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Ferula asafoetida Linn. and *Coriandrum sativum* Linn. - A review on physical, psychological and environmental health

Review Article

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Abstract

Background: *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn. belonging to Umbelliferae (Apiaceae) family are used in food for seasoning, restoration of taste, to increase shelf-life and to restore health. Their essential oils and extracts are extensively employed by industrial sector like food industry, beverage industry, fragrance industry, cosmetic industry and pharma industry. However, their use is not limited to food and industrial sector. They have diverse usage in physical ailments, psychological disorder, environmental health. Materials and methods: Data is collected from search engines like Scopus, PubMed, Research Gate, and Google Scholar. Result: Among several herbs used, asafoetida and coriander are only herbs used in spices, medical and environmental well-being. In tradition medicine asafoetida and coriander is used in epilepsy, hysteria, dental carries, alcoholism, stomach-ache, flatulence and coriander in rheumatoid arthritis, emesis, indigestion, fever, conjunctivitis and indolent swelling etc. Aside of this, they are widely used as botanical pesticides since pharmacological researches has shown that they have insecticidal, larvicidal, insect repellent, ovicidal, and acaricidal properties. As compared to manufactured chemicals, botanicals are thought to be less hazardous to the environment and human health. Recently, neuroprotective, antidepressant/ anxiolytic, learning and memory improvement, insecticidal, larvicidal, insect repellent, antifungal, antimicrobial, anti-helminthic, gastroprotective etc properties are proven pharmacologically and biologically in animal models and humans. Conclusion: Use of essential oils should be employed in physical, psychological and environmental health by various means such as aroma therapy, topical application, inhalation, ingestion, colognes, spray and baths, not only eradicate the disease but also to rejuvenate the whole body.

Keywords: Essential oils, Plant extracts, Phytoconstituents, Physical health, Psychological health, Environmental health, Aroma therapy.

Introduction

Essential oils are used in both physical and psychological health as well as internally, externally, in day and seasonal regimen. In Ayurveda, essential oils, phytotherapy, phytochemicals have been used for a variety of medical (physiological and psychological health) and environmental purposes. The earliest herbs, *Ferula asafoetida* Linn. (*Hingu*) and *Coriandrum sativum* Linn. (*Dhanyaka*), are aromatic plants belonging to the Umbelliferae (Apiaceae) family. The Apiaceae family consists of about 455 genera and 3,600–3,751 plants species that are often used in the form of spices.(1) The herbs have been utilized for environmental, medical, and culinary purposes from ancient times.(2) Aside from that, they are employed in food, beverage and pharmaceutical industries. In addition, their essential oils are used in fragrance, cosmetics, oral hygiene products, lubricating oils, diluting agents, and insecticidal agents. The plants' essential oils, also known as volatile aromatic compounds are hydrophobic liquid products of secondary metabolism(3)that provide a distinctive flavour, aroma to a plant(4)and have the potential to be low-molecular-weight chemical compounds with a range of 50–200 Da in different combinations. (3)Asafoetida's essential oils have rich components like coumarin (ferulenol, galbanic acid and umbelliprenin), coumarin esters (ferulone A, B), prenylated coumarins (ferprenin), monoterpene coumarins (auraptene), monoterpene (α-pinene, β-pinene), sesquiterpenes (germacranes, himachalanes, carotanes, guaianes, farnesiferol A and B, and sinkiangenorin C and E), carbohydrates (galactose, glucuronic acid, arabinose, rhamnose), phytoestrogen (ferutinin), diterpenes, phenols and sulphur containing derivatives.(4)Whereas coriander essential oils have biologically active components such as monounsaturated fatty acids, tocol, sterol, carotenoids,(3)oxygenated monoterpenes, monoterpene hydrocarbon, fatty acids, long chain alcohols, monoterpene hydrocarbon, monoterpene esters, aldehydes, ketones and phenols.(5)

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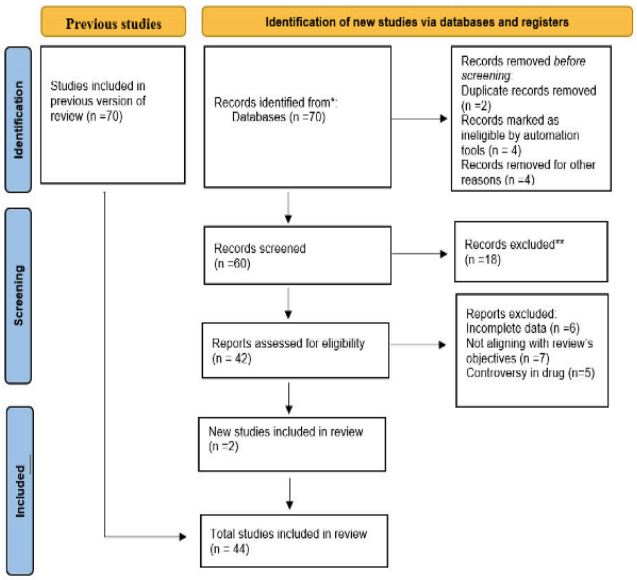
Materials and Methods



The information search regarding this review is carried out on the objective of presenting *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn. useful in physical, physiological and environmental health of aroma therapy. Literature is reviewed from Ayurvedic classical texts such as Samhita, Nighantu (lexicons) and Pharmacopeia of India. We used the search engine on the database platforms Scopus, PubMed, Research Gate, and Google Scholar based on the mesh terms like "*Hingu*", "*Dhanayaka*", "*Ferula asafoetida*", "*Coriandrum sativum*", "aroma therapy", "essential oil", "chemical constituents", "*Karma*", "mechanism of absorption and action", "physical Health", "And", "phycological health", "anxiety", "depression", "neurological disorder", "insecticidal activity", "grain pest", "insect repellent property", and "*Amayiaka prayoga*". The data was established in both original and review articles and is analysed, compiled, summarized and discussed according to the aim of present article. The Prisma flow chart of the following is provided below.

Result

The beneficial effects of essential oils are not exerted by inhalation of the vapours but also by absorption of the molecules through skin and gastrointestinal tract. According to the studies it is suggested that effects of essential oil are evoked by both pharmacological and psychological mechanism. A schematic illustration of administration and absorption route of essential oils are demonstrated in figure 1 and figure 2 respectively.

Chemical constituents of *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn.

Asafoetida consists of three main constituents i.e. resin (40- 64%), gum (25%) and essential oil (10-17%). Per 100 g of *Ferula asafoetida* Linn. contain protein 4.0%, moisture 16.0%, carbohydrates 67.8%, fat 1.1%, fibre 4.1% and minerals 7.0%. Minerals include substantial calcium, phosphorus, iron and vitamins such as niacin, carotene and riboflavin. Asafoetida's calorific value is 297 which contains 40-64% resinous material composed of ferulic acid, farnesiferols A, B and C umbelliferone and asaresinotannols.(7)

The oleo-gum-resin, or dried latex that was released from the tap root or rhizome of

Ferula asafoetida contains following nutritive elements like calcium (690 mg/10 g), iron (39.4 mg/10 g). Furthermore, it contains ferulic acid, esters, coumarins, sesquiterpene coumarins and other terpenoids. Galbanic acid is usually present in resin part of the asafoetida.(1)Gum contains 1- arabinose, polysaccharides, glycoproteins(8), rhamnose, glucuronic acid, glucose, galactose and volatile oil.(7)

Volatile oil extracted from asafoetida contains disulfides (major component), monoterpenes, 2-butyl propenyl disulfide, traces of vanillin, valeric acid and free ferulic acid. The odour of volatile oil is mainly due to disulphide ($C_{11}H_2OS_{22}$).(7)

Leaves of asafoetida contains essential oil having following components such as eremophilene, δ-cadinene, longiborneol, isoledene, dehydro aromadendrene, α-pinene, 2-J-pinene, ι-Gurjunene. J-Guaiene, ledenoxid, trans-caryophyllene.(9)

Figure 1: Route of administration of essential oils

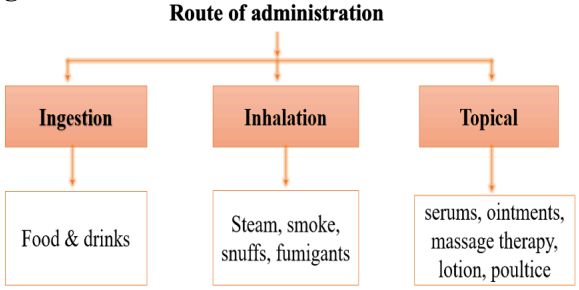


Figure 2: Route of absorption of essential oils(6)

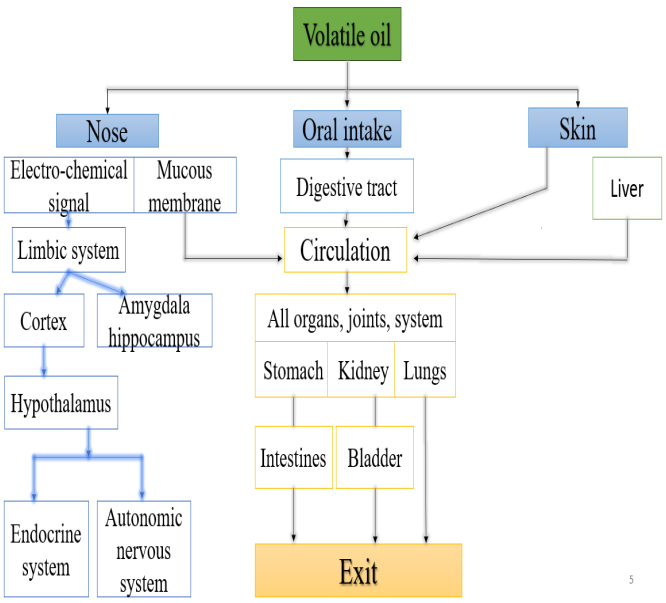


Table 1: Phytochemicals of *Ferula asafoetida* Linn.

Coumarins and sesquiterpene coumarins	Sesquiterpenes	Sulphur containing compounds	Polysulfide derivatives	Diterpene	Phenolics	Acetylene	Other compounds	References
Umbelliprenin	Fetidone A	2-Butyl 1-propenyl disulfide	Foetisulfide A	15-Hydroxy-6-en-dehydroabietic acid	3,4-Dimethoxycinnamyl-3-(3,4-diacetoxyphenyl) acrylate	Falcariniolone	Falcarinolone	(8)
Umbelliferone (7-hydroxycoumarin)	Fetidone B	1-(Methyl thio) propenyl 1-propenyl disulfide	Foetisulfide C	7-Oxocallitristic acid	Vanillin		Ferulic acid	(8)
5-Hydroxy umbelliprenin	Taraxacin	2-butyl 3-(methyl thio)-2-propenyl disulfide		Picealactone C			Oleic acid	(8)
8-Hydroxy umbelliprenin		Dimethyl disulfide					β-Sitosterol	(8)
8-Acetoxy-5-S-hydroxyumbelliprenin		Di-2-butyl disulfide					Arabinose	(8)
Gummosin		Asadisulfide					Rhamnose	(8)
Foetidine		Di-2-butyl trisulfide					Luteolin 7-β-D-glucopyranoside	(8)
Feselol		Di-2-butyl tetrasulfide					Glucuronic acid	(8)
Galbanic acid		Dipropyl disulfide					Galactose	(8)
Ferocaulicin								(8)
Assafoetidinol A								(8)
Assafoetidinol B								(8)
Asacoumarin A								(1)
Asacoumarin B								(1)
Franesiferol A								(1)
Franesiferol B								(1)
Franesiferol C								(1)
Komolonol								(1)
epi-samarcandin								(1)
epi-samarcandin acetate								(1)

Table 2: Uses of chemical components of *Ferula asafoetida* Linn. in various fields

Sr.no.	Plant part used	Component	Uses	Reference
1	Leaves, fruit and oleo-gum-resin	α-Pinene	To fragrance material, improve odor of insecticides, antiseptics and other industrial products.	(9)(10)
2	Leaves, fruit and oleo-gum-resin	β-Pinene	Anti-fungal, insecticidal, fragmenting household perfumery and polymer industry.	(9)(10)
3	Aerial parts, leaves, fruit and oleo-gum-resin	Limonene	In fragmenting artificial essential oils and household perfumery.	(9)(11)(10)
4	Leaves and fruit	Decanal	In fragrances and flavoring.	(10)
5	Leaves and fruit	1-Decanol	In lubricants, surfactants and solvents manufacturing.	(10)
6	Leaves and fruit	Dodecanal	Perfumery	(10)
7	Leaves and fruit	Dodecanol	In manufacturing cosmetics, emollient, surfactants, lubricating oils and Pharma industries.	(10)
8	Aerial part	Thymol	Antiseptic, antifungal, antibacterial, chief ingredient in racemic menthol production and works as disinfectant in	(10)
9	Leaves and fruit	Carvacrol	Anthelmintic, antiseptic and works as disinfectant in	(10)

10	Leaves and fruit	α-Copaene	Insecticidal	(10)
11	Leaves and aerial part	Germacrene D, B	Insecticidal and antimicrobial.	(9)(10)
12	Oleo-gum-resin	*Allo*-Ocimene	Perfumery and in diluting agents for dyes.	(10)(11)
13	Leaves, fruit and oleo-gum-resin	Myrcene	Diluting agent for dyes and varnishes.	(10)(11)
14	Oleo-gum-resin	*P*-Cymene	In fragmenting soaps, antiseptic preparations, industrial products and used as adulterant in musk perfumes.	(10)(11)
15	Leaves	2, 2 -diphenyl-1-pycrylhydrazyl	Antioxidant activity	(9)

The nutritional components in coriander are mainly due to its green leaves and dried seeds. Its leaves are rich in thiamine, zinc (4.72 mg/100 g), iron (42.46 mg/100 g), Vitamin A (up to 12 mg/100 g), vitamin C (up to 160 mg/100 g),(12) Vitamin B_2 (60 mg/100 g), (13) calcium (1246 mg/100 g), magnesium (694 mg/ 100 g), phosphorus (481 mg/100 g), sodium (211 mg/ 100 g), thiamine (1.252 mg/100 g), niacin (10.707 mg/ 100 g), riboflavin (1.500 mg/100 g), fatty acids, total monounsaturated (2.232 g/100 g) and dietary fibre (10.40 g). Fresh leaves comprise of 84% of water and low nitrate content than mature leaves.(12)

Coriander seeds are considered as good source of dietary fibre (41.9 g/100 g), vitamin C (21 mg/100 g), minerals such as iron (16.32 mg/100 g), potassium (1267 mg/100 g), calcium (709 mg/100 g), phosphorus (409 mg/100 g), magnesium (330 mg/100 g), sodium (35 mg/100 g), Zinc (4.70 mg/100 g), folate (200 µg/ 100 g), thiamine (0.239 mg/100 g), riboflavin (0.290 mg/100 g), niacin (2.130 mg/100 g), fatty acids, total monounsaturated (13.580 mg/100 g) and fatty acids, total polyunsaturated (1.750 mg/100 g). Coriander contains high value of volatile oil which is important for growth and brain functioning.(12)

Coriander seeds yield yellow oil with pleasant aroma in which oxygenated monoterpenes, monoterpene hydrocarbon, fatty acids and long chain alcohols are present.(5) The volatile components in seeds are longifolene, linalool, d-limonene (light lemon smell), α-pinene (moderate resin scent), γ-terpinene, eucalyptol, styrene, dimethyl glutarate, methyl methacrylate.(14)

Leaf oil contains aromatic acid including 2-decenoic acid, undecanoic acid, tridecanoic acid, E-11-tetradecenoic, capric acid and undecyl alcohol.(15)

Table 3: Phytochemicals of *Coriandrum sativum* Linn.(16)

Polyphenols (fruit)	Carotenoids (seed)	Isocoumarins (areal part)
Flavones	β-carotene	Coriandrone A
Tannins	β-cryptoxanthin epoxide	Coriandrone B
Anthraquinones	Lutein-5,6-epoxide	Coriandrone C
Ferulic acid	Violaxanthin	Coriandrone E
Chlorogenic acid	Neoxanthin	Coriandrin
Caffein		Dihydrocoriandrin

Table 4: Uses of chemical components of *Coriandrum sativum* Linn. in various fields.

Sr. no.	Plant part used	Component	Uses	References
1	Seed	β-Caryophyllene	Anxiolytic, antibacterial, antioxidant, gastroprotective, anti-inflammatory	(3) (17)
2	Seed, leaves	Citronellol	Anticonvulsant, Anti-inflammatory	(3)
3	Seed	Camphor	Insecticidal, antimicrobial, antiviral	(3)
4	Seed	Geraniol	Sedative, sleep enhancing, insecticidal and repellent	(3) (17)
5	Seed	Linalyl acetate	Flavoring agent, antimicrobial, anti-inflammatory activity	(3)
6	Seed	Limonene	Antidepressant, anxiolytic, sedative	(3) (17)
7	Fruit, Seed, leaves	Linalool	Antidepressant, anticonvulsant, sedative, antioxidant, antimicrobial, anti-inflammatory, antibacterial	(17) (3)(5)
8	Seed, leaves, fruit	α-and β-pinene	Anxiolytic, hypnotic, antimetastatic, antimicrobial	(17) (3)
9	Seed	β-Myrcene	Anticonvulsant, sedative, sleep enhancing, antioxidant, anti-inflammatory	(17) (3)
10	Seed, leaves	γ-Terpinene	Sedative effect, potential bio fuel alternative	(17) (3)
11	Seed, leaves	Terpinen-4-ol	Antidepressant, sedative, sleep enhancing, promotes anti-inflammatory cytokine production	(17) (3)
12	Seed	*p*-Cymene	Antimicrobial activity and natural antioxidant	(3)
13	Seed, Leaves	(2E)-dodecenal	Antibacterial	(3)
14	Leaves	(E)-2-Dodecenal	Anthelmintic activity	(3)
15	Leaves	Tridecanal	Antioxidant, antifungal, antibacterial activity	(3)
16	Leaves	1-Decanol	Bactericidal activity	(3)
17	Leaves	(E)-2-Tetradecenal	Antioxidant, antimicrobial activity	(3)
18	Leaves	Capric acid	Antibacterial, anti-inflammatory activity	(3)
19	Seeds	Luteolin	Anti-depressant, anxiolytic, sleep enhancing	(17)
20	Seeds	Quercetin	Anti-convulsant, anti-depressant, memory improvement activity.	(17)
21	Seeds	Rutin	Anti-depressant, anxiolytic, memory improvement activity	(17)

Ferula asafoetida Linn. and *Coriandrum sativum* Linn. as traditional medicine

Ferula asafoetida Linn.

According to *Charaka Samhita*, in *Unmada* (psychological disorders) powder of *Shirish* seed (*Albizia lebback* (L.) Benth.), *Mulethi* (*Glycyrrhiza glabra* Linn.), *Hingu* (*Ferula asafoetida* Linn.), *Lashuna* (*Allium sativum* Linn.), *Tagar* (*Valeriana wallichii* DC.), *Vacha* (*Acorus calamus* Linn.), *Kustha* (*Sassurea lappa* Clarke) are taken in equal part and mixed in goats' urine as *Nasya* and *Anjana* (collyrium). In *Apasmara* (*Kaphaja*) *Vachadi ghrita* is consumed orally. *Mustadya varti* is used as *Anjana* (collyrium) in *Apasmara.* (18)

In *Krimidanta* (dental carries) asafoetida (*Hingu*) is used to fill the dental carries. *Vishama Jvara* (quartan fever) is treated by snuffing asafoetida (*Hingu*) mixed with old ghee. In *Madatyaya* (alcoholism) *Hingu* mixed with *Suvarchalavana* and *Maricha* (*Piper nigrum*) given orally. (19)Asafoetida acts as emmenagogue when hot water extract of the dried resin is taken orally and in United States fluid extract of the resin is taken orally. It acts as carminative when hot water extract of the dried gum is taken orally. In guinea worm disease dried gum resin exudates are eaten. In stomachaches gum resin with salt and bark juice of *Moringa pterygosperma* is used externally. In Afghanistan hot water extract of the dried gum is taken orally to treat hysteria and whooping cough. In China and Egypt decoction of the plant is taken orally for vermifuge activity. In Nepal water extract of the resin is taken orally for its anthelminthic activity. It acts as aphrodisiac when hot water extract of the dried leaf and stem is taken orally by males in Brazil. In Malaysia gum is chewed to treat amenorrhea. For gastrointestinal disorders, asafoetida roasted in ghee (a clarified butter without any solid milk particles or water) is usually used.(20)

In Ayurveda classics, *Charaka Samhita*, *Ferula asafoetida* Linn. is used in the treatment of *Unmada* and *Apasmara* (psychological disorders) mainly in the form of *taila* (oil), *ghrita* (Ghee), *Nasya*, *Anjana* (collyrium) and *Varti*. The ayurvedic formulations used in *Unmada* are *Kalyanka ghrita, Hingwadya ghrita, Lashunadya ghrita, Apra ghrita* and *Siddharthkadi ghrita.* Similarly, formulations used in *Apasmara* are *Palankshadi taila, Vachadi ghrita, Mustadya varti.*(18)

Coriandrum sativum Linn.

Amavata (rheumatoid arthritis) decoction prepared with *Dhanyaka* (*Coriandrum sativum*) and *Shunthi* (*Zingiber officinalis*) is useful for *Dipana* (appetizer) and *Pachana* (digestive). In combination with *Erandamoola* (root of *Ricinus communis*) it alleviates the pain in arthritis. *Dhanyaka* (*Coriandrum sativum*) mixed with *Amla* (sour) and *Lavana* (salty) *dravyas* is given in *Chardi* emesis (emesis). Fine powder of coriander seeds is kept overnight in water and consumed in morning by adding sugar after sieving it with fine cloth is given for burning sensation in *Jvara* (fever). In indigestion decoction of *Dhanyaka* and *Shunthi* (*Zingiber officinalis*) is consumed orally. Decoction of herb is given with milk and sugar is given in bleeding piles. In headache, poultice of whole plant, specially leaves and tender twigs is applied as cooling medium. In indolent swelling, past of leaves is applied with barley meal. The infusion of plant is used as an eye wash in Conjunctivitis. (19)

Bioactivities of *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn.

Various scientific studies on the psychological, environmental, and pharmacological impacts of asafoetida and coriander are presented, along with critical analyses of the varied activity effects. Tables 5 and 6 provide a representation of the psychological and insecticidal effects of asafoetida and coriander.

Table 5: Psychological effect of *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn.

Plant name	Plant Part used	Dosage form/ type of extract and dosage	Activity	Tested living system/organ/cell	Observations	References
Ferula asafoetida Linn.	*Oleo gum resins*	Ethanolic extract	Anti-depressant	Adult albino mice (weighing 20-30g) and Wistar albino rats (weighing 180-200g)	*Ferula asafoetida* ethanolic extract (FAEE) showed effect at the dose of 400 mg/kg.	(21)
	Gum	Aqueous extract	Learning and memory	Male inbred albino rats of Wistar strain (weighing 200g-300g)	Showed improvement in memory score at the dose of 400 mg/kg and at same dose improves learning ability to some extent.	(22)
	Powder	Commercial powder	Spatial memory	Swiss albino mice	Asafoetida showed potency in improving memory at the dose of 400 mg/kg/day orally than Donepezil and Vitamin C.	(23)

	Oleo gum resin	Aqueous extract	Neuroprotective	Adult male BALB/c mice	Aqueous extract of oleo gum rein of asafoetida increased the amplitude and decreased the latent period of nerve compound action potential (CAP). Nerve conduction velocity (NCV) and amplitude of CAP also improved in asafoetida treated animals. Histological and behavioral studies showed that asafoetida was able to facilitate the healing process in peripheral nerves at the doses of 0.1 mg/kg, 1 mg/kg and 10 mg/kg.	(8)
Coriandrum sativum Linn.	Seed	Aqueous extract	Anxiolytic	Male albino mice (weighing 22-28 g)	Showed anxiolytic activity at the dose of 200 mg/kg on the elevated plus- maze test.	(24)
	Aerial parts	Hydroalcoholic extract	Neuroprotective	Wistar rats	Showed neuroprotective effect in PTZ-induced seizures in rats at the ranging dose of 50 to 100 mg/kg and prevented formation of dark neuron and apoptotic cells.	(17)
	Seed	Ethanolic extract	Anxiolytic	Male Swiss albino mice (weighing 22-28 g)	Showed, decreased mobility time and locomotor activity at the doses of 100 mg/kg and 200 mg/kg.	(25)
	Fresh leaves	Hydroalcoholic extract	Fear and anxiety (Anxiolytic)	Male adult zebra fish (*Denio rerio*) (Short fin wild type strain- 4 to 6 months old)	Showed anxiolytic effect at the dose of 50-100 mg/kg when zebra fish is exposed to fear and anxiety induced by exposure them to alarm substance.	(26)
	Seed	Aqueous extract	Anxiolytic	Male Swiss albino mice (weighing 20-25 g; age 7-8 weeks)	Showed anxiolytic activity assessed on 16th day by using elevated plus maze and light/dark transition at the doses of 100, 200, 400 mg/kg.	(27)
	Seed	Diethyl ether extract	Antidepressant	Adult male BALB/c mice (weighing 20-30 g)	Showed antidepressant activity by using forced swimming test and decreases mobility time at the dose of 3.2 mg/kg.	(28)

Table 6: Insecticidal activity of *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn.

Plant name	Plant part used; Major constituents	Dosage form/type of extract and sage	activity	Tested living system/organ/cell	Observations	References
Ferula asafoetida Linn.	Root	Ethanolic extract	Insecticidal	*Schizaphis graminum* (Cereal crop pest)	Concentration of 0.06% produced complete mortality and the LC50 was estimated to be 0.0224% (224 mg/l).	(29)
	Root	Ethanolic extract	Larvicidal	*Aedes aegypti L.*	Results showed poor larvicidal activity.	(29)
	Oleo-gum-resin; sec-butyl (Z)-propenyl disulphide and sec-butyl (E)-propenyl dissulphide	Essential oil dissolved in acetone	Larvicidal	*Spodoptera littoralis, Musca domestica* (larve)	Death recorded when essential oil dissolved in acetone is applied on dorsum of larvae in dose ranging from 10-100 ug.	(30)
	Gum; (E)-1-propenyl sec-butyl disulfide, β-pinene, (E)-β-ocimene, (Z)-β-ocimene and α-pinene	Essential oil	Insecticidal	*Aphis gossypii*	Exhibit appreciable insecticidal activity at 0.04uL/LC_{50} value and repellent activity at 10 uL/L.	(31)
	Latex	Essential oil	Insecticidal	Agonoscena pistaciae	LC_{50} values of essential oil were obtained at 5.62 mg/L concentration.	(31)

	Stem and root; (E) and (Z) sec-butyl propenyl disulfide and methyl 1-(methylthio) propyl	Essential oil	Ovicidal and larvicidal	Larvae of *culex pipiens* and *culex restuans*	Culex restuans (LC_{50}: 10.1 mg/L) are more sensitive to essential oil than Culex pipiens. The eggs exposed to essential oils were (55.8%) failed to hatch.	(31)
Coriandrum sativum Linn.	Fruit; Linalool. monoterpenoids	Essential oil (fumigation toxicity)	Insecticidal	*Tribolium castaenum, Sitophilus oryzae and Lasioderma serricorne*	Complete mortality against *T castaneum* and *L. serricorne* at 80% against *S. oryzae* at the 625 uL/L air dose after 24-hour exposure.	(32)
	Seed; Monoterpene mainly linalool, alpha-pinene, geranyl acetate and gamma-terpinene	Essential oil	Repellent	*Callosobruchus maculatus* (Fabricius) (Caleoptera:Bruchidae)	Concentration of 50ul/ml exhibits 100% repellent activity after 12 hours.	(33)
	Seed; Linalool	Essential oil (Steam distillation extraction)	Acaricidal and insecticidal	*Plodia interpunctella*	SDE oil showed insecticidal activity at the dose of 9.38 ug/cm^3.	(34)
	Arial part; 2-decenal, linalool, 2-dodecenal, 2-tridecenal, aliphatic aldehydes.	Essential oil	Repellent	*Ephestia Kuehniella*	Shows repellent activity at concentration of 0.1uLcm^{-2} (66.7%)	(35)
	Seed; Linalool or beta-farnesene, α-pinene, γ-terpinene.	Essential oil	Insecticidal	*Ephestia kuehniella*	Shows mortality of 50% at concentration of 56.81ul l^{-1} air.	(35)

Discussion

Asafoetida and coriander are mentioned in *Charka Samhita, Sushruta Samhita and Vagbhata Samhita.* Among several herbs used, asafoetida and coriander are only herbs used in spices, medical and environmental well-being. Asafoetida is perennial herb that grows 1.5-2.4-meter-high and is native of Iran, Afghanistan, Persia. Additionally, it is also cultivated in cold desserts of Himachal Pradesh and Kashmir. Whereas, coriander is an annual herb that grown throughout India and attains a height of 4–5 meters. It has a distinct perfume when rubbed. The usage of coriander dates back many centuries; it was first recorded in Sanskrit literature as early as 5000 B.C and in the early Greek Eber Papyrus as early as 1550 B.C.

Properties of *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn. according to Ayurveda

In Ayurveda classics, *Ferula asafoetida* Linn. (*Hingu*) is characterized under *Dipaniya, Shvashara, Sangyasthapana and katu skandha gana* (category) *by* Acharya Charaka. *Pippalyadi and Ushakadi gana* by Acharya Sushruta and in *Pippalyadi gana* by Acharya Vagbhata. It possesses *Katu* (pungent) rasa (taste), properties such as *Laghu* (light), *Snigdha* (unctuous) and *Tikshna, Ushna Veerya* (hot in potency) and *Katu Vipaka* (pungent, anabolic transformation). The action (*Karma*) possessed by *Hingu* are *Hridya* (cardiac tonic), *Artavajanana* (stimulate menstrual flow or ovulation), *Shulahara* (alleviates pain), *Chakshushya* (improves sight), *Bhedaniya* (emollient laxative), *Balya* (tonic) and *Kapha-vata hara* (pacifies kapha and vata dosha). (19)

Coriandrum sativum Linn. (*Dhanyaka*) is characterized under *Trishnaprashamana* and *Shitaprashamana gana* (category) by *Acharya Charaka*, whereas *Acharya Sushruta* and *Acharya Vagbhata* mentioned it under *Guduchyadi Gana. Dhanyaka* possesses *Kashaya-Tikta rasa* (taste), properties such as *Laghu* (light) and *Snigdha* (unctuous), *Ushana Virya* (hot in potency) and *Madhura Vipaka* (sweet, anabolic transformation). The action (*Karma*) possessed by *Dhanyaka* are *Dipana* (appetizer), *Pachana* (digestive), *Grahi* (absorbs fluid) *and Tridoshahara* (pacifies all three *doshas*).(19)

Route of action of volatile oils in psychological health

Stressors cause the paraventricular nucleus (PVN), a region of the hypothalamus, to release corticotrophin-releasing hormone (CRH), which in turn causes the pituitary gland to produce and secrete more adrenocorticotropic hormone (ACTH). In response, the adrenal glands produce glucocorticoids (cortisol in humans and corticosterone in rats) as a result of ACTH-induced adrenal synthesis. Glucocorticoids and

acetylcholine (ACh), which are produced by the adrenal gland and the efferent vagus nerve, respectively, bind to receptors on cytokine-producing cells (such as T cells, macrophages, and natural killer cells) to have anti-inflammatory effects. Furthermore, by promoting the production of the serotonin transporter (SERT), cortisol can raise serotonin reuptake in response to acute stress or persistent HPA activity. As a result, one of the characteristics of depression is reduced serotonin levels in the synaptic cleft. Stressors also trigger the proinflammatory sympathetic nervous system response, which raises blood pressure and heart rate by releasing adrenaline (AD) and noradrenaline (NA) from the sympathetic nervous system and the adrenal gland, respectively. In cytokine-producing cells, adrenaline and noradrenaline both activate transcription factors, such as the nuclear factor kappa-light-chain enhancer (NF-kB). The synthesis and release of proinflammatory cytokines, including as interleukin 1 (IL-1), interleukin 6 (IL-6), and tumour necrosis factor α (TNF-α), are then stimulated by the activation of NF-kB. These cytokines can go across the blood-brain barrier, activate the afferent vagus nerve, or enter the brain through other active molecules. Information related to mood regulation, motivation, arousal, and sensitivity to social threat is transmitted to brain regions through the afferent vagus nerve. Cytokines may alter the metabolism of neurotransmitters like dopamine (DA) and serotonin (5HT), whose dysregulation is closely linked to depression, when they enter the brain. Therefore, proinflammatory cytokine activation causes behavioural, emotional, and cognitive changes that may lead to anxiety disorders or depression. Essential oils have been shown to interact with both the anti-inflammatory and proinflammatory responses of the CNS to stress and can exert its anxiolytic effects by activating the GABAergic system. Essential oils can affect HPA axis by decreasing glucocorticoid levels producing a calming effect. Moreover, calming effects are also produced by increasing serotonin levels while decreasing glucocorticoids. EOs can exert its anxiolytic effects by activating the GABAergic system.(36)

Mechanism of action against insect pests

Essential oils and extract of leaves, flowers, fruits, seeds, stem, root and rhizomes of plants are used to manufacture botanical pesticides. The secondary metabolites of plants usually flavonoids, tannins, alkaloids, phenols, terpenes and resins have insecticidal, larvicidal, ovicidal, acaricidal and repellent characteristics. For instance, bioactive chemical in essential oil of asafoetida gum contains (E)-1-propenyl sec-butyl disulfide, β-pinene, (E)-β-ocimene, (Z)-β-ocimene and α-pinene are insecticidal in nature. The effects of plant extracts and essential oils on pests are diverse and can include toxicity, lethal activity, interference with metabolic processes, oviposition, repulsiveness, inhibition, denaturation of proteins, and obstruction of organism growth as well as development through disruption of essential enzyme production. The mechanism of action may occasionally involve blockage of electron transport, toxicity, immobility, and paralysis of the insect respiratory system. Fumigation is another kind of action that either kills the target pest or may do so. During fumigation, vaporised pesticides are released into the air, causing poisoning that kills the insect by entering its trachea through spiracles.(37)

Pharmacological studies

Antifungal

Antifungal activity of oleo-gum-resin of asafoetida was established by different studies against M. gypseum T. interdigitale, and A. parasiticus.(7)

Antifungal activity of coriander essential oil having concentration up to 0.15% is effective against growth of *Penicillium stoloniferum, Penicillium expansum, Aspergillus niger and* species of *Mucor* on moulds of cake and bakery products.(38)

Antibacterial

The essential oil of asafoetida oleo gum resin contains heterocyclic disulfide compounds and bicyclic monoterpenes. The antibacterial action against Gram-positive bacteria is seen due to higher space volume which allows cyclic chemicals to more readily penetrate into lipid bilayers, increasing the fluidity of the membrane and ultimately leading to membrane permeabilization and cell death.(11)

With minimum bacterium concentration of 6.25 µg/ mL (34 µM) (2E)-Dodecenal characterized from coriander fresh leaves found most effective against food borne bacterium, followed by (2E)-undecenal with concentration of 12.5 µg/mL (74 µM). The bactericidal activity against *Salmonella choleraesuis* is seen due to the presence of aliphatic (2E)-alkenals and alkanals in fresh coriander leaves.(38)

Antimicrobial

Alcoholic and aqueous extracts of asafoetida have showed anti-microbial activity against various bacterial and fungal strains such as *Escherichia coli, Bacillus subtilis*, *Pseudomonas aeruginosa, Staphylococcus aureus* and *Aspergillus niger* by agar disc diffusion method. Broad spectrum antimicrobial activity is showed by extracts.(8)

Coriander leaf essential oil showed antimicrobial activity at a dose 125 mg/mL–500 mg/mL by inhibiting various *Candida* species such as *Candida dubliniensis* CBS 7987, *Candida parapsilosis* CBS 604, *Candida krusei* CBS 573 and *Candida albicans* CBS 562.(39)

Antioxidant

When asafoetida was given orally at doses of 1.25 and 2.5% w/w to Sprague-Dawley rats, increased the antioxidant system, which had been lowered by treatment with N-methyl-N-nitrosourea. Rat liver was found to contain compounds reactive to thiobarbituric acid, which indicated a significant prevention of lipid peroxidation.(40)

In food industry lipid peroxidation (high lipid product) cause decline in nutrients resulting in change in texture, flavour, appearance and rancidity. Corander essential oil contains terpenoid components such as camphor, limonene, α-pinene and geraniol which show

radial scavenging activity and can be used as natural antioxidant to enhance the shelf-life.(38)

Gastroprotective

The gastroprotective effect was observed when colloidal solution of asafoetida was given to Albino rats (CF strain) at oral dose of 50 mg/kg through orogastric tube, 60 min. before the experiment in 18 hour fasted rats in gastric ulcers induced by 2 hours cold-restraint stress, aspirin, and 4 hours pylorus ligation.(41)

Effect of coriander seeds aqueous suspension on stomach mucosal lesions was studied on Wistar albino rats at oral doses of 250 and 500 mg/kg body weight. The protective effect of coriander on ethanol induced damage of gastric tissue was seen due to free-radical scavenging property of different antioxidant constituents.(42)

Anti-inflammatory

The *in vivo* study has been reported on use of asafoetida on mouse paw oedema. The result showed anti-inflammatory effect at the dose of 2.5 mg/kg. The anti-inflammatory activity possessed may be due to umbelliprenin (sesquiterpene coumarin) which inhibit activity of 5-lipoxygenase.(43)

A study has been reported on use of coriander oil topical application on 40 human volunteers. The result showed anti-inflammatory effect and reduced the UV-induced erythema with good skin tolerance.(8)

Anti-helminthic

Anti-helminthic activity of aqueous extract of asafoetida resin at concentration of 100 mg/ml was seen against *Pheretima postuma* due to presence of polyphenolic compounds like tannins. The extract showed paralysis (within 6 min.) and death of worms (within 18 min.).(7)

The *In vivo* study of hydro-alcoholic extract of coriander seeds show anti-helminthic activity against adult nematode parasite *Haemonchus contortus* at the dose of 0.18 mg/ml.(42)

Toxicity

A 5-week-old male black child with methemoglobinemia was brought in after receiving asafoetida gum formulation for colic relief. The patient had tachypnoea, cyanosis, and grunting as symptoms. Methylene blue administered intravenously for treatment. Prior research reported that intake of large dose of asafoetida can cause headache, anxiety, swelling of mouth and digestive illness like flatulence and diarrhoea. In pregnancy asafoetida should be avoided. (8)

With no known negative effects on people, coriander and its oil have a long history in the food business, culinary application, fragrance, and cosmetics industries. The FDA, FEMA, Council of Europe, International Organization of Flavour Industries, and American Herbal Products Association have all certified the safety of using coriander oil in food and dietetics. Prior research on coriander oil did not reveal any sensitive reactions in human subjects. However, a tiny number of people have been reported to experience allergic reactions to coriander, including stinging and itching on the lips and mouth as well as anaphylactic shock, according to some published research. The allergy is caused due to the allergen (linalool) present in coriander which is heat-resistant and very likely a protein with a specific IgE antibody in serum. However, there is no protein component in the essential oil, making it safe to use. In addition, investigations conducted on animals have demonstrated that administering coriander oil to rats and rabbits cause dermal toxicity.(44)

Conclusion

The phytoconstituents present in the essential oils, extracts of *Ferula asafoetida* Linn. and *Coriandrum sativum* Linn., have broad spectrum use in traditional medicine, psychological treatment and against insect pests. Current published studies have showed good results when essential oils are subjected to animal models. Hence, the use of essential oils should be employed in physical, psychological and environmental health by various means such as aroma therapy, topical application, inhalation, ingestion, colognes, spray and baths, not only eradicate the disease but also to rejuvenate the whole body.

Abbreviations

CAP- Nerve compound action potential
PTZ- Pentylenetetrazole
ACTH - Adrenocorticotropic hormone
HPA- Hypothalamic-pituitary-adrenal
NF-kB- Nuclear factor kappa-light-chain enhancer
CNS- Central nervous system
GABA- Gamma-ammino butyric acid
EO- Essential oil
CBS- Candida parapsilosis strain
FDA- Food and Drug Administration

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