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Evaluating the potential of Eucalyptus bosistoana essential oil

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Eucalypt essential oils are manufactured at commercial scale in many countries, but not in New Zealand. Recent research at the University of Canterbury School of Forestry investigated the potential for essential oil to be produced as an economic by-product of *Eucalyptus bosistoana* plantations. This eucalypt is a Class 1 durable species, selected by the NZ Dryland Forests Initiative for genetic improvement. The conclusion reached was that producing commercial essential oil as a by-product of timber plantations may well have economic potential.

Some essential oil use

Essential oils are volatile and complex natural compounds which have a characteristic fragrance and flavour. We are probably all familiar with the aroma of eucalypts and some of the health and hygiene products made with eucalypt essential oils.

The genus *Eucalyptus* represents approximately 900 species and subspecies but only around 20 are known to have the potential for producing commercial-grade essential oils. At present there is no commercial scale eucalypt oil production in New Zealand. The main oil source is from *E. globulus* produced in China, along with oil produced from *E. polybractea* from Australia. Other countries also produce essential oils from eucalypts.

International commercial eucalypt oil production

Category	Species	Countries
Medical	*E. globulus*	China, Portugal, Spain, India and Brazil
	E. Smithii	South Africa and Swaziland
	E. polybrachtea and *E. drives*	Australia
	E. radiata	Australia and South Africa
	E. exserta	China
	E. camaldulensis	Nepal
Perfumery	*E. citriodora*	China, Brazil and India
	E. staigeriana	Brazil
Industrial	*E. dives*	South Africa and Australia
	E. campaniulata	Australia

The main components of eucalypt essential oils are over 100 different terpenes. For commercial purposes, the quality of eucalypt oil is governed by the proportion of the terpene 1,8-cineole. The content of high-quality essential oil should be not less than 55 per cent, while the international standards specify a content of 70 per cent.

A brief history of eucalypt essential oil

Indigenous Australians used eucalypt oil for many centuries before Europeans arrived and eucalypt oil was the first Australian indigenous commercial export in the early years of European settlement. Distillation experiments on eucalypt oil were reported first in 1788 for Sydney peppermint, *E. piperita*.

The species *E. bosistoana* is named after Joseph Bosisto who realised the commercial export potential of eucalypt oil. At the time, *E. bosistoana* had not been extensively researched for biological or commercial purposes, but its timber was well regarded by settlers in Australia. Back in the 1850s, the major component of *E. globulus* essential oil was identified as eucalyptol later named 1,8-cineole.

The research undertaken

The overall objective of the research was to determine whether *E. bosistoana* essential oil has potential as a commercially viable by-product. It was also to determine whether the essential oil content in the leaves has any relationship to levels of pest and disease tolerance. The research had four main aims –

- To develop an analytical method for analysis of the essential oils
- To investigate the seasonal effect on the oil yield and composition of mature and immature *E. bosistoana* leaves
- To determine the genetic parameters of the leaf oil traits
- To outline the economic aspects of essential oil production.

Species comparison

A range of essential oils were analysed from *E. argophloia*, *E. globoidea*, *E. tricarpa*, *E. quadrangulata* and *E. sideroxylon*, in addition to the New Zealand grown *E. nitens*. The results confirmed that *E. bosistoana* produced the most oil at 15.8 microlitres per gram and had the best quality with, at 62 per cent, the highest 1,8-cineole level of the assessed species. The quality and quantity of *E. bosistoana* oil was comparable to *E. globulus*, the main source of eucalypt oil in the global market.

An interesting observation was that, until recently although *E. argophloia* and *E. bosistoana* were thought to be closely related, the essential oil of *E. argophloia* was not comparable to that of *E. bosistoana*. *E. argophloia* had the lowest oil yield and 1,8-cineole was absent. Research has in fact now proved that the two species are not closely related.

Sampling for monthly analysis

Seasonal variation

Seasonal variation of essential oil content and composition in immature and mature leaves of five *E. bosistoana* families was monitored by analysing monthly samples for two years months from March 2019 to April 2021. Leaf maturity influenced total oil content as well as the 1,8-cineole concentration. Mature leaves contained higher proportions but contained less total oil than immature leaves. The highest total oil yield was obtained from leaves collected during summer, suggesting summer is the best period for leaf harvesting.

Genetic control

There were significant differences in oil quantity and oil quality between the five *E. bosistoana* families which were intensively tested, indicating genetic control. One of nine breeding trials, initially established to select for superior growth and wood properties, was then analysed for essential oils. A total of 20 chemical components were quantified in leaf extracts from the trees.

Significant genetic control was found for oil quality as well as oil quantity in the leaves. While oil quality was unfavourably correlated to oil quantity – in other words, plant families with higher quality oil have lower quantity of oil in their leaves, this is not necessarily relevant for a commercial use. The reason is that total oil yield per hectare depends on oil content in individual leaves and also on the total leaf biomass.

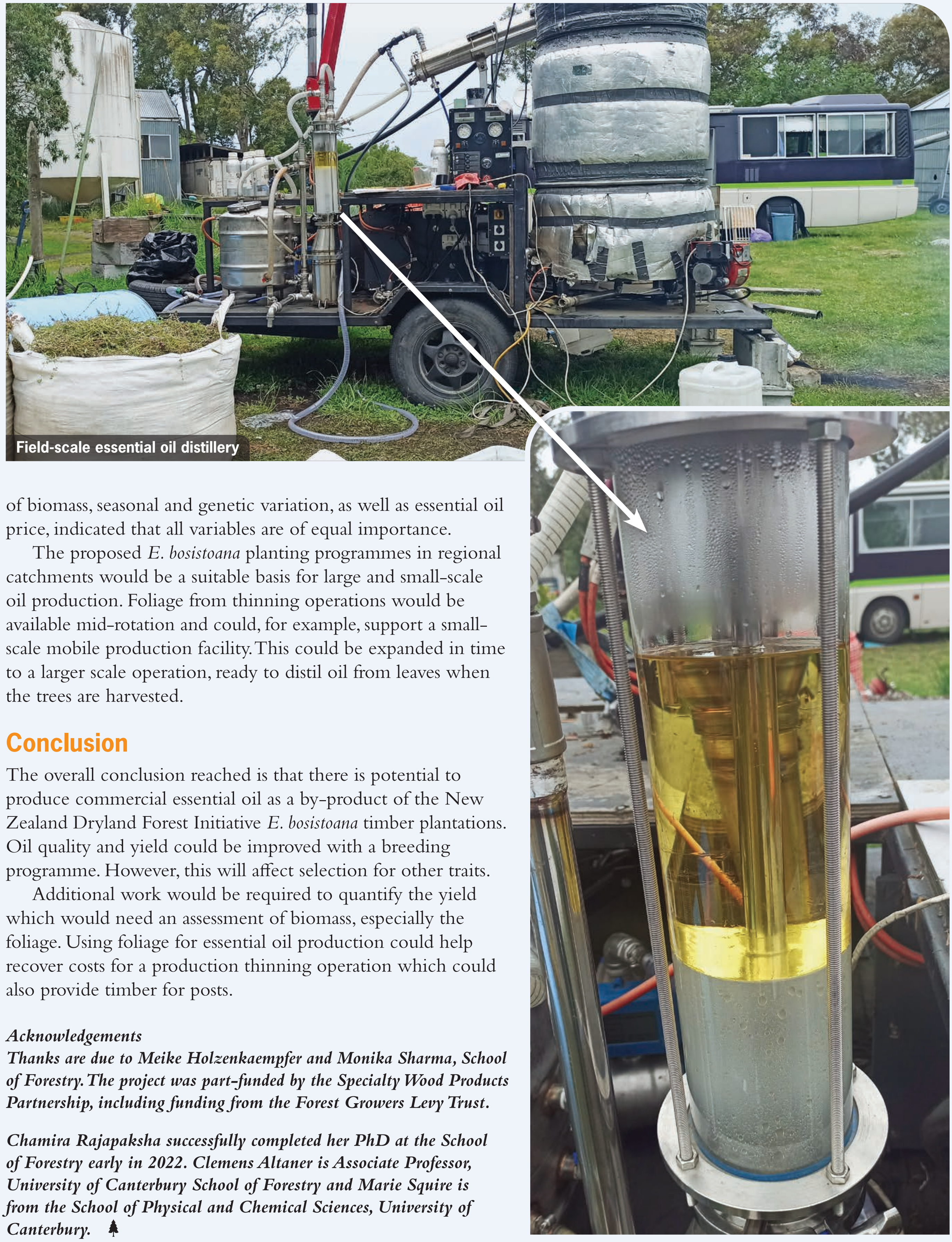
This means that you need to consider total biomass production as well as oil quantity in the leaves. Genetics of leaf biomass production has not been assessed in this study and therefore for now the focus has to be only on quality. Of the 85 *E. bosistoana* families tested in this part of the research, 19 possessed breeding qualities indicating that their oil would meet the commercial standard.

Economic aspects

There are some small-scale essential oil producers but there are no commercial eucalypt essential oils produced. To estimate suitability for commercial production, foliage biomass per hectare was estimated. A sensitivity analysis

Estimated leaf biomass and oil yield from peeler pole regime

Peeler pole plantation from a 20-year rotation	Stems a hectare	Fresh leaf biomass per tree kilograms per stem	Fresh leaf biomass kilograms a hectare	Oil yield kilogrammes a hectare	Oil value in dollars a hectare at $30 a kilogramme
Planting	1,100				
Thinning	400	6	2400	24.2	$727
Pruning	700	4	2,800	28.3	$848
Harvest	700	72	50,400	509	$15,282
Totals			**55,600**	**561.6**	**$16,848**



Field-scale essential oil distillery

of biomass, seasonal and genetic variation, as well as essential oil price, indicated that all variables are of equal importance.

The proposed *E. bosistoana* planting programmes in regional catchments would be a suitable basis for large and small-scale oil production. Foliage from thinning operations would be available mid-rotation and could, for example, support a small-scale mobile production facility. This could be expanded in time to a larger scale operation, ready to distil oil from leaves when the trees are harvested.

Conclusion

The overall conclusion reached is that there is potential to produce commercial essential oil as a by-product of the New Zealand Dryland Forest Initiative *E. bosistoana* timber plantations. Oil quality and yield could be improved with a breeding programme. However, this will affect selection for other traits.

Additional work would be required to quantify the yield which would need an assessment of biomass, especially the foliage. Using foliage for essential oil production could help recover costs for a production thinning operation which could also provide timber for posts.

Acknowledgements
Thanks are due to Meike Holzenkaempfer and Monika Sharma, School of Forestry. The project was part-funded by the Specialty Wood Products Partnership, including funding from the Forest Growers Levy Trust.

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