

<b>Taxon:</b> <i>Agathosma betulina</i> (P. J. Bergius) Pillans	<b>Family:</b> Rutaceae
<b>Common Name(s):</b> boegoe buchu honey buchu mountain buchu	<b>Synonym(s):</b> <i>Barosma betulina</i> (P. J. Bergius) Bartl. & H. L. Wendl. <i>Hartogia betulina</i> P. J. Bergius <i>Parapetalifera betulina</i> (P. J. Bergius) W. Y. Young

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Assessor Approved	<b>End Date:</b> 15 May 2023
<b>WRA Score:</b> -3.0	<b>Designation:</b> L	<b>Rating:</b> <span style="background-color: yellow;">Low Risk</span>

**Keywords:** Aromatic Shrub, Mediterranean climate, Fire Resprouter, Ballistic Dispersal, Ant-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Intermediate
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
203	Broad climate suitability (environmental versatility)	y=1, n=0	n
204	Native or naturalized in regions with tropical or subtropical climates	y=1, n=0	n
205	Does the species have a history of repeated introductions outside its natural range?	y=-2, ?=-1, n=0	?
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	n
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	n
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals		
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
408	Creates a fire hazard in natural ecosystems		
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	n
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	n
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic		
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)		
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	n
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	n
704	Propagules adapted to wind dispersal		
705	Propagules water dispersed	y=1, n=-1	n
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m <sup>2</sup> )		
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides		
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	y
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

**Supporting Data:**

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	<b>Source(s)</b>	<b>Notes</b>
	van Wyk, B.-E. & Wink, M. (2017). Medicinal Plants of the World. Second edition. CABI, Wallingford	[Not domesticated] "A. betulina occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale."

102	Has the species become naturalized where grown?	
	<b>Source(s)</b>	<b>Notes</b>
	WRA Specialist. (2023). Personal Communication	NA

103	Does the species have weedy races?	
	<b>Source(s)</b>	<b>Notes</b>
	WRA Specialist. (2023). Personal Communication	NA

201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	Intermediate
	<b>Source(s)</b>	<b>Notes</b>
	Iwu, M.M. (2014). Handbook of African Medicinal Plants, Second Edition. CRC Press, Boca Raton, FL	"Buchu is a southern African plant that appears to be naturally restricted to the Cederberg Mountain range of the Western Cape Province of South Africa. <i>Agathosma betulina</i> is particularly adapted to dry conditions and can be found on sunny hillsides where other crops will not succeed."
	Quick, L. J., & Eckardt, F. D. (2015). The Cederberg: a rugged sandstone topography. Landscapes and Landforms of South Africa, 85-93. Springer International Publishing, Cham, Switzerland	"Located within southern Africa's winter rainfall zone, the Cederberg presently experiences a Mediterranean type climate with warm, dry summers and cold wet winters. During winter, temperatures often drop below freezing and the mountain peaks are frequently covered in snow. The topographic complexity of the region (high ridges and peaks, broad linear valleys) leads to considerable spatial and temporal rainfall variability. For example, Pakhuis Pass, towards the north-eastern boundary of the Cederberg receives an average of 250 mm per year, the central Cederberg (Driehoek valley) is associated with an average of 500 mm per year, and the higher peaks may receive over 1,000 mm per year (Schulze 1997; Hijmans et al. 2005)."

Qsn #	Question	Answer
202	Quality of climate match data	High
	Source(s)	Notes
	Iwu, M.M. (2014). Handbook of African Medicinal Plants, Second Edition. CRC Press, Boca Raton, FL	"Buchu is a southern African plant that appears to be naturally restricted to the Cederberg Mountain range of the Western Cape Province of South Africa. <i>Agathosma betulina</i> is particularly adapted to dry conditions and can be found on sunny hillsides where other crops will not succeed."
	Quick, L. J., & Eckardt, F. D. (2015). The Cederberg: a rugged sandstone topography. Landscapes and Landforms of South Africa, 85-93. Springer International Publishing, Cham, Switzerland	"Located within southern Africa's winter rainfall zone, the Cederberg presently experiences a Mediterranean type climate with warm, dry summers and cold wet winters. During winter, temperatures often drop below freezing and the mountain peaks are frequently covered in snow. The topographic complexity of the region (high ridges and peaks, broad linear valleys) leads to considerable spatial and temporal rainfall variability. For example, Pakhuis Pass, towards the north-eastern boundary of the Cederberg receives an average of 250 mm per year, the central Cederberg (Driehoek valley) is associated with an average of 500 mm per year, and the higher peaks may receive over 1,000 mm per year (Schulze 1997; Hijmans et al. 2005)."

203	Broad climate suitability (environmental versatility)	n
	Source(s)	Notes
	Hardiness.zone. (2023). <i>Agathosma betulina</i> . <a href="https://hardiness.zone/plant/?sle=Agathosma&amp;art=betulina">https://hardiness.zone/plant/?sle=Agathosma&amp;art=betulina</a> . [Accessed 12 May 2023]	" <i>Agathosma betulina</i> is a bush in the Rutaceae family. It's registered as winter hardy at USDA zone 8 and higher. It typically grows around 2 m tall. The origin of this species is Africa."
	Williams, S., & Kepe, T. (2008). Discordant harvest: Debating the harvesting and commercialization of wild Buchu ( <i>Agathosma betulina</i> ) in Elandskloof, South Africa. Mountain Research and Development, 28(1), 58-64.	" <i>Agathosma betulina</i> is one of the most prominent endemic plants in South Africa to have global commercial value. It is endemic to the fairly dry Cederberg Mountains of the Western Cape in South Africa. Agriculture in the Cederberg Mountains is limited by altitude, dry climate, and rocky terrain."
	van Wyk, B.-E. & Wink, M. (2017). Medicinal Plants of the World. Second edition. CABI, Wallingford	"Origin <i>A. betulina</i> occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale."

204	Native or naturalized in regions with tropical or subtropical climates	n
	Source(s)	Notes
	Iwu, M.M. (2014). Handbook of African Medicinal Plants, Second Edition. CRC Press, Boca Raton, FL	"Buchu is a southern African plant that appears to be naturally restricted to the Cederberg Mountain range of the Western Cape Province of South Africa. <i>Agathosma betulina</i> is particularly adapted to dry conditions and can be found on sunny hillsides where other crops will not succeed. It can be found on the rocky sandstone slopes of the northwestern Cape region. <i>A. crenulata</i> grows on the damp lower and middle slopes and valleys, from Ceres to Swellendam (South Africa)."
	Quick, L. J., & Eckardt, F. D. (2015). The Cederberg: a rugged sandstone topography. Landscapes and Landforms of South Africa, 85-93. Springer International Publishing, Cham, Switzerland	"Located within southern Africa's winter rainfall zone, the Cederberg presently experiences a Mediterranean type climate with warm, dry summers and cold wet winters. During winter, temperatures often drop below freezing and the mountain peaks are frequently covered in snow."
	van Wyk, B.-E. & Wink, M. (2017). Medicinal Plants of the World. Second edition. CABI, Wallingford	"Origin <i>A. betulina</i> occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Preferred Climate/s: Mediterranean"

Qsn #	Question	Answer
205	Does the species have a history of repeated introductions outside its natural range?	?
	<b>Source(s)</b>	<b>Notes</b>
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 12 May 2023]	"A commonly used traditional S. African herbal remedy, it was introduced into western herbal medicine in the 18th century [254]. It is widely cultivated for medicinal use in S. Africa and to a limited extent in S. America [254]. The dried herb is traded internationally."
	van Wyk, B.-E. & Wink, M. (2017). Medicinal Plants of the World. Second edition. CABI, Wallingford	"A. betulina occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale."

301	Naturalized beyond native range	n
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"References: South Africa-N-1991, South Africa-W-1977." [Reports of naturalization not corroborated by cited reference][
	Spear, D., McGeoch, M. A., Foxcroft, L. C., & Bezuidenhout, H. (2011). Alien species in South Africa's national parks: checklist. Koedoe: African Protected Area Conservation and Science, 53(1), 1-4	"SA South African species, now outside its historical distribution range (extralimital)" [Cultivated outside natural range. No evidence of naturalization provided]
	Gallaher, T.J., Brock, K., Kennedy, B.H., Imada, C.T., Imada, K., & Walvoord, N. (2023). Plants of Hawai'i. <a href="http://www.plantsofhawaii.org..">http://www.plantsofhawaii.org..</a> [Accessed 12 May 2023]	No evidence in the Hawaiian Islands to date

302	Garden/amenity/disturbance weed	n
	<b>Source(s)</b>	<b>Notes</b>
	CABI. (2023). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="https://www.cabidigitallibrary.org/product/qi">https://www.cabidigitallibrary.org/product/qi</a> . [Accessed 12 May 2023]	No evidence
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence of impacts
	GBIF Secretariat (2023). <i>Agathosma betulina</i> (Bergius) Pillans. GBIF Backbone Taxonomy. Checklist dataset. <a href="https://www.gbif.org/species/3190125">https://www.gbif.org/species/3190125</a> . [Accessed 12 May 2023]	Recorded as introduced in - South Africa According to - Global Register of Introduced and Invasive Species - South Africa Evidence of impact - No Occurrences in GBIF - 45 occurrences

303	Agricultural/forestry/horticultural weed	n
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence
	CABI. (2023). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="https://www.cabidigitallibrary.org/product/qi">https://www.cabidigitallibrary.org/product/qi</a> . [Accessed 12 May 2023]	No evidence
	GBIF Secretariat (2023). <i>Agathosma betulina</i> (Bergius) Pillans. GBIF Backbone Taxonomy. Checklist dataset. <a href="https://www.gbif.org/species/3190125">https://www.gbif.org/species/3190125</a> . [Accessed 12 May 2023]	Recorded as introduced in - South Africa According to - Global Register of Introduced and Invasive Species - South Africa Evidence of impact - No Occurrences in GBIF - 45 occurrences

304	Environmental weed	n
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence
	CABI. (2023). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="https://www.cabidigitallibrary.org/product/qi">https://www.cabidigitallibrary.org/product/qi</a> . [Accessed 12 May 2023]	No evidence
	GBIF Secretariat (2023). <i>Agathosma betulina</i> (Bergius) Pillans. GBIF Backbone Taxonomy. Checklist dataset. <a href="https://www.gbif.org/species/3190125">https://www.gbif.org/species/3190125</a> . [Accessed 12 May 2023]	Recorded as introduced in - South Africa According to - Global Register of Introduced and Invasive Species - South Africa Evidence of impact - No Occurrences in GBIF - 45 occurrences

305	Congeneric weed	n
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	<i>Agathosma apiculata</i> reported to be naturalized. <i>Agathosma crenulata</i> reported to be naturalized, and cited as a weed with no evidence of impacts.
	CABI. (2023). Invasive Species Compendium. Wallingford, UK: CAB International. <a href="https://www.cabidigitallibrary.org/product/qi">https://www.cabidigitallibrary.org/product/qi</a> . [Accessed 12 May 2023]	No evidence

401	Produces spines, thorns or burrs	n
	<b>Source(s)</b>	<b>Notes</b>
	Iwu, M.M. (2014). Handbook of African Medicinal Plants, Second Edition. CRC Press, Boca Raton, FL	[No evidence] "Description – <i>Agathosma betulina</i> is a resprouting, broad-leaved aromatic shrub with erect woody stems reaching 2 m tall, but low-growing and prostrate varieties also occur. The leaves are of pale green color, leathery and glossy, with a blunt, strongly curved tip and a fine-tooth margin; round pellucid oil glands are conspicuously scattered throughout the leaf, along the margins and lower surfaces. They are strongly aromatic, usually opposite, ericoid, often crowded, simple, entire, from 0.5 to 3.5 cm long. The star-shaped flowers are produced in terminal clusters, 0.7-2 cm diameter, with five white, pink, red, or purple petals. The brownish fruits are five chambered. The two related buchu plants can be differentiated by the shape of the leaves: <i>A. betulina</i> is described as "round-leaf buchu," whereas <i>A. crenulata</i> is known as "oval-leaf buchu." The latter species has been described as a pungently aromatic, woody, single-stem shrub that reaches a height of 2.5 m. The glossy, dark green leaves are more than twice as long as they are broad, with many oil glands throughout. The delicate stems bear one to three, relatively large, white or mauve flowers in the leaf axils."

402	Allelopathic	n
	<b>Source(s)</b>	<b>Notes</b>
	WRA Specialist. (2023). Personal Communication	Unknown. No evidence found

Qsn #	Question	Answer
403	Parasitic	n
	Source(s)	Notes
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	"A much-branched woody shrub of about 1 m (ca. 3 ft) in height with white or pale purple star-shaped flowers that develop into characteristic segmented capsules with shiny black seeds." [Rutaceae. No evidence]

404	Unpalatable to grazing animals	
	Source(s)	Notes
	WRA Specialist. (2023). Personal Communication	Unknown

405	Toxic to animals	n
	Source(s)	Notes
	EFSA FEEDAP Panel. (2022). Safety and efficacy of a feed additive consisting of an essential oil from the leaves of <i>Agathosma betulina</i> (PJ Bergius) Pillans (buchu leaf oil) for use in all animal species (FEFANA asbl). <i>EFSA Journal</i> , 20(3), e07160	"Following a request from the European Commission, the EFSA Panel on Additives and Products or Substances used in Animal Feed (FEEDAP) was asked to deliver a scientific opinion on the safety and efficacy of an essential oil from the leaves of <i>Agathosma betulina</i> (P.J. Bergius) Pillans (buchu leaf oil), when used as a sensory additive (flavouring) in feed and water for drinking for all animal species. The FEEDAP Panel concluded that the essential oil under assessment is safe up to the maximum proposed use levels in complete feed of 0.1 mg/kg for chickens for fattening, 0.15 mg/kg for laying hens, turkeys for fattening and rabbits, 0.20 mg/kg for piglets, 0.25 mg/kg for pigs for fattening, 0.30 mg/kg for sows and dairy cows, 0.45 mg/kg for cattle for fattening, sheep, goats and horses, 0.5 for veal calves (milk replacer), fish, ornamental fish and dogs. For cats, the calculated maximum safe level in feed is 0.2 mg/kg complete feed. The FEEDAP Panel considered that the use in water for drinking is safe provided that the total daily intake of the additive does not exceed the daily amount that is considered safe when consumed via feed. No concerns for consumer safety were identified following the use of the additive up to the highest safe levels in feed. The essential oil under assessment should be considered as irritant to skin and eyes, and as a skin and respiratory sensitiser. The use of the additive in animal feed under the proposed conditions was not expected to pose a risk for the environment. Buchu leaf oil was recognised to flavour food. Since its function in feed would be essentially the same as that in food, no further demonstration of efficacy was considered necessary."
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 12 May 2023]	"Known Hazards - None known"

406	Host for recognized pests and pathogens	
	Source(s)	Notes



Qsn #	Question	Answer
	Malan, A. P., Knoetze, R., & Hugo, H. J. (2004). First report of the root-knot nematode <i>Meloidogyne javanica</i> on buchu ( <i>Agathosma betulina</i> ) in South Africa. <i>Plant Disease</i> , 88(5), 574-574	" <i>Agathosma betulina</i> , commonly known as buchu, has been used for centuries by the indigenous people of South Africa for medicinal purposes. Currently, the essential oils from buchu are used in medicine, food flavorings, and aromatic oils. Increased exploitation of natural growing buchu in the Fynbos biome and a worldwide shortage of buchu oil encouraged commercial cultivation in South Africa. The root-knot nematode ( <i>Meloidogyne</i> spp.) is one of the most common plant-parasitic nematodes found on commercial crops grown in the Western Cape. It has also been isolated from the soil and roots of plants in the natural Fynbos vegetation (2). In June 2003, a nursery propagating buchu plants experienced problems with poor growth. Examination of the buchu roots under a stereo microscope showed extensive galling with large numbers of female root-knot nematodes with eggsacs. Nematode extractions of the soil were also done. Only second-stage juveniles of <i>Meloidogyne</i> spp. (311 per 250 ml of soil) were recovered. A polymerase chain reaction (PCR)-based diagnostic method (1) was used for the identification of the root-knot nematode species. Ten intact females were dissected from the roots and individually placed directly in 5 µl drops of 1× PCR reaction buffer (16 mM [NH <sub>4</sub> ] <sub>2</sub> SO <sub>4</sub> , 67 mM tris-HCL, pH 8.8, 0.1% vol/vol Tween 20) containing 60 µg/ml of proteinase K. The tube was kept at -80°C for a minimum of 10 min. The tube was incubated at 60°C for 15 min and 5 min at 95°C. The PCR amplifications were then prepared directly in the same tube. Amplified DNA fragments were digested with <i>Hinf</i> I and <i>Dra</i> I. The digested DNA was loaded on a 2% agarose gel, separated by electrophoresis, and detected by ethidium bromide staining. The digested amplified DNA fragments correspond to those of <i>Meloidogyne javanica</i> . Morphological characteristics were used to verify the PCR-based identification of the nematode. To our knowledge, this is the first report of <i>M. javanica</i> causing extensive galling on the roots of <i>Agathosma betulina</i> . Visual damage to the roots indicates the root-knot nematode to be an important threat to the commercial cultivation of buchu."

407	Causes allergies or is otherwise toxic to humans	n
	<b>Source(s)</b>	<b>Notes</b>
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 12 May 2023]	"Known Hazards - None known"
	Iwu, M.M. (2014). <i>Handbook of African Medicinal Plants</i> , Second Edition. CRC Press, Boca Raton, FL	"The extracts of <i>A. betulina</i> and <i>A. crenulata</i> were shown to be nontoxic at the concentrations tested (IC <sub>50</sub> values > 100 µg/ml) using the MTT (3-[4, 5-dimethyl-2-thiazol-yl]-2, 5-diphenyl-2H-tetrazoliumbromide) cellular viability assay."

408	Creates a fire hazard in natural ecosystems	
	<b>Source(s)</b>	<b>Notes</b>
	Kruger, F.J., & Bigalke, R.C. (1984). Fire in Fynbos. In: de Booyesen, P.V., Tainton, N.M. (eds) <i>Ecological Effects of Fire in South African Ecosystems</i> . <i>Ecological Studies</i> , vol 48. Springer, Berlin, Heidelberg	"Fire has been and is also applied to increase or regulate the yield of veld products. Thus in the Cedarberg and southwards veld from which <i>Agathosma betulina</i> and <i>A. crenulata</i> are harvested is burnt by farmers in late summer or autumn, on about a 6 to 8 yr cycle, after the last of two or three biennial harvests. Experience has shown that such burns are required to rejuvenate the sprouting shoots and maintain yields, while also favouring recruitment from seed (Bands 1980)."
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	"The species resprouts after fire, unlike <i>A. crenulata</i> which regenerates from seeds only."



Qsn #	Question	Answer
	Van Wilgen, B. W., & Van Hensbergen, H. J. (1992). Fuel properties of vegetation in Swartboskloof. Fire in South African Mountain Fynbos: Ecosystem, Community and Species Response at Swartboskloof, 37-53. Springer-Verlag, Berlin Heidelberg	[Agathosma sp. believed to be flammable due to oil contents] "In addition, oils and waxes have up to twice the energy contents of other plant material (Philpot 1969). Fynbos is often stated to be more flammable due to such properties. Kruger and Bigalke (1984) mention oil contents of buchu ( <i>Agathosma</i> sp.) of around 1.4-4 %, and layers of cuticular wax on restioid plants to support this belief."
	WRA Specialist. (2023). Personal Communication	Occurs in fire prone ecosystems, and oils may increase flammability, but unclear if this results in increased fire risk.

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 12 May 2023]	"Requires a lime-free, moisture-retentive but well-drained soil in a sunny position [200]."
	Dave's Garden. (2023). <i>Agathosma</i> Species, Round-Leaf Buchu - <i>Agathosma betulina</i> . <a href="https://davesgarden.com/guides/pf/go/130406/">https://davesgarden.com/guides/pf/go/130406/</a> . [Accessed 12 May 2023]	"Sun Exposure: Full Sun Sun to Partial Shade"
	Iwu, M.M. (2014). Handbook of African Medicinal Plants, Second Edition. CRC Press, Boca Raton, FL	[Sunny hillsides] " <i>Agathosma betulina</i> is particularly adapted to dry conditions and can be found on sunny hillsides where other crops will not succeed. It can be found on the rocky sandstone slopes of the northwestern Cape region."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	n
	Source(s)	Notes
	van Wyk, B.-E. (2014). Culinary Herbs and Spices of the World. University of Chicago Press, Chicago, IL	"Buchu is propagated from seeds or cuttings and is grown in low phosphate (24 ppm maximum), sandy, low pH soils (pH 2.5-4.5) with ample watering (but in winter only)."
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 12 May 2023]	"Requires a lime-free, moisture-retentive but well-drained soil in a sunny position [200]."
	Dave's Garden. (2023). <i>Agathosma</i> Species, Round-Leaf Buchu - <i>Agathosma betulina</i> . <a href="https://davesgarden.com/guides/pf/go/130406/">https://davesgarden.com/guides/pf/go/130406/</a> . [Accessed 12 May 2023]	"These plants grow in poor, acidic, rocky soils, and have specific growth requirements - your standard potting soil mix won't do. A medium of sand and coconut coir is generally sufficient. These plants cannot survive where there are significant Phosphorus concentrations. Best results require the use of liquid fertilizers where P=0. Exceeding a paltry 20ppm concentration of P in the growth medium inhibits root growth and kills the plant. Similarly, pH should be maintained at a relatively low 4.5-6.5 for best results."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Iwu, M.M. (2014). Handbook of African Medicinal Plants, Second Edition. CRC Press, Boca Raton, FL	" <i>Agathosma betulina</i> is a resprouting, broad-leaved aromatic shrub with erect woody stems reaching 2 m tall, but low-growing and prostrate varieties also occur."

412	Forms dense thickets	n
	Source(s)	Notes
	van Wyk, B.-E. & Wink, M. (2017). Medicinal Plants of the World. Second edition. CABI, Wallingford	" <i>A. betulina</i> occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale." [No evidence]

Qsn #	Question	Answer
	Trinder-Smith, T. & Raimondo, D. (2016). <i>Agathosma betulina</i> (P.J.Bergius) Pillans. National Assessment: Red List of South African Plants version 2020.1. <a href="http://redlist.sanbi.org/species.php?species=3359-22">http://redlist.sanbi.org/species.php?species=3359-22</a> . [Accessed 12 May 2023]	"EOO 4624 km <sup>2</sup> , recorded from over 40 locations, this species has been heavily impacted by harvesting for its essential oils throughout its range. Although local declines in some subpopulations have been reported, the population is not suspected to have lost more than 10% of individuals. This species is a resprouter and is able to recover from moderate levels of harvesting. Only severe repeat harvesting of the same individuals in some areas has caused declines. Current provincial legislation managing the trade has resulted in cultivated material being promoted, most wild subpopulations are therefore no longer targeted."

501	Aquatic	n
	Source(s)	Notes
	Iwu, M.M. (2014). <i>Handbook of African Medicinal Plants</i> , Second Edition. CRC Press, Boca Raton, FL	[Terrestrial] "Buchu is a southern African plant that appears to be naturally restricted to the Cederberg Mountain range of the Western Cape Province of South Africa. <i>Agathosma betulina</i> is particularly adapted to dry conditions and can be found on sunny hillsides where other crops will not succeed. It can be found on the rocky sandstone slopes of the northwestern Cape region."

502	Grass	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2023). <i>Germplasm Resources Information Network (GRIN-Taxonomy)</i> . National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/">https://npgsweb.ars-grin.gov/</a> . [Accessed 5 May 2023]	"Family: Rutaceae Subfamily: Toddalioideae Tribe: Diosmeae"

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2023). <i>Germplasm Resources Information Network (GRIN-Taxonomy)</i> . National Germplasm Resources Laboratory, Beltsville, Maryland. <a href="https://npgsweb.ars-grin.gov/">https://npgsweb.ars-grin.gov/</a> . [Accessed 5 May 2023]	"Family: Rutaceae Subfamily: Toddalioideae Tribe: Diosmeae"

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	van Wyk, B.-E. & Wink, M. (2017). <i>Medicinal Plants of the World</i> . Second edition. CABI, Wallingford	"Buchu is a gland-dotted shrub of up to 2 m in height, with small, characteristically rounded leaves of which the tips curve backwards. The white or pale purple flowers are small and star-shaped."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	van Wyk, B.-E. & Wink, M. (2017). <i>Medicinal Plants of the World</i> . Second edition. CABI, Wallingford	" <i>A. betulina</i> occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale."

Qsn #	Question	Answer
	Trinder-Smith, T. & Raimondo, D. (2016). <i>Agathosma betulina</i> (P.J.Bergius) Pillans. National Assessment: Red List of South African Plants version 2020.1. <a href="http://redlist.sanbi.org/species.php?species=3359-22">http://redlist.sanbi.org/species.php?species=3359-22</a> . [Accessed 12 May 2023]	"Status and Criteria: Least Concern Assessment Date: 2016/06/28 Assessor(s): T. Trinder-Smith & D. Raimondo Justification: EOO 4624 km <sup>2</sup> , recorded from over 40 locations, this species has been heavily impacted by harvesting for its essential oils throughout its range. Although local declines in some subpopulations have been reported, the population is not suspected to have lost more than 10% of individuals. This species is a resprouter and is able to recover from moderate levels of harvesting. Only severe repeat harvesting of the same individuals in some areas has caused declines. Current provincial legislation managing the trade has resulted in cultivated material being promoted, most wild subpopulations are therefore no longer targeted."

602	Produces viable seed	y
	Source(s)	Notes
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	"Buchu is propagated from seeds or cuttings and is grown in low phosphate (24 ppm maximum), sandy, low pH soils (pH 2.5-4.5) with ample watering (but in winter only)."
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 12 May 2023]	"Propagation Seed - Cuttings of semi-ripe wood."
	Iwu, M.M. (2014). <i>Handbook of African Medicinal Plants</i> , Second Edition. CRC Press, Boca Raton, FL	"The inflorescence occurs in panicles at the apex of a hardy and long central stem of 3 to 8 m; greenish-yellow flowers that are rare develop into capsular fruits and into seed but produce a lot of plantlets that ensure fast propagation."

603	Hybridizes naturally	
	Source(s)	Notes
	Moolla, A., & Viljoen, A. M. (2008). 'Buchu'- <i>Agathosma betulina</i> and <i>Agathosma crenulata</i> (Rutaceae): A review. <i>Journal of Ethnopharmacology</i> , 119(3), 413-419	[Putative hybrids exist] "Blommaert and Bartel (1976) performed a chemotaxonomic study of 'Buchu'. They reported that the taxonomic classification of the two species is almost solely based on leaf form. In their natural habitat this criterion is probably valid. However, in present day plantings in which many progeny probably originated from hybrid seed, distinction of the two species on the basis of leaf form is often difficult (Blommaert and Bartel, 1976). The results indicate that the ratio of leaf length/width is a most useful criterion for identifying the two 'Buchu' species but due to possible hybridisation events various intermediate forms exist (Blommaert and Bartel, 1976; Hüsselmann, 2006)."

604	Self-compatible or apomictic	
	Source(s)	Notes
	Jeffery, D. J. (1997). The effects of population size on <i>Agathosma collina</i> (rutaceae) and its conservation implications. Master's Thesis. University of Cape Town, Cape Town, SA	[Unknown. Self-compatibility, with reduced seed set, documented in a congeneric species] "The species is self compatible but geitonogamous matings produced lower capsule set than outcrossed matings." ... "Andromonoecy, which is known to occur in 65 <i>Agathosma</i> species (Steiner 1987), is a breeding system in which male and hermaphrodite flowers occur on the same plant."

605	Requires specialist pollinators	n
	Source(s)	Notes

Qsn #	Question	Answer
	Un Mondo Ecosostenibile (2023). <i>Agathosma betulina</i> . <a href="https://antropocene.it/en/2023/01/26/agathosma-betulina-2/">https://antropocene.it/en/2023/01/26/agathosma-betulina-2/</a> . [Accessed 14 May 2023]	" <i>Agathosma betulina</i> is a spontaneous species that in its habitat is visited by a variety of insects, in particular bees and flies that carry out entomophilous pollination."
	Jeffery, D. J. (1997). The effects of population size on <i>Agathosma collina</i> (rutaceae) and its conservation implications. Master's Thesis. University of Cape Town, Cape Town, SA	[Related species insect pollinated] " <i>A. collina</i> is both andromonoecious and protandrous and the species is insect pollinated."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Tropical Plants Database, Ken Fern. (2023). <i>Agathosma betulina</i> . <a href="https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina">https://tropical.theferns.info/viewtropical.php?id=Agathosma+betulina</a> . [Accessed 14 May 2023]	"Propagation Seed - Cuttings of semi-ripe wood."
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	[Resprouts] "The species resprouts after fire, unlike <i>A. crenulata</i> which regenerates from seeds only." ... "Buchu is propagated from seeds or cuttings and is grown in low phosphate (24 ppm maximum), sandy, low pH soils (pH 2.5-4.5) with ample watering (but in winter only)."

607	Minimum generative time (years)	
	Source(s)	Notes
	Machado, M. D. P. (2003). Is Buchu ( <i>Agathosma Betulina</i> ) Harvesting Sustainable?: Effects of Current Harvesting Practices on Biomass, Reproduction and Mortality. MSc Thesis, University of Cape Town, Cape Town, SA	[Possibly 2+ years] "Flowers and fruits are not produced on plants younger than two years of age. The long-term maintenance of local populations will be compromised if harvesting frequencies less than three years continue for decades. The viability of seeds produced on two-year-old plants needs to be determined since local evidence suggests that this cohort is generally of low quality."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	"A much-branched woody shrub of about 1 m (ca. 3 ft) in height with white or pale purple star-shaped flowers that develop into characteristic segmented capsules with shiny black seeds."
	Un Mondo Ecosostenibile (2023). <i>Agathosma betulina</i> . <a href="https://antropocene.it/en/2023/01/26/agathosma-betulina-2/">https://antropocene.it/en/2023/01/26/agathosma-betulina-2/</a> . [Accessed 14 May 2023]	"The seeds are released after the flowers have dried. The fruit is a capsule which, when ripe, explodes to release the seeds."

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	van Wyk, B.-E. & Wink, M. (2017). <i>Medicinal Plants of the World</i> . Second edition. CABI, Wallingford	" <i>A. betulina</i> occurs only in South Africa and has a restricted natural distribution area in the mountains of the Western Cape Province. It is cultivated on a small but increasing scale."
	Randall, R.P. (2017). <i>A Global Compendium of Weeds</i> . 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Crop, Herbal, Ornamental Dispersed by: Humans"

Qsn #	Question	Answer
703	Propagules likely to disperse as a produce contaminant	n
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	[No evidence. although ballistically dispersed seeds could be carried in soil of potted plants or other produce growing in the vicinity] "Major Pathway/s: Crop, Herbal, Ornamental Dispersed by: Humans"

704	Propagules adapted to wind dispersal	
	Source(s)	Notes
	Jeffery, D. J. (1997). The effects of population size on <i>Agathosma collina</i> (rutaceae) and its conservation implications. Master's Thesis. University of Cape Town, Cape Town, SA	"Seeds of the Diosmeae are dispersed ballistically when the capsule dehisces (Pillans 1950). In addition, 95% of the Rutaceae, including <i>A. collina</i> , are myrmecochorous (Slingsby 1982). Myrmecochorous seed dispersal distances are very short (Bond and Slingsby 1983) resulting in restricted gene flow from this source."
	Un Mondo Ecosostenibile (2023). <i>Agathosma betulina</i> . <a href="https://antropocene.it/en/2023/01/26/agathosma-betulina-2/">https://antropocene.it/en/2023/01/26/agathosma-betulina-2/</a> . [Accessed 14 May 2023]	[Wind may contribute to distance and direction of ballistically dispersed seeds] "The seeds are released after the flowers have dried. The fruit is a capsule which, when ripe, explodes to release the seeds."

705	Propagules water dispersed	n
	Source(s)	Notes
	Un Mondo Ecosostenibile (2023). <i>Agathosma betulina</i> . <a href="https://antropocene.it/en/2023/01/26/agathosma-betulina-2/">https://antropocene.it/en/2023/01/26/agathosma-betulina-2/</a> . [Accessed 14 May 2023]	"The seeds are released after the flowers have dried. The fruit is a capsule which, when ripe, explodes to release the seeds." [Water may secondarily disperse seeds, but this plant is not known to be distributed naturally in riparian areas or in proximity to waterways or other bodies of water.]

706	Propagules bird dispersed	n
	Source(s)	Notes
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	"A much-branched woody shrub of about 1 m (ca. 3 ft) in height with white or pale purple star-shaped flowers that develop into characteristic segmented capsules with shiny black seeds."
	Un Mondo Ecosostenibile (2023). <i>Agathosma betulina</i> . <a href="https://antropocene.it/en/2023/01/26/agathosma-betulina-2/">https://antropocene.it/en/2023/01/26/agathosma-betulina-2/</a> . [Accessed 14 May 2023]	"The seeds are released after the flowers have dried. The fruit is a capsule which, when ripe, explodes to release the seeds."
	Jeffery, D. J. (1997). The effects of population size on <i>Agathosma collina</i> (rutaceae) and its conservation implications. Master's Thesis. University of Cape Town, Cape Town, SA	[Birds act as seed predators] "Dispersal by ants is characterized by rapid seed discovery and removal (Bond and Slingsby 1983). This rapid removal of seeds and subsequent burial has been shown to reduce the incidence of predation and is essential for the survival of the seeds and therefore for the maintenance of effective gene flow in several species of Proteaceae (e.g. Bond and Slingsby 1983). In the case of the Rutaceae <i>A. betulina</i> and <i>A. crenulata</i> are two species which have been studied by Blommaert (1972) and it was found that most dispersed seeds were eaten by mice and birds. Active myrmecochory may, therefore, reduce the predation of the ballistically dispersed seeds by rodents."

707	Propagules dispersed by other animals (externally)	y
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Jeffery, D. J. (1997). The effects of population size on <i>Agathosma collina</i> (rutaceae) and its conservation implications. Master's Thesis. University of Cape Town, Cape Town, SA	[Ant-dispersed] "Dispersal by ants is characterized by rapid seed discovery and removal (Bond and Slingsby 1983). This rapid removal of seeds and subsequent burial has been shown to reduce the incidence of predation and is essential for the survival of the seeds and therefore for the maintenance of effective gene flow in several species of Proteaceae (e.g. Bond and Slingsby 1983). In the case of the Rutaceae <i>A. betulina</i> and <i>A. crenulata</i> are two species which have been studied by Blommaert (1972) and it was found that most dispersed seeds were eaten by mice and birds. Active myrmecochory may, therefore, reduce the predation of the ballistically dispersed seeds by rodents."

708	Propagules survive passage through the gut	n
	<b>Source(s)</b>	<b>Notes</b>
	Un Mondo Ecosostenibile (2023). <i>Agathosma betulina</i> . <a href="https://antropocene.it/en/2023/01/26/agathosma-betulina-2/">https://antropocene.it/en/2023/01/26/agathosma-betulina-2/</a> . [Accessed 14 May 2023]	"The seeds are released after the flowers have dried. The fruit is a capsule which, when ripe, explodes to release the seeds."
	Jeffery, D. J. (1997). The effects of population size on <i>Agathosma collina</i> (rutaceae) and its conservation implications. Master's Thesis. University of Cape Town, Cape Town, SA	[Depredated by birds and rodents] "In the case of the Rutaceae <i>A. betulina</i> and <i>A. crenulata</i> are two species which have been studied by Blommaert (1972) and it was found that most dispersed seeds were eaten by mice and birds. Active myrmecochory may, therefore, reduce the predation of the ballistically dispersed seeds by rodents."
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	[Not adapted for frugivory] "A much-branched woody shrub of about 1 m (ca. 3 ft) in height with white or pale purple star-shaped flowers that develop into characteristic segmented capsules with shiny black seeds."

801	Prolific seed production (>1000/m2)	
	<b>Source(s)</b>	<b>Notes</b>
	Machado, M. D. P. (2003). Is Buchu ( <i>Agathosma Betulina</i> ) Harvesting Sustainable?: Effects of Current Harvesting Practices on Biomass, Reproduction and Mortality. MSc Thesis, University of Cape Town, Cape Town, SA	[Unknown] "Although the number of seedlings in a 2 m radius around buchu plants is not correlated with the age of the adult, a positive relationship between the number of seedlings and the biomass of these adults has been found. This suggests that plants that grow larger produce more viable seeds."

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	<b>Source(s)</b>	<b>Notes</b>
	Machado, M. D. P. (2003). Is Buchu ( <i>Agathosma Betulina</i> ) Harvesting Sustainable?: Effects of Current Harvesting Practices on Biomass, Reproduction and Mortality. MSc Thesis, University of Cape Town, Cape Town, SA	[Unknown] "Further research on the resprouting-reseeding capacity of buchu, as well as on pollination, dispersal and longevity of the seeds in the soil is necessary to understand the biology of <i>A. betulina</i> ."

803	Well controlled by herbicides	
	<b>Source(s)</b>	<b>Notes</b>
	WRA Specialist. (2023). Personal Communication	Unknown. No information on herbicide efficacy or chemical control of this species.

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	van Wyk, B.-E. (2014). <i>Culinary Herbs and Spices of the World</i> . University of Chicago Press, Chicago, IL	"The species resprouts after fire, unlike <i>A. crenulata</i> which regenerates from seeds only."
	Iwu, M.M. (2014). <i>Handbook of African Medicinal Plants</i> , Second Edition. CRC Press, Boca Raton, FL	[Resprouting] " <i>Agathosma betulina</i> is a resprouting, broad-leaved aromatic shrub with erect woody stems reaching 2 m tall, but low-growing and prostrate varieties also occur."

805	<b>Effective natural enemies present locally (e.g. introduced biocontrol agents)</b>	
	<b>Source(s)</b>	<b>Notes</b>
	WRA Specialist. (2023). Personal Communication	Unknown



**Summary of Risk Traits:**

*Agathosma betulina*, commonly known as Buchu, is a flowering plant native to South Africa. It belongs to the Rutaceae family and is known for its aromatic leaves, which have been used for centuries in traditional medicine and herbal remedies. The Buchu plant is a small evergreen shrub that grows up to 2 meters in height. It has small, leathery leaves that are rich in volatile oils, giving them a strong fragrance reminiscent of blackcurrant. These leaves are the main part of the plant used for medicinal purposes. This species has a limited distribution in its native range and is not known to be naturalized or invasive anywhere in the world. Although it could spread locally through its dehiscent seeds, and resprouts after fire, it is unlikely to have detrimental impacts in the Hawaiian Islands.

**High Risk / Undesirable Traits**

- Reproduces by ballistically dispersed seeds.
- May reach maturity in 2+ years
- Seeds dispersed by ballistic dehiscence, by ants, and through intentional cultivation.
- Resprouts after fire.

**Low Risk Traits**

- No reports of naturalization or invasiveness, but limited evidence of introduction outside native range.
- Unarmed (no spines, thorns, or burrs).
- Non-toxic
- Grows best in high light environments (dense shade may inhibit spread)