

1 Minireview Article
2 A SCIENTIFIC UPDATE ON *PASSIFLORA*
3 *FOETIDA*

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10 ABSTRACT

11 **Introduction:** This review describes the importance of medicinal plant *Passiflora foetida* in the modern world. Between 190 countries, approximately 85% have dependency of traditional systems of Ayurveda, Homeopathy and Unani that have contributed for exploring remedial plants. *Passiflora* is a prominent medicinal plant with major phyto-constituents such as flavonoids, glycosides, alkaloids, phenolic and volatile constituents those are potent for potential therapeutic practice.

Aim: This article focus, specifically on *Passiflora foetida* describing its distribution taxonomic, morphology, remedial uses, photo-constituents and clinical applications.

Study design: Comprehensive literature survey, including national and international journals for assembly of the pharmacological aspects of medicinal *P. foetida* has been done.

Results: *P.foetida* extracts have potential tendency against anxiety, insomnia, sexual dysfunction, inflammation and cancer. They are rich in fiber content, used in paper production industries. In various, countries *Passiflora* fruits are farmed for making cold drink, ice cream, flavor thus best source for economic earning.

Conclusion: Current review form package of pharmacological importance of *P. foetida* that will assist a researcher for identification of bioactive compounds. Information regarding medicinal and Phytochemical are discussed that would be beneficial in research design. This plant carries a large number of bioactive phyto-constituents that may be effectively raised for drug in pharmaceutical industry.

12
13
14 **Keywords:** *Passiflora foetida*, secondary metabolites. Phytochemical, phenylpropanoid
15 pathway.

1. INTRODUCTION

Earth is a best source for numerous medicinal plants. The global market for medicinal plants and herbal medicines is estimated to be worth of US\$ 80 billion per year. International export trade in curative plants from India is 32600 tons/year [1]. According to World Health Organization [2] healing plants have neutral side effects, greater specificity and efficacy [3] thus, worlds 70 percentages of countries depend on a conventional health care system [4]. About 85 percentages of traditional medicines in India are prepared from extracts of leaf, stem, root and flower. Human have advanced to next age were indiscriminate deforestation, industrialization, urbanization and uncontrolled population have resulted in disappearing of numerous medicinal plants in alarming rate. Thus, many scientific researchers have extracted active component and formulate drugs from the natural available plant sources thus several developing countries such as Bangladesh (90%), Myanmar (85%), India (80%), Nepal (75%), Sri Lanka (65%), Indonesia (60%) and few other south east asian countries have deliberately focused research on medicinal plants [4]. therapeutic plants are the best source for treatment of varied minor to harsh human diseases such as cough, temperature, skin burns, fungal infection, inflammation, Diabetes mellitus and rheumatoid arthritis [5].

2. *Passiflora foetida* information

Passiflora foetida Linnaeus, 1753 annual vine climber grows 1-6 m tall with eye catcher beautiful flower, that has been previously in 15th century noted for the Passion of Christ, and named as passionflower [6]. This plant has woody roots, solid stem, tendrils, and leaves carry distinctive hairs all over plants that secrete an odorous chemical and thus specific named stinking passion flower [7]. There are about 600 species of this plant reported in several places in Asia. Including India, Thailand, Myanmar, Indonesia, Singapore and many more that are occurred in tropical and sub tropical part of the world [8] [9].

Taxonomic Tree

Domain: Eukaryota
Kingdom: Plantae
Phylum: Spermatophyta
Subphylum: Angiospermae
Class: Dicotyledone
Order: Violales
Family: Passifloraceae
Genus: *Passiflora*
Species: *Passiflora foetida* [10].

3. Data base content Useful data base for *P. foetida* information.

1. <http://www.threewa.co.uk/passion/>
2. <http://www.media-public.de/passiflora>
3. www.biosecurity.qld.gov.au [11]
4. <http://www.passionflow.co.uk/>
5. <http://www.passiflorasociety.org/>
6. <http://passiflora.org/>
7. <http://www.marinespecies.org>
8. <http://www.nlm.nih.gov>

4. Traditional uses

This plant is used for traditional purposes and there are numerous herbal products prepared from *Passiflora foetida* that are accepted in India, America, France, Brazil, Vietnam and European nations. In India, this plant is used for forming lotions for skin disease & for preparation of medicinal powder for digestive problems. In Brazil, this plant is used to formulate lotions for skin diseases with inflammation. In Vietnam, leaves are used for tea making for vanishing sleeping and nervous disorders.

5. Medicinal uses

Passiflora foetida is well known for its used in medicinal purpose it is used as surface covering for smothering weed and to enhance organic matter production. The leaves are employed in baths for skin affections [12]. Raw fruits are directly eaten in Thailand [13] Fruits are used for preparation of refreshment in Venezuela [14]. Common disease in chickens such as Newcastle disease is treated with different preparations of the fruits, leaves, stem and seeds [15]. *Passiflora foetida* organ's parts have various medicinal values for treating chronic pain, cough, asthma, insomnia, hysteria, emmenagogue, biliousness, digestive problems, including dyspepsia [16]. *P. foetida* shows fungicidal activity [17] Leaf extracts of *P. foetida* show antibacterial properties against four human pathogenic bacteria, i.e. *Pseudomonas putida*, *Vibrio cholerae*, *Shigella flexneri* and *Streptococcus pyogenes* [18]. Leaf extracted in methanol shows fungicidal and against bacteria with presence of cyclopropane, triterpene and glycoside compounds [19]. Expectorant for nervous conditions, spasms and [20] anti inflammatory activity was observed in mice study [21]. A research by [22] suggests that *P. foetida* extracts possess antidepressant effects that could be used in the treatment of patients with depressive disorders. Vitexin could be anti-inflammatory and Kaempferol, Apigenin and luteolin may lead to anti-allergic drug development for compensation of excessive steroidal drugs usage has been observed by [23]. [24] Confirmed anti ulcer and antioxidant activity of *P. foetida* in gastric tissue of ulcer rat's models and concluded antiulcerogenic effect is related to antioxidant activity.

6. *Passiflora foetida* status in India

In India *P. foetida* grown as runner plant occurred mostly in wet places associated in spiky trees and grows over the surface of land if support is unavailable. It is normally seen as a decorative plant because of its flower. Life stages of *P. foetida* are represented in figure 1.

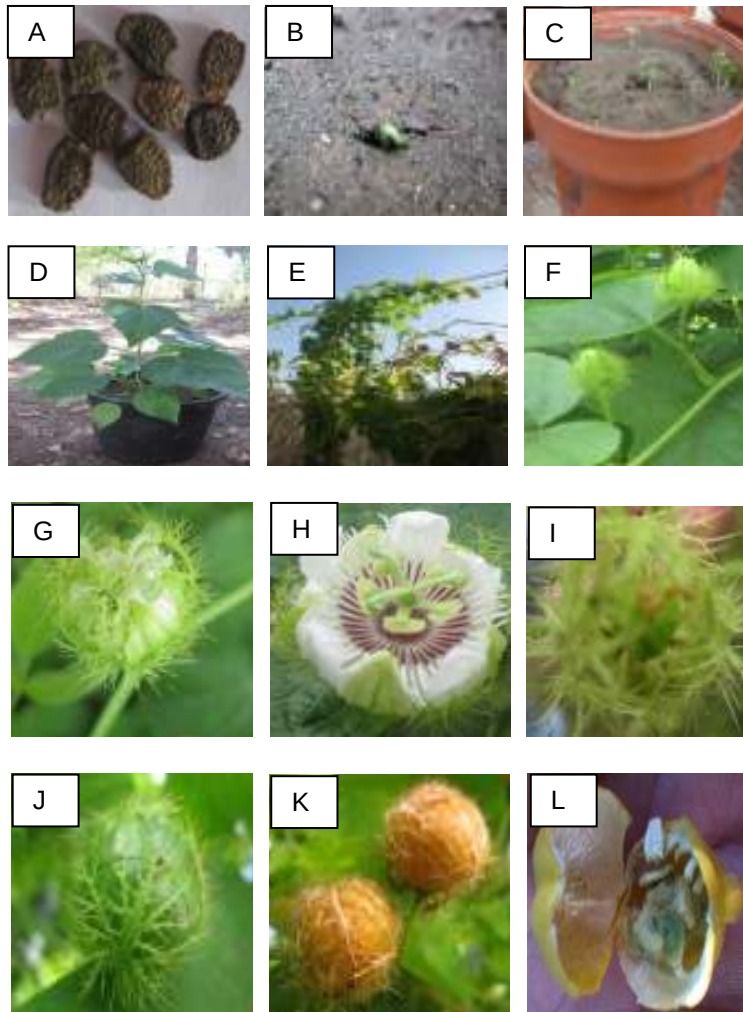


Figure 1 The photo shows pictures of various life stages of *Passiflora foetida*.

A: Seeds, B: Germinating seed, C: Partial developed plant, D: Maturing plant, E: Matured plant. F: Flower bud. G: opening of a flower. H: Mature flowers. I: Closing of a flower. & fruit formation of a closed flowers. J: developing fruit. K: Fully developed fruit. L: Seed bursting.

7. *Passiflora foetida* status in foreign countries

In several nations, *P. foetida* grows as annual climbing herb produced from seed that may be survived, germinated in warm and moist soil. This plant is seen in moist lands, marshy, neglected places, riverbanks and lake side. *P. foetida* favors are grown on soaked areas, dry conditions and tolerate in arid conditions [13]. In Guam, wild *Passiflora* was seen in both volcanic and limestone soils and is grown in waste land [25]. *P. foetida* usually sited along a spiky tree that serves as support for growth of the plant. However, if this support is unviable, then *P. foetida* grows in a form of mat over surface area. In Hawaiaia, *P. foetida* are observed in large groups growing over a long lava flow, road sides. *P. foetida* forms an impact on other plants by growing as mat covering in the absence of support and inhibiting other plants from growing. It is a common weed in several countries, including Australia, Bolivia and Argentina [20].

8. Native place

Natural community of this plant was observed in river, lakes, costal mountain ranged in Central America, Africa, South-East Asia, Pacific region and in the state of Parana and Brazil South America [26].

9. Geographical distribution

P. foetida plant is widely distributed in South America, American Samoa, Cocos Islands, Commonwealth of the Northern Mariana Islands, Cook Islands, Federated States of Micronesia, Fiji, French, Galapagos Islands, Guam, Hawaiai, Kiribati, Marshall Islands, New Caledonia, Solomon Islands, Tonga, Vanuatu, Wake Island, Wallis and Futuna Islands, Poland, Finland, European countries, Japan, Malaysia, Thailand, Kenya, Nigeria, south Africa, Singapore, China, Hong Kong, India, including Assam, Amravati, Nagpur and Tamil Nadu. Table 1 clearly represent the language and common name for *Passiflora foetida* in India and Table 2 indicates *P. foetida* distribution around the world with their origin and called name.

Table 1 represents the language and common name for *Passiflora foetida* in India.

Sr no	Language	Country	Commonly known	References
1	English	India	love in a mist, Stinking passion flower, Smelling flower	(27)
2	Hindi	India	Rakhi flower, krishnna kamal, Jhumka lata,	*
3	Bengali	India	Jhumka lota	*
4	Manipuri	India	Lam Radhikanachom	*
5	Marathi	India	Vel ghani	*
6	Kannada	India	Kukkibali	(27)
7	Malayalam	India	Chirrachantiya, Poochapalam	(27)
8	Tamil	India	Siruppunaikkali, Chiru punai k kali, Mupparisavalli	(27)
9	Telugu	India	Tellajumiki	(27)

Note: * Local sources

187 **Table 2** Presentation of origin, occurrence, common name, invasive and country for
 188 *Passiflora foetida*.

Sr no	Country	Origin	Commonly known	Invasive	References
ASIA					
1	Cambodia	-	-	-	(28)
2	China	-	long zhu guo	-	(28, 17, 29)
3	Hong Kong	-	-	-	(17)
4	Christmas Island (Indian ocean)	-	-	-	-
5	India	Native	banchathail, mukkoopera, Krishna kamal, rakhi flower.	Non invasive	(28, 17, 30)
6	Maharashtra	-	Krishna kamal, rakhi flower.	-	(31)
7	Japan	-	kusa-tokeiso	-	(28)
8	Lebanon	-	-	-	(28)
9	Malaysia	-	pokok lang bulu, timun dendang	-	(28, 32)
10	Sarawak	Native	-	-	(33)
11	Myanmar	-	-	-	(32)
12	Philippines	-	kurunggut, lupok-lupok, masafloa, melon meleonan, pasionariang-mabaho, prutas taungan	-	(17,34, 32)
14	Singapore	-	timun dendang, timun hutan, timun padang	-	(35, 32, 27)
15	Sri Lanka	-	wal wel dodam or padawal , dalbattu, kodimathulai, madahalu, udahalu	-	(36, 28, 17, 37)
AFRICA					
16	Congo	-	-	-	(28, 17, 38)
17	Ghana	-	-	-	(17)
18	Kenya	-	-	-	(28)
19	Madagascar	-	Tsipopoka	-	(28)
20	Nigeria	-	-	-	(17)
21	South Africa	-	running pop	-	(39)
North America					
22	Mexico	Native	clavellín blanco, granadilla, jujito	Non invasive	(28, 26)

			peludo, jujo		
23	USA	-	-	-	(17)
24	Arizonan	Native	-	Not invasive	(26)
25	Hawaii	-	scarlet fruited passion flower	-	(40,28, 17)
Central America And Caribbean					
26	Bahamas	Native	-	Not invasive	(26)
27	Barbados	Native	-	Not invasive	(26)
28	Belize	Native	-	Not invasive	(26)
29	British virgin island	Native	-	Not invasive	(26)
30	Costa Rica	Native	-	Not invasive	(26)
31	Cuba	Native	-	Not invasive	(28, 26)
32	Curacao	Native	-	Not invasive	(26)
33	Dominica	Native	-	Not invasive	(26)
34	Dominican Republic	Native	caguazo, mariballa	Not invasive	(28, 17,26)
35	Elsalvador	Native	-	Not invasive	(41,17, 26)
36	Guadeloupe	Native	-	Not invasive	(26)
37	Guatemala	Native	-	Not invasive	(26)
38	Haiti	Native	-	Not invasive	(26)
39	Honduras	Native	-	Not invasive	(28,17,26)
40	Jamaica	Native	granadilla, love in a mist, sweet cup	Not invasive	(28,17,26)
41	Martinique	Native	-	Not invasive	(26)
42	Montserrat	Native	-	Not invasive	(26)
43	Nicaragua	Native	-	Not invasive	(28,17,26)
44	Panama	Native	-	Not invasive	(28,17, 26)
45	Puerto Rico	Native	flor de pasion	Not	(28,17,26)

			silvestre, silvestre, tagua tagua	invasive	
46	Saint Kitts and Nevis	Native	-	Not invasive	(26)
47	Saint Vincent and the Grenadines	Native	-	Not invasive	(26)
48	Trinidad and Tobago	Native	-	Not invasive	(17,26)
South America					
49	Argentina	Native	ataco, corona de Cristo, granadilla, Pendón	Not invasive	(42,26)
50	Bolivia	Native		Not invasive	(43,26)
51	Brazil	Native	Maracujazinho (San Luis Island), maracujá catinga, maracujá de cheiro, maracujá de cobra, maracujá de estalo, maracujá de lagartinho, maracujá fedorento, maracuja- da-petra	Not invasive	(44,28,26)
52	Chile	Native	-	Not invasive	(42,26)
53	Colombia	Native	bejuco canastilla, chulupa de loma, cinco llagas, cocorilla, curubo, flor de la pasión, gulupo	Not invasive	(28,17,26)
54	Ecuador	Native	Love in a mist	Not invasive	(26)
55	Galapagos island	Native	-	Not invasive	(45,26)
56	French Guiana	Native	passiflore fétide	Not invasive	(26,37)
57	Guyana	Native	-	Not invasive	(26)
58	Paraguay	Native	-	Not invasive	(26)
59	Peru	Native	bolsa mullaca, granadilla, granadilla cimarrona, puru-puru	Not invasive	(28,17,26)
60	Suriname	Native	-	Not invasive	(17,26)
61	Uruguay	Native	-	Not	(42)

62	Venezuela	Native	cojón de gato, parchita de culebra, parchita de Montana	invasive Not invasive	(41,28, 26)
Oceania					
63	American Samoa	-	pasio vao	-	(32)
64	Australia	-	mossy passion flower	-	(28,46)
65	Australian northern tertiary	-	-	-	(47,28)
66	New South Wales	-	-	-	(47,28, 46)
67	Queensland	Introduced	-	-	(47,28, 46)
68	South Australia	-	-	-	(28,46)
69	Western Australia	-	-	-	(28)
70	Cooks island	-	-	-	(32)
71	Fiji	-	Wild Passion Fruit	-	(28, 17,48)
72	Tonqan	-	vaine 'ae kumā, vaine 'initia	-	(29)
73	Vanuatu	-	-	-	28
74	Wallis and Futuna islant	-	-	-	28

Note: This table is prepared from the information given on web site [44] and assembled from website (CAB International: www.cabi.org/isc) on dated 2 January 2014.

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190 **10. Habitat**

191 This plant found usually in association with spike plants or shrubs and grows on, moist
 192 marshy places, dry, arid, river side, lake side and few reports for long side of lava. It is a
 193 weed plant in many places of Pacific and Atlantic were found along road side vegetation.
 194 However, it is grown for a decorative and gardening purpose in India and Poland.

195 **11. Propagation and seed Germination**

196 *Passiflora foetida* is propagated from seed and by planting branch of stem in soil. Seed
 197 sowed germinates within two weeks after sowing.

198 **12. Morphology**

199 Love-in-a-mist is a perennial vine climber [9] sometime surface coverer, which has a trifoliate
 200 leaf, an edible fruit and has beautiful eye catching flower. Figure 1 E shows complete

201 morphology of the *P. foetida* climbers. It is to be notated that when a support is present *P.*
202 *foetida* grows faster and spread over the surface in no time.

203 • **Seed** Ripped seeds are blackish to brown in color, flattened and wedge in shape of
204 3-4mm in size [7] seeds are as shown in figure 1A.
205

206 • **Leaves** are shown in figure 1D they are three lobed with spiked viscid hairy leaves
207 3-parted; segments-apices acute; leaf based cordate; both sides hispid-hirsute;
208 blades 3, 5-10cm long, 4-12cm wide; petiole 2-6cm long; with prominent veins.
209

210 • **Steam** The stems are 1-6m long, branched, thin, wiry and woody, covered with sticky
211 yellow hairs with tendrils [7]

212 • **Tendrils** Tendrils are spring like coiled in nature and grasped support present around
213 and helps the plant to grow faster.

214 • **The flower** the flowers are erected at axis white color outer side and dark pink to
215 violet to inner circular side with figure like projection outward from flower. A flower is
216 about 5-6 cm in diameter with 13-15 petals and 8-11 sepals. The stamens arising
217 from the top middle of flower with three styles. Peduncle 3-5 cm long and a bract 2-4
218 cm long. The flower is displayed in figure 1 H, figure 1G show opening of flower and
219 1, I show closing of a flower. This species has unique opening and closing pattern of
220 flowering.
221

222 • **Seedling** germinates from soil with hypocotyl 4-12 mm long green in color, two
223 juvenile leaves ovate in shape. The temperature range 19-29°C is good for
224 seedlings [49]. Seedling can be seen in figure 1 B was small green color hypocotyl is
225 coming out from the soil.

226 • **Special features**

227 **A) The bract** of this plant trap insect and exude a digestive enzyme. The larvae heliconii
228 butterflies of family nymphalidae grow on this plant.

229 **B) Unique flower opening and closing** *P. foetida* produces flowers in september and
230 december in India. It has a unique pattern of opening it is usually open in morning 5 am and
231 closed around 11 am on a same day, alike is followed for next three days. Later, flowers
232 closed to form fruit. *P. foetida* produces flowers and fruits between october and february in
233 Brazil [44] and throughout the year, mainly from september to may in Argentina [42].

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235 13. Phytochemicals of *P. foetida*

236 The important phytochemicals of this plant are alkaloids, phenols, glycoside, flavonoids,
237 cyanogen compounds [5] [18]. Other constituents are C-glycosyl flavonoids based on
238 apigenin and luteolin. Chrysoeriol, kaempferol, isoschaftoside, isovitexin and vitexin are
239 some of the other phytochemicals found in *P. foetida* [50] [7]. Aromatic metabolites such as
240 coumarin, phenolic volatiles and ester-related compounds show antimicrobial activitie, which
241 are induced up on mechanical wounding [34]. Vitexin exhibited anti-inflammatory and anti-

242 spasmodic properties. Cyanohydrin glycoside tetraphyllin A, tetraphyllin B, tetraphyllin B
243 sulphate, deidaclin, volkenin, fatty acids, linoleic acid, alpha-pyrone named passifloricin are
244 some of the other phytoconstituents reported in *P. foetida* [16]. In recent vitexin and isovitexin
245 show inhibition of formation of advanced glycation end products (AGEs) that are found to be
246 implicated in diabetic complications [13].

247

248 **14. Biosynthesis of Phytoconstituents of *P. foetida* through Phenylpropanoid pathway**

249 Plant usually produced secondary metabolites to overcome biotic and abiotic stress [51] by
250 activating phenylpropanoid pathway producing diverse metabolites such as lignin, alkaloids,
251 flavonoid, iso flavonoid, phlobaphene [25]. First most enzyme phenylalanine ammonia-lyase
252 (PAL) greatly increased its activity after wounding was observed by [52]. Phenylalanine
253 ammonia-lyase is converted to cinnamic acid further through subsequent oxygenases,
254 transferases and reductase reaction p- Coumaryl CoA is generated [19], which is a
255 precursor for other secondary metabolites produced through diverse pathway route. The
256 figure 2 shows a complete pathway for production of secondary metabolites. In recent, some
257 other aromatic metabolites like coumarin, phenolic volatiles and ester-related compounds
258 are also found to be produced against a stress response. There may be the chance of
259 obtaining some unique antimicrobial and microbial compounds that are produced on wound
260 stress which may not be produced in (un-wounded) healthy plant [12].

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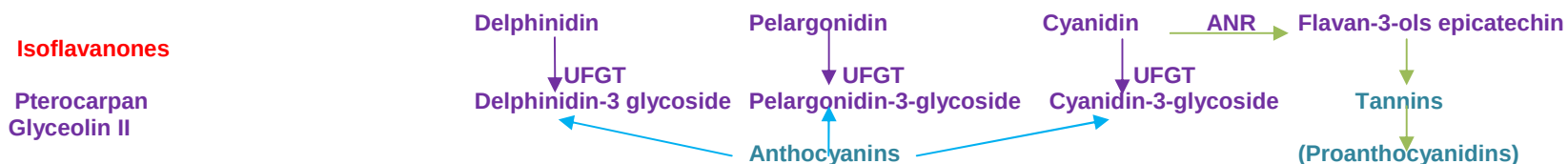


Figure 2: Phenylpropanoid metabolic pathway: this pathway has been grafted using information available from paper cited above. Enzyme are denoted in uppercase, following are enzyme listed below, Phenylalanine ammonia lyase (PAL), Cinnamic acid 4-hydroxylase (C4H) 4-coumarate:CoA ligase (4CL), Hydroxycinnamoyltransferases (HCT) [18], p-Coumarate 3- hydroxylase (C3H), Caffeoyl CoA O-methyltransferase (CCoAOMT), Cinnamoyl CoA reductase (CCR), Ferulate 5-Hydroxylase (F5H) (Aguade., 2001), Caffeic acid O-methyltransferase (COMT), Cinnamyl alcohol dehydrogenase (CAD). (CHS) Chalcone synthase: (CHI), Chalcone isomerase: (IFS), Isoflavone synthase: (F3'H), flavonoids 3' hydroxylase (F3',F5'), flavonoid ' , 5' hydroxylase: (DFR), dihydroflavonol-4- reductase: (ANS), anthocyanidin synthase: (UFGT), UDP- flavonoid glucosyl transferase: (BA2H), benzoic acid 2- hydroxylase [52] [26] and metabolites are Tannins, Proanthocyanidins, Anthocyanins, Isoflavanones, Phytoalexines, Isoflavones, Glucose ester, other ester , G Lignin, S Lignin, Salicylic acid, p- Coumaric acid , Caffeic acid, Ferulate acid, 5-OH Ferulate acid and Sinapic acid.

303 15. Economic importance

304 The studies performed by [53] suggest that *P. foetida* is rich in fiber content, about 17.7%
305 and shall be economic for various paper production industries. It has been reported that all
306 parts of *P. foetida* such as leaf, root, stem fruit has tremendous medicinal properties, making
307 plant hot spot for new drug discovery in pharmaceutical industry [44]. In various, countries
308 Passiflora fruits are farmed for making cold drink; ice cream flavor thus *P. foetida* farming
309 could be the best source for economic earning.

310 16. Future Prospects

311 *P. foetida* traditional and medicinal uses would be crucial for treatments of several diseases.
312 The complete understanding of phyto constituents of *P. foetida* would be beneficial for
313 designing a drug with better efficiency and efficacy. This paper would help researchers for
314 understanding physiology and various secondary compounds that are produced upon abiotic
315 or biotic stimuli. Phenylpropainoid pathway understanding would clear the puzzle of
316 biosynthesis of those compounds. This will help in studies of phenylpropanoid pathways in
317 related and distance species, for production of novel compounds. The well-known research
318 on *P. foetida* is not up to the mark; very few works have been done in India. Some paper
319 indicated *P. foetida* for sedative, hypnotic, sleep aids and herbal products with solid support
320 for clinical cases.

321 17. CONCLUSION

322 Medicinal plants have significantly provided the discovery of novel drugs that are safe with
323 improved efficiency and efficacy. In this review, a complete information package is provided
324 specifically of *P. foetida* that would be helpful for sketching of research work and
325 identification of viable bioactive compounds. *P. foetida*, distribution, medicinal uses, habitat,
326 morphology, phytochemical are discussed that would be useful in research design. This
327 plant carries large numbers of bioactive phytoconstituents that may be effectively raised for
328 drug in pharmaceutical industry. This paper would boost in research information with working
329 on *P. foetida*.

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