles, gum disease. The wood was also used for canoe structures, fishing tools, gardening tools, war weapons and firewood. The gum or manna has mannitol as a main ingredient, which was used medicinally to relieve oedema and remove excess fluid from the body (Booker et al., 1987).

Habitat and production

New Zealand lies in the Southern Hemisphere in the Pacific Ocean. Its nearest landmass is Australia, which lies to the west. New Zealand has two main islands, the North and the South. Whilst the climate may be considered temperate there are wide variations from the subtropical Northland rainforests to the glacial and alpine Deep South. Rainfall varies with the western side of both islands receiving higher rainfall. Annual rainfall is between 600 and 1600 mm per year. Annual temperature averages from 10 °C in the South and 16 °C in the North, with July being the coldest month (<http://www.niwa.cri.nz/edu/resources/climate/overview>). The areas where manuka oil is harvested for distillation range in latitude from 35°24′ in Auckland, in the North Island, to 45°53′ in Otago in the South Island. Essential oil yield ranges from 0.17% to 0.57% depending on the location grown (Perry et al., 1997).

As both plants grow readily most commercial production is from wild harvested areas rather than plantation type locations, with the distilled oil being incorporated into a variety of commercially prepared products as well as being sold undiluted. Re-growth is rapid after harvesting therefore there is currently no risks of damage to a wild resource. In the future, however, plantations may evolve specialising in a particular chemotype, in a similar fashion to Australian tea tree with high terpinen-4-ol content. Essential oil is obtained from manuka and kanuka through steam distillation of the leaves and branches. However, manuka may require a lengthy distillation period (up to 5 h) to ensure that the maximum amount of β-triketones is present (Porter, 2001). Of the two, manuka is more popular and hence most of the existing literature relates to this oil.

Constituents

Manuka and kanuka have around 100 different constituents present; however, not all have been identified with certainty. Almost all of the volume (95%) is attributed to about 50% of the constituents (Christoph et al., 1998). It is of value to aromatherapists and other health professionals to understand that these two oils are quite unique particularly when compared to their close relatives from the Myrtaceae family. Table 1 compares the main constituents of common essential oils of the Myrtaceae family commonly used within aromatherapy practice.

Manuka oil distilled from plants grown in the North Island, especially around the East Coast area have higher (>30%) levels of triketones (leptospermone and flavesone), where as South Island oils contain more sesquiterpene hydrocarbons and oxygenated hydrocarbons (up to 65%). Total monoterpene content also varies from 3% to 40% depending on the location grown (Perry et al., 1997). Essential oil distilled from *L. scoparium* grown in Australia has much lower levels of both triketones and sesquiterpenes (Flynn et al., 1979; Perry et al., 1997). Variances in composition have also been noted depending on the age of the plant. For example, the amount of monoterpenes (α-pinene, β-pinene and myrcene) increases from less than 1% in young trees to between 17% and 34% from trees that are three years older. These variations are also seasonal, with pinene levels at their highest in the spring and summer when the foliage is growing. These factors are all important when considering commercial production (Porter et al., 1998).

Table 1 Comparison of various essential oils from the Myrtaceae family

	M. alternifolia[a]	*M. cajeputii*[b]	*M. quinquenervia* ct cineole[c]	*L. scoparium* N. Island	*L. scoparium* S.I*[d,a]	*K. ericoides* N. Island*[b]	*K. ericoides* S.I[c]	*K. ambigua* Australia[e]
α-Pinene	0	0	0	1.30	6.3	61.6	72.4	39.9
β-Pinene	0.90	0	20	0.50	0.4	0	0.7	0
Myrcene	0	0	0	0	1.7	—	0.3	0
p-Cymene	0	0	0	0	0.7	2—5	2.9	0
Other monoterpenes	11.80	0.40	Trace	33	2.4	<3	<8	
Sesquiterpenes	Trace	Trace	Trace	10.5—34	70	<2	7	5
1,8-Cineole	<20[f]	<50	>60	0	<7	6	5.1	15.8
Globulol	Trace	0	>14	0	0	0	0	11.9
Terpinen-4-ol	30[7]	60	0	0	0	0	0	0
Viridiflorol	0	0	3.20	Trace	0	3.2	?	9.4
Geraniol	0	0	0	0	7.2	0	0	0
Linalool	0	0	0	?Trace	6—20	0	1.4	0
α-Terpineol	0—Trace	20	5.70	?	0—1.3	1.1	0	2.9
Caryophyllene	0	0	0	<3	8.3	0	0	?
Humulene	0	0	0	?Trace	5.5	0	0	?
Eudesamol isomers	0	0	00	0	10.11	0	0	?
Leptospermone	0	0	0	10—20	0	0	0	?
Iso-leptospermone	0	0	0	2—7	0	0	0	
Calamenene	0	0	0	>9	1.5	0	1.1	0

[a] Sheppard-Hanger (1998); Webb (2000).
[b] Sheppard-Hanger (1998).
[c] Sheppard-Hanger (1998).
[d] Chemical analysis of South Island Manuka and Kanuka supplied by Brooklyn Valley Essential oils with permission (results from two different harvests).
[e] Kunzea analysis, Webb (2000, 2002).
[f] The Australian Standard (AS 2782-1985) states that 1.8 cineole must be <15% and the terpinene-4-ol content >30% (Carson et al., 1995).

Initially, four chemotypes were identified based on the amounts of leptospermone present (Porter and Wilkins, 1999). Leptospermone has the full chemical name of 3,5-hydroxy-4-(2-methyl-1-oxopentyl)-2,2,6,6,-tetramethyl-4-cyclohexane-1,3-dione (van Klink et al., 1999). Group I is rich in triketones and occurs primarily in the East Coast of the North Island of New Zealand. Group II is high in linalool and eudesamol, and mainly occurs in the Nelson region, northern South Island. Group III is rich in pinenes from Canterbury in the Central South island. The fourth group is deficient of all the above constituents in any significant level and are found scattered around the country. The density and refractive index of a sample helps determine the potential antibacterial activity without the need for expensive GLC analysis of each batch. When the polar fraction, which contains the triketones, is removed from a sample the remaining non-polar sample is inactive against bacteria (Porter and Wilkins, 1999). More recent research has identified a further 10 chemotypes with varying amounts of terpenes, sesquiterpenes, linalool and esters amongst other constituents (Douglas et al., 2004). Despite the obvious differences in constitution, the geographical location is rarely noted on price lists unless purchasing directly from a grower (see Fig. 1).

The sesquiterpene hydrocarbon, (−)-*trans*-calamenene ($C_{15}H_{22}$), is present between 9.6% and 18% in some manuka oils, mainly from the South Island. Guenther (1975) makes a brief mention that calamenene is formed from calamenol when it loses its water. As a group, sesquiterpene hydrocarbons are less common than the monoterpenes (Tisserand and Balacs, 1995) and they are believed to be antiseptic, bactericidal, analgesic and antiinflammatory (Sheppard-Hanger, 1998). Calamenene is also found in calamus, clove bud, Tolu balsam and black pepper (Sheppard-Hanger, 1998). There does not appear to be any correlation between the amount of leptospermone and (−)-*trans*-calamenene present; therefore its presence can only be detected by GLC analysis. Total sesquiterpene hydrocarbon content can range between 60% and 70% consisting of at least 30 different sesquiterpene hydrocarbons (Christoph et al., 1998). Within South Island manuka there is also humulene, selinene and cadinene which may not be familiar constituents to aromatherapists. South Island kanuka has spathulenol, which does not appear to be present in other samples.

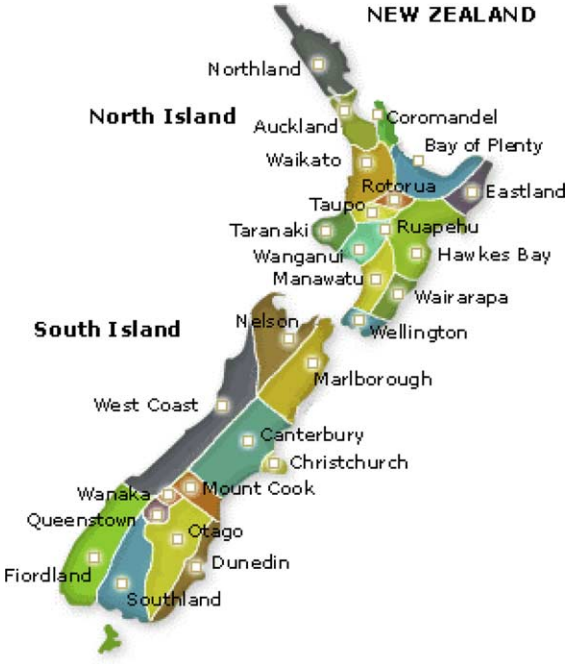

Figure 1 Map of New Zealand.

Therapeutic uses

Much of the current empirical literature evaluates the antimicrobial effects of manuka and kanuka (Rhee et al., 1997) and comparing these effects with the more common *M. alternifolia*. Earlier studies indicate that manuka is effective against Gram-positive organisms and ringworm and kanuka has some action against these as well, but neither are as effective as tea tree (*M. alternifolia*) against Gram-positive organisms (Cooke and Cooke, 1991; Lis-Balchin, 1996; Lis-Balchin et al., 1996a,b; Lis-Balchin and Hart, 1998). With manuka, the antimicrobial actions are attributed to the β-triketones, namely leptospermone, isoleptospermone and flavesone (Christoph et al., 2000). Various investigations of the effects of manuka, kanuka, cajeput (*Melaleuca cajeputi)*, niaouli (*Melaleuca quinquenervia)* and a β-triketone complex (containing flavesone, isoleptospermone and leptospermone) on several microorganisms were conducted by Christoph et al. (2000). α-Terpineol was used as a positive control. Each oil was tested against both Gram-negative and Gram-positive bacteria, a yeast, dermatophytes and moulds using minimal inhibitory concentrations (MIC) to determine effectiveness.

M. alternifolia had the broadest range of effects, followed closely by *M. cajeputi* and *M. quinquenervia*, which are both high in 1,8-cineole. Kanuka was only effective against Gram-positive bacteria at concentrations of between 0.2% and 0.4%; this was lower than tea tree at 0.2—0.45%. Kanuka had virtually no effect against the yeasts.

Manuka had mixed effects on all microorganisms, with greater potency against the Gram-negative organisms at concentrations of 0.05—0.15%. It was the most effective of all the whole oils against *P. aeruginosa* at 0.85% compared to 1—2% for the rest of the whole oils. Manuka had virtually no effect against the moulds and yeast, but was most effective against the dermatophytes, at 0.3% compared to 0.6—1.1% for the rest. Most notably the β-triketone complex was the most effective against all the microorganisms, except for moulds. It was higher than the complete manuka oil, from which it originated. The authors suggest that this effect may be due to the different lipophilicity (fat solubility) of the whole oil as it contains up to 70% of terpene hydrocarbons, which are lipophilic. The lack of effect of kanuka oil on *C. albicans* may also be due to the high percentage of terpene hydrocarbons (85%), whereas the other oils, which are effective, contain lower amounts and also sesquiterpene hydrocarbons (Christoph et al., 2000).

A later study then explored the effects of adding the β-triketone complexes to both *M. alternifolia* and *M. quinquenervia* (Christoph et al., 2001). In this study there was a 40% increase in inhibition of *S. aureus* and *M. catarrhis* (a respiratory pathogen) but not with *P. aeruginosa* or *E. coli*, with variable activity noted. Manuka also had some activity against skin and ringworm fungi. Studies conducted on North and South Island manuka and kanuka and other New Zealand grown plants indicate that North and South Island manuka is spasmolytic on smooth muscle from the guinea pig and North and South Island kanuka was found to be spasmogenic (Lis-Balchin et al., 1996a,b). This was attributed to the high α-pinene content of the kanuka oils. In comparison, *M. alternifolia* and *L. petersonii* (lemon tea tree) were spasmolytic. Both manuka and kanuka oils had variable antibacterial and antifungal activity, much lower than tea tree and the oils of thyme, origanum and marjoram. *L. petersonii* also had variable antibacterial and antifungal activity but overall performed better than manuka or kanuka. A combination of North Island manuka and kanuka had higher activity than the individual oils. Lis-Balchin et al. (1996a,b) concluded that manuka and kanuka should not be considered as being useful as universal antibiotic oils, especially as they are more expensive than the other oils internationally, which are more effective and more readily available. Within New Zealand manuka is comparable to Australian tea tree in price. However, there does appear to be value in using manuka oil as an antispasmodic (Lis-Balchin and Hart, 1998).

In vitro studies suggest that kanuka oil is effective against Herpes simplex Type 1 and Polio Type 1 viruses. The active compounds were identified as isomers of isobutyryl methoxyresorcinol and unnamed β-triketones (Bloor, 1992). Larger clinical trials relating to this have not been located.

Clinical implications for aromatherapists

Both manuka and kanuka essential oils have a therapeutic potential beyond the antimicrobial actions noted above. There does not appear to be any toxicology concerns relate to either oil based on the identifiable constituents present. A search through the literature did not reveal any published reactions to either oil. Lis-Balchin et al. (2000) believes that caution should be applied with these oils as there has not been formal toxicology studies conducted. They also conducted a series of studies on various animal tissues and note that manuka and kanuka decrease the force of spontaneous contractions of the uterine muscle cells which may be of concern in pregnancy and labour (Lis-Balchin et al., 2000). Anecdotal information gathered informally from aromatherapy students and practitioners in New Zealand suggest that these oils have been used extensively without undue concern. One aromatherapist reported that kanuka was used in a bath for a lady who was pregnant and her skin reacted, whereas she had used the oil extensively without problem prior to being pregnant. It would be valuable to know if there are any other examples of possible reactions attributed to either kanuka or manuka.

Given the presence of several sesquiterpene hydrocarbons there is considerable scope to utilise the oils for their anti-inflammatory and antispasmodic actions. Kanuka oil from the North and South Island has *p*-cymene present, which suggests it has analgesic properties (Sheppard-Hanger, 1998). Possible conditions include chronic inflammatory conditions such as polymyalgia rheumatica, fibromyalgia, and rheumatoid arthritis. Possibly kanuka would be of benefit in incidences of acute muscle strain acting as an analgesic and anti-inflammatory. As aromatherapists are used to purchasing different chemotypes of some oils such as rosemary and thyme species, it would be prudent to consider this with manuka and kanuka. At the very least a practitioner should know which island in New Zealand the oil has been produced from and ideally some indication of sesquiterpene and β-triketone content. From an aesthetic perspective both manuka and kanuka have distinctive aromas, which some may find appealing. Both oils would blend

well with wood oils such as sandalwood or cedarwood. The aroma can be softened with the addition of lavender, lemon or lemon myrtle (*Backhousia citriodora)*. However, it does depend what action the individual aromatherapist is aiming to achieve from the blend as to what oils are chosen.

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