Pharmacognostic profile & pharmacological activities of ferula asafetida

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Abstract:

Ferula asafoetida, commonly known as asafoetida or “hing,” is an oleo-gum resin obtained from the roots of *Ferula* species belonging to the family Apiaceae. Traditionally valued for its culinary, aromatic, and therapeutic significance, asafoetida contains an array of phytochemicals including carbohydrates, resins, coumarins, essential oils, saponins, flavonoids, and lignans. These constituents contribute to its wide spectrum of pharmacological properties. This chapter provides a comprehensive overview of the botanical description, chemical composition, taxonomic classification, and various pharmacological activities of asafoetida. Research evidence demonstrates its relaxant, neuroprotective, memory-enhancing, digestive, antispasmodic, hypotensive, hepatoprotective, antimicrobial, anticancer, anticarcinogenic, antihyperglycemic, anxiolytic, and anthelmintic activities. Various in-vitro and in-vivo studies validate the medicinal potential of asafoetida, highlighting mechanisms involving antioxidant action, enzyme modulation, neurotransmitter regulation, and cellular protection. The chapter also includes the use of Imipramine as a standard reference drug for evaluating antidepressant activity of *Ferula asafoetida* aqueous extract. Overall, the literature suggests that asafoetida is a promising natural therapeutic agent with significant pharmacological relevance for future herbal drug development.

Keywords:

Ferula asafoetida; Asafoetida, Hing, Oleo-gum resin, Phytochemicals, Ferulic acid, Coumarins, Essential oils, Neuroprotective activity, Relaxant effect, Memory-enhancing activity, Digestive enzymes, Antispasmodic.

1. Introduction:

Ferula asafoetida is an herbaceous plant belonging to the Umbelliferae family. The oleo-gum resin is derived from the rootstock and root of the plant. Known as asafoetida, this gum resin is highly valued as a condiment in India and Iran and is primarily obtained from *Ferula asafoetida*. The Latin name reflects its meaning: "carrier" or "vehicle," with "asa" being a Latinized form of the Farsi word for "resin," and "foetidus" meaning "smelly" or "fetid" in Latin. Asafoetida has long been used as a popular household remedy and is a key component in many traditional medicinal preparations. As a flavoring agent, asafoetida is commonly used in spice mixtures, adding a distinct taste to curries, meatballs, dal, and pickles (Kareparamban et al., 2012, Mahendra & Bisht et al., 2012).

Ferula plants develop massive taproots or carrot-shaped roots, which are about 12.5 to 15 cm in diameter at the crown when the plant reaches 4-5 years of age. Just before the plant flowers, in March-April, the upper part of the living rhizome is exposed, and the stem is cut close to the crown. The exposed area is then covered with a dome-shaped structure made of twigs and earth. The cut surface exudes a milky sap. After several days, the exudate is scraped off, and a fresh slice of the root is cut to allow more latex to flow. The resin is collected along with the slice. This process of slicing and resin collection continues until the exudation stops, which typically occurs about three months after the initial cut. The resin is usually gathered from consecutive incisions made at the junction of the stem, rhizome, and taproot (Mahendra & Bisht, 2012, Amalraj et al., 2017)

Other Names: Anghuzeh (Farsi); asafétida (Spanish); asafoetida; awei (Chinese); aza(Greek);

devil's dung; férule persique or merde dudiable (French); haltit or tyib (Arabic); hing (Hindi);

mvuje (Swahili); stinkasant or teufelsdreck (German); stinking gum (Augustine et al., 2017)



Figure 1. Figure illustrating A. Asafoetida Plant, B. Asafoetida Seeds and C. Asafoetida Oleo-gum Resin

1.1. Chemical constituents:

Asafoetida consists of 67.8% carbohydrates per 100 grams, moisture 16.0%, protein 4.0%, fat 1.1%, minerals 7.0% and fibre 4.1%. It is mineral and vitamin contents embody substantial calcium besides phosphorus, iron, carotene B and vitamin B. Its calorific value is 297, contains 40-64% resinous material composed of ferulic acid, umbelliferone, asaresinotannols, farnesiferols A, B, and C etc., about 25% gum composed of glucose, galactose, l-arabinose, rhamnose, and glucuronic acid and volatile oil (3-17%) consisting of disulfides as its major components, notably 2-butyl propenyl disulfide (E- and Z-isomers), with monoterpenes (αand β-pinene, etc.), free ferulic acid, valeric acid, and traces of vanillin (LAF). The disagreeable odour of the oil is reported to be due principally to the disulphide C11H20S2 (Mahendra & Bisht, 2012).

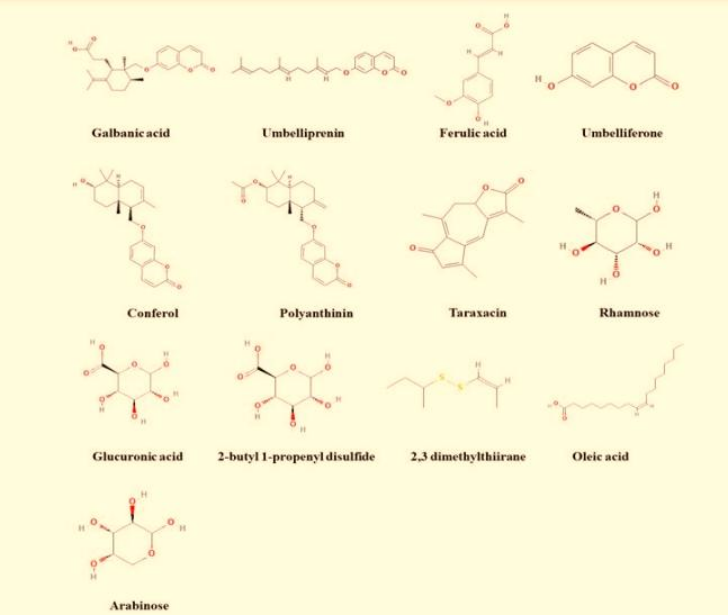


Figure. 2: Chemical structure of active constituents of asafoetida

Table1. Phytochemicals isolated from different parts of the plant

Plant Part	**Phytochemical**	**Reference**
Resin	Ferulic acid	Bhatia et al., 2006
	Asaresinotoxin	Prakash et al., 2016
	Gum resin polysaccharides	Pandey et al., 2013
	Sesquiterpene coumarins	Satyan et al., 2005
Root	Ferulic acid	Khedher et al., 2021

	Resinoid compounds	Prakash et al., 2016
	- Essential oils (e.g., α-pinene, β-pinene)	Kamatou et al., 2014
Leaf	- Essential oils	Ahmad et al., 2010
	- Flavonoids	Jain et al., 2017
	- Saponins	Bhuvaneswari et al., 2019
Seeds	- Asaresinotoxin	Mishra et al., 2019
	- Essential oils (e.g., cuminaldehyde)	Sharma et al., 2020
	- Lignans	Saini et al., 2015

Taxonomic Hierarchy (Mahendra & Bisht et al., 2012)

Kingdom: Plantae

Subkingdom: Viridiplantae

Infrakingdom: Streptophyta

Superdivision: Embryophyta

Division: Tracheophyta

Subdivision: Spermatophytina

Class: Magnoliopsida

Superorder: Asteraceae

Order: Apiales

Family: Apiaceae

Genus: Ferula L.

Species: Ferula asafoetida L. – asafoetida, asafoetida

1.2. Pharmacological and clinical studies of asafoetida:

1.3. Relaxant effect:

The relaxant impact of the natural resin on the tracheal smooth muscle of guinea pigs and its probable mechanisms were investigated by three accumulative concentrations of the aqueous extract (2, 5 and 10 mg/mL), theophylline (0.25, 0.50 and 0.75 mM) and saline were examined on the non-incubated tracheal smooth muscle of guinea pig precontracted by 10mM methacholine ingroup 1, pre-incubated tissues by propranolol and chlorpheniramine, narrowed by methacholine in group 2 and pre-incubated tissues by propranolol contracted by methacholine in group 3. All concentrations of theophylline in group 1 and all concentrations of the extract within the additional three groups showed considerable relaxant effects compared thereto of saline (Gholamnezhad et al., 2012).

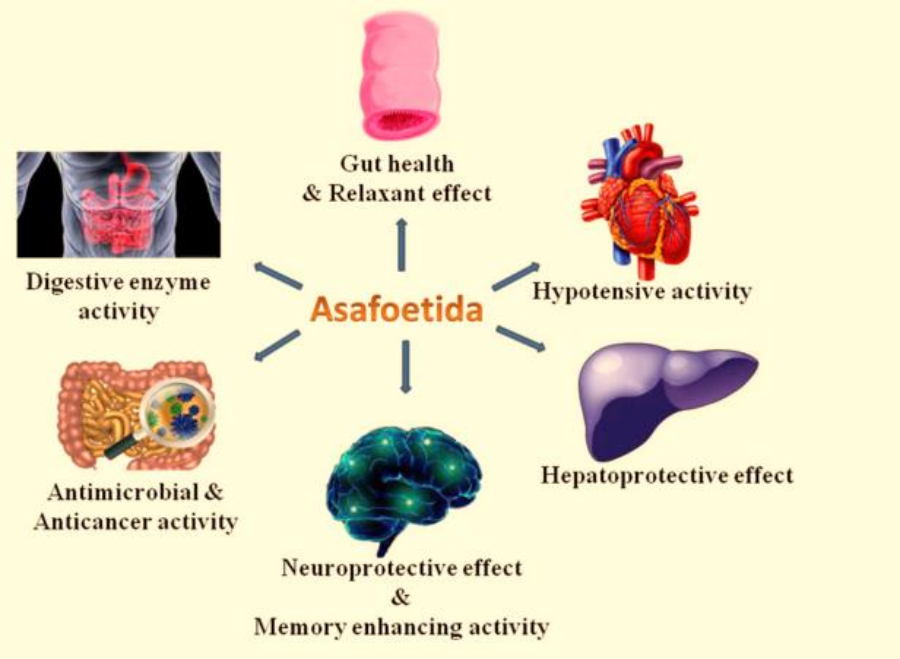


Figure No. 3: Schematic representation of various biological activities of asafoetida

1.4. Neuroprotective effect:

Cerebellar granule neuron cells were treated with F. asafoetida extract at 100mg/mL concentration before, after and during exposure to 30mM glutamate. Neuro-protective effects of extracts of pure natural resin against glutamate-induced neurotoxicity confirmed by associate exaggerated glutamate-induced reduction in cellular viability and attenuated glutamate-induced apoptotic/necrotic cell death. The extract inhibited apoptosis in cerebellar granule neurons by causing cell cycle arrest in the G0G1 phase, which explains why F. asafoetida extract is useful as a therapy for neurologic disorders (Tayeboon et al., 2013).

1.5. Memory enhancing activity:

Following oral administration of two doses (200 and 400 mg/kg) of F. asafoetida aqueous extract with rivastigmine as a positive control, learning and memorization were assessed using elevated plus maze

and passive avoidance paradigms. The extract produced significant improvement in memory score and dose-dependent improvement of transfer latency in the elevated plus-maze model. Dose-dependent inhibition of brain enzyme and significant improvement in inhibitor levels were additionally noted. Memory enhancing the potential of pure asafoetida may be attributed to acetylcholinesterase inhibiting and antioxidant properties (Vijayalakshmi et al., 2012).

1.6. Digestive enzyme activity:

A few common spices or their active principles were examined for their possible influence on the digestive enzymes of the pancreas in experimental rat. Groups of animals were maintained for eight weeks on the subsequent spice diets curcumin (0.5 mg), capsaicin (15 mg), piperine (20 mg), ginger (50 mg), cumin (1.25 mg) fenugreek (2 mg), mustard (250 mg) and asafoetida (250 mg). Among these spices, asafoetida conspicuously increased pancreatic enzyme activity and additionally stimulated pancreatic amylase. The positive influence of the pancreatic digestive enzymes exerted by a good number of spices consumed in the diet could be a factor contributing to the well-recognized digestive stimulant action of spices (Platel & Srinivasan, 2000).

1.7. Antispasmodic and hypotensive activity:

The effects of F. asafoetida gum extract on the contractile responses of the isolated guineapig ileum stimulated by histamine, acetylcholine, and KCl, and on the mean arterial blood pressure of rats were investigated. The average amplitude of spontaneous contractions of the isolated guinea-pig ileum was decreased when compared with the control. Acetylcholine treatment of the precontracted ileum with F. asafoetida gum extract resulted in dose dependent relaxation. In anaesthetized rats, F. asafoetida gum extracts significantly reduced mean blood pressure. It is possible that the relaxant compounds in F. asafoetida gum extract non-specifically interfere with a variety of histaminic receptor and muscarinic adrenergic activities or with the mobilisation of calcium ions required for smooth muscular contraction (Fatehi et al., 2004)

1.8. Hepatoprotective effect:

The hepatoprotective activity of Momordica charantia Linn., Nardostachys jatamansi, and F. asafoetida extracts against experimental hepatotoxicity. These extracts were developed as polyherbal suspensions, and they showed significant activity upon evaluation for hepatoprotective and physicochemical activities. Formulation 3 (containing chloroform, petroleum ether, and aqueous extracts of F. asafoetida, petroleum ether, and ethanol extracts of M. charantia Linn., and N. jatamansi) demonstrated significant hepatoprotective effect by decreasing elevated serum enzyme levels such as glutamate pyruvate transaminase, glutamate oxaloacetate transaminase, and experimental data also suggested that treatment with Formulation3 enhances the recovery from hepatotoxicity induced by carbon tetrachloride (Dandagi et al., 2008).

1.9. Antimicrobial activity:

Crude extracts of natural resin were evaluated for their antimicrobial activity against numerous flora and microorganism strains. The agar disc diffusion method revealed that alcoholic and aqueous extracts of asafoetida had a significant effect against Bacillus subtilis, Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, and Aspergillus niger. The crude extract showed a broad spectrum of antimicrobial activities by inhibiting the various fungi and bacteria. asafoetida extracts yielded an inhibition zone of 4-16 mm diameter in the antimicrobial agar disc diffusion assay (Shrivastava et al., 2012). The volatile oil obtained from the earlier stages of F. asafoetida growth might be used as safe and effective natural antioxidants within the food industries to induce higher aerophilous stability of fatty foods throughout storage, whereas the volatile oil obtained from the later stages of F. asafoetida growth could be used in the health industry as a secure and effective supply of bactericide agents.

1.1.1. Anticarcinogenic activity:

Asafoetida extract inhibited two-stage chemical carcinogenesis induced by croton oil and 7,12-dimethylbenzanthracene on mice skin, significantly reducing papilloma formation. It indicates the potential use of asafoetida as anti-cancer agents as well as anticancer promoters. (Saleem et al., 2001) investigated the potential of antioxidant and anticarcinogenic activity of asafoetida in Swiss albino mice. The pre-treatment of animals with asafoetida enhanced the antioxidant level and significantly reversed the induced ornithine decarboxylase activity and DNA synthesis. Asafoetida are often an efficient chemopreventive agent and capable of alleviating cutaneal carcinogenesis.

1.1.2. Anticancer activity:

The chemopreventive potential of different doses of F. asafoetida oleo-gum-resin on 1,2-dimethylhydrazine induced rat colon carcinogenesis by evaluating tumour size, tumour multiplicity and tumour incidence, serum total sialic acid levels as well as histoarchitecture of the colons of rats subjected to various treatment. The study revealed that asafoetida supplementation attenuates 1,2-dimethylhydrazine induced deleterious effects in rats. The minimum dose of asafoetida (10 mg/100 g) exhibited a more prominent effect as it continuously influenced all the tested biochemical parameters, which can be used as a promising chemo preventive agent against colon carcinogenesis (Saleem et al., 2001).

1.1.3. Antihyperglycemic effect:

The hypoglycaemic activity of the asafoetida extract in streptozotocin-induced diabetic rats was evaluated. The asafoetida extract administration at a dose of 50 mg/kg for 4 weeks has shown the hypoglycaemic activity in streptozotocin-diabetic rats during the 2nd week and 4th week of the treatment period. The blood glucose level in streptozotocin-induced diabetic animals is reduced may be at least in part by the presence of the phenolic acid and tannins in the extract (Latifi et al.,).

1.1.4. Anxiolytic effect and anthelmintic activity:

The anthelmintic activity of three different concentrations of liquid extract of F. asafoetida against Pheretima posthuman were used in the determination of time of dysfunction and death of the worm. The extract has exhibited significant anthelmintic activity at the best concentration of 100 mg/mL. It has also shown better activity than the standard drug of piperazine citrate (RG et al., 2013). The effect of dried Allium sativum clove powder, F. asafoetida dried latex powder and flower and the dried powder of Syzygium aromaticumin in-vitro treatment against liver fluke Fasciola gigantic were studied by Kumar and Singh (Kumar & Singh et al., 2014). The anthelmintic activities of all three plants were both concentration and time-dependent. The ethanol extract was more toxic than other organic extracts. The ethanol extract of F. asafoetida was highly toxic against F. gigantic. The dried root latex powder of F. asafoetida can be used as a potent helminthicide.

1.1.5. Standard Drug:

Imipramine, a tricyclic antidepressant (TCA), was used as the standard drug in this study to compare the antidepressant activity of the *Ferula asafoetida* aqueous extract (FAAE). Imipramine is widely recognized for its efficacy in treating major depressive disorder (MDD) and related mood disorders. It works by inhibiting the reuptake of serotonin and norepinephrine, two key neurotransmitters involved in regulating mood and emotional responses (Mendels et al., 1975).

In this study, Imipramine was administered orally at a dose of 15 mg/kg body weight once daily to the animals in Group III, which served as the standard group. The administration continued for 14 days, coinciding with the period of depression induction using the Chronic Unpredictable Mild Stress (CUMS) model. The dose and duration were selected based on previous studies demonstrating the efficacy of Imipramine in reversing depressive-like behaviors in rodents (Porsolt et al., 1978).

Behavioral assessments, such as the Forced Swim Test (FST) and Tail Suspension Test (TST), were employed to evaluate the drug's antidepressant effects. In these tests, Imipramine has been shown to reduce immobility time, which is indicative of decreased behavioral despair, a hallmark of depression. The efficacy of Imipramine in improving behavioral outcomes was used as a benchmark to evaluate the potential antidepressant properties of the *Ferula asafoetida* extract.

Imipramine's role as a standard drug in this study ensures a reliable comparison for determining the effectiveness of FAAE in treating depression-like symptoms in mice.

2. Conclusion:

Asafoetida (*Ferula asafoetida*) is a medicinally rich oleo-gum resin with a long history of traditional use and strong scientific support for its diverse pharmacological activities. Its complex phytochemical profile—comprising ferulic acid, coumarins, volatile oils, polysaccharides, flavonoids, and saponins—contributes to its therapeutic benefits. Evidence from various experimental studies reveals that

asafoetida exhibits relaxant, neuroprotective, digestive, antimicrobial, antispasmodic, anticancer, antihyperglycemic, and hepatoprotective properties. These activities are mediated through mechanisms such as antioxidant effects, enzyme regulation, neurotransmitter modulation, and cytoprotective actions. The use of Imipramine as a standard drug in antidepressant studies further demonstrates the potential of asafoetida extract in neurobehavioral disorders. Overall, the findings indicate that asafoetida is a powerful natural remedy with significant potential in modern pharmacology. Continued research and clinical evaluation could lead to its wider application in therapeutic formulations and integrative medicine.

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