Review

Backhousia citriodora F. Muell. (Lemon Myrtle), an unrivalled source of citral

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Abstract: Lemon oils are amongst the highest volume and most frequently traded of the flavour and fragrance essential oils. Citronellal and citral are considered the key components responsible for the lemon note with citral (neral + geranial) preferred. Of the myriad of sources of citral, the Australian myrtaceous tree, *Backhousia citriodora*, is considered superior. This review examines the history, natural occurrence, the cultivation, the taxonomy, the chemistry, the biological activity, the toxicology, standardisation and the commercialisation of *Backhousia citriodora* especially in relation to its essential oil.

Keywords: *Backhousia citriodora,* lemon myrtle, lemon oils, citral, geranial, neral, iso-citrals, citronellal, flavour, fragrance, biological activity.

1. Introduction

There are many natural sources of lemon oil or lemon scent. According to a recent ISO Strategic Business Plan [1], the top production of lemon oils come from lemon (7500 tonne), *Litsea cubeba* (1700 tonne), citronella (1100 tonne) and *Eucalyptus* (now *Corymbia*) *citriodora* (1000 tonne). Lemon oil itself, cold-pressed from the peel of *Citrus limon* L., Rutaceae, contains a mere 2-3% of citral (geranial + neral) [2-4], the lemon flavour ingredient. Consequently, the oil is used more for its high limonene (60 - 80%) and minor component content as a fragrance, healthcare additive [5] or solvent rather than a citral lemon-flavour. Citral- and citronellal-rich oils are the commercial lemon-scented oils. Significant sources [6] of these essential oils are listed in Table 1 [6-44].

The aim of this review is to examine investigations into *Backhousia citriodora,* a source of lemon-scented essential oil, that suggest that Lemon Myrtle is superior to other current commercial sources with respect to citral content, oil yield, organoleptic and medicinal properties.

2. Taxonomy

2.1 Etymology

In 1845 lemon scented myrtle was named *Backhousia citriodora* F. Muell. by botanist Ferdinand von Mueller, the genus after the English botanist, James Backhouse and the species epithet from the distinctively strong lemon scent of the foliage [45]. The genus *Backhousia*, from the Myrtaceae family is endemic to eastern Australia and is a close relative of the genus Choricarpia with which it forms the *Backhousia* alliance [7]. “Lemon scented myrtle", the primary common name was shortened to, "lemon myrtle", for the native foods industry to market the leaf for culinary use. “Sweet Verbena Myrtle” and “Lemon Ironwood” are also common names. As *B. citriodora* has two chemoypes, distinction needs to be made between the citral chemotype and the L-citronellal chemotype [38, 39].

2.2 Habit

Mature lemon myrtle trees reach 8 m (25 ft) in height, or higher (to 30m) when crowned, but are often smaller. The leaves are evergreen, opposite, lanceolate, 4–15 cms long and 1-5 cm (0.59–0.98 in) broad, glossy green, with an entire margin. The flowers are creamy-white, 5–7 mm (0.20–

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0.28 in) in diameter, produced in clusters at the ends of the branches from summer through to autumn, after petal fall the calyx is persistent [45] (Figure 1).

Figure 1. *[...]sia citriodora* **in plantation & in flower sho[...] distribution**

2.3 Distribution

B. citriodora is endemic to only the east coast of Australia in Queensland from the Sunshine Coast regions of Eumundi, Maroochydore, Noosa and Woondum, to the ranges west of Miriam Vale and the Mackay, Whitsunday, Townsville and Herberton regions. Plantations have been established from north Queensland to northern New South Wales for both the production of dried leaf and lemon essential oil [45. The largest of these cover 200 and 70 acres producing over 2400 tonne of fresh leaf on stem per annum (46).

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1 **Table 1.** Commercial and potentially commercial sources of citral and citronellal essential oil

	Species	**Common Name**	**Plant Part**	**% Oil**	**% lemon constituent**	**Reference**
Citral	*Backhousia citriodora*	Lemon Myrtle	leaves	1.1 – 3.2	80 -97	[6-11]
	Litsea citrata				90	[11]
	Cymbopogon flexuosus	Lemongrass	leaves	0.2 -0.4	60 - 90	[11-14]
	Cymbopogon citratus	Lemongrass West Indian	leaves	0.2 -0.3	73-90	[6, 15-17]
	Leptospermum liversidgei var. A.	Olive Tea Tree	Aerial parts	0.6 – 0.8	70-80	[11, 18-21]
	Leptospermum petersonii	Lemon Tea tree	leaf	2.0 – 7.0	50-77	[18-21]
	Litsea cubeba	Litsea, may chang	fruit		63 - 78	[11, 22, 23]
	Aloysia triphylla (Lippia citriodora)	Lemon Verbena			43-68	[6, 24, 25]
	Melaleuca teretifolia	Banbar or Marsh Honey Myrtle	Leaves, stems	1.5	66-68	[26, 27]
	Ocimum gratissimum				66.5	[11]
	Lindera citriodora				65	[11]
	Melissa officinalis	Melissa			64	[23, 28-30]
	Calypranthes parriculata				62	[11]
	Citrus limon	Lemon petitgrain	Leaves & twig	0.6	7 - 50	[31-33]

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	Ocimum x africanum	Lemon Basil			42	[6, 28]
	Melaleuca stipitata	Bukbuluk	Leaves	0.7-3.1	44	[34]
	Eucalyptus staigeriana	Lemon ironbark	leaves	2.9 – 3.4	30 - 50	[20, 28]
	Citrus aurantifolia leaves	Petitgrain			36	[11]
	Melaleuca citrolens	Gulbarn	Leaves, stems	1.3 - 3.9	16 - 43	[34-36]
	Thymus citriodorus	Lemon thyme		0.4	16	[6, 37]
Citronellal	*Backhousia citriodora*	Lemon Myrtle	leaves	1.8 – 3.2	80 -89	[20, 38, 39]
	Corymbia citriodora (Eucalyptus citriodora)	Lemon-scented gum	Leaves & twig	0.5 – 4.2	65 - 85	[20, 40, 41]
	Leptospermum liversidgii Var. B	Olive Tea Tree	Aerial parts	0.5	70 - 80	[20]
	Ochrosperma citriodorum, (Baeckea citriodora)		Aerial parts	0.3 – 1.0	54 - 80	[20]
	Leptospermum petersonii	Lemon Tea tree	leaf	2.0 – 7.0	40	[19-21]
	Cymbopogon winterianus	Citronella, Java type	leaves	~ 0.5	31 - 40	[15,42]
	Cymbopogon nardus	Citronella, Sri Lanka type	leaves	1 - 9	1- 47	[43, 44]

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2.4 Chemotypes

Backhousia citriodora has two essential oil chemotypes: The citral chemotype is more prevalent and is cultivated in Australia for flavouring and essential oil. Citral as an isolate in steam distilled lemon myrtle oil is typically 90–98%, and oil yield 1–3% from fresh leaf. This is the highest content natural source of citral (Table 1). The citronellal chemotype is uncommon and can be used as an insect repellent [5, 44] as it has similarities to citronella (*Cymbopogon nardus*) and lemon scented gum (*Corymbia citriodora*, formerly *Eucalyptus citriodora*). Although first reported by Penfold et al. in 1950, [38] it was only in 2001 that this chemotype was rediscovered and the oil fully characterized [39]. The unique characteristic of this chemotype is that the oil is a source of L-citronellal whereas many sources contain either the racemic form or the D-isomer. This chemotype does not breed true as seed collected from a citronellal type tree has given progeny with a 1.05:1 ratio of the citronellal:citral chemotypes [39, 45].

3. Uses

The organoleptic and bioactivity properties of citral have led to the essential oil of *B. citriodora* being used in a number of applications. Commercial production has two main applications [45]: fresh or dried herb sales and distillation for essential oil production. Chief secondary uses include use by florists and the plant nurseries where flowers and leafy branches are very popular ornamentally and the tree itself is an asset to any garden.

Citral, itself has a GRAS (Generally recognized as safe) listing by the United States Food and Drug Administration (FDA) whereby when added to food, it is considered safe by experts [6].

Hence lemon myrtle oil has been used for citral applications and added as a flavoring and scenting agent to foods, cosmetics, aromatherapy massage oils and various household products (such as detergents, soaps, air fresheners, and insect repellents) to give a lemon or verbena scent [6].

Citral is also an excellent starting material for the synthesis of vitamin A and the valuable fragrant ionones, [6, 10, 20, 45].

Also, citral has proven bioactivity for numerous potential applications [6, 11, 47, 48] and *B. citriodora* oil or extract has been reported to possess antimicrobial [47-51], food pathogenic [52, 53], post-harvest pathogenic [54], skin infection [55,56] and anti-inflammatory & anti-oxidative [57, 58] properties). Some of these will be detailed later in this review.

4. Essential Oil

The citral chemotype yields 1.1 – 3.2% (fresh weight) of oil with 80-98% citral [10, 59]. For commercial equipment, Archer has reported consistent yields of 1.5% (w/w) compared with a variable 0.4-3.2% for laboratory distillations [45].

A first report of the less common citronellal chemotype indicated yields of 0.5 – 0.9% (fresh weight) of oil with 62-80% citronellal [20, 39]. Year-old trees from a progeny trial however yielded 1.8-3.2% (dry weight) with 85-89% citronellal [39]. Propagation of seed from a single citronellal-type mature tree gave mixed progeny with an approximate 1:1 ratio of the citral and citronellal chemotypes. In contrast, progeny from two citral chemotypes gave only 3/48 of the citronellal chemotype [39]. This rarer form of L or (-) citronellal provides a starting material for the stereospecific synthesis of terpenoids used in the perfume and flavor industry [20].

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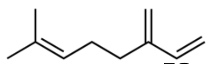
5. Oil Chemistry

The major components of the essential oil of *B. citriodora* are shown in Table 2 and Figures 2 and 3. Initially thought to be one compound, the major component was called citral because of its lemony aroma and flavor. This terpene aldehyde was found to be a mixture of the two geometric isomers neral **9** (IUPAC Name: (2E)-3,7-dimethylocta-2,6-dienal), and geranial **10** ((2Z)-3,7-dimethylocta-2,6-dienal) also known as citral a and citral b respectively in the ratio of 1.2 – 1.5 as shown in Table 2 [45].

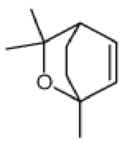
Table 2. The percentage proportion ranges for key constituents in the essential oil of the citral chemotype of *Backhousia citriodora*.

Component	Min %	Max %
β -Myrcene (1)	tr[a]	0,7
2,3-Dehydro-1,8 cineole (2)	tr[a]	0,9
6-Methyl-5-hepten-2 one (3)	tr[a]	2,9
Citronellal (4)	tr[a]	1,0
exo-Isocitral[b] (5)	tr[a]	2,0
Z-Isocitral[b] (6)	tr[a]	2,7
Linalool (7)	tr[a]	1,0
E-Isocitral (8)	tr[a]	4,3
Neral (9)	32,0	40,9
Geranial (10)	44,0	60,7
Nerol (11)	tr[a]	0.6
Geraniol (12)	0,5	2,5
Total Citral[b]	80,0	96,0

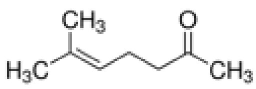
[a] tr = traces < 0,01 % [b] Total Citral is the addition of all 5 citral isomers [c] On non-polar gas chromatography (GC) column stationary phases, nerol often co-elutes with neral.



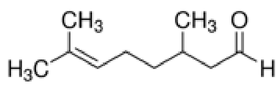
β -Myrcene (1)



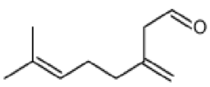
2,3-Dehydro-1,8-cineole (2)



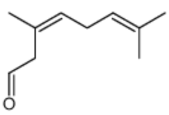
6-Methyl-5-hepten-2 one (3)



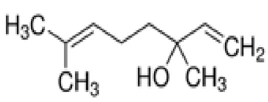
Citronellal (4)



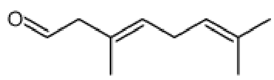
***exo*-Isocitral (5)**



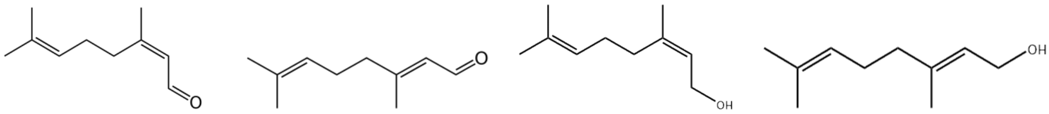
***Z*-Isocitral (6)**



Linalool (7)



***E*-Isocitral (8)**



Neral (9) **Geranial (10)** **Nerol (11)** **Geraniol (12)**

Figure 2 Major constituents of *B. citriodora* essential oil.

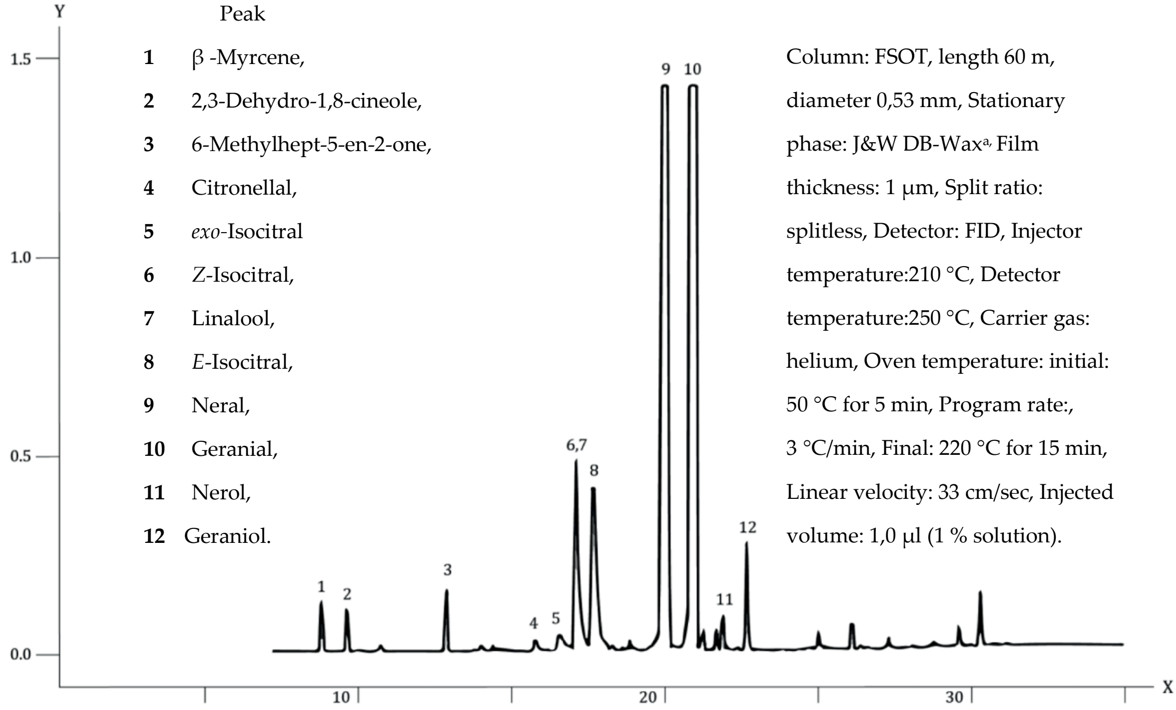


Figure 3 Gas Chromatographic trace of *B. citriodora* oil on a polar column.

B. citriodora components were determined by gas chromatography using flame ionisation detection (GCFID) and gas chromatography-mass spectrometry (GCMS). The most dominant of the minor components are the iso-citrals **5,6,8**. These isomers of citral seem to always co-exist with citral and are thought to be oxidative, thermal or acid/base rearrangement artefacts of citral sourced either naturally or synthetically [10, 60-62]. A published patent reported the purification of citral by fractional distillation at controlled pH 3-7. This procedure reduced the formation of iso-citrals [63].

With gas chromatography (GC), the preferred analytical method for determining essential oil quality, the choice of solvent for injection of aldehyde-rich oils like *B. citriodora* is important. Alcoholic or ketonic solvents such as ethanol or acetone are unsuitable because of their tendency to form acetals and ketals if left in these solvents for a length of time [64]. This was also seen in the analysis of cinnamaldehyde from *Cinnamomum* species using methanol as a solvent [65].

6. Bioactivity

An increasing amount of data is now being published affirming the popularity of lemon myrtle as a complimentary medicine [48, 66].

Many anecdotal reports of bioactivity are now being confirmed by *in vitro* and *in vivo* investigations. The Australian Therapeutic Goods Administration (TGA) is reported to have approved three *B. citriodora* essential oil medicines by 2006 [56, 66].

Even when Rideal-Walker co-efficients were the chief measure of microbial activity, *Backhousia citriodora* essential oil scored well [45]. 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 [45, 49-51].

The leaf paste has been confirmed for its antimicrobial and antifungal properties against many microbes including *Clostridium perfringens*, *Pseudomonas aeruginosa*, and a hospital isolate of methicillin resistant *Staphylococcus aureus* (MRSA)[50, 51]. Three others found the oil to also be an effective antibacterial and antifungal agent against food pathogenic bacteria [52] , against food born pathogens [53] and against the plant postharvest pathogen *Monilinia fructicola* [54] where *in vitro* inhibition of spore germination and mycelial growth was recorded.

Anti-viral activity has been recorded in a clinical trial in treating *Molluscum contagiosum*, a skin virus causing pearly, flesh-coloured, dome shaped papules with central umbilication frequently among children [55, 56]. The trial showed that at the end of 21 days, there was a more than 90% reduction in lesions in 9/16 children treated with lemon myrtle oil.

Anti-Inflammatory and anti-oxidative properties have also been investigated [57, 58] suggesting that lemon myrtle extract could be used as a potential therapeutic agent having potent anti-inflammatory effects that could be used to treat inflammatory bowel disease. Different drying and extraction techniques for optimizing the anti-oxidant activity of the leaf have also been investigated [67, 68].

Also, Gao et al. 2020 [69], have found lemongrass essential oil and its active component, citral, a suppressant for “Dual-Species Biofilms of *Staphylococcus aureus* and *Candida* species”.

In addition, it has been suggested that lemon myrtle extract is suitable for use in ocular health nutritional products, not because of citral content, but as a source of lutein and other antioxidants along with folate and the trace minerals, magnesium and calcium [57, 70].

Studies with insects have shown that effective insect repellents based on natural active ingredients can deliver repellency on par with synthetic actives in the field. For example, Greive et al. [71] in preliminary studies showed that lemon myrtle oil has insect deterrent activity. Repellency of 82% was recorded against *Aedes aegypti* mosquitoes for 30 minutes in laboratory tests with greater efficacy (97%) achieved when mixed (1:5) with *Melaleuca ericifolia* oil, a source of linalool.

7. Toxicology

Citral, the major component of *Backhousia citriodora* oil, has GRAS (Generally recognized as safe) status and is listed by the United States Food and Drug Administration (FDA) and hence when added to food, is considered safe by experts [6, 47, 48].

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When a chemical or chemical category has been agreed by OECD member countries, several documents are available to the public. The OECD-generated *profile* (called either the Screening Information Dataset (SIDS) Initial Assessment Profile (SIAP) or the Initial Targeted Assessment Profile (ITAP)) contains brief summaries of SIDS endpoints as well as the major conclusions of the hazard assessment. Hence there is much information available at sites like: https://hpvchemicals.oecd.org/UI/handler.axd?id=0ea83202-3f4f-4355-be4f-27ff02e19cb9 [11, 66, 72-76] summarising the toxicology of citral. These reports draw the following conclusions: *"For human health, acute toxicity of citral was found to be low in rodents because the oral or dermal LD50 values were more than 1000 mg/kg. This chemical is irritating to skin and not irritating to eyes in rabbits, and sensitizing to skin in guinea pigs. In humans, this chemical was irritating and sensitizing to the skin at high concentrations but not by consumer products. Several repeated dose oral studies show no adverse effect of citral at less than 1,000 mg/kg for 5 days to 13 weeks exposure and some histological changes in the nasal cavity or forestomach, the first exposure sites, probably due to irritation, at more than 1,000 mg/kg. The NOAEL for repeat dose toxicity was 200 mg/kg/day"* and: *"Citral was not carcinogenic in rats or male mice. However, there was a marginal increase in malignant lymphoma in female mice that may have been related to citral. The daily citral exposures (mg/kg/day) achieved in rats and mice at the lowest dose tested in the two-year study represents approximately 10 times the average daily intake of 5 mg/kg/day in humans"* and finally *"Under the conditions of these 2-year feed studies, there was no evidence of carcinogenic activity of citral in male or female F344/N rats exposed to 1,000, 2,000, or 4,000 ppm. There was no evidence of carcinogenic activity of citral in male B6C3F1 mice exposed to 500, 1,000, or 2,000 ppm. There was equivocal evidence of carcinogenic activity in female B6C3F1 mice based on increased incidences of malignant lymphoma."* [75]
A thorough investigation of lemon balm (*Melissa officinalis* L.) essential oil has been published [30] and its oral toxicity determined in mice. Although rich in citral, a high citronellal content makes this oil more like a typical *Leptospermum petersonii* oil [18-21]. In a similar manner, *Leptospermum petersonii* was evaluated by the Complementary Medicines Evaluation Committee as an oil with citral as major component to conclude that the oil "is suitable as an excipient ingredient up to 5% concentration in Listable topical medicines only." [76].

The antimicrobial and toxicological properties of *Backhousia citriodora* essential oil, have been investigated by Hayes and Markovic, 2002 [49]. *In vitro* cytotoxicity testing indicated that both lemon myrtle oil and citral had a very toxic effect against human cell lines: primary cell cultures of human skin fibroblasts. However, 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. These same authors performed *in vitro* percutaneous absorption investigations of the essential oil of lemon myrtle (*B. citriodora*) on freshly excised human full-thickness abdominal skin obtained from patients undergoing elective surgery [72]. Absorption of lemon myrtle oil in human skin discs was evaluated following topical application of neat lemon myrtle oil to the epidermal surface. Citral was the only component found to be absorbing into skin at all exposure periods. When a formulated product containing 1% lemon myrtle oil was applied, total absorption of citral was measured. 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.

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In a review on the "Maternal reproductive toxicity of some essential oils and their constituents", Dosoky, 2021 (6) affirms *B. citriodora* as the best source of citral and specifies its non-mutagenic and non-carcinogenic attributes [72-76] and reports on an inhibition of tissue morphogenesis and tumour production. The author then reviews a host of animal studies on the reproductive toxicity of citral for animals including reduced fertility in rats, dose-dependent malformations in chicken embryos, suppression of enzymes responsible for fetal development, teratogenesis in chicken embryos and restricted fetal cranial development. One suggested action mechanism indicates competition with estrogen for estrogen receptor sites. Consequently, the use of essential oils high in citral, like *B. citriodora*, should be restricted during pregnancy because of a possible teratogenic hazard [6].

8. Standards

Only in recent years have standards been developed for the essential oil of *Backhousia citriodora*. There have however been a number of monographs, especially ISO Standards, elaborated for other citral [4, 12, 17, 22, 31] and citronellal [40, 42, 43]-rich oils.

In 2001, Standards Australia's CH21 Essential Oil Committee, elaborated a monograph entitled "Oil of *Backhousia citriodora*, citral type (lemon myrtle oil)", AS 4941-2001". This Standard [8] specified appearance, colour, aroma and physical constants i.e. specific gravity, refractive index, optical rotation, solubility in alcohol and flash point. The chromatographic table, similar to Table 2 above, listed the major components giving typical minimum and maximum percentages for each constituent. Also supplied are typical chromatograms usually run on both a polar (similar to Figure 3 above) and non-polar stationary phase with significant peaks identified. Included in a 2011 amendment in this first Standard's trace, were the regions where one would expect the alkanals n-octan-1-al, n-nonan-1-al, n-decan-1-al, byproducts of the synthesis of citral to elute. Peaks in this region would indicate adulteration of the oil. This revised Standard was improved with a revision [8, 77] of the geraniol percentage figures to 0.5 – 2.5%. This was achieved by examining the oil on gas chromatographic traces giving clear separation of geraniol and geranial which are difficult to resolve on many non-polar and intermediate-polarity stationary phases.

Approaches to the International Standard's Organisation's TC54 Essential Oil Committee in 2018 resulted in the adoption a slightly modified version of this Australian Standard as an International Standard which is expected to be published in 2022 [9].

9. Commerce

Although all parts of the tree, including the flowers, timber and, indeed the whole tree, can be used [45], it is the leaf that is most sought after and the main reason for plantation establishment. The leaf and terminal branches are steam distilled for a citral-rich oil used as a lemon flavor, fragrance and aromatherapy oil component. The leaf, processed as whole fresh leaf, whole dried leaf, or dried and milled herb, is also popular for lemon herbal tea and other culinary and lemon flavor uses. Lemon myrtle finds itself in teas, breads, biscuits, cakes, cheeses, chutneys, jams, pastas and vinegars, as a flavour; soaps, cosmetics and pot pourris as a fragrance and aromatherapy oils as a fragrant therapeutic and as an air freshener, disinfectant and in a range of body care products. Because of toxicity investigations, topical use at less than 1% in a formulation is recommended [45].

There have been a host of industry production and use-related publications extolling the value and benefits of lemon myrtle and its essential oil [60, 78-90].

Although past production figures have been difficult to acquire, several tonnes of oil and fresh or dried leaf are produced annually in Australia from millions of trees in several hundred of hectare of plantation. At the 2003 IFEAT International Conference in Sydney, McCartney [78] reported an estimated current annual production of 5 - 8 tonne.

In 2012 Clarke [79] estimated farmgate Australian production of lemon myrtle in 2011 to be 575 – 1100 tonnes leaf and 3 – 8 tonnes oil, with a gross value of $7 – 23 million with 90 per cent of oil exported, mainly to the United States and the European Union. According to Biosecurity Australia [80, cited in 79], 57.4 tonnes of organically certified lemon myrtle oil were exported from Australia to the European Union in 2011, virtually all to Germany. Most essential oil experts consider this a highly exaggerated figure but the importance of the species as an internationally and locally traded commodity cannot be understated. In a 2014 report, Foster [81] summarises the industry, relying on the 2011 figures of Clarke [79] and recording a leaf production figure of 838 tonne of leaf. A very recent (2020) market study [82] estimates the current state of the industry and projects growth forward to 2025. A current farm gate value of Aus $12.2m is larger than any of the other Australian native foods and botanicals and is predicted to double in the next five years. There are more than 50 enterprises producing leaf and/or oil with three a substantial size producing about 250 tonne of dry leaf and approximately 8 tonne of oil with farm gate values estimated at Aus $37.50 and Aus$ 350.00 respectively [82].

9. Conclusion

Lemon myrtle, *Backhousia citriodora,* citral type, is becoming established as an unrivalled source of citral lemon whether it be in leaf or oil form. With further development, this species may well become a superior source of citral. The oil yield is higher, citral content better and the aroma cleaner, fresher and sweeter. In tree form, harvesting becomes more problematic as they do not recover and coppice from ground level harvesting in the same manner as tea tree (*Melaleuca alternifolia*) and blue mallee (*Eucalyptus polybractea*) will do. Leaf can be hand-picked or tipped with a mechanical harvester.

The lesser known citronellal chemotype is unlikely to be developed commercially until further trials are done despite the advantages of having an excellent source of the rarer L-enantiomer [39]. Because this chemotype does not breed true, plantation trials are still at early stages and genetic material for plantations is harder to source, immediate commercialization is not envisaged.

The medicinal properties of the citral chemotype are being increasingly investigated as efficacy in many areas is being proven in both *in vitro* and in *vivo* research. Toxicity testing is proving that the product is generally safe when used in appropriate concentrations for most applications except for pregnant mums.

Backhousia citriodora, citral type, lemon myrtle oil, has attracted the world's attention in recent decades and is consequently assured a strong place in the flavor, fragrance and health care industries for decades to come. However, there is still much work to be done, especially at the molecular level [91] and at detecting adulteration [92].

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