Australian Government
Rural Industries Research and Development Corporation

Australian Standards for Oil of Australian Lavandin Cultivars

RIRDC Publication No. 11/133

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by Ian Southwell

February 2012

RIRDC Publication No. 11/133
RIRDC Project No. PRJ-000021

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ISBN 978-1-74254-312-3
ISSN 1440-6845

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Electronically published by RIRDC in December 2011
Print-on-demand by Union Offset Printing, Canberra at www.rirdc.gov.au
or phone 1300 634 313

Foreword

Although lavender has been grown in Australia since 1921, early plantings were predominantly of true lavender, *Lavandula angustifolia.*

The camphoraceus lavandin hybrids, *Lavandula* x *intermedia*, are hardier, grow faster and produce more oil per kilo of plant matter than the true lavenders. Additionally, they produce more plant matter per hectare than true lavenders. Forward-thinking Australian growers saw the potential for broad acre multiple-row growing and harvesting of lavandin cultivars. Such flowers, oils and products were popular with consumers but shunned by wholesalers because of the lack of an Australian standard.

There is a need for a standard or standards for *L.* x *intermedia* oils derived from cultivars not presently covered by standards. For example the International Organization for Standardization (ISO) has standards for true lavender (*L. angustifolia*), spike lavender (*L. latifolia*) and two *L. angustifolia* x *L. latifolia* hybrids: abrial and grosso. There are a number of other hybrids cultivated as well.

Many of the oils from cultivars grown in Australia (e.g. super, allardii) have no standard, are more popular with consumers but avoided by commercial oil traders. Industry colleagues in Europe encounter similar problems.

Consequently, the lavandin oil growers saw it as important to create standards for these oils so that they could broaden their market base. If the formation of a standard opened new wholesale markets, then the benefits to growers would be further incentive to increase production and, subsequently, growers would hopefully receive better returns.

Measurement of the specifications required for the elaboration of a standard indicated that, at present, the data recorded was insufficient. When a greater number of samples is available and more consistent quality is achievable, then Standards Australia can be approached about elaborating further standards that accurately reflect Australian production.

The data recorded in this project is of value in defining the characteristics of the oils currently produced; pointing producers in the right direction with respect to the best varieties to plant, suggesting the best chemical compositions to target and relating these to the best-smelling oils as assessed by a perfumery expert.

This project was funded from industry revenue and ‘in kind’ contributions with matching funds from the Australian Government.

This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our Essential Oils and Plant Extracts R&D program, that aims to provide the knowledge and skills base for industry to provide high, consistent and known qualities in their essential oils and plant extracts products that respond to market opportunities and enhance profitability.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation

About the Author

The New South Wales State Government saw the importance of the essential oil industry to the economy of the state more than 100 years ago and established a research and development (R&D) centre at the Museum of Applied Arts and Sciences in Ultimo, Sydney. This centre was relocated to New South Wales Agriculture at the Biological and Chemical Research Institute in 1979 and then to the Wollongbar Agricultural Institute in 1983.

Author Ian Southwell joined the staff at the centre in 1968 as an Honours graduate from Sydney University and worked for 38 years as a Research Chemist and later as Research/Senior Research/Principal Research Scientist undertaking R&D in the field of plant chemistry, especially in relation to essential oil chemistry. During that time, he has published more than 160 research papers, project reports, technical bulletins, conference papers and book chapters in this field and been awarded Masters and PhD degrees from the Universities of Sydney and Manchester respectively. As a fellow of the Royal Australian Chemical Institute, he has completed several overseas aid assignments in the essential oil field, spoken at many plant and essential oil conferences and attracted substantial funding for research projects. As a member of Standards Australia's CH21 Committee, Ian has contributed to the elaboration of numerous Australian essential oil standards and represented Standards Australia at the International Organization of Standardization ISO TC54 Committee.

In 2005, Ian set up Phytoquest, a plant and essential oil chemistry consultancy working with clients including the Essential Oil Producers Association of Australia (EOPAA), the Australian Tea Tree Industries Association (ATTIA), The Australian Lavender Growers' Association (TALGA), the Rural Industries Research and Development Corporation (RIRDC) and individual oil producers. Consequently, Ian remains up-to-date with industry developments and active in R&D projects.

Acknowledgments

We acknowledge The Australian Lavender Growers' Association, especially Mike Basile, for sample co-ordination, collection and posting.

The project would not have been possible without the contribution of producers' samples of substantial volume which would otherwise have been used for formulation and commercial sale.

We are grateful to the analysts from the following participating laboratories: (1) Mike Russell, Industry & Investment NSW, Diagnostic and Analytical Services, Environmental Laboratory, Wollongbar, New South Wales; (2) Ashley Dowell, Centre for Phytochemistry and Pharmacology, Southern Cross University, Lismore, New South Wales; and (3) Charles Cornwell and John Fergeus, Australian Botanical Products Pty Ltd, Hallam, Victoria, for the measurement of the physical constants and gas chromatographic chemical compositions.

Bill Gunning, Laboratory Manager, Oilcheck Pty Ltd, Sefton, New South Wales, is acknowledged for organising flash point determinations and John Lambeth, Highlight Creations, Mount Colah, Sydney, New South Wales, for organoleptic evaluations.

Bob Lowe, formerly from Industry & Investment New South Wales, Diagnostic and Analytical Services, Environmental Laboratory, Wollongbar, New South Wales is thanked for providing access to lavender results from early projects.

Abbreviations

FP	flash point
GC	gas chromatography
GEC	global economic crisis
ISO	International Organization for Standardization
OR	optical rotation
R&D	research and development
RD	relative density
RI	refractive index
RIRDC	Rural Industries Research and Development Corporation
S in E	solubility in alcohol
TALGA	The Australian Lavender Growers' Association

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Executive Summary

What the report is about

This report records the quality of the lavandin samples that are currently being distilled by numerous lavender growers throughout Australia. The specifications used to determine essential oil quality were measured for locally produced lavandin oils and compared both with the specifications published for internationally traded oils and other Australian-produced oils submitted for this project.

Who is the report targeted at?

The results presented in this report are of interest to those currently producing lavender oils, those thinking of becoming lavender oil producers, and those who use or sell lavender and lavandin oils in local and international outlets.

At a more academic level, the report would be of value to essential oil chemists with an interest in new sources of lavandin oil, to chromatographers who analyse oils and to breeders and geneticists who seek to produce superior clones.

Where are the relevant industries located in Australia?

The largest lavender oil producer in Australia has always been the Bridestowe Estates lavender farm at Nabowla, between Lilydale and Scottsdale in northern Tasmania. This has been the only plantation in Australia to produce export-grade lavender oil which for years has competed with the best quality oil produced world-wide.

In addition, there are numerous other plantings of lavender and lavandin cultivars grown either elsewhere in Tasmania or on the mainland in all states/territories except the Northern Territory.

Bridestowe Estate has been known to produce 1–1.5 tonne of oil annually. Much of this oil is exported; although recent years have seen such plantations generate more income from tourist visits and sales than from exported oil sales. Other producers have the potential to collectively produce an equivalent quantity of oil marketed only as formulated products or oils sold at tourist outlets.

A total production of 2 tonne was estimated in 2003 (McCartney 2003). This same communication quoted import figures of 43 tonne valued at A$2.2 million for 2002/3; giving some indication of the potential this industry has for import replacement.

Producers from all over Australia will benefit from this research as will oil buyers and product formulators.

Background

The cosmetic and fragrance industry's love of lavender has not escaped Australian farmers' attention. Commercial production of this oil in Australia dates back to 1921 when CK Denny established a plantation in northern Tasmania from French seed stock. Over the years, Bridestowe Lavender Farm has undertaken considerable cultivar selection of *Lavandula angustifolia*, and it has built a reputation for its consistent high-quality lavender oil.

However, considerable interest has been raised elsewhere in the cultivation of lavender for a range of applications. Presently, there are several small-scale lavender farms dotted throughout the country, predominantly servicing the dried flower and tourist markets. These grow many different species, including the three main oil yielders. Production of oil from these farms is very limited and tends to be mainly from *L. intermedia* x (lavandin), although it is possible to find some quantities of excellent-quality *L. angustifolia* oil. The main production regions for these lavender and lavandin oils have

extended from Tasmania and Victoria to southern and western New South Wales, south-east Queensland, south-east South Australia and the Margaret River region in Western Australia (McCartney 2003).

Four years ago, at the commencement of this project, interest in, and small-scale production of, lavender, especially lavandin, had increased dramatically with quantities similar to the Bridestowe production coming cumulatively from one hundred or so small plantings. The quality of oil produced from these plantings has been variable. Some oil has been equivalent to international standard quality but other oil, although in no way inferior on organoleptic grounds, possesses physical and chemical parameters that differ from both international and Australian standards.

Consequently, there was seen to be a need to elaborate an Australian standard for Australian-produced lavandin oils so that the industry can aim for a common, high-quality, internationally acceptable oil. If such oil can be produced consistently and in sufficient quantity for export, these standards can then be proposed to the International Organization for Standardization (ISO) as international standards.

This project then commenced to record and assess data from freshly distilled lavandin oil samples to determine whether such data was adequate in both quantity and quality to justify establishing Australian standards for locally distilled lavandin oils.

Aims/objectives

At present there are no standards for the majority of the lavandin oils produced in Australia. The purpose of this proposed research is to:

1. Collect and analyse lavandin oils from Australian lavandin oil producers and collate the data for the purpose of developing new Australian standards to suit the range of lavandin oil cultivars which are currently grown and for which no standard(s) exist.

2. Use the collected data to determine if the present Australian Standard AS 5028-2002 for lavandin GROSSO oil satisfactorily accommodates the typical GROSSO oils derived from Australian-grown plants, and to recommend revisions if it does not.

Producers, plant breeders, formulators, marketers and end-users would all benefit from the elaboration of standards that accurately list the specifications of Australian-produced lavandin oils.

Methods used

Samples were collected (aimed for 50 samples over 2 years) from industry producers over as wide a range of locations and climates as possible. Accessioned oils were firstly stored at Wollongbar Agricultural Institute (WAI) before being submitted to the testing laboratories for analysis.

Three specialist essential oil testing centres were chosen: the WAI (now called the Wollongbar Primary Industries Institute); Southern Cross University's Centre for Phytochemistry and Pharmacology; and Australian Botanical Products. These laboratories were all familiar with testing oils to standard specifications (e.g. British Pharmacopoeia, European Pharmacopoeia or ISO)

For the measurement of physical and chemical specifications, the five standard tests most common in lavender or lavandin standards are: gas chromatography (GC) for the determination of the chemical constituents of oils; refractive index (RI); relative density (RD); optical rotation (OR); and solubility in alcohol (S in E).

Samples were also sent to the Oil Check Pty Ltd laboratory for Pensky Martins flash point determinations as flash point data are mandatory requirements for the classification of liquids as dangerous or safe goods for transport. For this reason, flash points are included in essential oil ISO standards 'for information only'.

Perfumery oils are of no value, even when all physical and chemical data meet specifications, if they do not exhibit a characteristic aroma. Consequently, samples were sent to an experienced perfumer for olfactory evaluation.

The data collected was to be collated and analysed. At this stage Standards Australia CH21 Committee members would be able to assess the results and determine whether the elaboration of a new standard for Australian-produced lavandin was justified. Finally, all outcomes were to be published in a final report for the Rural Industries Research and Development Corporation (RIRDC).

Results/key findings

This research clarified the industry's position with respect to the quantities and qualities of lavandin oils being produced throughout Australia.

The industry has experienced a downturn since the project was initiated. Consequently, insufficient samples were received for a statistically significant outcome. The submitted oils were found to be most variable with respect to the measured parameters: flash point; aroma; physical constants (RI, RD, OR, S in E); and chemistry.

As the project continued, it became obvious that now is not the time to approach Standards Australia or ISO about elaborating new standards especially for Australian-produced lavandin oils. At a later time, when more samples which are less variable in nature are available, standards elaboration could be re-considered. The members of the Standards Australia committee concurred with this position.

In the meantime, previous results determined at WAI, were revisited with the view to correlating plant variety with chemical quality and market acceptance.

Implications for relevant stakeholders for:

The industry now has a better idea of the quality and quantity of current lavandin oil production.

Communities are now better able to assess the risk of investing in lavandin oil production.

Standards Australia and ISO have a better understanding of oil quantities, qualities, the time-span and the data needed for the elaboration of standards for Australian-produced lavandin oils.

Recommendations

Lavandin oil producers need to:

- consolidate their industry by developing the best varieties
- examine distillation and storage techniques to ensure: (1) times are of adequate length to include missing high-boiling compounds and herbal coumarin notes; and (2) 'old', stale and burnt notes are not evident
- reconsider the elaboration of specific standards for locally grown lavandin when production has increased and quality is less variable
- for most producers, continue the practice of value-adding and marketing regionally rather than seeking access to international markets for bulk oil.

Introduction

Although much has been written on lavender, a good review was published in 2002 in Roland Hardman's series *Medicinal and Aromatic Plants – Industrial Profiles*. Maria Lis-Balchin edited Volume 29 entitled *Lavender, the genus* Lavandula, which contains chapters covering the taxonomy, history, cultivars, phytochemistry, distillation, standardisation, chemical composition, bioactivity, uses and research of *Lavandula* species (Lis-Balchin 2002a).

The cosmetic and fragrance industry's love of lavender has not escaped Australian farmers' attention. Commercial production of this oil in Australia dates back to 1921 when CK Denny established a plantation in northern Tasmania from French seed stock. Charles Denny's son, EFK Denny (always known as 'Tim') undertook considerable cultivar selection of *Lavandula angustifolia* and built a reputation for Bridestowe Estate's consistently high-quality lavender oil. The Bridestowe plantation at Nabowla, between Lilydale and Scottsdale, remains the only sizeable commercial operation for true lavender oil in Australia with an annual production of approximately 1.5 tonnes of oil which competes with the best-quality oil produced world-wide.

In addition there are numerous other plantings of lavender and lavandin cultivars grown either elsewhere in Tasmania or on the mainland in all states/territories except the Northern Territory.

Bridestowe Estate has been known to produce 1–1.5 tonne of oil annually. Much of this oil is exported; although recent years have seen such plantations generate more income from tourist visits and sales than from exported oil sales. Other producers have the potential to collectively produce an equivalent quantity of oil marketed only as formulated products or oils sold at tourist outlets.

A total production of 2 tonne was estimated in 2003 (McCartney 2003). This same communication quoted import figures of 43 tonne valued at A$2.2 million for 2002/3; giving some indication of the potential this industry has for import replacement.

The number of producers is hard to estimate as producer turnover is rapid, production volumes are usually small, value adding and local marketing dominates and there are a number of formal industry associations. Production has declined in recent years due to drought, bushfires, floods and the global economic downturn. If the 30 growers quoted by Monaro Country Lavender is indicative, then there must be 50–100 producers in Australia.

However, considerable interest has been raised elsewhere in the cultivation of lavender for a range of applications. Presently, there exists several small-scale lavender farms dotted throughout the country, predominantly servicing the dried flower and tourist markets. These grow many different species, including the three main oil yielders. Production of oil from these farms is very limited and tends to be mainly from *L. intermedia* x (lavandin), although it is possible to find some quantities of excellent-quality *L. angustifolia* oil. The main production regions for these lavender and lavandin oils have extended from Tasmania and Victoria to southern and western New South Wales, south-east Queensland, south-east South Australia and the Margaret River region in Western Australia (McCartney 2003).

Four years ago, at the commencement of this project, interest in, and small-scale production of, lavender, especially lavandin, had increased dramatically with quantities similar to the Bridestowe production coming cumulatively from one hundred or so small plantings. The quality of oil produced from these plantings has been variable. Some oil has been equivalent to international standard quality but other oil, although in no way inferior on organoleptic grounds, possesses physical and chemical parameters that differ from both the international and Australian standards.

Although lavender oils are superior from an organoleptic viewpoint and hence demand higher prices, lavandin oils have many advantages. For example, the higher oil yield often compensates for the lower

price on a dollar return per hectare basis. Hence many Australian producers have chosen to cultivate lavandin rather than lavender.

An explanation of lavender nomenclature is necessary at this point. The flowers of true lavender, *Lavandula angustifolia* Mill., when distilled yield lavender oil. Spike lavender oil is sourced from *Lavandula latifolia* Medik. Hybrids of these two species, *Lavandula angustifolia* Mill. x *Lavandula latifolia* Medik. (ISO 2007), sometimes called *L* .x *intermedia* (Lis-Balchin 2002c; Upson 2002) or *L. hydrida* (Baser and Buchbauer 2009), come in many forms. ISO lists the following hybrid types: abrialis, grosso, super and sumian (ISO 2007) and has elaborated standards for abrialis (ISO 2001) and grosso (ISO 2008) in addition to spike (ISO 2009) and true lavender (ISO 2002).

In Australia, producers have concentrated on either *L. angustifolia* (e.g. Bridestowe Estate) or *L. intermedia* (especially the 'Super' cultivars, for which some data has been published elsewhere). When Australia's exported *L. angustifolia* became important on the world market, better recognition of the product and its intrinsic properties was sought. The Australian-distilled lavender oil contained higher levels of 3-octanone than oils from other origins. This was acknowledged in 2002 when ISO revised the Standard for Oil of Lavender to include specifications from different countries of origin including Australia (ISO 2002).

With international standards for lavender existing only for lavender, lavandin grosso, lavandin arbrialis and spike lavender, Standards Australia have taken these standards as they stand and published them as Australian standards to give the present industry interim goals until more is known about the quality of the oils produced and sold in Australia.

Subsequently there was seen to be a need to elaborate an Australian standard for Australian-produced lavandin oils so that the industry can aim for a common, high-quality, internationally acceptable oil. Many of the lavandin oils produced in Australia are of the 'Super' variety rather than the grosso or abrialis oils for which standards already exist. Although variety 'Super' is listed in the ISO Nomenclature Standard, no draft standard exists at present (ISO 2007). If Australian-variety oils can be produced consistently and in sufficient quantity for export, standards can then be proposed firstly to Standards Australia and then to ISO as national and international standards respectively.

Hence this project was commenced to record and assess data from freshly distilled lavandin oil samples to determine whether such data was adequate in both quantity and quality to justify establishing Australian standards for locally distilled lavandin oils.

Objectives

The aims of the project were to:

1. Collect and analyse lavandin oils from Australian lavandin oil producers and collate the data for the purpose of developing new Australian standards to suit the range of lavandin oil cultivars which are currently grown and for which no standard(s) exist.

2. Use the collected data to determine if the present Australian Standard AS 5028-2002 for lavandin GROSSO oil satisfactorily accommodates the typical GROSSO oils derived from Australian-grown plants , and to recommend revisions if it does not.

Methodology

Commercially distilled lavandin oil samples were collected from producers over the experimental phase of the project from 2007 to 2010. Although volumes of 50 ml are needed for the gas chromatography (GC) and mandatory physical constants, 100–150 ml is needed for flash point determination. Hence 200 ml of each sample was requested. Although hundreds of samples collected from numerous producers over a number of harvest years is ideal, our objectives from the outset were more conservative as we aimed for 50 samples over two to three harvests.

The submitted samples were stored under refrigeration at one collection point, WAI, ready for dispatch to the participating laboratories.

When sufficient samples had accumulated, they were dispatched to the following laboratories for analysis:

- Australian Botanical Products, Hallam, Victoria (chromatographic profile list of components and percentage composition; refractive index (RI); relative density (RD); optical rotation (OR); solubility in alcohol (S in E))

- Wollongbar Agricultural Institute (now the Wollongbar Primary Industries Institute), Industry & Investment NSW, Wollongbar, New South Wales (chromatographic profile list of components and percentage composition; RI; RD; OR; S in E)

- Southern Cross University, Centre for Phytochemistry and Pharmacology, Lismore, New South Wales (chromatographic profile list of components and percentage composition; RI; RD; OR; S in E)

- Oilcheck Pty Ltd, Sefton, New South Wales (flash point determinations)

- Highlight Creations, Mount Colah, New South Wales (organoleptic evaluations).

Results were collated into spreadsheets and analysed.

Data were made available to the Standards Australia CH21 Essential Oil Committee and written up as a final report for the Rural Industries Research and Development Corporation (RIRDC).

Many aspects of these methods are mandatory for ISO standard procedures or suggestions from the RIRDC Essential Oils and Plant Extracts Advisory Committee.

Results

1 Samples

Details of the samples submitted are shown in Appendix 2. In this report, samples are only identified by number, variety and source location. Details of submitter are confidential and available only from TALGA with permission.

The results are shown here in summary form and in appendices in entirety for the following:

- 24 samples submitted for ISO analysis
- 17 flash points determined (some sample volumes were too low for determination of individual flash points)
- 23 additional industry samples for GC only
- 36 submitted for perfumery evaluation
- 426 previous WAI results reviewed.

2 Flash point results

The first twelve samples were in insufficient quantities for individual flash point (FP) analyses, so they were bulked as 50/50 pairs as shown in Appendix 3.

The overall range 50–72°, with a mean of 62°, standard deviation ±7.4° is a very broad range (Table1); reflecting the broad range of chemical composition, and falling on both sides of the dangerous goods flash point limit of 60.5°. The mean falls above the dangerous goods range for transport purposes but lower than that for all the other forms of lavender except for spike with is rich in 1,8-cineole (FP ~ 49°C). For a standard, meaningful flash points need to be less variable than this. The complete flash point results are shown in Appendix 3.

Table 1. Flash point comparison

Variety	**Degrees C**
Project mean [n = 17, (range)]	62 (50–72)
Lavender	71
Spike	60
Grosso	65–74
Arbrialis	74–77
Dangerous goods limit	60.5

3 Perfumery evaluation

Thirty samples of lavandin were evaluated along with six lavender samples. They were compared with fresh market grosso oil and individual reports are available. Evaluation took place by the same perfumer in two stages: Stage 1 included 13 lavandin oils (samples #1–13; 2007 I 5–Int 08 19 of Appendix 2); and Stage 2 evaluated 23 oils (six lavender (LA 10/01–LA 10/06); six lavandin non-project samples (LI 10/01–LI 10/06); 11 project samples (samples #14–24; LI 09/09–LI/S23, see Appendix 2).

The results were variable: some excellent, some lacking. Many of the lavandin samples lacked the herbal coumarin notes. Longer distillation times may bring over some of these missing high-boiling compounds. On the other hand, some 'old', stale and burnt notes were evident in some samples. With the *L. angustifolia*, some were excellent with others falling short.

In summary, the aroma of these oils is heading in the right direction but still has a long way to go. The complete perfumery assessment is shown in Appendix 4.

4 ISO standard results

A typical ISO lavender standard (ISO 2001, 2002, 2008, 2009) has the following requirements:

- appearance
- colour
- odour
- relative density
- refractive index
- optical rotation
- solubility in alcohol
- acid value
- acid value
- ester value
- ester value after acetylation
- chromatographic profile.

In addition to these mandatory requirements, the lavender/lavandin standards contain at least two annexes which are for information only. These are most useful as they contain:

- typical chromatograms (copies of typical traces usually on both a polar and a non-polar column)
- flash point data (actual values with the equipment and method used).

4.1 Appearance

Submitted oils were consistently clear mobile liquids.

4.2 Colour

Submitted oils were consistently colourless to pale yellow in colour.

4.3 Odour

Submitted oils were consistently of a characteristic, camphoraceous, lavender-like odour.

4.4 Relative density at 20°C

Relative density, or specific gravity, is the ratio of the density (mass of a unit volume) of the oil to the density of a given reference material (in this case water).

The mean value of the submitted samples fell within the abrialis and grosso ranges, on the lower edge of the spike range and above the *L. angustifolia* range (Table 2). As expected, the total range of submitted samples was broad, encompassing most of the published ranges. The relative densities of all submitted samples are available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 3.

Table 2. Relative densities of submitted samples with respect to published ISO standards for lavender and lavandin oils

Variety	Minimum	Maximum	Mean
Submitted project samples	0.880	0.900	0.894
Lavandin, abrialis	0.887	0.897	–
Lavandin, grosso	0.891	0.899	–
Lavender, spike	0.894	0.907	–
Lavender, angustifolia	0.878	0.890	–

4.5 Refractive index at 20°C

The refractive index or index of refraction of a substance is a measure of the speed of light in that substance. It is expressed as a ratio of the speed of light in a vacuum relative to that in the considered medium.

The mean value of the submitted samples fell within all the ISO standard ranges (Table 3). As expected, the total range of submitted samples was broad, encompassing most of the published ranges and sometimes outside these ranges. The refractive indices of all submitted samples are available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 3.

Table 3. Refractive indices of submitted samples with respect to published ISO standards for lavender and lavandin oils

Variety	Minimum	Maximum	Mean
Submitted project samples	1.458	1.468	1.461
Lavandin, abrialis	1.460	1.466	–
Lavandin, grosso	1.458	1.462	–
Lavender, spike	1.461	1.468	–
Lavender, angustifolia	1.455	1.466	–

4.6 Optical rotation

Optical rotation is the turning of the plane of linearly polarised light about the direction of motion as the light travels through certain materials. It occurs in solutions of chiral molecules such as occur in most essential oils.

The mean value of the submitted samples fell only within the abrialis and spike ISO standard ranges (Table 4). As expected, the total range of submitted samples was broad, sitting outside the higher end of the range for arbrialis and grosso, totally outside the angustifolia range but totally within the spike lavender range. The optical rotations of all submitted samples are available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 3.

Table 4. Optical rotations of submitted samples with respect to published ISO standards for lavender and lavandin oils

Variety	Minimum	Maximum	Mean
Submitted project samples	–4.8	0.7	–2.1
Lavandin, abrialis	–5	–2	–
Lavandin, grosso	–7	–3	–
Lavender, spike	–7	+2	–
Lavender, angustifolia	–12.5	–6	–

4.7 Solubility in alcohol

The lipophilic or hydrophilic nature of an essential oil can be assessed by checking solubility in a range of volumes of an ethanol/water mixture. For lavender/lavandin oils this is in a 70 per cent ethanol/water mixture.

The maximum equivalent volume needed to dissolve one volume of oil (mean and range) was fractionally lower than the published ISO standards (Table 5). The solubility in alcohol data for all submitted samples is available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 3.

Table 5. Solubility in alcohol data for submitted samples with respect to published ISO standards for lavender and lavandin oils

Variety	Minimum	Maximum	Mean
Submitted project samples	0.8	2.8	1.9
Lavandin, abrialis		4	–
Lavandin, grosso		3	–
Lavender, spike		3	–
Lavender, angustifolia		3	–

4.8 Acid value, ester value, ester value after acetylation

Although these parameters are listed in ISO standards, they are infrequently measured. GC determinations have largely superseded these methods. ISO has retained them as a fall back where chromatography is inadequate or unavailable. They were not measured as part of this project.

4.9 Chromatographic profile

All the above requirements are secondary to the chemical composition of the oil. The ISO specifies that the analysis of the essential oils be carried out by GC. In the chromatogram obtained, the representative and characteristic components are identified and shown in a table (see Tables 6 and 7 below). The proportions of these components, indicated by the integrator constitute the chromatographic profile of the essential oil. Details of these compositions are available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 3.

Table 6. Lavandin project composition summary

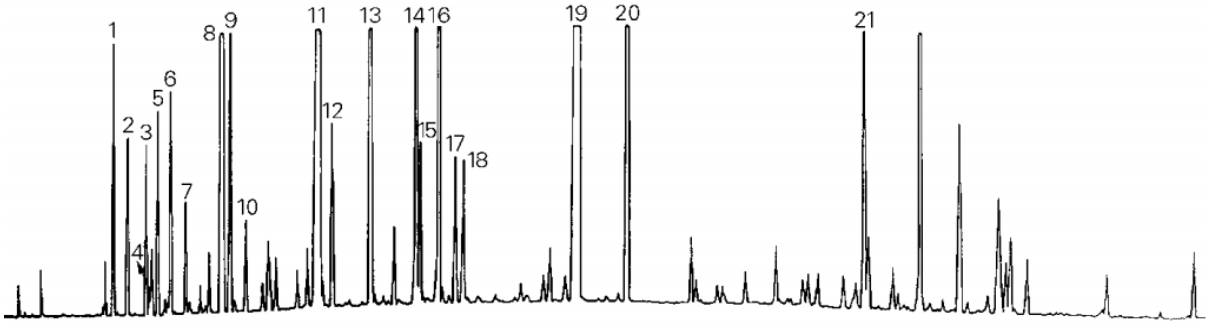
Component	Mean	Min	Max	Comments
Limonene	1.1	0.6	2.0	Close to grosso
1,8-cineole	12.1	8.9	16.4	Higher than abrialis, grosso, super
β-Phellandrene	0.9	0.2	3.1	Close to but above *angustifolia*
cis-β-ocimene	3.2	1.1	8.0	Higher than abrialis, grosso
trans-β-ocimene	1.1	0.1	3.1	Close to grosso, lower than abrialis
octan-3-one	0.12	0.02	0.5	Lower than *angustifolia*
camphor	10.8	6.1	16.0	Higher than grosso, abrialis, super, close to spike
Borneol	3.2	1.4	10.9	Generally higher than all
Linalool	33.7	21.1	43.0	Generally higher than grosso, abrialis, lower than spike
Linalyl acetate	18.1	5.4	26.3	Lower than grosso, abrialis, much higher than spike
Lavandulol	0.2	0	0.7	Closer to grosso, lower than abrialis
Terpinen-4-ol	0.5	0	4.2	Wide range, some close to grosso, spike
Lavandulyl acetate	0.9	0.2	2.5	Close to grosso, spike
α-Terpineol	0.8	0.3	1.3	Similar to *angustifolia*

Table 7. Component range comparison (key components only) with existing ISO standards and (for super) published data ([a]Charles et al. 2002; [b]Lis-Balchin 2002b)

Component	Lavandin project	Lavandin super	Lavandin (abrialis)	Lavandin (grosso)	Lavender (spike)	Lavender
1,8-Cineole	8.9–16.4 (12.1)	6.8±0.5[a] 2.0[b]	6–11	4.0–8.0	16–39	0–1.0
Camphor	6.1–16.0 (10.8)	3.5±1.1[a] 3.0[b]	7–11	6.0–8.5	8–16	0–0.5
Borneol	1.4–10.9 (3.2)	– –	1.5–3.5	1.5–3.5	–	–
Linalool	21–43 (33.7)	38.5±1.9[a] 29.3[b]	26–38	24–37	34–50	25–38
Linalyl acetate	5.4–26.3 (18.1)	17.7±1.0[a] 30.4[b]	20–29	25–38	Tr–1.6	25–45

The fact that these figures are outside the range of the existing standards does not exclude such oils from standardisation. If the demand was sufficient, and the production significant in quantity and consistency, then elaboration of a standard would be warranted.

4.10 Typical chromatogram



1 α-Pinene
2 Camphene
3 1-Octen-3-ol
4 3-Octanone
5 β-Pinene
6 Myrcene
7 Hexyl acetate
8 1,8-Cineole + limonene
9 *cis*-β-Ocimene
10 *trans*-β-Ocimene
11 Linalool
12 1-Octen-3-yl acetate
13 Camphor
14 Borneol
15 Lavandulol
16 Terpinen-4-ol
17 α-Terpineol
18 Hexyl butyrate
19 Linalyl acetate
20 Lavandulyl acetate
21 β-Caryophyllene

Operating conditions

Column: capillary; length 50 m; internal diameter 0,32 mm
Thickness of film: 0,25 µm
Stationary phase: polydimethylsiloxane (OV 101)
Oven temperature: programmed from 65 °C to 170 °C at a rate of 1,5 °C/min
Injector temperature: 200 °C
Detector temperature: 220 °C
Detector: flame ionization type
Carrier gas: hydrogen
Volume injected: 0,2 µl
Split ratio: 100:1

Figure 1. Oil of lavandin Grosso [*Lavandula angustifolia* Miller × *Lavandula latifolia* (L.f.) Medikus], French type (ISO 2008).
Typical chromatogram taken on an apolar column.

4.11 Flash point

In Table 1, the results of 17 flash point determinations were recorded (see Section 2 above). If standardisation were to proceed and less variation had been evident, then this data would be available for the 'for information only' annex reporting flash point values as seen in other standards.

5 Project addendum

Although the original project proposed 50 samples, the actual project realised only 13 samples when the project was due to be wound up. A project variation for an extension of 24 months with a 20 per cent RIRDC contribution budget cut was granted. To salvage more from the project, it was decided to review 426 earlier WAI analysis results to recommend planting varieties. This became the project addendum. Following this, 11 more samples were submitted. The results of 426 lavender and lavandin submitted samples from WAI were reviewed.

Varieties among the *angustifolias* showing promise included 'Munstead', 'Twickel Purple', 'Vera', 'Bosisto', 'Hidcote', 'Avice Hill', 'Swampy', 'Bosisto' and 'Bee'. Intermedias showing promise included 'Super', 'Grosso', 'Margaret', 'Wilson's Giant' and 'Miss Donnington'. The chromatographic results from this project addendum are available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 4.

6 Communication of results to the industry

The above results were communicated to the industry regularly via the TALGA Oil Chairperson. In addition, at the TALGA International Symposium held at the Country Club in Launceston 6–9 February 2011, the author presented a summary of the results as a Powerpoint presentation entitled *Standards: A necessary evil or a lifesaver?*' and the presentation is available online at <https://sites.google.com/site/rirdclavandinfinalreport/ian-southwell> as Attachment 5.

Discussion

In relation to the objectives of the project, a number of comments need to be made:

- The results of this research clarified the industry's position with respect to the quantities and qualities of the lavandin oils being produced throughout Australia.

- The industry has experienced a downturn since the project was initiated. The reasons for this downturn are climatic and economic. At the commencement of the project, many producing areas were in drought. This was followed by the catastrophic Victorian bushfires in summer 2009 which burnt out at least three lavandin farms. These events coincided with the global economic crisis (GEC) which had a significant impact on the industry as much of it was funded from income derived from superannuation, shares and other funds suffering from the GEC. Consequently, insufficient samples were received for a statistically significant outcome. Only 13 had been received by the time the project was initially due to be wound up.

- Discussions with RIRDC initiated a project variation; a two-year time extension was granted to allow extra time for the industry to submit samples; $4 000 was cut from the budget; the shortfall in samples was to be balanced by re-analysing previous results determined at WAI with the view to correlate plant variety with chemical quality and market acceptance. This is shown in this report as the project addendum. During this extension period, a further 11 samples were submitted making a total of 24 (48 per cent of the original industry projection).

- The project was still considered worthwhile albeit on a smaller scale.

- As the project continued, it became obvious that now is not the time to approach Standards Australia or the ISO about elaborating new standards especially for Australian-produced lavandin oils.

Implications

The submitted oils were found to be most variable with respect to the measured parameters: flash point; aroma; physical constants (optical rotation, specific gravity; refractive index; solubility in alcohol) and chemistry.

Now is not the time to approach Standards Australia or the ISO about elaborating new standards especially for Australian-produced lavandin oils. At a later time, when more samples which are less variable in their specifications, are available, standards elaboration could be re-considered.

After consultation, the members of the Standards Australia committee agreed that the lavandin oil industry is not yet at the right stage of development for the elaboration of separate standards for Australian-produced lavandin oils.

Recommendations

- Consolidate the industry by developing best varieties for oil yield and quality while the industry is still relatively small.
- Examine distillation and storage techniques to ensure that: (1) times are of adequate length to include missing high-boiling compounds and herbal coumarin notes; and (2) ‘old’, stale and burnt notes are not evident.
- Reconsider the elaboration of specific standards for locally grown lavandin when production has increased and quality is less variable.
- Most producers should continue the practice of value-adding and marketing regionally rather than seeking access to international markets for bulk oil.
- Be aware that there may become a time when regulatory authorities will require products to meet existing standards.

Appendix 1 TALGA area liaison representatives

TALGA has, amongst its members, liaison officers who are located throughout Australia. TALGA members and other interested lavender growers can contact these members in regards to queries regarding membership, lavender growing or members and activities within their region.

Area	Name	Phone	Email
National Co-ordinator	**Bruce Bebbington**	08 9761 7535	lavenderfields@bigpond.com
New South Wales (Hume Country Lavender – Monaro Region)	**Nerida Cullen**	02 4822 6986	colepark@goulburn.net.au
New South Wales (Hunter Valley Region)	**Kathryn Davies**	02 4998 8337	lagunalavender@bigpond.com
Queensland	**Tere Bonner**		tere@aloomba.com
South Australia	**Meg Bilney**	08 8853 7222	oakenstaffhomestead@yahoo.com
Victoria (Eastern Victoria)	**Jean Sargeant**	03 5964 8238 03 9005 6238 (SKYPE)	lucyslavender@bigpond.com
Victoria (Central Victoria)	**Fiona Glover**	03 5334 4175	fiona@creativedriedflowers.com
Western Australia	**Heather Walford**	08 9756 0242	lavenderfarm@westnet.com.au
Tasmania	**Robert Ravens**	0448 106 565	robert@bridestowelavender.com.au

Appendix 2 Sample details

Project	Sample No.	Cultivar	Source
1	2007 I 5	Miss Donnington	Marulan NSW
2	2007 I 13	Super	Manjinup WA
3	2007 I 17	Super	Stanthorpe NSW/Qld
4	2007 I 19	Miss Donnington	Stanthorpe NSW/Qld
5	2007 I 20	Margaret Rocky Hall	Stanthorpe NSW/Qld
6	Int 08 8	Super	Yass NSW
7	Int 08 9	Super	Manjinup WA
8	Int 08 10	Super	Laggan NSW
9	Int 08 15	Super	Marulan NSW
10	Int 08 16	Super	Goulburn NSW
11	Int 08 17	Impress Purple	Ararat Vic
12	Int 08 18	Super	Ararat Vic
13	Int 08 19	Miss Donnington	Ararat Vic
14	LI 09/9	Margaret Rocky Hall	Inglewood Qld.
15	LI 09/14	uncertain	
16	LI 09/15	uncertain	
17	LI 09/16	uncertain	
18	LI 09/17	uncertain	
19	LI/S18	Super	Manjinup WA
20	LI/S19	Margaret Rocky Hall	Stanthorpe NSW/Qld
21	LI/S20	Impress Purple	Stanthorpe NSW/Qld
22	LI/S21	Super	Marulan NSW
23	LI/S22	Super	Laggan NSW(early harvest)
24	LI/S23	Super	Laggan NSW (late harvest)
25*	LA10/1	Bee	
26*	LA10/2	Avice Hill	
27*	LA10/3	Bee	
28*	LA10/4	Pacific Blue	
29*	LA10/5	Avice Hill	
30*	LA10/6	Bosisto	
31*	LI10/1	Grosso	
32*	LI10/2	Abrial	
33*	LI10/3	Impress Purple	
34*	LI10/4	Miss Donnington	
35*	LI10/5	Allardii	
36*	LI10/6	Super???	

*GC and perfumery assessment only

Appendix 3 Flash point results

Project sample no.	Sample no.	Flash point (°C)
1 + 2	2007 I 5 + 13 (50/50)	66.0
4 + 5	2007 I 19 + 20 (50/50)	72.0
6 + 7	Int 08 8 + 9 (50/50)	70.0
8 + 9	Int 08 10 + 15 (50/50)	70.0
10 + 11	Int 08 16 +17 (50/50)	64.0
12 + 13	Int 08 18 +19 (50/50)	71.0
14	LI 09/09	65.0
15	LI /S 14	59.0
16	LI/S/15	53.0
17	LI/S/16	58.0
18	LI/S/17	65.0
19	LI /S 18	50.0
20	LI/S/19	65.0
21	LI/S/20	55.0
22	LI/S/21	65.0
23	LI/S/22	54.0
24	LI/S/23	50.0

Appendix 4 Perfumery evaluation reports

Stage 1: Perfumery evaluation report

"As per your request, I have odour evaluated the 13 lavandin oil samples against a fresh sample of market Lavandin grosso oil (and also fresh market samples of Lavandin abrialis and Lavender oil 40/42 for reference).

The odour quality varied quite noticeably across the 13 samples with inconsistencies in top/middle/base notes. In other words a given sample may have a poor top-note, but be satisfactory in the middle and/or base notes.

As the primary function of lavandin oil is in the top note of a fragrance,

I used this as the determining factor in rating the 13 oils, so if the top note was not within the odour profile of the market sample of Lavandin grosso oil, the sample failed to be categorized in the top bracket, even if it had excellent middle and/or base notes.

The most obvious difference between the market lavandin grosso oil and the submitted oils was a lack of herbal coumarin notes, which present themselves in the middle and particularly the base notes. This suggests to me that your lavandin needs to be distilled for longer in order to bring over some of the missing high-boiling compounds i.e. coumarin etc.

I have divided the 13 samples into 4 groups (as well as giving individual comments on the attached sheet [table]).

Best: #2, #6, #8; Second: #12, #9 (10); Third: #1, 3, 7, 5; Last: #4, 11, 13.

J. Lambeth, Fragrance Consultant, 11th May 2009"

#1	(2007 I 5)	Bit too fruity, not floral enough, going towards abrialis – strange dry out.
#2	(2007 I 13)	Sweet lavender-like – lots of power, slightly "old", otherwise very good.
#3	(2007 I 17)	Sweet 'malty' note (still note?), overlying good lavandin notes but not complex or herbal enough.
#4	(2007 I 19)	Strange sweet note reminiscent of dimethyl sulphide (still note?) which spoils the top-note. Bit lifeless, poor dry-down.
#5	(2007 I 20)	Quite sweet, lavender like, but thin on herbal coumarin notes? Distill longer.
#6	(Int 08 8)	Very nice, well rounded. Distill a bit longer to achieve more back notes?
#7	(Int 08 9)	Nice and fresh, bit camphoraceous, but good back notes.
#8	(Int 08 10)	Fresh sweet nice. Short on herbal coumarin backnotes, otherwise good.
#9	(Int 08 15)	Bit light, bit resiny, lacks a little floralness. Improves. Good dry-down.
#10	(Int 08 16)	Unusually sweet (malty) topnote, but very floral – bit light. ? Distill longer.
#11	(Int 08 17)	Bit thin and light, strange "tea" like and other odours. Lacks backnotes.
#12	(Int 08 18)	More volatile, less lavendery than grosso. Bit more towards abrialis. Improves a lot.
#13	(Int 08 19)	Bit fresh, earthy, camphoraceous and thin. Some strange notes including a cis-3-hexenol type green note.

Stage 2: Perfumery evaluation report

“As per your request, I have odour evaluated the 23 submitted Lavandin Oil samples against a fresh sample of Drom quality Lavandin Grosso Oil (and also fresh Drom quality samples of Lavandin Oil Abrialis, Lavender Oil 40142 and Spike Lavender Oil for reference.)

All samples were evaluated 3 times.

The odour quality varied enormously over the 23 samples. Several of the samples had odour profiles with more resemblance to Lavender Oil rather than Lavandin. LA 10/2 was particularly outstanding.

The initial top note of Lavender/Lavandin is the most important aspect of these oils; however a number of the samples had unacceptable top notes, ruining their otherwise good profiles.

The primary difference between the Drom standard Lavandin Oil Grosso and the 23 submitted oils is the lack of herbaceous sweet caramel coumarin notes which are characteristic of the Drom quality.

The best Lavandin samples were: LI/S16 & LI/S17; Second Row Samples were: LI/S20, LI 10/2, LI/S18, LI 09/9; Unsuitable: LI 10/5, LI 10/6, LI/S19; Special interest: LA 10/2 & to a lesser extent LA 10/3, LA 10/1, LA 10/4, LA 10/5.

J. Lambeth, Fragrance Consultant, 19th July 2010"

	LA 10/1	Sweet Lavender top note, lacks herbal and camphoraceous elements of Lavandin. Odour falls between Lavender Oil 40/42 and Lavandin Oil.
	LA 10/2	Sweet Lavender with noticeable 3-Octanone top note. Good Lavender like. Lacks the herbal Camphor notes of Lavandin. Almost "Bridestowe" Lavender like. Very pleasant stand alone Lavender. Interesting in its own right.
	LA 10/3	Good fresh Lavender top note. Lot of 3-Octanone. More like Lavender than Lavandin.
	LA 10/4	Good powerful top note. Odour profile falls between Lavender Oil and Lavandin Abrialis.
	LA 10/5	Sweet Lavender top note. Odour profile falls between Lavender Oil and Lavandin Grosso.
	LA 10/6	Thin and lacking characteristic Lavender/Lavandin note. Bit "white camphor oil" like.
	LI 10/01	Fresh camphoraceous sage like. The Lavender notes smell "aged".
	LI 10/2	Good Lavender notes but missing Coumarin back notes. Quite (Linalyl) Acetate like.
	LI 10/3	Bit camphoraceous, lacking in floral notes. Bit "old" Lavender odour.
	LI 10/4	Camphoraceous and thin. More like Lavandin Abrialis without the base notes.
	LI 10/5	Herbal and Thujone like note with camphoraceous tones. Not much Lavender. Like sage oil plus a bit of Armoise.
	LI 10/6	Strange green carbonate/sweet minty top note. Unpleasant urine and burnt notes.
#14	(LI 09/9)	Rather camphoraceous. More like Abrialis, but without the caramel Coumarin notes.
#15	(LI/S14)	Similar to LI/S5 but less extreme. Bit sage/camphoraceous. Top notes lacking floral brightness of Lavender. lmproved mid notes but still somewhat "old" smelling. Smokey/burnt notes in dryout.
#16	(LI/S15)	Good Lavandin. Fresh well balanced. The best "commercial" Lavandin of the submitted samples. Well balanced.
#17	(LI/S16)	Good Lavandin. Fresh well balanced. The best "commercial" Lavandin of the submitted samples. Well balanced.
#18	(LI/S17)	Very nice, sweet with characteristics ol Grosso and Lavender Oil 40/42. Dryout a touch "smokey".
#19	(LI/S18)	Begins with a peculiar sage-malty note which spoils an otherwise good all-rounder. Quite (Linalyl) Acetate like.
#20	(LI/S19)	Strange foreign (to Lavandin) volatile top note. Slight smokey and camphoraceous note spoils this oil.
#21	(LI/S20)	Good Lavandin top notes. Lacks the Coumarin sweetness of Grosso. More towards Abrialis. Has a Borneol like note.
#22	(LI/S21)	Malty sweet top notes. Good middle notes. Lacks Coumarin notes. Overall a bit "thin".
#23	(LI/S22)	Bit sweet (spearminty) other notes more like Abrialis than Grosso. A touch thin / camphoraceous. Overall shows potential, excluding the initial top note.
#24	(LI/S23)	Sweet malty top note. Overall like Lavender 4O142 and Lavandin. Settles down well. Spoilt by its initial oversweet note.


3000
2500
2000
1500
1000
500

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Australian Standards for Oil of Australian Lavandin Cultivars

by Ian Southwell

Publication No. 11/133

This report records the quality of the lavandin samples that are currently being distilled by numerous lavender growers throughout Australia. The specifications used to determine essential oil quality were measured for locally produced lavandin oils and compared both with the specifications published for internationally traded oils and other Australian-produced oils submitted for this project.

The results presented in this report are of interest to those currently producing lavender oils, those thinking of becoming lavender oil producers, and those who use or sell lavender and lavandin oils in local and international outlets.

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