REFERENCES

LEMON IRONWOOD
Backhousia citriodora

1. **Woodward**, Penny: An Australian Herbal - A practical guide to growing and using herbs in Temperate Australia and New Zealand. Hyland House. 1990. ISBN No. 0-908090-92-7.

Woodward refers to the lemon ironwood which grows to about 5 meters, with fragrant, dark green, ovate leaves, and clusters of cream flowers from August to November. It is of the family Myrtaceae. The lemon scent of the leaves is derived from the high citral content of the essential oil. The leaves retain their scent when dried, and can be used in potpourri and scented sachets.

2. **Malcom** Christine: In search of rare essences for green-minded consumers. DCI May 1994, p.24-26, 106.

Indonesian production

Backhousia citriodora - a very rich source of citral

3. **James Duke Data Base**

Backhousia citriodora (Myrtaceae)
Ethnobotanical Uses: Soap

Phytochemeco Database - USDA - ARS - NGRLStephen M. Beckstrom-Sternberg and James A. Duke

* = Chemical(s) found in plant shown to be effective for the ailment medicated
** = Plant itself shown to be effective for the ailment medicated
Thu Apr 30 3:36:28 US/Eastern 1998

Lemon myrtle the essential oil

3. **CSIRO - Forestry and Forest Products**

Lemon myrtle the essential oil

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More lemon than the lemon is how enthusiasts describe the oil distilled from the Australian lemon myrtle (Backhousia citriodora).

THE lemon myrtle occurs naturally as a large shrub to medium-sized tree (3-30 m) mainly in rainforests of coastal Queensland from Brisbane to Cairns. It is well known as an ornamental with abundant flowers and fragrant lemon-scented leaves. According to the Australian Rainforest Bushfood Industry Association (ARBIA) the oil was first distilled in 1890 by a German doctor who sent it home to be used in the essential oil industry. Apparently, the equipment he used can still be seen today near the trees he used for leaf harvesting.

Many oils can be classed as 'lemon' oils because of their aroma. Lemon oil itself is cold pressed from lemon peel and is actually less 'lemony' than many other oils because it contains only 3-10% of citral, the best known of the lemon scent components. Lemon myrtle, by contrast, contains 95% citral.

The second lemon scent compound is citronellal - the main component in oils of lemon scented gum (Eucalyptus citriodora), citronella oil and some rare varieties of lemon myrtle. Earlier this century lemon myrtle was used in Australia as a source of citral-rich essential oil for lemon flavouring and fragrance but it was supplanted by citral-rich oils distilled from lemon grass and litsea. Seed of lemon myrtle have a low germination percentage, and vegetative propagation by rooted cuttings appears to be the most effective way of mass producing planting stock for commercial plantations. Cuttings are expensive, in short supply and with no - or only rudimentary - selection of clones for growth potential and oil characteristics. This lack of quality planting stock is constraining the development of the industry. Experience with other oil producing tree species, such as tea tree has shown that large gains can be achieved from selection and breeding.

Dr John Doran of CSIRO Forestry and Forest Products and Dr Alan House of the Queensland Forestry Research Institute have begun a breeding program for lemon myrtle with the aim of providing growers with good quality planting stock at a reasonable price

The program involves assembling a collection of lemon myrtle germplasm collected from across the species' range; gathering baseline data on the variation in commercial traits in the species; developing a selection and propagation strategy and ultimately releasing improved genotypes for industry use.

Genetic material

Not surprisingly, given the location of native populations of lemon myrtle, the seed collecting expeditions provided much sought after field work. Although attempts were made to locate the rare, citronellal-rich type of lemon myrtle, two collecting trips failed to find trees of this type. Some collecting sites are poorly represented in the breeding population due to the very poor germination of the seedlots collected. Many seedlots did not germinate at all, while others germinated at a rate as low as four per 100 seeds sown.

Seedlings and clones are now being field tested at Beerburrum in south-east Queensland. The first trial to be established includes a selection of 16 families (seedlots) collected in 1994.

In January 1996, Dr Doran and his colleagues sampled the fastest growing plants to estimate oil concentration. The average oil concentration of the progeny measured on a percentage weight basis was 1.5% compared to 1.8% for the parent trees. Individuals in the best growing family ranged in oil concentration from 0.9% to 2.5% indicating plenty of scope for selection for high oil concentration combined with high biomass production. Oil quality is measured by gas chromatography and is mainly genetically determined.

Dr Doran has selected the six most vigorous of 16 original families planted at Beerburrum for propagation trials and clonal hedge establishment. Pioneers in the industry are promoting the use of the essential oil and strong smelling foliage and fruits of lemon myrtle in perfumes, food flavourings, confectionery, herbal teas and in aromatherapy, emphasising the rainforest origins of the species. Commercial plantations of lemon myrtle have already been established and expansion of planting is expected as demand for the products grow.

Brophy, JJ; **Goldsack**, RJ; **Fookes**, CJR; Forster, PI. Leaf oils of the genus Backhousia (Myrtaceae). Journal of Essential Oil Research (1995) 7(3): 237-254. [En, 41 ref.] [Department of Organic Chemistry, University of New South Wales, Sydney, NSW 2052, Australia.]

Backhousia is endemic to eastern Australia. The essential oils, hydrodistilled from the leaves of 8 described and one undescribed species of Backhousia, were analysed by GC and GC-MS. The major essential oil components of the 5 suspected chemotypes of B. angustifolia were 1,8-cineole [eucalyptol], (E)-beta-ocimene, angustifolenone, angustifolionol, dehydroangustione and angustione. B. anisata existed in 2 chemotypes; the major compound was either (E)-anethole or methyl chavicol. The essential oil of B. bancroftii, which varied quantitatively between trees, contained octyl acetate (0.3-61.7%), dodecyl acetate (0.2-21.0%), dodecanol (trace-22.9%), decyl acetate (0.5-39.0%), decanol (0.1-17.4%), 2,4,6-trimethoxy-3-methylacetophenone (trace-23.0%) and a novel compound, named bancroftinone (6-hydroxy-2,4-dimethoxy-3-methylacetophenone) (trace-90.0%) as its main constituents. B. citriodora existed in 2 chemotypes in which either geranial or citronellal predominated. The main constituents of the essential oil of B. hughesii were beta-bisabolene (1.0-44.0%) and an unidentified sesquiterpene hydrocarbon (8.0-54.0%). The essential oil of B. kingii contained alpha-pinene (24.0-49.0%), limonene (7.0-24.0%) and 1,8-cineole (10.0-17.0%) as the principal constituents. Four chemotypes of B. myrtifolia were found; the major components were methyl eugenol, (E)-methyl isoeugenol, elemicin and (E)-isoelemicin. The main components of the essential oil of B. sciadophora were alpha-pinene (44.0-55.0%), beta-pinene (2.4-8.0%), limonene (6.5-12.7%) and linalool (2.8-6.7%). The principal components of the essential oil of the undescribed Backhousia sp. (Didcot P.I. Forster PIF12671) were alpha-pinene (11.0%), beta-pinene (5.3%), beta-caryophyllene (12.0%), dodecyl acetate (8.1%) and dodecanol (8.2%).

Hayes, A. J.; **Markovic**, B.: Toxicity of Australian essential oil **Backhousia** citriodora (lemon myrtle). Part 2. Absorption and histopathology following application to human skin. Food and Chemical Toxicology. 41, 10, 2003. p.1409-1416. Chemical Safety and Applied Toxicology (CSAT) Laboratories, School of Safety Science, The University of New South Wales, Sydney, NSW 2052, Australia. EM- amanda.hayes@unsw.edu.au
SN- 0278-6915, RN- 5392-40-5; 141-27-5; 106-26-3.

The in vitro percutaneous absorption of the essential oil of lemon myrtle (**Backhousia** citriodora) has been studied in freshly excised human full-thickness abdominal skin obtained from patients undergoing elective surgery. Absorption of lemon myrtle oil in human skin discs (4.9 cm2) was evaluated using a Franz cell diffusion system following topical application of neat lemon myrtle oil (100 microl or 18.29 mg/cm2) to the epidermal surface at exposure durations of 1 to 12 h. Gas chromatography mass spectrometry (GCMS) was used as an analytical technique to determine the absorption of lemon myrtle oil components in full-thickness skin. Citral; (consisting of isomers, geranial and neral) was the only component of lemon myrtle oil found to be absorbing into skin at all exposure periods. At the maximum exposure duration of 12 h, the total absorption of citral in the full-thickness skin disc was 0.29 +- 0.07 mg/cm2 (mean +- S.D., n=4) of the applied dose. Although the absorption of lemon myrtle oil components was limited, haematoxylin and eosine (H & E) staining showed significant losses in the cellular functioning of skin including; losses of integrity and

solubilisation of the stratum corneum, cellular necrosis (to 15%) and cellular vacuolation (to 25%) on comparison to control skin. When a formulated product containing 1% lemon myrtle oil (0.18 mg/cm2) was applied to human skin discs (4.9 cm2) at 8 h exposure the total absorption of citral in the full-thickness skin disc was 5.12 +- 0.60 x 10-4 mg/cm2 (mean +- S.D., n=4) of the applied dose. No other components were detected. The histopathological assessment indicated limited damage to epidermal cells. The combination of the above methodologies enabled the generation of data that could be used for a comprehensive evaluation of the toxicity effects of lemon myrtle oil for topical application.
RF- 15 ref.

Svoboda, K. P.; **Greenaway**, R. I.: Lemon scented plants. International Journal of Aromatherapy, 2003, 13, 1, p.23-32. SN- 0962-4562. SAC Ayr, Department of Plant Biology, Ayr, KA6 5HW, UK. EM- k.svoboda@au.sac.ac.uk

This review provides a summary of both established and new lemon-scented species in the world market, with detailed description of the five more unusual representatives of this group (namely Magnolia grandiflora, Cupressus macrocarpa, **Backhousia** citriodora, Cedronella canariensis and Dracocephalum moldavica) and an analysis of the chemicals responsible for the lemon scent.

Kedzia, A.; **Ostrowski-Meissner**, H.: The effect of selected essential oils on anaerobic bacteria isolated from respiratory tract. Herba Polonica. 2003, 49, ½, p.29-36. Department of Oral Microbiology, Medical University of Gdansk, Smoluchowskiego St. 4, 80-214 Gdansk, Poland. SN- 0018-0599
A total of 111 strains (77 strains were Gram-negative and 34 were Gram-positive) of anaerobic bacteria isolated from respiratory tract of 38 patients from Poland, were tested. The following essential oils were used for these determinations: tea tree oil (Melaleuca alternifolia), manuka oil (Leptospermum scoparium), Australian lemon myrtle oil (**Backhousia** citriodora) and Australian sandalwood oil (Santalum spicatum). The susceptibility bacterial strains was determined by plate dilution techniques in Brucella agar with 5% sheep blood. Incubation was performed in anaerobic conditions. The MIC was interpreted as the lowest concentrations of the essential oils inhibiting the growth of bacteria. The results indicated, that strains of Prevotella (40-81%), Porphyromonas (40-60%) and Fusobacterium (53-65%) were the most sensitive to the lowest concentrations of the 4 essential oils (MIC <= 0.03-0.12 mg/ml). From among Gram-positive anaerobic bacteria, the strains of the Peptostreptococcus were the most susceptible to manuka oil and tea tree oil (82-95% strains, respectively, were susceptible with values of MIC from <= 0.03 to 0.12 mg/ml). The most active against all examined anaerobic bacteria were the manuka oil and the tea tree oil. These essential oils were more active against Gram-positive anaerobic bacteria.

Pengelly, A.: Antimicrobial activity of lemon myrtle and tea tree oils. Australian Journal of Medical Herbalism. 2003, 15, 1, p.9, 11. CS- 63 Desmond Street Cessnock, NSW 2325, Australia. EM- pengelly@hunterlink.net.au. SN- 1033-8330, RN- 5392-40-5; 470-82-6; 141-27-5; 106-26-3

The composition of the tea tree (Melaleuca alternifolia) and lemon myrtle (**Backhousia** citriodora) essential oils was analysed by chiral phase GC-mS. Lemon myrtle oil contained over 96% citral made up of isomers of neral and geranial, while tea tree oil consisted of 42.8% terpinen-4-ol and < 5% 1-8 cineol. When tested against pathogenic organisms, such as Candida albicans, Escherichia coli, Staphylococcus aureus and Pseudomonas aeruginosa, lemon myrtle oil showed minimum inhibitory concentration (MIC) values similar to citral, while values for tea tree oil were higher. When varying blends of lemon myrtle and tea tree oils were tested, the blends with higher percentages of lemon myrtle oil consistently presented lower MIC values. In the case of the highly resistant strain P. aeruginosa, MIC values were very high compared to other organisms -- 2% for lemon myrtle oil and citral, while it was resistant to tea tree oil at 10%, the maximum concentration applied. MTC cytotoxicity assay using human skin cell lines, skin fibroblasts and a liver-derived cell line showed that pure lemon myrtle oil and citral were very toxic, whereas pure tea tree oil was moderately toxic. A 1% lemon myrtle oil product was considerably less toxic, comparable to aspirin used as a baseline standard. From a combination of the data gathered with extrapolations of toxicity studies (including LD50 values) for citral, the no observed adverse effect level (NOAEL) was calculated at 0.5 mg/litre at a 24-h exposure, and reference dose (Rfd) was estimated at 0.01 mg/litre. It is concluded that a 1% solution of lemon myrtle oil used in a topical antimicrobial product would be low in toxicity.

Blewitt, M.; **Southwell**, I. A.: **Backhousia** anisata Vickery, an alternative source of (E)-anethole. Journal of Essential Oil Research. 2000, 12, 4, p.445-454. P.O. Box 24, Bellingen, NSW 2454, Australia.

Naturally occurring **Backhousia** anisata was surveyed within the Bellinger Valley of eastern Australia, the only region where it is known to be endemic. During the course of the survey, 26 sites were located. Ten of these were chosen for further study. The geography and climate of each site was assessed and the basic soil chemistry determined. A total of 44 trees from the ten sites were then selected to define the growth characteristics and chemical composition of individual trees. Leaf samples were extracted with ethanol to determine (E)-anethole and methyl chavicol percentages. Leaf from selected trees was also steam distilled for determination of oil yield and oil quality for comparison with other anethole- and methyl-chavicol-rich oils. The chemical composition and physical constants of the anethole-rich oils when compared with those of other commercial sources, suggest that B. anisata provides an excellent alternative source for the (E)-anethole rich aniseed, star anise and fennel oils. These results better define the natural distribution of the **Backhousia** source of (E)-anethole and methyl chavicol and attempt to match distribution with the physical, climatic, geographic, growth, chemical characteristics and flavour and fragrance potential of each chemotype.

Southwell, I. A.; **Russell**, M.; **Smith**, R. L.; **Archer**, D. W.: **Backhousia** citriodora F. Muell. (Myrtaceae), a superior source of citral. Journal of Essential Oil Research. 2000, 12, 6, p.735-741. Wollonghar Agricultural Institute, NSW Agriculture, Bruxner Highway Wollonghar NSW 2477, Australia. RN- 5392-40-5

Leaves from the citral chemical variety of lemon myrtle, **Backhousia** citriodora, were examined for volatile constituents by GC and GC/MS analysis of both steam volatile oils and solvent extracts. Identified constituents present at more than 0.1% on average in the essential oil were myrcene (0.1-0.7%), 6-methyl-5-hepten-2-one (0.1-2.5%), linalool (0.3-1.0%), citronellal (0.1-0.9%), iso-neral (0.6-2.7), iso-geranial (1.0-4.2%), neral (32.0-40.9%) and geranial (46.1-60.7%). Physical constants were found to fall within the ranges of 0.888-0.910 for relative density, 1.4853-1.4909 for refractive index, -1.5degrees-+0.4degrees for optical rotation and 0.8-2.3 volumes for solubility in 70% ethanol. Comparison of chemical and physical data with those of other citral-rich commercial essential oils showed that B. citriodora was richer in citral than both lemongrass (Cymbopogon flexuosus and C. citratus) and Litsea cubeba. Micro-extraction of fresh leaves with absolute ethanol gave volatile extracts with higher proportions of citral and lower proportions of cogeners iso-neral and iso-geranial than steam distillation suggesting partial double bond migration during the distillation process. No significant variation in citral content was observed between flush growth and mature leaves or between fresh and dried leaves.

Doran, J. C.; **Brophy**, J. J.; **Lassak**, E. V.; **House**, A. P. N.: **Backhousia** citriodora F. Muell. -- rediscovery and chemical characterization of the L-citronellal form and aspects of its breeding system. Flavour and Fragrance Journal, 2001, 16, 5, p.325-328. CSIRO Forestry and Forest Products, PO Box E4008, Kingston, ACT 2604, Australia. SN- 0882-5734

The rare L-citronellal form of B. citriodora was first reported in 1950, but attempts to relocate it were unsuccessful until 1996. The quest to relocate trees of this type has been driven by interest in L-citronellal for perfumery. The common, citral form of the species is already under cultivation for oil production in Australia. This paper reports on the rediscovery of the L-citronellal form, first in 1996 in a one-year-old provenance/progeny trial of B. citriodora in south-eastern Queensland, and then in a natural population on Queensland's Sunshine Coast in 1998. The three L-citronellal trees in the trial gave foliar oil concentrations (g/100 g dry weight) of 3.2, 2.2 and 1.8, respectively, when sampled in November 1996. The same trees sampled in March 1999 gave pale yellow oils consisting of 85-89% citronellal, 6-9% isopulegol isomers with small quantities of citronellol (approx. 3%) and several other compounds. Data on physicochemical properties of these oils are given in the paper. Seeds from a single mature L-citronellal tree gave progenies of both L-citronellal and citral forms in a ratio of approximately 1:1. Propagation materials from plants of the L-citronellal form need to be collected and assembled in breeding populations. If this chemotype shows economic potential, this will form the basis of selection and breeding programmes.

Hayes, A. J.; **Markovic**, B.: Toxicity of Australian essential oil **Backhousia** citriodora (Lemon myrtle). Part 1. Antimicrobial activity and in vitro cytotoxicity. Food and Chemical Toxicology. 2002, 40, 4, p.535-543. Chemical Safety and Applied Toxicology (CSAT) Laboratories, School of Safety Science, The University of New South Wales, Sydney, 2052, Australia. EM- amanda.hayes@unsw.edu.au. SN- 0278-6915

The antimicrobial and toxicological properties of the Australian essential oil, lemon myrtle, (**Backhousia** citriodora) were investigated. Lemon myrtle oil was shown to possess significant antimicrobial activity against the organisms Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Candida albicans, methicillin-resistant S. aureus (MRSA), Aspergillus niger, Klebsiella pneumoniae and Propionibacterium acnes comparable to its major component-citral. An in vitro toxicological study based on the MTS (3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4- sulfophenyl)-2H-tetrazolium) cytotoxicity assay was performed. In vitro cytotoxicity testing indicated that both lemon myrtle oil and citral had a very toxic effect against human cell lines: HepG2 (a hepatocarcinoma-derived cell line); F1-73 (a fibroblast cell line derived from normal skin) and primary cell cultures of human skin fibroblasts. Cytotoxicity IC50 (50% inhibitory concentration) values ranged from 0.008 to 0.014% (w/v) at 4 h to 0.003-0.012% (w/v) at 24 h of exposure. The no-observed-adverse-effect level (NOAEL) for lemon myrtle oil was calculated as 0.5 mg/litre at 24 h exposure and the RfD (reference dose) was determined as 0.01 mg/litre. A product containing 1% lemon myrtle oil was found to be low in toxicity and could potentially be used in the formulation of topical antimicrobial products.

Kibbler, H.; **Williams**, C. M.; **Williams**, R. R.; **Johnston**, M. E.: Inhibition of adventitious

rooting in **Backhousia** citriodora F. Muell. cuttings correlate with the concentration of essential oil. Journal of Horticultural Science and Biotechnology. 2002, 77, 6, p.705-711. SN-1462-0316, RN- 5392-40-5. CS- School of Agriculture & Horticulture, The University of Queensland, Gatton Campus, Queensland 4343, Australia.
EM- hkibbler@pobox.une.edu.au

B. citriodora is a tree or large shrub from which the commercially important essential oil citral is obtained. B. citriodora is typical of the many commercially valuable woody Australian Myrtaceae species that are recalcitrant in forming adventitious roots from cuttings after maturation. A series of experiments were conducted to identify an endogenous rooting inhibitor in line with established criteria. Endogenous levels of citral were correlated with the rooting capacities of juvenile versus mature, and easy- versus difficult-to-root genotypes of B. citriodora, in both winter and summer. The biological activity of citral was confirmed in bioassays on mung beans and easy-to-root B. citriodora seedlings. Evidence of a common mechanism of root inhibition with other species in the Myrtaceae and the role of action of citral are discussed.
RF- 25 ref.

Burke, B. E.; **Baillie**, J. E.; **Olson**, R. D.: Essential oil of Australian lemon myrtle (**Backhousia** citriodora) in the treatment of molluscum contagiosum in children. Biomedicine & Pharmacotherapy. 2004, 58, 4, p.245-247. Cardiovascular Section, Center for Biomedical Research, Inc., 2572 Waterbury Lane, Boise, ID 83706-4980, USA.
EM- drq10@iglide.net. SN- 0753-3322

Molluscum contagiosum is a common viral illness of childhood and is increasingly found as a sexually transmitted disease in sexually active young adults. Current treatment options are invasive, requiring tissue destruction and attendant discomfort. Thirty-one children (mean age 4.6 +- 2.1 years) with the diagnosis of molluscum contagiosum (mean length of time with condition 8.6 +- 5.3 months) were treated with once daily topical application of a 10% solution (v/v) of essential oil of Australian lemon myrtle (**Backhousia** citriodora) or vehicle (olive oil). At the end of 21 days, there was greater than 90% reduction in the number of lesions in 9/16 children treated with lemon myrtle oil, while 0/16 children met the same criteria for improvement in the vehicle group (P < 0.05). No adverse events were reported.

Developing New Product Innovation Using Australian Native Plant Extracts

Jarmyn, Robert – Marketing Manager, Essential Oils and Aromatic Ingredient, Bronson and Jacobs Pty Ltd. Developing New Product Innovation Using Australian Native Plant Extracts.

Name: Aniseed Myrtle Extract

Botanical name: *Backhousia anisata*

Description: A rare and endangered tree that grows in sub-tropical rainforest of northern New South Wales. It has rough, corky brown bark and lanceolated leaves with a distinct aniseed fragrance.

Extraction: Vegetable glycerin extraction of the whole leaf

Appearance	Translucent mobile liquid
Colour	Pale to dark brown
Odour	Sweet aniseed
Relative Density @ 20^{o}C/20^{o}C	1.030 – 1.1495
Refractive Index @ 20^{o}C	1.3205 - 1.459
Water Present	40-60%
Glycerin Present	40-60%
Miscibility with 85% (v/v) ethanol @ 20^{o}C	Soluble
Solubility in Water	Soluble
pH	4.8 –5.3

Microbial

Total Viable count	<100 cfu

Major Constituents: Methyl Chavicol, E-Anethole, □-Farnesene

Traditional usage

The Backhousia species have been used for a variety of culinary applications for their distinctive flavour and aroma. The aboriginal people are reported to have used the anisata leaf to aid with digestive problems and for its oestrogenic properties. There are also reports of a poultice of anisata leaves being used on the hair and skin prior to marriage ceremonies for its softening and conditioning properties. [10]

Reported Properties: Carminative (digestive), Anti-microbial (minor), Anti-irritant, Soothing (neurological) Stimulates factor K production[11]

Potential uses & applications

Skin Protection, Hair Conditioning, Soaps, Shaving Gels, Cosmetics & Toiletries,

10. J.J. Brophy, R.J. Goldsack, C.J.R. Fookes, P.I. Forster, *Leaf Oils of the Genus Backhousia (Myrtaceae)*, Journal of Essential Oil Research, 7, 237-254 (May/June 1995)

Pub-Med search

Hood JR, **Cavanagh** HM, **Wilkinson** JM: Effect of essential oil concentration on the pH of nutrient and Iso-sensitest broth. Phytother Res. 2004 Nov;18(11):947-9. School of Biomedical Sciences, Charles Sturt University, Australia.

The role of pH on the antimicrobial activity of essential oils has not been well studied. The effect of four essential oils: Backhousia citriodora, Melaleuca alternifolia, Lavandula angustifolia and Santalum spicatum (0.1% to 10%) on the pH of two commonly used media, nutrient broth and Iso-sensitest broth, was therefore undertaken. Small (less than 0.5 pH units) but statistically significant differences between the pH of the two media followed the addition of M. alternifolia, L. angustifolia and S. spicatum essential oil. In general the effect on pH was greatest at higher concentrations and the fall in pH was greatest in the nutrient broth. The addition of B. citriodora essential oil to nutrient broth resulted in a fall in pH from 7.29 0.02 (no oil) to 5.2 0.03 (10% oil). This effect was not observed in the Iso-sensitest broth.

Burke BE, **Baillie** JE, **Olson** RD.: Essential oil of Australian lemon myrtle (Backhousia citriodora) in the treatment of molluscum contagiosum in children. Biomed Pharmacother. 2004 May;58(4):245-7. Cardiovascular Section, Center for Biomedical Research, Inc., 2572 Waterbury lane, Boise, ID 83706-4980, USA. drq10@iglide.net

Molluscum contagiosum is a common viral illness of childhood and is increasingly found as a sexually transmitted disease in sexually active young adults. Current treatment options are invasive, requiring tissue destruction and attendant discomfort. Thirty-one children (mean age 4.6 2.1 years) with the diagnosis of molluscum contagiosum (mean length of time with condition 8.6 5.3 months) were treated with once daily topical application of a 10% solution (v/v) of essential oil of Australian lemon myrtle (Backhousia citriodora) or vehicle (olive oil). At the end of 21 days, there was greater than 90% reduction in the number of lesions in 9/16 children treated with lemon myrtle oil, while 0/16 children met the same criteria for improvement in the vehicle group (P < 0.05). No adverse events were reported.

Hayes AJ, **Markovic** B.: Toxicity of Australian essential oil Backhousia citriodora (lemon myrtle). Part 2. Absorption and histopathology following application to human skin. Food Chem Toxicol. 2003 Oct;41(10):1409-16. School of Safety Science, The University of New South Wales, Sydney, NSW 2052, Australia. amanda.hayes@unsw.edu.au

The in vitro percutaneous absorption of the essential oil of lemon myrtle (Backhousia citriodora) has been studied in freshly excised human full-thickness abdominal skin obtained from patients undergoing elective surgery. Absorption of lemon myrtle oil in human skin discs (4.9 cm(2)) was evaluated using a Franz cell diffusion system following topical application of neat lemon myrtle oil (100 microl or 18.29 mg/cm(2)) to the epidermal surface at exposure durations of 1 to 12 h. Gas chromatography mass spectrometry (GCMS) was used as an analytical technique to determine the absorption of lemon myrtle oil components in full-thickness skin. Citral; (consisting of isomers, geranial and neral) was the only component of lemon myrtle oil found to be absorbing into skin at all exposure periods. At the maximum exposure duration of 12 h, the total absorption of citral in the full-thickness skin disc was 0.290.07 mg/cm(2) (meanS.D., n=4) of the applied dose. Although the absorption of lemon myrtle oil components was limited, haematoxylin and eosin (H&E) staining showed significant losses in the cellular functioning of skin including; losses of integrity and solubilisation of the stratum corneum, cellular necrosis (to 15%) and cellular vacuolation (to 25%) on comparison to control skin. When a formulated product containing 1% lemon myrtle oil (0.18 mg/cm(2)) was applied to human skin discs (4.9 cm(2)) at 8 h exposure the total absorption of citral in the full-thickness skin disc was 5.120.60 x 10(-4) mg/cm(2) (meanS.D., n=4) of the applied dose. No other components were detected. The histopathological assessment indicated limited damage to epidermal cells. The combination of the above methodologies enabled the generation of data that could be used for a comprehensive evaluation of the toxicity effects of lemon myrtle oil for topical application.

Wilkinson JM, **Hipwell** M, **Ryan** T, **Cavanagh** HM.: Bioactivity of Backhousia citriodora: antibacterial and antifungal activity. J Agric Food Chem. 2003 Jan 1;51(1):76-81. School of Biomedical Sciences, Charles Sturt University, Locked Bag 588, Wagga Wagga, NSW 2678, Australia.

Backhousia citriodora products are used as bushfoods and flavorings and by the aromatherapy industry. The antimicrobial activity of 4 samples of B. citriodora oil, leaf paste, commercial tea (0.2 and 0.02 g/mL), and hydrosol (aqueous distillate) were tested against 13 bacteria and

8 fungi. Little or no activity was found to be associated with the leaf tea and hydrosol, respectively. Leaf paste displayed antimicrobial activity against 7 bacteria including Clostridium perfringens, Pseudomonas aeruginosa, and a hospital isolate of methicillin resistant Staphylococcus aureus (MRSA). The 4 essential oils were found to be effective antibacterial and antifungal agents; however, variation was apparent between oils that did not correlate with citral content. The antimicrobial activity of B. citriodoraessential oils was found to be greater than that of citral alone and often superior to Melaleuca alternifolia essential oil. B. citriodora has significant antimicrobial activity that has potential as an antiseptic or surface disinfectant or for inclusion in foods as a natural antimicrobial agent.

Hayes AJ, **Markovic** B.: Toxicity of Australian essential oil Backhousia citriodora (Lemon myrtle). Part 1. Antimicrobial activity and in vitro cytotoxicity. Food Chem Toxicol. 2002 Apr;40(4):535-43. Chemical Safety and Applied Toxicology Laboratories, School of Safety Science, The University of New South Wales, 2052, Sydney, Australia. amanda.hayes@unsw.edu.au

The antimicrobial and toxicological properties of the Australian essential oil, lemon myrtle, (Backhousia citriodora) were investigated. Lemon myrtle oil was shown to possess significant antimicrobial activity against the organisms Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Candida albicans, methicillin-resistant S. aureus (MRSA), Aspergillus niger, Klebsiella pneumoniae and Propionibacterium acnes comparable to its major component-citral. An in vitro toxicological study based on the MTS (3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxyphenyl)-2-(4-sulfophenyl)-2H-tetrazolium) cytotoxicity assay was performed. In vitro cytotoxicity testing indicated that both lemon myrtle oil and citral had a very toxic effect against human cell lines: HepG2 (a hepatocarcinoma-derived cell line); F1-73 (a fibroblast cell line derived from normal skin) and primary cell cultures of human skin fibroblasts. Cytotoxicity IC50 (50% inhibitory concentration) values ranged from 0.008 to 0.014% (w/v) at 4 h to 0.003-0.012% (w/v) at 24 h of exposure. The no-observed-adverse-effect level (NOAEL) for lemon myrtle oil was calculated as 0.5 mg/l at 24 h exposure and the RfD (reference dose) was determined as 0.01 mg/l. A product containing 1% lemon myrtle oil was found to be low in toxicity and could potentially be used in the formulation of topical antimicrobial products.