Journal of Applied Horticulture, 25(3): 257-259, 2023
https://doi.org/10.37855/jah.2023.v25i03.45
Journal of Applied Horticulture
ISSN: 0972-1045

Spiny coriander (*Eryngium foetidum* L.): A novel aromatic herb with rich chemo diversity and flavour potential

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Abstract

Spiny coriander (*Eryngium foetidum* L.) is a perennial medicinal herb commonly cultivated in tropical regions, notably in India, where it is celebrated for its culinary applications, providing garnish and flavor enhancement to a multitude of dishes while also being employed in traditional remedies for various ailments. In this study, we investigated the volatile flavor constituents of this unique plant *via* Gas Chromatography-Mass Spectrometry (GC-MS) analysis and found that the essential oil content of *Eryngium* leaves was approximately 0.15%. GC-MS analysis of the essential oil extracted from *E. foetidum* leaves revealed the presence of 50 distinct compounds. Remarkably, among constituents, trans-2-dodecenal was the most abundant, representing a substantial 23.74% of the total composition, thereby playing a pivotal role in defining the unique flavor of *Eryngium.* With their remarkable chemodiversity, *Eryngium species* hold great potential for applications in various industries, including the culinary, pharmaceutical and fragrance sectors.

Key words: *Eryngium foetidum* L., trans-2-dodecenal, spiny coriander, Eryngial

Introduction

Eryngium foetidum L., known as spiny coriander, is a perennial herb from the Apiaceae family. It is grown extensively in tropical regions worldwide due to its medicinal properties and distinct pungency (Acharya *et al.*, 2021; Dawilai *et al.*, 2013). The herb is native to tropical America and the Caribbean islands and was introduced to Southeast Asian countries by the Chinese in the late 1800s (Paul *et al.*, 2011; Singh *et al.*, 2014). In India, it is abundantly cultivated in the eastern and northeastern regions, even in soils of low fertility. The leaves and branches of *E. foetidum* are commonly used in culinary practices for garnishing and flavoring, serving as a substitute for coriander due to their similar aroma and fragrance (Chowdhury *et al.*, 2007; Eyres *et al.*, 2005; Mohamed-Yasseen, 2002). In addition to its culinary uses, *E. foetidum* possesses various pharmaceutical properties. It exhibits anticlastogenic, anti-inflammatory, anthelmintic, and anticarcinogenic effects (Cardozo *et al.*, 2004; Chandrika *et al.*, 2015). These medicinal attributes make it valuable in traditional medicine. The leaves of this underutilized herb contain an essential oil, consisting of approximately 0.29% trans-2-dodecenal (eryngial). This essential oil has several industrial applications. It's important to note that while *E. foetidum* shows promise for its medicinal and industrial potential, further scientific research is necessary to validate and fully understand these properties (Paul *et al.*, 2011; Singh *et al.*, 2014). Extracts from *Eryngium* plants, rich in eryngial, have effectively treated parasites, arthritis, and skin diseases. They have also been used as a key ingredient in developing skin-whitening agents. *E. foetidum*, with its adaptability, perennial nature, and robust stature, holds significant industrial potential (Acharya *et al.*, 2021; Dawilai *et al.*, 2013). As health concerns continue to rise, the demand for *Eryngium* leaves is increasing for their medicinal and industrial applications. Several *Eryngium* species, containing bioactive compounds, have been used to treat various human physiological disorders (Thomas *et al.*, 2017; Wong *et al.*, 1994). While some reports exist on the pharmaceutical applications of *E. foetidum*, there is limited research on the phytochemical composition of its leaves and branches. Therefore, this study aimed to analyze the phytochemical profile of *E. foetidum* leaves collected from the western ghats of India using GC and GC–MS/MS techniques to explore its industrial potential. The phytochemical profiling of spiny coriander holds great practical significance in various industries, ranging from food and agriculture to pharmaceuticals and cosmetics. The knowledge of its bioactive compounds can open up new opportunities for its utilization in a wide array of applications, promoting its sustainable cultivation and enhancing its value in both traditional and modern contexts.

Material and methods

E. foetidum L. plants were collected from Karnataka, India. Fresh *Eryngium* leaves were assessed for various phytochemical compositions using GC-MS analysis.

Isolation of essential oil: Fifty-gram of dried leaves of *E. foetidum* were utilized for essential oil extraction utilizing a Clevenger device and a hydro-distillation process. The seeds were ground to a fine powder before being hydro-distilled in 500 mL of water. The layer of essential oil was carefully removed using a micropipette after 3 hours of continuous running and no increment in essential oil quantity was apparent for more than 1 hour. Anhydrous sodium sulphate was used to extract the water from the oil. The appropriate mild yellowish oil was collected and the percentage (W/W) was calculated (Saxena *et al.*, 2016).

Estimation of composition of essential oil through GC-MS: The essential oil was analysed using gas chromatography (GC) and a Shimadzu mass spectrometer (MS) (GC/MS-TQ8040 NX SHIMADZU, Shimadzu Corp., Tokyo, Japan). The GC has a fused silica capillary column, SH-Rxi-5 Sil MS, with 20 m 9 0.18 mm dimensions and a film thickness of 0.18 mL. Split mode (10:1) was used to inject the diluted essential oil while maintaining a constant flow rate of 1 mL/min for the helium gas. The oven temperature was set to 70 °C for one minute, then gradually raised to 300 °C at a rate of 5 °C per minute with a total run time of 55 min. The temperature of the injector port was set to 280 ºC, and the temperature of the ion source was set to 230°C. The constituents of EOs were identified by comparing based on linear indices relative to a series of n-alkanes (C8–C24) at the same chromatographic conditions and by comparing retention indices with those reported in the literature and stored on the MS library [NIST 10 (National Institute of Standards and Technology, Gaithersburg, MD, USA).

Results and discussion

The essential oil content of 0.15% was observed from the *Eryngium* leaves. Gas chromatography mass spectrometry analysis of essential oil from *E. foetidum* revealed 50 compounds (Table 1). The identified volatile components of *E. foetidum* were Octane, 2-Undecene, Benzene, 11-Methyldodecanol, 1-Heptanol, 2-Isopropyl-5-methyl-1-heptanol, trans-2-dodecenal, Dodecane, 2,6,10-Trimethyltridecane, 10-Methylnonadecane, Phenol, Octadecyl octyl ether, Nonadecyl pentafluoropropionate, 1-Decanol, 1-Hexacosene, Dodecane, Octacosyl trifluoroacetate, Eicosyl octyl ether, Octatriacontyl pentafluoropropionate, 3-Eicosene, (E)-, 1-Dodecanol, Tetradecanoic acid, Methyl oleate (Fig. 1). In a previous study, odour-impacting oil constituents were investigated in common and spiny coriander samples from Fiji through gas chromatography (GC) technique (Eyres *et al.*, 2005). It concluded trans-2-dodecenal as the most odour active constituent in spiny coriander oil which agreed with our current finding. Out of these 50 compounds, the maximum peak area was obtained by beta trans-2-dodecenal (23.74%) which is the key constituent accountable in the flavour of Eryngium (Borah *et al.*, 2023) followed by phenol (5.83%), 3-Eicosene, (E)- (4.81%), Benzene (4.63%), 1-Heptanol (3.43%), 1-Dodecanol (2.94%) whereas the minimum peak area was obtained by Dodecane (0.91%). The identified phytochemicals contribute to spiny coriander's distinct flavor and aroma, making it a desirable culinary herb in various cuisines (Paul *et al.*, 2011). Another researcher also reported that trans-2-dodecenal is the major compound responsible for the odour of the spiny coriander (Borah *et al.*, 2023).

Table 1. Essential oil composition of *E. foetidum* obtained through GC-MS analysis and expressed as the relative %

RT	Area (%)	Chemical constituents
5.888	1.45	Octane
7.470	1.22	2-Undecene
11.915	4.64	Benzene
13.273	2.43	11-Methyldodecanol
13.498	3.43	1-Heptanol
13.717	2.47	2-Isopropyl-5-methyl-1-heptanol
14.490	23.74	trans-2-dodecenal
17.237	1.19	Dodecane
17.449	1.44	2,6,10-Trimethyltridecane
17.687	1.73	10-Methylnonadecane
18.498	5.83	Phenol
18.935	1.89	Octadecyl octyl ether
19.133	2.09	Nonadecyl pentafluoropropionate
19.363	2.04	1-Decanol
19.599	1.18	1-Hexacosene
22.394	0.91	Dodecane
23.747	1.82	Octacosyl trifluoroacetate
23.930	1.56	Eicosyl octyl ether
24.056	1.51	Octatriacontyl pentafluoropropionate
24.159	4.81	3-Eicosene, (E)-
24.344	2.94	1-Dodecanol
24.621	1.96	Tetradecanoic acid
33.231	1.71	Methyl oleate

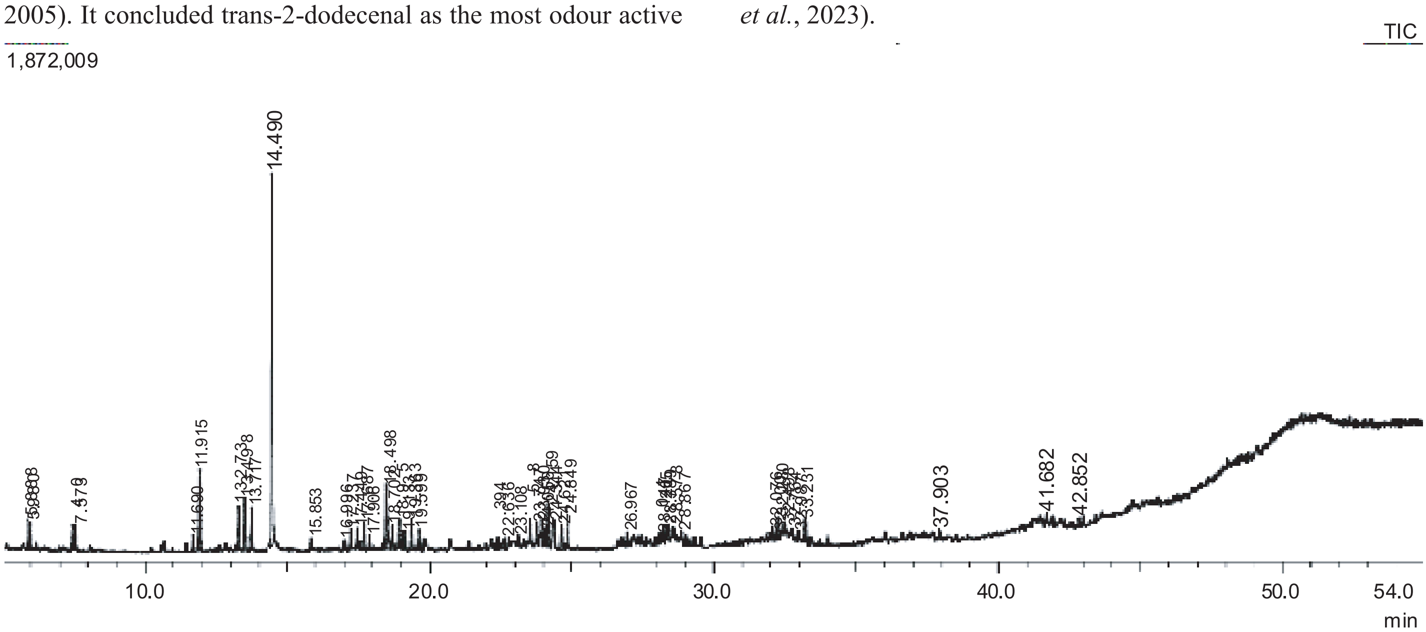

Fig. 1. Gas chromatogram of essential oil from the leaves of *E. foetidum.* 1.Octane 2. 2-Undecene 3. Benzene 4. 11-Methyldodecanol 5. 1-Heptanol 6. 2-Isopropyl-5-methyl-1-heptanol 7. trans-2-dodecenal 8. Dodecane 9. 2,6,10-Trimethyltridecane 10. 10-Methylnonadecane 11. Phenol 12. Octadecyl octyl ether 13. Nonadecyl pentafluoropropionate 14. 1-Decanol 15. 1-Hexacosene 16. Dodecane 17. Octacosyl trifluoroacetate 18. Eicosyl octyl ether 19. Octatriacontyl pentafluoropropionate 20. 3-Eicosene, (E)- 21. 1-Dodecanol 22. Tetradecanoic acid 23. Methyl oleate

The phytochemical profiling of spiny coriander (*E. foetidum* L.) has shed light on its diverse chemical composition and potential applications as a perennial spicing-culinary herb. The findings have far-reaching implications for the food industry, healthcare sector, and sustainable agriculture. Utilizing this knowledge in the development of functional foods, nutraceuticals, and traditional medicines can lead to enhanced consumer experiences and improved health outcomes. Overall, spiny coriander stands as a promising herb with immense potential for various real-world applications. Perennial sturdy *Eryngium*, well suited to poor and marginal soils, can be promoted for large-scale production of aromatic compounds and flavonoids for industrial use as an alternative to perishable seasonal *Coriandrum*.

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Received: July, 2023; Revised: September, 2023; Accepted: September, 2023