

# In Essence

Journal of the International Federation of Professional Aromatherapists

'Hearing'  
essential oils

Smell training

Aromatic  
plants of Arizona

Virtual  
connections

Spotlight on  
sandalwood

# Sandalwood: conservation and custodians

Dr **Kelly Ablard** outlines major threats to the *Santalum* species and highlights conservation efforts underway in Western Australia to ensure sustainable management and the future security of *Santalum spicatum*



## Taxonomy

*Santalum spicatum*, commonly referred to as Western Australian sandalwood or Dutjahn by Aboriginal desert nomads, belongs to the family Santalaceae, and is recognised as a 'true' sandalwood. The Santalaceae, or sandalwood family, is a widely distributed family of

flowering plants recognised for their partially parasitic behaviour on host plants, and their aromatic wood.

Recognised synonyms of *S. spicatum* include *S. cygnorum* Miq., *Eucarya spicata* (R.Br.) Sprague & Summerh., *Fusanus cygnorum* Kuntze, *F. spicatus* R.Br., *F. spicatus* var. *frutescens* Hochr., and *Mida cygnorum* (R.Br.) Kuntze (RBGK, 2021).

## Occurrence

*Santalum spicatum* occurs across a wide range of environmental conditions from Western Australia to South Australia. Its original habitat, currently over 50 million hectares, is located deep in the Gibson desert, northeast of Kalgoorlie, and is recognised under Australian Native Title as the Dutjahn Homelands.

## Biology

*Santalum spicatum* is a root hemi-parasitic tree capable of photosynthesis but requires nutrients and water from host trees to survive and grow. Ideal hosts include nitrogen-fixing trees from the *Acacia*, *Cassia*, *Casuarina*, and *Eremophila* genera. Some of these species are commonly referred to by the Wongi and Martu peoples as a water tree, and the gidgee tree (Smith, 2019; D. Farmer, personal communication, April 27, 2021).

*Santalum spicatum* grows slowly reaching heights of 3-10 m tall. They are single- or multi-stemmed, and flower during years when there is consistent rainfall between January and April (Kealley, 1991). This can vary between the species' two ecotypes; the arid and the semi-arid ecotype (Byrne *et al*, 2003a).

For example, where there is more rainfall in the semi-arid areas in the south the species has larger leaves



Western Australian sandalwood (*Santalum spicatum*) tree

and nuts, higher chlorophyll content, generally thicker stems, and a lower concentration of oil than species in the arid areas in the north (Loneragan, 1990; Fox & Band, 1993). Further, the semi-arid ecotype can produce fragrant heartwood from age 5-10 years while the arid ecotypes require longer before reaching harvestable oil content (FPC, 2017).

*Santalum spicatum* has a preferentially outcrossed mating system but is also capable of self-fertilisation under extreme conditions. A red-brown fruit with leathery skin develops from the flower when germination is successful. However, the survival rate of germinated seeds is as low as 20% in plantations and 1-5 % in cultivated plots (Kealley, 1991). It is understood that the mating system of populations in the north have higher levels of genetic diversity than those in the south (Byrne *et al*, 2003b).

## CONSERVATION

There are currently 18 accepted *Santalum* species of which 70% have been classified as threatened or near threatened, and one is extinct. Six of these accepted species occur in Australia - *S. spicatum*, *S. lanceolatum*, *S. acuminatum*, *S. murrayanum*, *S. obtusifolium*, and *S. album*. ►



*Dutjahn custodians and harvesters in the bush alongside a dutjahn (Santalum spicatum) tree*

The top threats to *Santalum* species include climate change, habitat destruction, pathogens, illegal harvesting and overexploitation with little or no signs of regeneration, (WCMC, 1998; Das and Pullaiah, 2021; IUCNa,b, 2021; RBGK, 2021). The most heavily exploited threatened species is *S. album*, which is utilised within its native regions and internationally for its scented wood and essential oil extracted from the heartwood (Das & Pullaiah 2021).

However, most of the world demand for sandalwood essential oil is supplied from Western Australian sandalwood *S. spicatum* because its chemical and aromatic profiles are similar to *S. album* (Shea *et al*, 1998; Burnes *et al*, 2003a; Pullaiah & Swamy, 2021). Unlike *S. album*, *S. spicatum* is not vulnerable to extinction but commercial demand continues to grow for it (Lingard and Perry, 2018), a situation which has been ongoing since 1845 (Loneragan, 1990).

Sustainable management of this species is therefore necessary, especially if *S. spicatum* essential and seed (carrier) oil are to continue to mitigate some of the heavy exploitation of threatened species such as *S. album*. This need was recognised in 1926 when Professor E H Rennie, in his presidential address to the Australian Association for Advancement of Science, said, “every precaution should be taken to provide against a complete extinction of this valuable tree” (Williams, 2010).

The concept of sustainability urges the current generation to make decisions for the benefit of their children seven generations into the future. Given the broad concept of sustainability, Airmid Institute tailored five sustainability standards to essential- and carrier oil-bearing plants (such as *S. spicatum*), their environment, and to strengthen communities, and foster continuous success. The five standards, which are meant to overlap, are: social, environmental, cultural, economic, and distribution and labelling.

To meet these standards entails enhancing the quality of the environment and natural resources; implementing renewable and on-land resources efficiently and naturally; financial stability; and, through local and global community outreach and engagement, research and education. Success also requires collaboration between, for example, scientists and indigenous peoples.

This is extremely important when dealing with a species whose plant biology and cultivation is delicate and

complicated, and when regeneration is required after harvesting. Further, extraction of essential and seed oil from plant material must also be carefully done, and in a timely fashion. Distillations should be efficient, and should preferably integrate renewable resources into the process. Chemical analysis should be performed on batches regularly and the data available for the public, and additional quality-control checks of the laboratory and distillation equipment should be frequently performed.

The implementation of any one of these standards throughout the supply chain of an internationally commercially valuable essential and carrier oil-bearing plant such as *S. spicatum* is critical, especially if, for example, it can be used as an alternative to threatened *S. album*. One company dedicated to the management of a sustainable and quality supply of *S. spicatum* within these five pillars is demonstrated by Australian-based DSO company, a company brought to life by Dutjahn Custodians.

Dutjahn Custodians are Traditional Gibson Desert 2nd contact Aboriginal desert nomads of Wongi and Martu heritage who have been sustainably harvesting dutjahn since 1977. Dutjahn custodians Clinton Farmer, Chairman of Kutkabbuba Aboriginal Corporation, and Darren Farmer, Dutjahn Director, were instrumental in winning a landmark Native Title settlement over their homelands in 2014. They carried out the vision of their ancestors to establish the DSO company so that it could be a successful example of socio-economic independence for other Aboriginal communities in their homeland.

Their initiatives gained further momentum in 2017 when the Aboriginal desert nomads partnered with the founders of Australia’s largest Western Australian sandalwood plantation growers. Their relationship is rooted in the combined ancestral knowledge of, and respect for, wild dutjahn, and modern knowledge of Western Australian sandalwood oil production. The five sustainability standards help to demonstrate that their work will ensure a sustainable and quality source of essential and carrier oil for future generations.

## **Social sustainability**

This means: Enriching and preserving communities through social engagement, community investment, equal access to social resources, equal opportunity, and community-based education while respecting social diversity, respecting community members, and implementing practices that will benefit future generations.

### *Community*

- DSO was the first Australian company to be awarded the United Nations Equator Prize. Recipients of this award are recognised for their exemplary work in developing sustainable environmental solutions to the impacts of climate change in collaboration with local and Aboriginal communities
- A percentage of DSO profits are dedicated to Aboriginal community-based educational and training programmes.



### Collaboration

- DSO and the K. Farmer Dutjahn Foundation (KFDF), an external not-for-profit foundation, have collaborated on health projects aimed to protect Aboriginal communities against Covid-19, and are in the process of developing more projects focused on education, and environmental and cultural protection. DSO is committed to contributing AUD\$200,000.00 to KFDF to support these projects and the Aboriginal people.
- DSO has many clients who request specific grades of oil to meet a chosen odour and/or chemical profile. Work is conducted internally or externally in collaboration on specialty research and development projects for mutual benefit

### Environmental sustainability

This means: the ongoing management of a physical environment that supports and enriches biodiversity, protection and preservation of natural resources, and which balances the needs of communities to benefit future generations.

#### Ancestral cultivation

- Aboriginal desert nomads work closely with Nature to preserve dutjahn (D. Farmer, personal communication, April, 27, 2021). In this respect, they are master cultivators and caretakers. This comes from their ancestral knowledge passed down for hundreds of generations, as well as from their strong connection to their environment and the seasons, an understanding of ecology, a deep respect for Nature, and their dedication to caring for the plants they are responsible for.
- Their knowledge about dutjahn pollination biology, flowering times, and outcrossing rates is comprehensive. It is understood that a high level of genetic diversity is key for the survival of many plants including dutjahn that are experiencing impacts of climate change. Dutjahn Custodian Darren Farmer explains that climate change is a big problem for dutjahn because it is resulting in longer periods of drought; he recently witnessed the longest dry season in 40 years (personal communication, April 27, 2021). Given that dutjahn caretakers rely on rain as their only source of water, they turn to their cultural resources and an understanding of dutjahn biology for answers. Genetic diversification through selective regeneration and genetic reinforcement of those seeds from trees that look straight in form, grow a lot annually, are healthy (eg disease free), and respond well to micro-climatic changes is one solution.
- Seeds are planted by hand when the weather permits, and the timing of germination needs to be exact. Without the right host for this hemi-parasitic plant, dutjahn will not grow and the oil may not be of the highest quality. Host trees are not planted by the Aboriginal caretakers, so they must be able to identify and choose the right host for each dutjahn seed. Limiting factors such as location, host plant health, general water availability, and micro-climatic conditions can make finding a suitable match for a dutjahn plant challenging. High-quality oil is a post-indicator of a good



*Western Australian sandalwood (Santalum spicatum) plantation*

host match. To an untrained person, for this process to be successful, could take decades to fully understand. However, success lies with the Aboriginal caretakers' intuitive decisions guided by their ancestral knowledge.

#### Natural resources

- Natural resources are the only resources utilised by the Aboriginal caretakers.

#### Pest control

- Aboriginal caretakers are easily able to identify dutjahn pathogens, and rely on their cycles, not chemicals, to naturally control them.

#### Sustainable sourcing

- The Western Australian Forest Products Act 2000 establishes the Forest Products Commission (FPC) to manage *S. spicatum* harvesting and supply (Forest Products Act 2000; Biodiversity Conservation Act 2016). The FPC mission is to support an 'environmentally sustainable and commercially viable forest products industry (FPC, 2017); Dutjahn Custodians have been recognised for their work in line with this mission, so were granted a supply contract. Not only does DSO source wood from Native Title Lands but they also source from Western Australian Plantations Pty Ltd., and purchase wood from aboriginal harvesters primarily from the Kuktububba Aboriginal Community and the area in and around Wiluna, Western Australia.
- DSO is now a Provisional Member to UEBT Union for Ethical Biotrade (<https://www.ethicalbiotrade.org/about-uebt>) and aims to become a full member with verified certification by the end of 2021.
- The Western Australian Sandalwood Plantations also currently manages over 13,000 hectares of sandalwood plantations, which began harvesting in 2015 and will continue over the next 25 years

#### Sustainable harvesting

- DSO harvest teams comprise 80-100 per cent Aboriginal people. Harvesters are dedicated and will travel 600km or further into the bush to set up base camp. They set out early to harvest whole trees, debark them, and load them onto trucks for processing and distillation. For each tree that is removed, 10-15 seeds are planted ►

- Successful harvesting relies not only on harvesting itself, but also on nurturing the delicate relationships formed between communities whose land is being worked on. Dutjahn custodians and harvesters need to understand cultural etiquette within family groups and engage respectfully. Doing so makes the harvesting process physically, socially, and emotionally beneficial.

### **Cultural sustainability**

This means: practices and education based in respect for, and preservation of others' traditions, values, customs, belief systems, living environments and lifestyles.

#### *Education and engagement*

- DSO employs a Cultural Liaison whose focus is to build cultural-based education programmes for DSO staff, clients and other stakeholders so that they can communicate and operate internally and externally, in a culturally appropriate way
- Ranger programmes, designed to provide training on indigenous methods, have been developed for various DSO projects.

#### *Indigenous involvement*

- What makes DSO so unique is its partnership with, and deep respect for, the Dutjahn custodians and Aboriginal peoples. It is well documented that, within this industry, other institutional frameworks did little to consider Aboriginal people's knowledge and interests, learn from them, and to prioritise long-term economic opportunities for them (Lingard and Perry, 2018). DSO is the exception, so much so that Australian Minister Kelly hopes that Dutjahn can be used as a model for a successful Indigenous enterprise (Mozley, 2019). Already evident, the strong relationship between DSO and the Aboriginal communities has resulted in high retention rates and a solid foundation for the future growth of DSO.
- DSO is highly influenced by Wongi and Martu culture. All their Executive business decisions, community engagement, education programmes, traditional ceremonies and work with dutjahn are directly tied into their culture (D. Farmer, personal communication, April 27, 2021).
- 50% of DSO Directors are represented by Aboriginal people, and 17% of the DSO workforce on the production end is Aboriginal

#### *Spiritual connection*

Spirituality is integral to the many Aboriginal desert nomad cultures. DSO Aboriginal caretakers and Dutjahn custodians find many spiritual benefits to their culture when working so closely with dutjahn and in Nature (D. Farmer, personal communication, April 27, 2021).

### **Distribution and labelling sustainability**

This means: accurate and truthful information disclosed to the public, transparency, and integrity in distribution, recycling, and reusable practices and policies. Sourcing and trading within legal parameters and with necessary permits.

#### *Transparency*

- Any new product development is set within transparent contractual commercial guidelines to ensure adherence to Access and Benefit Sharing and with Prior and Informed Consent with Indigenous Australians.

#### *Renewable supplies*

- DSO will roll out a new system of environmentally friendly packaging options as early as July 2021.

#### *Distillation*

- Essential oil from sustainably wild-harvested green and dead plant material, and sustainably managed green plantation wood is extracted using steam distillation in a stainless steel still. The first fraction of the crude oil is removed and set aside. The second fraction undergoes further refinement via a proprietary process
- Hydrosol, the by-product of distillation, is used in cosmetic applications and as an addition to wood powder for incense manufacture.

#### *Quality control*

- Quality assurance measures are in place throughout the manufacture process from wood receipt lot verification, crude oil production, purified oil production and blending of purified oils. Records are kept, weights are measured, identities are verified, and batch quality validated.
- *Santalum spicatum* essential oil is quality controlled physically, chemically and organoleptically. Each crude batch of oil is tested with Refractive Index, Optical Rotation, Acid Value and Gas Chromatograph with Flame Ionization (GCFID). The chemical analysis of each crude lot assists in the final blending of the finished batches. Each final purified and blended batch is chemically, physically and organoleptically tested prior to release for sale. Most DSO oil is made to meet ISO specification for *S. spicatum* essential oil unless otherwise requested. For example, refined oils from different provenances and/or tree parts can be blended to create DSO grades of essential oil to customer specification.

#### *Transportation*

- To help reduce greenhouse gas emissions, DSO and their suppliers consolidate shipments with larger transport vehicles. This allows the harvest crews to spend many weeks in remote areas collecting multiple tons of wood before transport to the processing facilities.

### **Economic sustainability**

This means: practices that support long-term economic growth and fair and adequate compensation, without compromising social, environmental, and cultural sustainability.

- DSO is 50% Aboriginal-owned
- DSO Directors started the business with experience, cultural respect and monetary investment offering the seed money to grow the business. Since its inception the DSO Board, with years of financial experience has ensured the company grew responsibly, managing its material and

human capital expansion sustainably, avoiding excessive debt and undue risk. Financial stability came from wise investments and good business practice but also with assured partnerships from key customers who recognized DSO's special business model. Givaudan and The Estee Lauder Companies are foundational partners to DSO's success by buying product at a fair and equitable price and committing to ordering timeframes. Relationships are the key to DSO's success.

- DSO is developing a line of Aboriginal-inspired products that will come with stories told by the communities who will sell them.

## TRADITIONAL USES

Dutjahn has been used as traditional medicine, for protection, and in cultural practices and ceremonies by the Martu and Wongi Nations for centuries.

**Traditional medicine:** The moist inner lining of dutjahn bark is placed directly onto an area of the body that is wounded to help reduce inflammation and infection, and to help accelerate healing.

The hard outer lining of dutjahn bark, crushed leaves, and its nuts can be heated over a fire and used externally to help reduce muscle pain, prevent infection, and accelerate healing of an external or internal injury.

The cream from the dutjahn nut is often used to moisturise the skin and to help combat skin problems within the communities that were brought in by Europeans.

**Protection:** Dutjahn is a symbol of protection. This is one of the many reasons the bark is burned to ward off snakes, provide a barrier between humankind and evil spirits, and to protect families camped out in the bush.

The bark is also burned to ward off mosquitoes. Interestingly, research conducted on a sesquiterpene alcohol derived from *S. spicata* (dutjahn) was found to be a top candidate for use as a mosquito abatement (Spafford, 2007).

**Cultural practices:** There is a cultural expectation to confer a gift when visiting custodians on territory outside your homeland. The gifts are given to gain trust and thus be allowed the freedom to enter restricted areas. A gift of dutjahn wood, a boomerang, or meat would be considered acceptable and generous.

**Cultural ceremonies:** The smoke from burning dutjahn bark is used in smoking ceremonies for social cleansing, and to enhance the practice of meditation. Objects used as part of these ceremonies are often made from dutjahn wood.

There are some ceremonies still practised today using the bark and other parts of dutjahn that are too sacred to disclose (D. Farmer, personal communication, 27.04.21).

When sourcing aromatics, it is important to keep sustainability standards like these in mind, and to respect the importance of their modern and traditional use

within Indigenous communities. Doing so will help ensure sustainable, ethical sources of medicinal and aromatic plants for generations to come.

## References

- Biodiversity Conservation Act (2016). Western Australian. *Version 00-d0-01*. [www.legislation.wa.gov.au](http://www.legislation.wa.gov.au).
- Byrne M, Macdonald B & Brand J (2003). Phylogeography and divergence in the chloroplast genome of Western Australian sandalwood (*Santalum spicatum*). *Heredity*, 91, 389-395.
- Byrne M, Macdonald B, Broadhurst L & Brand J (2003). Regional genetic differentiation in Western Australian sandalwood (*Santalum spicatum*) as revealed by nuclear RFLP analysis. *Theoretical and Applied Genetics*, 107, 1208-1214.
- Das SD & Pullaiah T (2021) Sustainable use, threats, and conservation of sandalwood. In T. Pullaiah, VA Bapat, VD Reddy, SC Das, MK Swamy & KSR Murthy (Eds.), *Sandalwood: Silviculture, Conservation and Applications*. (267-277). Springer.
- Fox JED & Brand JE (1993). Preliminary observations on ecotypic variation in *Santalum spicatum* 1. Phenotypic variation. *Mulga Research Centre Journal*, 11, 1-12.
- FPC (Forest Products Commission) (2017). *Native sandalwood industry strategy for Western Australia: Six steps for a valuable, sustainable industry in regional WA*, Western Australian Government. <https://www.wa.gov.au/government/publications/fpc-native-sandalwood-industry-strategy>.
- International Union for Conservation of Nature (IUCN) (2021, August) Regional Red List. <https://www.iucnredlist.org>.
- International Union for Conservation of Nature (IUCN) (2021, August) Global Red List. <https://www.iucnredlist.org>.
- Kealley IG (1991). The management of sandalwood. *Wildlife Management Program 8*. (1-137). Department of Environment and Conservation. Western Australian Parliament.
- Lingard K & Perry M (2018). An assessment of the regulatory framework of the Western Australian sandalwood industry. *Australian Forestry*. <https://doi.org/10.1080/00049158.2017.1420455>.
- Loneragan OW (1990). Historical review of sandalwood (*Santalum spicatum*): research in Western Australia. *Research Bulletin No. 4*. Department of Conservation and Land Management, Perth.
- Mozley S (2019). Dutjahn sandalwood oils becomes first Australian business to win UN equator prize. *National Indigenous Times*. <https://nit.com.au/dutjahn-sandalwood-oils-becomes-first-australian-business-to-win-un-equator-prize/>.
- Pullaiah T & Swamy MK (2021) Sandalwood: The green gold. In T. Pullaiah, VA Bapat, VD Reddy, SC Das, MK Swamy & KSR Murthy (Eds.), *Sandalwood: Silviculture, Conservation and Applications*. (1-9). Springer.
- RBGK (Royal Botanic Gardens Kew) (2021). Plants of the world online. <http://www.plantsoftheworldonline.org/> Accessed August 2021.
- Shea SR, Radomiljac A, Brand J & Jones P (1985). An overview of sandalwood and the development of sandal in farm forestry in Western Australia. In Radomiljac AM, Ananthapadmanabho HS, Welbourn RM, Satyanarayana RK (Eds.), *Sandal and its Products*. ACIAR: Canberra. 9-15.
- Smith PA (2019) Stimulation of Western Australian sandalwood (*Santalum spicatum*) oil production using multiple treatments. *Edith Cowan University*. <https://ro.ecu.edu.au/theses/2202/>.
- Spafford H, Jardine A, Carver S, Tarala K, van Weiss M & Weinstein, P. (2007). Laboratory determination of efficacy of a *Santalum spicatum* extract for mosquito control. *Journal of the American Mosquito Control Association*, 22(3), 304-311.
- WCMC (World Conservation Monitoring Centre) (1998). *Santalum fernandezianum*. IUCN Red List of Threatened Species 1998. <https://dx.doi.org/10.2305/IUCN.UK.1998.RLTS.T30406A9544750.en>. Accessed August 2021.
- Williams C (2010). *Medicinal plants in Australia*. Vol. 1, Bush pharmacy. Rosenberg Publishing.

Photographs reproduced by kind permission of Dutjahn

Dr Kelly Ablard, Founder and Executive Director, Airmid Institute, is a conservation biologist and certified aromatherapist dedicated to the global education, research, and sustainable management of medicinal and aromatic plants (MAPs). A global presenter, she has authored peer-reviewed research in the fields of conservation, sustainability, genetics, chemical and behavioural ecology, evolutionary biology and ethnobotany. She currently conducts research in Peru with the Shipibo and Quechua Indigenous peoples into their threatened MAPs, and in Southern California on the overexploited white sage. Kelly is also Co-owner/Co-principal of Essence of Thyme College of Holistic Studies Ltd, British Columbia, Canada. [www.airmidinstitute.org](http://www.airmidinstitute.org) [info@airmidinstitute.org](mailto:info@airmidinstitute.org)