

Seminar report

TRUE CORIANDER AND ITS MIMICS

By

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DECLARATION

I, Anjukrishna V. U. (2018-12-030) hereby declare that the seminar entitled 'True coriander and its mimics' has been prepared by me, after going through various references cited at the end and has not copied from any of my fellow students

Vellanikkara

24/01/2020

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CERTIFICATE

This is to certify that the seminar report entitled '**True coriander and its mimics**' has been solely prepared by **Anjukrishna V. U.** (2018-12-030) under my guidance and has not been copied from fellow students.

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True coriander and its mimics

1. Introduction

Nature is filled with amazing wonders and man is trying to find out and understand the unusual ways in which plants and animals thrive in nature. Among the countless marvels that we witness, one of the most exciting thing that has captivated the plant lovers is the mimicry shown by the plants. Mimicry involves the evolved resemblance of a species acting as ‘mimic’ to a living or non-living ‘model’, such that a selective agent or ‘dupe’, unable to distinguish between them. Mimicry is best understood as an unconscious adaptive resemblance that simply evolves by natural selection. Despite mimicry in animals being, the phenomenon remained rarely confirmed and largely controversial in plants (Ruxton et al., 2004). Only in the last three decades has evidence been presented suggesting that floral mimicry may be widespread in some plant families.

In evolutionary biology mimicry in plants where the plants evolve to resemble another organism physically or chemically. *Diuris* spp. an Australian orchid species and native pea plants showed strong morphological similarity compared to the co-flowering plant community, while the spectral reflectance of *Diuris* spp. was similar to that of *Daviesia* spp (Scaccabarozzi *et al.*, 2018). Orchids (Orchidaceae) are an unusual group among flowering plants in that approximately one-third of known species (6500–9000 species) are believed to attract their pollinators via deception. Within the astonishing diversity of orchid pollination systems, sexual deception is one of the most stunning. An example is the genus *Ophrys*, where plants attract male bees as pollinators by mimicking female mating signals (Schiestl and Cozzolino, 2008).

There are a lot of plants showing such similarities morphologically and chemically. Some plants are not similar in morphological characters but may possess the similarities in chemical constituents present in the plant but, the plants from different genus or species. Some plants are having the similar chemical constituents responsible for the flavour and aroma of the plant. Such plants can be collectively called as mimics.

2. True coriander

True coriander (*Coriandrum sativum* L.) is one of the herbal spices which is believed as one of the divisive and important constituent of South Indian dishes. Coriander (*Coriandrum sativum* L.) is a culinary and medicinal plant from the *Umbelliferae* family. Coriander is native to the Mediterranean and Middle East, and found wild in Egypt and Sudan (Sharma *et al.*, 2012). It is unclear when or where the common *Coriandrum sativum* species originated, though it was likely first cultivated for use in Southeastern Europe and Southern Russia and historically, India has been one of the largest producers and consumers of coriander leaves, worldwide (Diederichsen, 1996). The different names of the Chinese Parsely (English), *dhaniya* (Hindi), *dhanyaka* (Ayurvedic name), *kottumalli vitai* (Siddha name), *kothamalli* or *mallyila* (Malayalam) *etc.* Fresh coriander leaves are more commonly known as cilantro. The pharmacopoeial names are *Coriandri fructus* for the coriander fruit and *Coriandri aetheroleum* for the coriander fruit oil (Sharma *et al.*, 2012). All parts are used in this plant. They can be either used in the form of herb by using its immature leaves or in the form of spice by using the dried matured seeds.

Coriander (*Coriandrium sativum* L.) is mainly cultivated in Rajasthan, Uttar Pradesh, Madhya Pradesh and Southern states like Karnataka, Andhra Pradesh and Tamil Nadu states of India (Vadiraj *et al.*, 1998). Coriander cultivation is limited to some extent in Kerala. In addition to India, coriander is also commercially cultivated in a number of countries, including Morocco, Romania, Bulgaria, France, Spain, Italy, the Netherlands, Myanmar, Pakistan, Turkey, Mexico, Canada, Argentina and Australia and, to some extent, in the UK and USA. India is the largest producer of coriander herb as well as seed.

True Coriander is an annual, erect herb with a tap root system. The plants attain heights from 20–120 cm and flower 45–60 days after sowing; the flowers mature in 65–120 days, depending upon the variety and whether irrigated or rain fed. The upper leaves are wispy and finely divided; the lower ones broad, undivided and trilobite. Some varieties form a rosette of leaves at the base. Each branch as well as the main shoot terminates in a compound umbel bearing 3–10 umbels, each umbel containing 10–50 pentamerous flowers. Hermaphrodite and staminate flowers may occur in each umbel. The flowers are small, protoandrous and difficult to manipulate for controlled pollination. Coriander fruit consists of the dry cremocarp of *C. sativum* L. and is nearly globular with a 1.5–5.0 mm diameter. The fruit consists of two single-seeded mericarps and is tan

to yellow–brown in color when ripe. Coriander may also be divided into two types according to the size of the fruit: *vulgare* types, with a fruit diameter of 3.0–5.0 mm, are usually grown in tropical and sub-tropical regions which yields an essential oil about 0.8- 1.8%, while *microcarpum* types, with a fruit diameter of 1.5–3.0 mm, tend to be grown in temperate regions and yield essential oil about 0.10 - 0.35%.



A



B



C

Plate 1. Coriander plants; A- Coriander leaves; B- Flower with compound umbel; C- Seed

2.1. Nutritive value of coriander leaves

Like other Leafy green spices, coriander is also an important part of a healthy diet. Coriander contains variable amounts of proteins, fats, carbohydrates, fibers, minerals and vitamins, like other herbal spices. Coriander is loaded with nutrients such as vitamins, phytonutrients and minerals. This plant is very low in saturated fat and cholesterol. It is packed with vitamins, minerals and fiber. It's fairly rich in Vitamin C and is also rich source of vitamin k which plays a

key role in helping the blood clot, preventing excessive bleeding. It is also rich in minerals like calcium magnesium and phosphorus.

Table 1. Nutritive value of True coriander herb

Principle	Nutrient Value	Minerals	Nutritive value
Energy	23 Kcal	Calcium	67 mg
Carbohydrates	3.67 g	Iron	1.77 mg
Protein	2.13 g	Magnesium	26 mg
Total Fat	0.52 g	Manganese	0.426 mg
Cholesterol	0 mg	Phosphorus	48 mg
Dietary Fiber	2.80 g	Zinc	0.50 mg
Vitamins	Nutrient Value	Phyto-nutrients	Nutrient Value
Vitamin A	6748 IU	Carotene- α	36 μ g
Vitamin C	27 mg	Carotene- β	3930 μ g
Vitamin E	2.50 mg	Crypto-xanthin- β	202 μ g
Vitamin K	310 mg	Lutein-zeaxanthin	865 μ g

(Anonymous, 2019)

2.2. True coriander seed and herb oil

True coriander is one of the leading essential oil yielding plants as all parts of the plant can produce oil. Russia is the leading producer of seed oil. The aromatic odor and taste of coriander seeds is largely due to its volatile oil, which is a clear, colorless to light yellow liquid. The odor and flavor of mature seed and fresh herbage are completely different. The flavor of the seed oil is warm, spicy–aromatic, sweet and fruity. The characteristic aroma of herb oil is pungent and intensely fresh-green and soap-like. The volatile oil content from seed is 0.3-1.5% (Purseglove *et al.*, 1981) seed oil and oleoresin can be extracted. From finely ground seed. Essential Oil contains the volatile components which are responsible for its aroma and flavor, and oil is collected through steam distillation for 4 -6 hours. Oleoresin is a mixture of resin and volatile oils which is obtained by solvent extraction for 4 -6 hours. Acetone, ethanol and hexane can be used as solvent for the extraction of oleoresin. The volatile oil is composed of different complex compounds especially hydrocarbons like terpene and sequeterpenes and oxygenated compounds like alcohols, aldehydes, ketones, oxides, ethers and esters. These compounds are responsible for its flavour and characteristic odour.

Table 2. Chemical composition of True coriander (*Coriandrum sativum* L.) herb oil

Compound	Content (%)
E- 2- decenal	26
E-2- tetradecenal	7
Decanal	6.6
E- 2- dodecenal	5.4
1- decanol	19.6

(Shavandi *et al.*, 2012)

2.2.1. Chemical composition of coriander seed oil

The essential oil (steam distilled) is produced mainly in Eastern Europe and Russia is the leading producer. There are more than 40 compounds which are responsible for its flavour and aroma are identified the oil by GC-MS analysis. Linalool is the main aroma chemical of oil which forms two-third of the oil (Burdock and Carabin, 2009).

Table 3. Chemical composition of True coriander (*Coriandrum sativum* L.) seed oil

Alcohol (%)	Hydrocarbons (%)	Esters (%)
Linalool (60-80 %)	C- terpinene terpinene (1- 8 %)	Geranyl acetate (0.1- 4.7 %)
Geraniol (1.2-4.6 %)	R – cymene (3.5 %)	Linalyl aceate (2.7 %)
Terpinen 4 - ol (3 %)	Limonene (0.5 -4 %)	
α terpineol (\leq 0.5 %)	Camphene (1.4 %)	
	Myrcene (0.2-2 %)	

(Burdock and Carabin, 2009)

2.2.2 Chemical composition of seed oil

The seed oil and herb oil is different to each other. In contrast to seed oil herb oil contains an alcohol (linalool as main constituent) coriander herb oil contains different compounds and 95% of the total oil is aldehydes. They are (E)-2 decenal, E- 2 tetradecenal, decanal, 2 dodecenal. There is an alcohol also which is 1- decanol (Cadwallader *et al.*, 2005). Among these compounds the aldehyde compound E 2 decenal would be expected to be the most predominant and potent odourant which gives the oil with a very powerful, waxy, orange like, aldehyde odour.

The quantitative variation of the essential oil from the aerial parts of cultivated *Coriandrum sativum* L. were examined during 2008 year in Iran. Plant materials were harvested at different

phenological stages (i.e. vegetative, full flowering, green fruits, and brown fruits). Essential oils were obtained from the aerial parts of the plant by using an all glass Clevenger-type apparatus, for 3 h. The results of this experiment indicated that essential oil yields shown marked increase during maturation process. Essential oils at the green fruits stage of maturity (immature fruits) was more than other stages so that yields of oil (w/w %) at different stages were in the order of vegetative (0.14 %), full flowering (0.23 %), green fruits (0.37 %) and brown fruits (0.31 %) (Ramezani *et al.*, 2008).

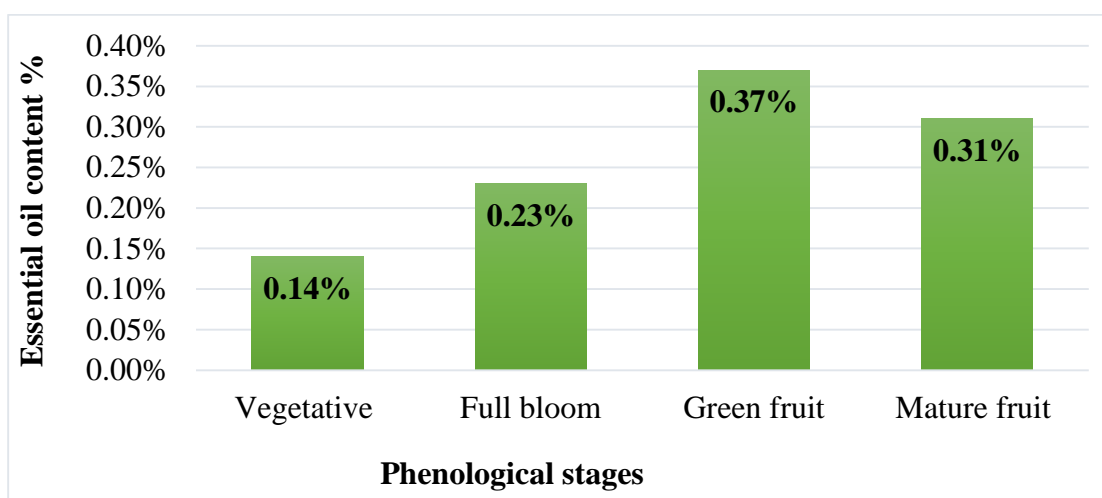


Figure 1. Effect of phenological stages on essential oil content of coriander

2.3. Economic uses

Coriander as one of the first spices to be used as a common flavouring substance. The stem, leaves and fruits have a pleasant aromatic odour. The entire plant, when young, is used in preparing chutneys and the leaves are used for flavouring curries, sauces and soups; coriander oil and oleoresin are primarily used in seasonings for sausages and other meat products. They find application in baked goods, condiments, chewing gums, and also in curry mixes.

This plant is of economic importance as it has a pleasant odor, due to the particular composition of the essential oil (up to 1%), that monoterpenoid and linalool is main components, which are mainly used as flavoring agent in food products like liquor, cocoa products, pastry, pickles and cookies. The fruits are also used in the preparation of fish and meat, seasoning but also for baking. The average use levels range from 0.1 to 100 ppm. In perfumery, the warm and sweet notes of coriander oil blend well with bergamot and sage colognes, with floral notes in jasmine, lilac, honeysuckle and apple-blossom. The high linalool and the petroselinic acid content, in the

seed oil, suggests the exploitation of the plant as a low-cost renewable source of bioactive compounds for industrial processing in the fields of cosmetics, perfumes and nutraceuticals.

2.4. Pharmacological activities of true coriander

Coriander has been used in traditional medicine from ancient time. There are some proven pharmacological activities for essential oil and leaf extracts. That is they have antimicrobial, antioxidant, antidiabetic, anticancerous, anti-mutagenic activity, it is also used as flavouring agent in pharmaceutical preparations. Essential oil of coriander is also used in aroma therapy, a complementary therapy becoming popular now a days.

It is believed that putting fresh leaf juice in the eyes, during an attack of small pox, prevents eye damage. Coriander juice, mixed with a pinch of turmeric powder, is an effective remedy for pimples, blackheads and dry skin.

Aligita *et al.* (2018) evaluated the activity of coriander leaves as an antidiabetic agent, utilizing both in vivo and in vitro method. In in vivo method, the extract was orally administered to the insulin deficiency mice model (Aloxan induced at dose of 65 mg/kg BW) with dose of 200, 400, and 800 mg/ kg BW for 14 days. The results showed that after 3 days of administrations, the extract at each dose and Glibenclamide 0.65 mg/kg BW could lower the glucose blood level significantly, compared to the positive control group.

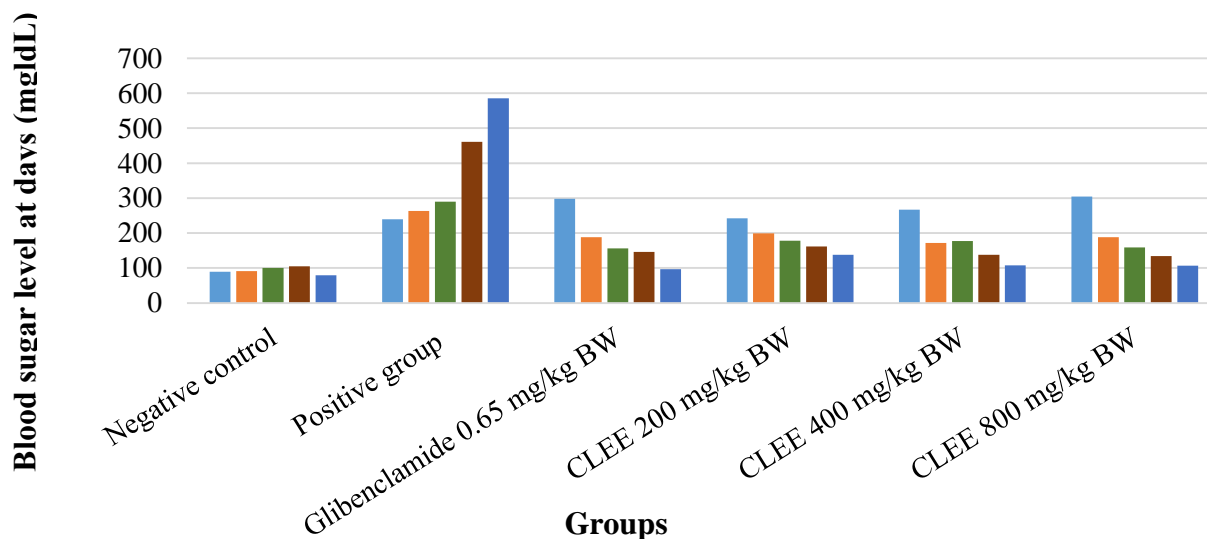


Figure 2. Antidiabetic Activity of Coriander (*Coriandrum Sativum* L.) Leaves Ethanolic Extract (CLEE)

3. Coriander mimics

As seen in other flowering plants, true coriander also has some mimics not by morphological features but by the smell, flavor and aroma. These plants are found in various parts of the world and are having the same uses as that of true coriander. They are Mexican coriander, Vietnamese coriander, and Bolivian coriander. These plants are collectively called as cilantro mimics. Many studies have done on these medicinal plants as important fragrance and flavour agent in common. Most of the investigations are on the extraction methods and chemical properties of these plants.

4. Mexican coriander

Eringyum foetidum L. is a herb extensively used as a medicinal and aromatic plant in most of the tropical region. It belongs to the same family of coriander, apiaceae. It is also called culantro, which is believed to be originated from Caribbean island. It is found in the parts of Asia and Africa. *E. foetidum* is rare, endemic in India and is localized in small pockets of Tamil Nadu, Kerala, Karnataka, Assam, Andaman and Nicobar Islands. The plant is called as wild coriander or culantro because of its aroma similar to that of normal (Chandrika *et al.*, 2011). The plant commonly known as spiny coriander, long coriander or African coriander. Spiny coriander is known by several names in different languages such as saw tooth coriander because of toothed leaf blade; Mexican coriander, African malli (Malayalam); *bandhania* (Hindi) (Singh *et al.*, 2014).

Spiny coriander is grown as annual in the Northeastern states of India (Mizoram, Manipur, Nagaland, Assam and Tripura), Andaman & Nicobar Islands, and few parts of Tamil Nadu, Kerala and Karnataka; but unknown to other parts of India. Under cultivation, the plant prefers acidic (pH 5.5–6.5), well drained heavy soil; but tends to bolt and flower profusely in hot, high light and long days of summer months which is ultimately detrimental to leaf growth and succulence, quality and aroma. The plants are easily propagated by seeds in spring or suckers during monsoon (Singh *et al.*, 2014).



A



B

Plate 2. Mexican coriander; A- Whole plant; B- Variation in leaf

4.1. Nutritive value of Mexican coriander

Unlike true coriander Mexican coriander leaves are rich in nutrients. The aerial parts of Mexican coriander are good sources of several nutrients including minerals, vitamins, carotenoids, antioxidants and phytosterol. The Mexican coriander is rich in calcium, iron, carotene, and riboflavin. The quantity of all nutrients and minerals present in 100g of herb is high in Mexican coriander.

Table 4. Nutritive value of Mexican coriander (*Eryngium foetidum* L.)

Principle	Nutritive value	Vitamins	Nutritive value	Minerals	Nutritive value
Moisture	86–88%	Vitamin A	10,460 IU/100g	Iron	0.06% (13 mg)
Protein	3.3%	Vitamin B ₂	60 mg	Phosphorus	0.02% (98 mg)
Fat	0.6%	Vitamin B ₁	0.8 mg	Calcium	1.23% (99 mg)
Carbohydrate	6.5%	Vitamin C	150–200 mg		

(Ramcharan, 1999)

4.2. Essential oil

Like true coriander Mexican coriander also yields essential oil on steam distillation. The yield depends on the quality of the herb and method of distillation adopted. The essential oil is extracted from the dried leaves. There is a significant variation in yield of oil and compounds of essential oil from the leaves of Mexican coriander. The variation may be due to factors like cultivar, climate and growth conditions, geographical origin, age of herb, harvesting, post-harvest

handling and analytical methods used. The essential oil of *E. foetidum* L. may vary content from 0.1 – 0.95 % of dry weight of the leaves (Ramacharan, 1999).

4.2.1 Chemical composition of essential oil.

Aliphatic aldehydes are very significant constituent of essential oil of *E. foetidum* L. and 2 – dodecenal is the main component of the oil. Chowdhury *et al.* (2007) isolated the essential oil from the leaves of Mexican coriander by hydro distillation method and around sixty compounds have been identified, among the identified compounds, 2 dodecenal account the major volume of the oil. The main ‘character impact’ odorant of the herb is 2 dodecenal. The oil is also filled with sesquiterpenes and monoterpenes.

Table 5. Chemical composition of essential oil of Mexican coriander (*Eryngium foetidum* L.)

Compound	Content (%)
E- 2 dodecenal	37.4
Tetradecanal	4.4
2-tridecenal	6.7
Duraldehyde	5.1
Dodecanoic acid	10.7
Trans-2-decanoic acid	9.7

(Chowdhury *et al.*, 2007)

4.3. Economic uses

Eryngium foetidum L. is most popular spice in Caribbean and in Asia cuisine. Now it is getting demand on Kerala as it can be used during cooking. Its pungent unique aroma give a characteristic flavour to the dishes in which it is incorporated. Harvested leaves are commonly topped over soups, salsa a famous Spanish sauce and curries. Now the herb is getting demand in Kerala too as it is easy to grow and it can be used at the time of cooking itself and not a garnishing.

4.4. Ethno medical and Pharmacological activities

There are numerous traditional uses have been identified and most of them are mainly medicinal. Traditional preparations having medicinal properties to cure a no. of diseases. Ancient tribes of Mexico, Caribbean, Nicaragua and India used various preparations of the plant mainly for pains such as stomach aches.

Table 6. Ethno medical uses of Mexican coriander (*E. foetidum* L.)

Preparation	Use
Infusion	Fever, hypertension diabetes, flu, constipation
Bath	Colds, heat, muscular pain
Decoction/ tincture	Diarrhoea, stomach ache, cold
Concoction mixed with milk	Stomach ache, asthma
Crushed root and leaf	Indigestion

(Paul *et al.*, 2011)

Extracts of *E. foetidum* L. have been evaluated for anthelmintic, anti-convulsant, anti-inflammatory, analgesic, antimalarial and antibacterial properties that were reported from traditional use. All pharmacological studies were done *in vitro* or on animal models and therefore lack the clinical data which determine their suitability for human use (Paul *et al.*, 2011). Okon *et al.* (2013) screened phytochemical such as saponins, flavonoids, alkaloids, tannins and anthraquinones, cardiac glycosides and terpenes. The LD 50 value for *E. foetidum* L. leaves extract was 1649.24 mg/kg. The ethanolic extract of *E. foetidum* L. decreased the inflammation induced in both xylene and egg albumin. The degree of inhibition of leaves extract was not significant when compared to the effect of standard inflammatory drug, acetyl salicylic acid (53.26%). These results indicate that the extracts could possess analgesic and anti-inflammatory properties.

Table 7. Effect of extract of *E. foetidum* L. leaves on xylene-induced ear edema in Wistar**Albino mice**

Groups	Treatment	Dose	Ear edema (mm ³)	Inhibition (%)
Negative control	Distilled water	10.0 (mL)	0.06	-
Positive control	Dexamethasone	4.0 (mg/kg)	0.02	66.67
Treated	Low dose	164.92 (mg/kg)	0.05	16.67
Treated	Middle dose	329.84 (mg/kg)	0.04	33.33
Treated	High dose	494.76 (mg/kg)	0.02	66.67

(Okon *et al.*, 2013)

5. Vietnamese coriander

It is a popular herb in Mexico and South America with a distinctive somewhat strong flavor similar to cilantro. *Polygonum odoratum* Lour. (*Persicaria odorata*) is a culinary herb belongs to the family polygonaceae, which is indigenous plant to Tropical south Asia or Peninsular Southeast Asia. Vietnamese coriander is known by different names in different countries. Widely accepted name includes Vietnamese coriander, Cambodian mint, hot mint and Vietnamese mint. In Vietnam the plant known by the name Rau Ramm, Often pronounced as zow-zam. In Malaysia, the plant is known as kesum which is actually a Malay word. In Singapore, the plant is called as *laksa* plant.

Vietnamese coriander, or Vietnamese cilantro, is a heat-loving perennial with slightly spicy, flavorful leaves that are a great culinary substitute for cilantro or mint. The plant is perennial. The leaves are having distinctive dark purple marking in the centre of the leaves which are green. The plant can be propagated through cuttings, and roots are produced easily from the nodes of the cuttings.



A

B

Plate 3. Vietnamese coriander; A- leaves; B- Whole plant

5.1. Essential oil

Vietnamese coriander have a very strong coriander odour. Hunter *et al.* (1997) have studied the volatile constituent of the herb oil extracted by steam distillation from the leaves and stems was a clear to pale yellow oil with a strong but diffusive predominating aldehydic odor with cool earthy and vegetable like undertones. The oil yield is 0.04-0.05% on steam distillation of aerial parts of the plant (Nguyễn Xuân Dũng, 1995).

5.1.1. Chemical composition of essential oil

Aliphatic aldehydes are the major compounds of the essential oil. Hunter *et al.*(1997) analyzed the essential oil by GC/MS AND 17 chemical compounds were identified and reported that the aldehydes such as dodecanal, decanal, and decanol are the main compounds of oil.

Table 8. Chemical composition of Vietnamese coriander (*Polygonum odoratum* Lour.)

Chemical constituent	Content (%)
Dodecanal	44.1%
Decanal	27.7%
Decanol	10.9%
Dodecanol	2.6%
β -caryophyllene	3.8%

(Hunter *et al.*, 1997)

5.2. Economic uses

Vietnamese coriander is used in Southeast Asian cooking, it's actually more often used in the place of peppermint. It has a very strong, smoky flavor and, because of its strength, should be used in quantities about half that of cilantro. The leaf is identified with Vietnamese cuisine, where it is commonly eaten fresh in salads. The plant is widely used in the production of Kesom oil, a potential source of natural aliphatic aldehydes.

5.3. Pharmacological activities

Vietnamese coriander believed to have a wide range of medicinal and pharmaceutical properties such as aphrodisiac, antimicrobial property, anti-inflammatory activity, antitumor promoting activity, and antioxidative property. Saad *et al.* (2014) reported that the extract obtained with percolation with soxhlet technique shows the best antibacterial activity followed by maceration with ultrasonication. Decoction extracts shows the weakest antibacterial activity against all four bacteria (*Escherichia coli*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Salmonella spp.*).

Table 9. Zone of inhibition of *P. odoratum* leaves extracts against microbes

Organism	Leaf extract (mg/ml)/ Zone of inhibition (mm)									STD drug	Negative control
	Decoction			Maceration with ultra-sonication			Percolation using Soxhlet extractor				
	50	70	100	50	70	100	50	70	100		
<i>E. coli</i>	0	0	6	10	10	11	14	14	15	25	0
<i>S. aureus</i>	0	0	6	9	9	9	12	13	13	24	0
<i>B. subtilis</i>	0	0	0	8	8	8	10	10	11	24	0
<i>S. typhi</i>	0	0	0	8	9	9	8	9	9	22	0

GTM-Gentamycin; DW-Distilled water; STD- Standard

(Saad *et al.*, 2014)

6. Bolivian coriander

Papalo or Bolivian coriander (*Porophyllum ruderale* Cass.) a member of asteraceae, is another South American herb that sits somewhere on the coriander scale. The plant is indigenous to South American country, Brazil. It is an annual plant found from the warm temperate areas of Sothern North. America and tropical Americas to Bolivia and Peru. The plant is known by different names like papalo, mampuito, papaloqulite, pored leaf, summer cilantro. It's spicier and has a stronger, sharper scent.

Porophyllum ruderale Cass. is an erect, usually rather sparsely branched annual plant growing 20 - 100cm tall. The leaves impart a very strong, unique, cilantro-green pepper-cucumber flavor. All parts of the plant are having unpleasant smell. The leaves are scented and the oil glands are arranged in every undulating notches of the leaves. It produces strong odour while heating or bruising the foliage. In some parts of the country the plant is considered as a weed. The flowers are brushy stubble on the end of the long bud. Its Seed head contains numerous fluffy seeds.



A



B



C



D



E

Plate 4. Bolivian coriander; A - Whole plant; B - Leaves; C - Flower; D - Seed head; E - Seeds

6.1. Essential oil

The essential oil yield is very less compared to true coriander. On steam distillation leaves and root yields an essential oil about 0.05% and 0.013 respectively (Bezerra *et al.*, 2002).

6.1.1. Chemical composition of essential oil

Unlike other coriander mimics the major compound is a monoterpene called limonene which account 75 % of the total volatile oil but contains aliphatic aldehyde in small quantity. The essential oil is analyzed by GC/MS method and identified 6 chemical compounds. The aldehyde compounds, (E, E) – dodecadienal, and decenal are responsible for its coriander flavour. The other main chemical constituents are sabinene and p- pinene (Bezerra *et al.*, 2002).

Table 10. Chemical composition of Bolivian coriander (*Porophyllum ruderale* Cass.)

Compound	Content (%)
Limonene-	75%
(E,E)-dodecadienal-	21.8%
Sabinene	1.8%
P-pinene	1.1%
Decanal	1.7%
myrcene	0.9%

(Bezerra *et al.*, 2002).

6.2. Economic uses

Bolivian coriander has been used in Mexico well before Columbus, as the same of cilantro. The leaves impart a very strong, unique, cilantro-green pepper-cucumber flavor. The fresh herb is used for culinary purpose as it can't retain their flavour while drying.

6.3. Pharmacological activities

While Bolivian is an interesting herb that is gaining popularity in American cuisine due to its unusual flavor, it remains an important part of people's daily diets in countries such as Mexico and Bolivia because of its medicinal properties. *Porophyllum ruderale* Cass. is an aromatic herb having numerous pharmacological activities like anti-inflammatory properties, antibacterial, anti-stress, arterial hypertension, anti leishmanial activity , traumatism, antidote against snake poison, pain relief and rheumatism (Lima *et al.* , 2011).

Lima *et al.* (2011) investigated the anti-nociceptive and anti-inflammatory activities of the *Porophyllum ruderale* aqueous extract. The study showed that higher doses of *Porophyllum ruderale* anti-nociceptive to acetic acid induced nociception. The doses of 100, 200 and 400 mg/kg significantly inhibited the acetic acid induced writhing 63.4, 89.6 and 94.8%, respectively.

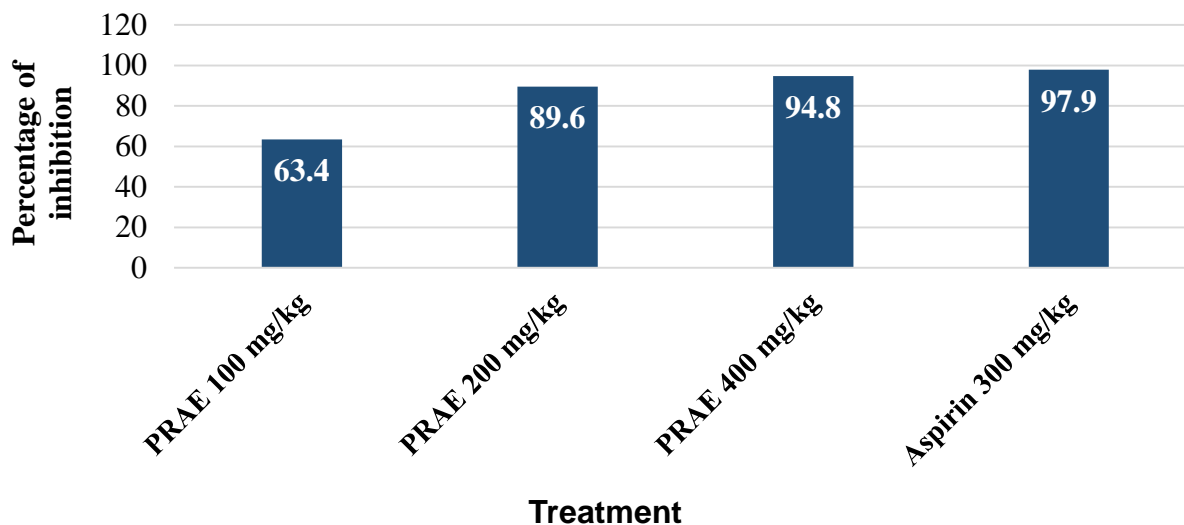


Figure 3. Percentage of inhibition of acetic acid induced nociception by *P. ruderale*
PRAE- *Porophyllum ruderale* aqueous extract

7. Discussion

1. Among the different coriander mimics which one is mostly found in Kerala?

Among the true coriander and coriander mimics true coriander is more familiar to Kerala. Mexican coriander is also getting popularity nowadays.

2. Among the different coriander groups which is difficult to grow in Kerala?

Widely used one is true coriander, but true coriander is difficult to grow as it needs dry and cool climate for bolting. The incidence of pest and disease will be more under the cultivation in Kerala as the relative humidity and temperature will be more favourable for the pest and diseases like aphids and damping off respectively.

3. How did Mexican coriander and Bolivian coriander get their names?

As the name Mexican coriander, *Eryngium foetidum* is native to Mexico- Caribbean Island. Bolivian coriander is native to South American country, Brazil. The plant growth occurs in the

countries namely Bolivia, Peru, Northern Brazil; Central America, Panama to Mexico; North America and Texas. The plant population is more in Bolivia.

4. What is anti-leishmanial properties of Bolivian coriander?

Leishmaniasis is an infection caused by protozoa of the genus *Leishmania*, showing several clinical forms: cutaneous (CL), mucocutaneous (MCL), and visceral (VL) leishmaniasis. No vaccines are available for any form of the disease, and the chemotherapy is still inadequate and expensive. Aerial parts of *P. ruderale* have been used popularly in the treatment of lesions caused by *Leishmania* sp. Terthiophene derivatives isolated from plants have shown antifungal and antibacterial activity. Terthiophenes and polyenes isolated from species of the family asteraceae have shown activity against microorganisms, viruses, and tumor cells.

5. Is there any morphological mimics for true coriander?

Coriander leaves have a strong aroma and bear a resemblance to Italian flat-leafed parsley. The leaves are extensively used around the world as a condiment or a garnish on culinary dishes. In some parts of the country tarragon and dill is also used as a substitute for coriander leaves.

8. Conclusion

Both the true coriander and its mimics *viz.*, spiny coriander, Vietnamese coriander and Bolivian coriander are unusually rich in aliphatic aldehydes which are excellent source for the production of natural aliphatic aldehydes. Currently used synthetic aliphatic aldehydes are highly expensive and hence, have only limited availability.

All members of cilantro group may have their own specific reasons for the similarity in the chemical profile. However, we can utilize them in the production of flavour and fragrance ingredients as true coriander

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10. Abstract

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PSMA 591 : Masters Seminar

Name : Anjukrishna V. U.

Venue : Seminar Hall

Admission No. : 2018-12-030

Date : 28-11-2019

Major advisor : Dr. N. Mini Raj

Time : 12.15 pm

True coriander and its mimics

Abstract

Mimicry shown by the plants is one of the most exciting things that has captivated the plant lovers all over the world. True coriander (*Coriandrum sativum* L.) is an important spice in South Indian dishes. It is used both as a herbal spice and seed spice. True coriander has got some mimics, not by morphological features but by smell, flavour and aroma. They are Mexican coriander (*Eryngium foetidum* L.), Vietnamese coriander (*Polygonum odoratum* Lour.) and Bolivian coriander (*Porophyllum ruderale* Cass.). These plants are collectively called as coriander mimics or cilantro mimics.

Coriander mimics possess intense fresh-green, soapy and aldehydic notes similar to the true coriander. The essential oils contain constituents such as hydrocarbons and oxygenated compounds which are responsible for the characteristic odours and flavours.

True coriander is one of the world's leading essential oil yielding plants. Seed oil has a characteristic odour of linalool with mild sweet, warm and aromatic flavour. In herb oil, most of the volume is occupied by the aliphatic aldehydes like (E)-2-decenal, decanal, (E)-2-dodecenal *etc.* (Cadwallader *et al.*, 2005). Ethanolic extract of coriander leaf is found to be effective against diabetes (Aligita *et al.*, 2018).

Mexican coriander or spiny coriander is a leafy spice, a substitute condiment for the true coriander due to its similar pungent smell. The essential oil is rich in aliphatic aldehyde and the main "character-impact" odourant of the herb is (E)-2-dodecenal. It has been used in traditional ethno-medicine for the treatment of various ailments. Extract of Mexican coriander leaves showed anti-inflammatory properties (Okon *et al.*, 2013).

Vietnamese coriander or Vietnamese cilantro is a perennial herb with slightly spicy flavour which makes it a great culinary substitute for cilantro and mint. Hunter *et al.* (1997) found that dodecanal and decanal are the major constituents present in the essential oil of Vietnamese coriander. The leaf extract of Vietnamese coriander is found to be effective especially against *Escherichia coli* and *Staphylococcus aureus* (Saad *et al.*, 2014).

Bolivian coriander or papalo is widely used in Mexican cuisine. Its flavor has been described as a peppery cross between coriander and cucumber. The leaves of papalo contain essential oils and active chemical constituents. The leaf oil has limonene, a monoterpene and (E, E) - dodecadial, an aldehyde as its main constituents. Aqueous extract of Bolivian coriander is well known for its antinociceptive activity (Lima *et al.*, 2010).

Coriandrum sativum L., *Eryngium foetidum* L., *Polygonum odoratum* Lour. and *Porophyllum ruderale* Cass. have got unusually high content of aliphatic aldehydes and are a good source for production of the same. Currently used synthetic aliphatic aldehydes are highly expensive and hence, have only limited availability. In summary, all members of cilantro mimics can be utilized in the production of flavour and fragrance ingredients as true coriander.

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