



(REVIEW ARTICLE)



## Essential oils and uses of *Eryngium foetidum* L.

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### Abstract

*Eryngium foetidum* is a species belonging Apiaceae which is used as medicine, vegetables, and spices. The plants used as medicine related to its secondary metabolites. The writing of this article is based on a literature review obtained online sources and offline used keywords *Eryngium foetidum*, secondary metabolites of *E. foetidum*, and uses of *E. foetidum*. In ethnobotany *E. foetidum* used to treat fever, hypertension, headache, abdominal pain, asthma, arthritis, diarrhea, and malaria. The essential oil of *E. foetidum* is dominated by (E) -2-dodecenal, dodecanoic acid, trans-2-dodecanoic acid, (E) -2-tridecenal, duraldehyde, and tetradecane. The bioactivity of *E. foetidum* has anti-microbial, antioxidant and anti-inflammatory. The ability of *E. foetidum* essential oils as an anti-microbial is very potential to be developed as a natural food preservative.

**Keywords:** *Eryngium foetidum*; Anti-microbial; Essential oil; antioxidant

### 1. Introduction

Plants as medicinal and food ingredients a very important in the development of human civilization. The plants are direct or indirect impact to human health, so it's to be carried out as new alternative therapeutic agents. The plants more than 7,000 species used as traditional medicinal. The plants efficacy is related to their bioactive compounds such as phenols, flavonoids, and tannins [1].

*Eryngium foetidum* (EF) is a species belonging Apiaceae which is used as a vegetable, spice, and traditional medicine. The EF has been used as a spice in some culinary in tropical regions [2], garnish, pickles, flavoring, and food seasoning [3]. The local communities in countries, EF is cultivated as an ornamental, vegetable and medicinal plant [4], but in Indonesia region its wild and considered a weed. Although EF is native in the Caribbean [5], however in Indonesia, its in very easy to find in various landscapes such as yards, rice fields, gardens, and roadsides. Those is easily recognizable by its sharp and distinctive aroma when its organs are touched and the surface leaves is equipped with spines (Figure 1) [6], so it is also known as prickly coriander [3]. The aroma produced by EF is very sharp [3], allegedly related to the volatile oil or essential oil content.

The industry foods the used EF as ingredient, so that it has economic value [3]. The local communities, the EF used to treat some diseases such as fever, hypertension, headache, earache, stomachache, asthma, arthritis, diarrhea, malaria, and epilepsy [3;4]. The using of food plants as medicine has advantages because its management is relatively easier because the processing process is in conjunction with other food ingredients. Mabeku et al [7] stated that the EF use as a food ingredient also has an impact on the health of the digestive tract because it can inhibit the growth of the pathogenic bacteria such as *Helicobacter pylori*.

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Although many studies of the EF, there is still limited discussion about secondary metabolites and their bioactivity. The assumption that the uses of plants as medicine is relatively safer than synthetic compounds is not entirely true. The accuracy of the dosage, processing method and source of raw materials is very important so as to minimize the side effects. The use of plants as medicine is related to the content of bioactive compounds or their secondary metabolites. This study will provide information about the use of EF and its bioactivity so that it can be used as information in the development of EF as a standardized traditional and herbal medicine.

## 2. Methods

The writing of this article is based on a literature review of books, article have been published online and offline. Literature was obtained Google scholar uses the keywords *Eryngium foetidum*, bioactivities of *E. foetidum* and secondary metabolites of *E. foetidum*. The articles were synthesized to be comprehensive information i.e utilization, bioactivity and secondary metabolites of *E. foetidum*.

## 3. Results and discussion

### 3.1. Botani of *Eryngium foetidum* L.

*Eryngium* L. is complex genera in belonging Apiaceae. The *Eryngium* has about 250 species in all over the world with the distribution center of South America. One of the widely used genera is *Eryngium*. The genera of *Eryngium* is estimated more than 250 species [1] and is used as food and medicine. *Eryngium foetidum* and *Eryngium antihystericum* are species that have long been cultivated and used as essential oil producers [6].

The origin of EF is not known with certainty but is thought to have originated in Central and South America [6] and is endemic to the Caribbean [5]. The local people in Indonesia, its called as *walangan* (Jakarta), *ketumbar jawa* (Sumatra), and *tumbar mungsi* (Javanese). The EF leaves have an aroma similar to coriander and because of their origin from Central America they are also known as Mexican Coriander. The leaves EF have been used as ingredient to various dishes such as soups, curries and young leaves are used as fresh vegetables or vegetables. *Eryngium foetidum* has been long cultivated in South America, Vietnam, Thailand, Philippines, Cambodia and Japan [6].

In Southeast Asia, this plant is an introduced plant, which is thought to have spread through ethnic Chinese. In Java, EF has been known since 1896 while in Sumatra it has been known since 1915 [6]. Eryngial is a of the most important essential oil compounds in the genus *Eryngium* which has anti-bacterial activity [1].



**Figure 1** Habitus of *Eryngium foetidum* L. [6].

*Eryngium foetidum* is a perennial herb that grows upright and can grow to a height of up to 80 cm and often has branches. The shape of the root resembles a spear or is also known as a taproot. The stem forms a rosette and will elongate when it wants to flower with dichasial branching (Figure 1). The leaves are single sitting sub-sessile and form a rosette and produce an odor when crushed. Shape strands of lanceolata-ovate to spatulate-oblong with a size of 5-32 cm x 1-4 cm.

The basal part of the leaf forms a sheath. Serrate thorny leaf margins. The inflorescence arises from the terminal or spike-like tip and branches to form a corymb, and gives rise to 2 bracts. The bracts are stiff, 1-6 cm long and often resemble normal leaves. The flowers are subsessile with tubular calyces about 1 mm long with 5 small, erect and triangular teeth. The petals are 5 in number and are elliptical-oblong in size with a size of 0.5-0.75 mm x 0.25 mm, greenish-white in color, and curved at the ends. The stamens are 5 and the pistil has 2 filiform stalks. Fruit shaped schizocarp ovoid-obovoid with a size of 0.5 mm x 0.75 mm [6].

### 3.2. Secondary Metabolites of *Eryngium foetidum* L.

Secondary metabolites are compounds produced by plants from secondary metabolic processes. Based on the synthesis process, secondary metabolites are divided into alkaloids, phenolics and terpenoids [8]. Terpenoids are very diverse in structure and function, but can be grouped into monoterpenoids, sesquiterpenoids, diterpenoids and triterpenoids. Monoterpenoids and sesquiterpenoids are volatile compounds and are one of the essential oil groups, therefore they produce a distinctive aroma [9].

*Eryngium foetidum* which is also known as prickly coriander [10]. EF is known as an aromatic plant and in Plant Resources of South East Asia 13 into spice plants [11] which are plants used as spices. The compounds of EF have 0.1-0.95% essential oil. This plant is also used as a substitute for coriander and contains iron, carotene, riboflavin, calcium, vitamins and saponins [10]. This plant is widely used as a food seasoning and seasoning for various dishes. The content of secondary metabolites of EF varies depending on the ecotype such as EF collected from Andaman, Darjeeling and Karnataka contained different total phenols, flavonoids, tannins and vitamin C content. The phenolic content of EF was high in Darjeeling samples whereas, Andaman samples showed high amounts of flavonoids and tannins, and from Karnataka are rich in vitamin C [10].

The essential oil composition in EF is estimated at 60 [3] – 81 species [12] which is influenced mainly by genetic variability and geographic location (3). Some secondary metabolites found in EF such as, cholesterol, brassicasterol, campesterol, stigmasterol (as the main component as much as 95%) clerosterol, sitosterol, D5-avenasterol, D524-stigmastadienol and D7-avenasterol [5]. The main essential oil of EF is eryngial (E-2-dodecenal) [3], but the content varies greatly which is influenced by various factors. Sing et al [3] stated that EF has many significant variations in plant morphology and essential oil content.

Essential oils are produced by various plants including EF and are often used to identify certain species. The content and types of essential oils contained in EF vary greatly depending on the origin, origin, distillation method, and analytical method. *Eryngium foetidum* from Bangladesh which was analyzed using GC-MS found as many as sixty-three essential oil compounds and the dominant compounds found were (E)-2-dodecenal (37.4%), dodecanoic acid (10.7%), trans acid -2-dodecanoic (9.7%), (E)-2-tridecenal, (6.7%), duraldehyde (5.1%) and tetradecanal (4.4%) [13].

Essential oil of EF which obtained by hydro distillation and analyzed using Chromatography-Mass (GC), Gas Chromatography-Mass/Spectrometry (GC/MS) and <sup>13</sup>C-NMR found a small amount of hydrocarbon monoterpenes and sesquiterpenoids and a large number of aromatic compounds and linear aldehydes with a composition of 2,3,6 trimethylbenzaldehyd (5 ,5-23.7%), (E)-2-dodecanal (15.9-37.5%), (E)-2 tetradecenal (18.7-25.3%) very dominant (14). The results of chromatographic fractionation of EF extracts obtained various compounds such as -cholesterol, brassicasterol, campesterol, stigmasterol (as the main component as much as 95%) cholesterol, sitosterol, D5-avenasterol, D524-stigmastadienol and D7-avenasterol [5]. The hydro distillation results were collected in a Clevenger trap and analyzed by GC and GC/MS. The main components are 2,4,5 trimethyl benzaldehyde (27.7%), (E)-2 dodecanal (27.5%), carotol (8.8%), 3-dodecanal (5.2%) and  $\gamma$ -terpinene (3.5%) [15]. Thomas et al [16] stated that EF leaf essential oil obtained by hydro distillation and gas chromatography-mass spectrometry (GC-MS) analysis showed that the dominant compound was (E)-2-Dodecenal (28.43%), 13- tetradecenal (27.45%), dodecanal (14.59%) and 2,4,5-trimethylbenzaldehyde (10.77%). He further stated that the dominant compounds from the stem were dodecanal (20.21%), 2,4,5-trimethylbenzaldehyde (18.43%) and (E)-2-dodecenal (8.27%), while in root 2, 4,5-trimethylbenzaldehyde (56.08%), 13-tetradecenal (9.26%) and (E)-2-dodecenal (7.65%). The hydro distillation results analyzed by GC and GC/MS showed that the main components of EF were 2,4,5 trimethyl benzaldehyde (27.7%), (E)-2 dodecanal (27.5%), carotol (8.8 %), 3-dodecanal (5.2%) and -terpinene (3.5%) [15].

### 3.3. Uses of *Eryngium foetidum*

Some species belonging *Eryngium* genera are used as spices and are used for the treatment of hypertension, digestive problems, asthma, burns, fever, diarrhea, and malaria [1].

### 3.3.1. Anti-inflammatory and Anti-oxidant

Inflammation is caused by the entry of foreign objects, pathogens into the body. *Eryngium foetidum* is used in traditional medicine for the treatment of several anti-inflammatory disorders. The hexane extract EF and stigmasterol resulted in reduced edema in the same proportion in the two test models (acute and chronic). Myeloperoxidase activity was greatly reduced by both EF extract and stigmasterol, in acute but not chronic models. The extract of is effective against topical inflammatory processes. Stigmasterol also exerts significant topical anti-inflammatory activity and cannot be considered a major anti-inflammatory agent, therefore other bioactive components may be involved in the activity of the hexane extract [5]. Anti-inflammatory activity can be evaluated with reference to the gene expression of iNOS, COX-2, TNF- $\alpha$  and IL-6 [17].

The secondary metabolites of EF leaves have compounds that responsible for anti-inflammatory and antioxidant activity. Approximately 24% carotene and 35% lutein were found in the aqueous extract of EF leaves (2). The transfer of caffeic and chlorogenic acid to the aqueous fraction was 76%-81%, while kaempferol was 48% (2). The ethanol extract of EF was shown to contain lutein, carotene, chlorogenic acid, kaempferol and caffeic acid, known compounds. Has anti-inflammatory bioactive properties [17].

This study assessed the anti-inflammatory and antioxidant activity of EF leaf extract on LPS-activated murine macrophages. RAW cells pretreated with or without EF extract for 1 hour before incubation with LPS for 24 hours showed anti-inflammatory activity. Anti-inflammatory activity can be evaluated with reference to the gene expression of iNOS, COX-2, TNF- $\alpha$  and IL-6. Treatment with EF extract inhibited the increase in IL-6, TNF-, iNOS and COX-2, together with mRNA in a dose-dependent manner resulting in reduced intracellular NO and ROS content). EF leaf extract has a suppressive effect on proinflammatory mediators so it has a high potential to be used as a dietary supplement to reduce the risk of cancer associated with inflammation [17].

The essential oil obtained by hydro distillation and analyzed by gas chromatography-mass spectrometry (GC-MS). The free radical scavenging capacity of essential oils was determined using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and iron-reducing antioxidant power (FRAP) assays. EF leaf essential oil contained a high proportion of (E)-2-Dodecenal (28.43%), 13-tetradecenal (27.45%), dodecanal (14.59%) and 2,4,5-trimethylbenzaldehyde (10.77%); stem oil consisted of dodecanal (20.21%), 2,4,5-trimethylbenzaldehyde (18.43%) and (E)-2-dodecenal (8.27%), while 2,4,5-trimethylbenzaldehyde (56.08%), 13-tetradecenal (9.26%) and (E)-2-dodecenal (7.65%) were the most dominant in root oil. The IC<sub>50</sub> values for leaf, stem and root oils were 56 respectively. g/mL, 46 $\mu$ g/mL and 54.5 g/mL in the 2,2-difenil-1- picrylhydrazyl (DPPH) test while leaf oil showed the highest reduction potential among the test oils in the ferric reducing antioxidant power (FRAP) test [16].

### 3.3.2. Anti-microbial

The use of plants as antimicrobials has long been carried out either directly or indirectly. The addition of various types of spices to various types of food can directly or indirectly increase the shelf life of food. Silalahi (18) stated that the addition of *Etlintera elatior* to *arsik* (a type of fish curry) resulted in food being more durable. This results in various types of plants having the potential to be used as natural preservatives.

Plants used as antimicrobials are plants that produce compounds that can inhibit growth or cause microbial damage. The researchers have reported the activity of EF as an antimicrobial against such as: *Listeria monocytogenes* [12], *Helicobacter pylori* [7], *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pneumoniae* [19]. The content of essential oil is a compound that inhibits microbial growth [12]. Leaves of EF extract used for biosynthesis of ZnO nanoparticles showed excellent antibacterial agents against bacterial pathogens such as *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Streptococcus pneumoniae*. The maximum inhibition zones in ZnO containing EF extract were 32.23  $\pm$  0.62 and 28.77  $\pm$  1.30 mm for *P. aeruginosa* and *E. coli*, respectively [19].

The ability of EF as an antimicrobial is influenced by various factors such as concentration. The use of ethanol extract of EF with a concentration of 15 ppm during pasteurization of pineapple juice at 60°C has implications for the time required for a 4-log reduction in *L. monocytogenes* CFU/ml by 74.9% (from 8.5 to 2.1 minutes) compared to treatment without EF extract. EF-assisted pasteurization is a promising strategy for reducing the thermal impact during juice production so that it can be applied in the food industry [12].

Mabeku et al [7] reported that EF extract had antibacterial activity against 6 clinical strains of *Helicobacter pylori* in vitro and in vivo. Methanol extracts of EF with concentrations of 125, 250, and 500 mg/kg and ciprofloxacin (500 mg/kg as control) administered for 7 days to Swiss mice inoculated with *H. pylori* were able to suppress *H. pylori* infection. Mabeku et al [7] stated that the number of animals infected with *H. pylori* was only 17% when given the EF extract while

those not given were infected with 100%. This number is still higher than the control, which is 0% with ciprofloxacin administration. Plant extracts ( $381.9 \pm 239.5$  CFU) and ciprofloxacin ( $248 \pm 153.2$  CFU) significantly reduced bacterial mass in the gastric mucosa compared to uninoculated and inoculated mice ( $14350 \pm 690$  CFU).

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#### 4. Conclusion

The ethnobotanically *Eryngium foetidum* is used to treat fever, hypertension, headache, stomach pain, asthma, arthritis, diarrhea, and malaria. The essential oils contained in the EF pad were dominated by (E)-2-dodecenal, dodecanoic acid, trans-2-dodecanoic acid, (E)-2-tridecenal, duraldehyde, and tetradecane. The *Eryngium foetidum* has been an anti-microbial, antioxidant and anti-inflammatory.

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#### Compliance with ethical standards

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I declare that article there is no conflict of interest.

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