

Studies on the Reproductive biology and ecology of *Senna Angustifolia* Vahl. In the Vindhya region of Madhya Pradesh, India.

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Abstract: A plant originally from tropical Africa, *Senna* (*Cassia angustifolia* Vahl.) made its way to the Indian state of Tamil Nadu in the eleventh century. Sennosides A and B, derived from immature pods and senna leaves, are used for their antioxidant, antibacterial, anticancer, and purgative effects. More than 80% of senna's biological action is attributed to its two stereoisomers, Sennosides A and B, which are dihydroanthraone glucosides. The current name for the *Senna* species, which comprises *Cassia angustifolia*, *Cassia senna* L., and any hybrids between the two, is *Senna alexandrina* Mill. It is a Leguminosae family member. The little evergreen shrub called "senna" is native to Yemen in southern Arabia. The pods and leaves contain sennosides, which have laxative properties. The sennoside A and B hydroxy anthracene glycosides, which are present in the pods, flowers, and leaves of the senna plant, are responsible for the plant's therapeutic characteristics.

Keywords: *Cassia angustifolia* Vahl., Purgative effects, therapeutic characteristics.

INTRODUCTION

Senna angustifolia Vahl. also referred as Indian senna, is a significant medicinal plant which is a member of family Fabaceae. The species is also commonly known to have pharmacological importance especially with presence of bioactive compounds called sennosides A and B that have strong laxative effects. These are majorly found in the leaves and pods of this plant and are widely used in the traditional as well as the contemporary pharmaceutical preparations in the treatment of constipation and other gastrointestinal disorders. Due to its medicinal value, *Senna angustifolia* has received a lot of interest in botanical, pharmacological, and ecological studies.

Genus *Senna* is a taxonomically complicated genus that has a number of species that were assigned to genus *Cassia*. The most related of them are *Senna angustifolia* and *Cassia senna* that are now all known as *Senna alexandrina* Mill. The plant is a small perennial shrub, which has pinnate leaves, yellow flowers in the form of racemes, and elongated pods with a number of seeds. The diagnostic characteristics of the organism (morphological, and anatomical) are also helpful with the help of the features of the leaves, rhyme, and seeds which are used to identify the plant and classify it correctly.

Despite the fact that the plant was indigenous to the tropical parts of Africa and the Arabian Peninsula, it has since been introduced in India many centuries ago and has been able to effectively adapt to semi-arid and dry climatic conditions. It is presently cultivated and naturalized in some of the regions of India because of medicinal significance and commercial worth. Ecological adaptiveness of *Senna angustifolia* enables it to thrive in the sandy soils, arid regions, and areas with relatively low rainfall.

The plant is growing in various locations in the Vindhyan plateau (mostly in the districts of Sidhi, Rewa and Satna of the central Indian state of Madhya Pradesh). These regions lie under Vindhya region and the region is rocky, has a dry deciduous forest and moderate climatic conditions enabling the growth of different medicinal plants. The ecological factor of this area, such as loamy soils, hot weather and the seasonal precipitation, gives an ideal environment to the growth and reproduction of *Senna angustifolia*.

The reproductive biology and ecological distribution of this species is significant to the conservation of this species, sustainable use and cultivation in the Vindhya region. Reproductive functions like flowering, pollination, fruit composition, and seed embryo are essential in the natural multiplication and existence of the species. Also, ecological research assists in identifying the effect that the environmental factors have on the growth, distribution and productivity of plants.

Thus, the current research is expected to examine the reproductive biology, morphological aspects, and ecological distribution of *Senna angustifolia* in the Vindhya region of Madhya Pradesh, in the districts of Sidhi, Rewa, and Satna, in particular. Another aim of the study is to record the ecological circumstances that the species grows naturally and also emphasize its medicinal and economic significance.

Ecology and Distribution of *Senna angustifolia* in the Vindhya Region

Vindhya region of Madhya Pradesh with districts of Sidhi, Rewa and Satna furnish good ecological conditions to the *senna angustifolia*. The rainfall is moderate during the monsoon months and it is relatively cool during the winters which are characterized by hot summers. Many medicinal plant species such as *senna* are able to thrive in these climatic conditions.

The Vindhya plateau soils are usually sandy-loamy and well drained soils, which are conducive to the growing and naturally growing of *Senna angustifolia*. The plant is also drought resistant, and is able to live in arid and semi-arid habitats and therefore is well adapted to the ecological environment in this region. The fields the species occur on the field boundaries, in the open scrublands, and on the margins of dry forests in several regions.

The farmers in some districts like Sidhi, Rewa and Satna sometimes plant *Senna angustifolia* as a source of its medicines leaves and pods (used in the pharmaceutical industry). Along with cultivated population, there is also wild population or semi-natural population of the plant in dry wastelands and rocky ecologies. The plants mostly bloom in the warm seasons and it takes a short time after flowering to produce pods thereby facilitating seed production and natural regeneration.

The ecological flexibility of *Senna angustifolia* enables it to survive in environments where water resources are limited and soils in the environment are relatively low. These conditions enable it to proliferate and hence it is a significant medicinal plant species in the semi-arid areas such as the Vindhya plateau. The ecology and reproductive behavior of the species under study of the Vindhya region can help to understand better the distribution patterns, environmental adaptability, and sustainable cultivation of this species.

LITREATURE REVIEW

Zeeshan, et.al. (2018). The present scenario in Pakistan is characterized by the widespread usage of herbal medicinal plants and species. Alkaloids, flavonoids, glycosides, phenols, steroids, and other specialized colors are only a few examples of the many secondary metabolites produced by plants' regular metabolism. Consequently, ethnobotanical approaches are becoming more popular among botanists as a result of their cheaper cost, wider margin of safety and effectiveness, and less negative effects of plants. The unique phytochemicals found in plants have indisputable therapeutic value. A number of medicinal

herbs have been touted as potential remedies for human health issues, with a focus on those involving the gastrointestinal tract (GIT), the liver, the stomach, and the colon.

Sivakumar, et.al. (2024). Among the many medicinal and therapeutic uses for plants, *Cassia angustifolia*—sometimes called Indian Senna—belongs to the Fabaceae (Leguminosae) family. The high concentration of sennoside anthraquinone derivatives in senna leaves makes them an effective natural laxative for promoting bowel movements and relieving constipation. When used orally, *Cassia angustifolia* alleviates indigestion, gas, and other gastrointestinal issues. Because of its significance in the pharmaceutical business, senna cultivation is on the rise in India. Thanks to senna variants, India can now supply the global pharmaceutical market. Among the many medicinal and therapeutic uses for plants, *Cassia angustifolia*—sometimes called Indian Senna—belongs to the Fabaceae (Leguminosae) family. The high concentration of sennoside anthraquinone derivatives in senna leaves makes them an effective natural laxative for promoting bowel movements and relieving constipation. When used orally, *Cassia angustifolia* alleviates indigestion, gas, and other gastrointestinal issues. Because of its significance in the pharmaceutical business, senna cultivation is on the rise in India. Thanks to senna variants, India can now supply the global pharmaceutical market.

Bagwe, et.al. (2019). Assessment of the Immunomodulatory Effects of *Cassia angustifolia* Vahl. *Journal of Pharmaceutical Sciences from Around the World*. An increasingly popular method of treating a wide range of illnesses is by modulating immune functioning with the use of medicinal plants and their derivatives. *Cassia angustifolia* Vahl was tested for its immunomodulatory effects on male Swiss albino mice that had been immunosuppressed by cyclophosphamide. Mice were given 2, 5, and 10 mg/kg of crude methanolic leaf extract of *C. angustifolia* orally for a duration of 14 days. Levamisole was administered to the animals as a positive control. Animals were pricked in the heart on Day 15 to draw blood, and several immunological parameters were used to assess the immune response. After being given the extract, the animals had a dramatic rise in neutrophil counts and leucocytosis. After treating with the extract, we observed an increase in the neutrophil phagocytic index and a delay in the type hypersensitivity reaction. The dosage that elicited the strongest immunological responses was 5 mg/kg. There was a dose-dependent rise in hemagglutination antibody titer levels in the rats given the extract.

Khare, et.al. (2017). Herbal remedies, in contrast to allopathic drugs, are now more effective in treating a wide range of illnesses with few side effects. Senna, whose scientific name is

Cassia angustifolia, is a member of the Leguminosae family and a popular laxative all around the globe. The districts of Tirunelveli, Madurai, and Ramnath Puram in Tamil Nadu are the most common places to find Senna. The primary chemical components of *C. angustifolia* are amino acids, tannins, alkaloids, flavonoids, and carbohydrates. This research aims to examine the pharmacological, phytochemical, and pharmacogenetic characteristics of *C. angustifolia*. Extractive values, fluorescence studies, ash values, chemical testing, and loss on drying were all performed using the powdered medication. Research was also carried out at both the macroscopic and microscopic levels. Paralytic stomata, nonlignified unicellular trichomes with warty walls, and a fibrovascular bundle were seen in the isobilateral structure of the leaf in the transverse section (T.S.). Several reagents were used to study the fluorescence properties of leaf powder in visible light and ultraviolet (UV) light (254 nm and 365 nm). Tannins, amino acids, alkaloids, flavonoids, and carbs make up senna.

Kumar, et.al. (2017). The tropical plant *Cassia siamea* Lamk belongs to the Caesalpiaceae family and was originally from Southeast Asia. Traditional uses include crude form or decoction of leaves and flowers for the treatment of fever, malaria, diabetes, hypertension, asthma, constipation, diuresis, central nervous system disorders, jaundice, abdominal pain, and menstrual pain, among others. It is also famous for its nutritional, medicinal, and economic significance. Vegetables made from *C. siamea* leaves and blossoms are popular in various Asian countries. This study compiles and summarizes data on *C. siamea* from every known source, dating back to 1925. There are a number of pathological issues that the *C. siamea* plant has shown promise in treating medicinally. Its nutritional and economic value are not to be overlooked either. Anthraquinones, coumarins, alkaloids, flavonoids, glycosides, triterpenoids, sterols, and other polyphenols are among the plant's primary phytochemical components. Additional *in vitro* and *in vivo* investigations on this plant have investigated its unique pharmacological characteristics, including its analgesic, antioxidant, anti-inflammatory, antimalarial, vasorelaxant, anticancer, antiarrhythmic, antiandrogen, anti-HIV, and anxiolytic effects.

SENNA (CASSIA ANGUSTIFOLIA VAHL)

The little perennial under shrub known as "senna" originates from Yemen in southern Arabia. Senosides, found in the pods and leaves, are laxatives. It was brought to Tamil Nadu in the 18th century and is now cultivated as an annual crop in 8,000 to 10,000 hectares (ha) under

rained and irrigated conditions. The crop lasts for around five to seven months. Gujarat (Anand), Karnataka (Bangalore), and other states have also shown successful cultivations.



Figure 1: CassiaAngustifoliaVahl

Despite having similar yield and quality, the absence of structured marketing has prevented it from becoming a cash crop in Rajasthan (Jodhpur) and Delhi. The leaves, pods, and sennoside concentrates make up the bulk of the exports, but the plant is also used by pharmaceutical companies to make calcium sennoside granules, pills, and syrups that are sold domestically. Our primary target markets are the United States, Germany, Hungary, Japan, and the Netherlands. Pods and leaves exported from India are worth twenty million rupees a year. Also, the nations that were previously part of the Soviet Union purchase sennosides (concentrates), with an annual export value of around Rs. 20 million.

- **Description of the Plant**

This little perennial under shrub, *Cassia angustifolia* ($2n=28$), is less than 1 m tall and has ascending branches; it is a member of the Leguminales family. Big, complex, and pinnate leaves. When crushed, the mature leaves have a distinctive fetid odor and have a huge ranging from bluish-green to light green. The many-flowered racemes of axillary (on subterminal) upright blooms are a brilliant yellow in hue. Depending on when it is sown and cultivated, the blooms may be carried anywhere from 35 to 70 days of age; nevertheless, they are not limited to a certain season. The pods emerge soon after the flowers have finished blooming; they are somewhat curved, measuring 3.5 to 6.5 cm in length and 1.5 cm in width. They are initially green but become a greenish-brown or dark brown as they mature and dry. The seeds in each pod are 5–7 and are compressed, smooth, and dark-brown in color.



Pod



Flower



Seed

Figure 2: Species of *C. angustifolia*

With the exception of the size of its pods and leaflets, the other species grows and looks very much like *C. angustifolia*. These pamphlets are narrower and shorter. Oblong in shape with a little upward curvature and generously rounded ends, the pods are noticeably short, flat, and broad. - Moreover, it is remarkable that the two species are thought to be differentiated by surface making on the test (seed) and stomatal index (leaves). *Cassia italica* and *Cassia obouata* both contain a respectable amount of anthraquinone compounds; the former is widespread in India, while the latter is rarer. *C. italica*, a possible new source of the senna medicine, thrives on sandy, salty soils in west Rajasthan and Saurashtra (Gujarat).

- **Reproductive Biology of *Senna angustifolia***

Senna angustifolia reproductive biology is significant in its reproduction, genetic variation and its ability to survive in various environmental conditions. Bisexual axillary races of flowers typify the plant and the reproductive mechanism of the plant is typical of most of the members of the family Fabaceae. Most flowers are usually in the warm months and the timing and

intensity of flowering depend on the temperature, moisture content of soil, as well as sunlight in the environment. In most parts of India such as some parts of Madhya Pradesh, flowering is initiated approximately 35-70 days after sowing and this varies according to climatic conditions and the methods used to cultivate them.

Senna angustifolia is primarily entomophilous (insect mediated) in pollination. The bright yellow flowers will tend to attract bees and other insects that pollinate the flowers, thus easily transferring the grains of pollen between the anthers and the stigma. Such interaction increases cross-pollination and helps bring about genetic variability in natural populations. These floral, such as notable stamens and nectar production, are advantageous to the effective pollination and fertilization.

Once pollinated and fertilized fruit develops at a fast rate. It is a slightly curved, flat pod, which grows out of the fertilized ovary and has some seeds. The pods are initially green and eventually change brown when they mature. The maturation of fruits normally takes a few weeks following flowering, each pod would have 5-7 seeds on average.

The last phase in the reproductive cycle is seed formation and dispersal. The seeds are smooth, compressed and dark brown in color, and they have a hard seed coat which protects the embryo and which keeps them viable at dry environmental conditions. These reproduction traits make *Senna angustifolia* adapt very well in semi-arid areas and lead to its successful nurturing and natural spreading in various areas in India.

- **Harvesting, Processing and Storage**

Sennoside concentration is highest in young senna leaves and pods, but product is sold by weight, thus finding the sweet spot between the two is important for harvesting. It has also been shown that between 50 and 90 days after planting, senna plants produce leaves with greater sennosides. When the plants are 50–70 days old, depending on their overall development rate, is when you should begin harvesting their leaves. Harvesting the leaves by hand removes most of the developing tips and encourages greater branching, both of which are necessary since mechanical harvesting drastically limits the amount of foliage development. In order to ensure that the harvested material consists of both leaves and pods, the plants are plucked twice, first around 90–100 days and again at 130–150 days.

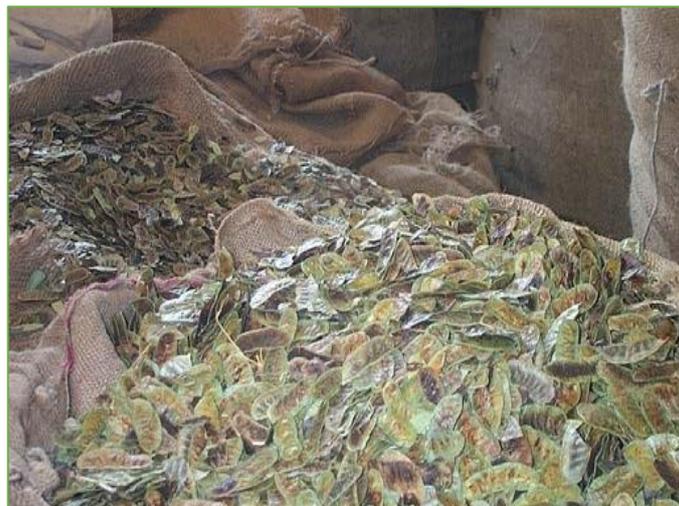


Figure 3: Harvested Crop

Spreading the harvested crop thinly in an open field will help minimize its moisture content. The remaining drying process takes place in drying sheds that have good ventilation. It dries entirely in around ten to twelve days. Light green to greenish-yellow should be the hue of the dried pods and leaves. The sennoside content drops and the color becomes black or brown due to improper or delayed drying, resulting in a decreased price. It is also possible to try mechanical drying at 40°C for a short period of time. Although they do add bulk to the fruit, the seeds themselves do not contain any sennosides.

Pharmacology of *C. angustifolia*

The medicinal properties of senna are due to its hydroxy anthracene glycosides, particularly sennoside A and B, which are found in the plant's pods, flowers, and leaves. The secretagogues feature of these β -linked glycosides leads to an increase in fluid secretion overall and a particular effect on colonic motility, which improves colonic transit. These glycosides do not pass through the esophagus and colon. A comprehensive review of senna and its products' pharmacology, clinical applications, quality assurance methods, patented and marketed formulations, and international trading environment is the goal of this study. Sennosides not only alleviate severe IBS symptoms, but they also speed up colonic peristalsis, which in turn increases fecal weight and dry bacterial bulk, as shown by Godding's research.

The researchers found that arachidonic acid metabolites, particularly PGE₂ and PGF₂ α , play a role in the effect of rhein anthrones on the reversed segment. They also found that the large intestine could expel luminal contents in a caudal direction after adding sennosides. They

concluded that rhein anthrone-induced diarrhea requires the involvement of the calcium channel, which can be blocked by nifedipine but not verapamil. They also found evidence of an increase in propulsive activity, as indicated by a greater number of migrating long spike bursts in the left and human sigmoid colon. It seems that this motor-specific intestinal pattern is common in induced or non-specific diarrhea. The linear and concentration-dependent transport of sennosides A and B, as well as their aglycones Sinnidin A and B, across monolayers of calcium carbonate is shown.

Weak absorption from apical to basolateral and PCC values similar to mannitol were observed. A greater amount of transport occurred in the secretory direction, suggesting that substances that were not well absorbed were expelled into the intestinal lumen, perhaps via efflux pumps. Therefore, the laxative effects of senna are mostly due to metabolites and not the naturally occurring dianthrone. Glycosides (sennosides) include sennidines, the most common aglycone, and hydroxy anthracene derivatives of dianthrone, which are found in senna fruits. Dianthrone is really synthesized enzymatically in the plant as it is being dried at low temperatures; they are not chemicals that exist naturally.

Phytochemistry and Pharmacological of *Cassia angustifolia*

The Leguminosae family includes the well-known traditional Indian plant *Cassia angustifolia* among its members. Another name for it is Alexandrian senna. The medicinally useful *Cassia angustifolia* Vahl. is one of over 500 species of flowering plants in the genus *Cassia*. Andhra Pradesh, Karnataka, Gujarat (Anand and Mehsana), Rajasthan (Kodhpur), Delhi, and the arid coastal areas of Tamil Nadu are among the states in India where *Cassia angustifolia*, often known as senna, is found. With its spreading branches, this plant may reach a height of half a meter to two meters. Long, oval-shaped leaflets adorn its intricate, feathery leaves. Clusters of yellow flowers emerge from greenish-brown pods that are 0.8 to 1.4 cm wide and contain brown, smooth seeds.

Phytochemical Constituents

The United States Food and Drug Administration (FDA) has approved *Cassia angustifolia* as a non-prescription therapy for constipation. *Cassia angustifolia* leaves are a popular remedy in Unani medicine for a variety of ailments, including asthma, skin problems, and joint pain. It purges pathogenic humors and restores harmony to the three humors—Safr (yellow bile), Sawda (black bile), and balgham (phlegm)—through the elimination of morbid humors.

- **Leaves:**

There are 5–8 pairs of 2.5–1.5 cm oval-lanceolate leaflets on each of the slim, grayish-green leaves. This plant yields pods that are medium in size. The leaflets are usually undamaged due to their short and strong petioles. Their size varies from around 1.5 to 6.0 cm in length and 0.5 to 1.5 cm in width. They have a unique smell and a somewhat bitter, mucilage-like flavor. The leaflets have a hairy and glabrous surface on both sides.

- **Seeds:**

Cassia angustifolia produces medium-sized pods. These flat, wedge-shaped seeds have a surface that is marked by lateral ridges and furrows, a hilum, a micropyle, and a raphe; their color may range from yellowish to ceramic-brown. Pods might be cylindrical, somewhat bent, or otherwise haphazard in form. Upon maturation, they change color from green to brown. The hilum is lengthy and oval, with a scar running down its border; the micropyle is diminutive; and the raphe is ridged and extends in an arc on the side opposite the micropyle.

- **Flowers:**

During the months of July through September, the plant displays its fragrant, big golden blossoms. Type 5 flowers have loose, somewhat zygomorphic elements; terminal or axillary racemes may be up to 15 cm long and have pedicels that are 3 to 4 cm long. With a width of 6–9 mm and a length of 10–13 mm, the sepals are quite uneven and have a yellow-green hue. With a width of 7–10 mm and a length of 14–17 mm, the petals are golden and somewhat irregular. The ovary is hairy and stipitate, and there are ten free stamens.

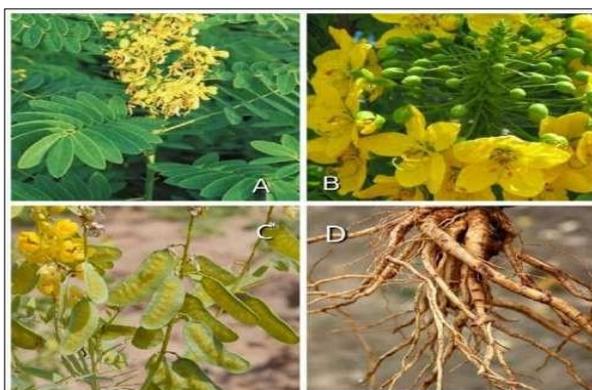


Figure 4: Morphological description of *Cassia angustifolia* (A-Leaves, B-Flowers, C-pods, D-Roots)

CONCLUSION

Indian Senna, or *Cassia angustifolia*, was shown to have a beneficial effect at low doses of the pesticide but became harmful to plant biochemical processes at high concentrations, as demonstrated by the decrease seen at these concentrations compared to the control. The tropical African plant *Cassia angustifolia* Vahl., more often known as Senna, was brought to the Indian state of Tamil Nadu in the eleventh century. The purgative, antibacterial, anticancer, and antioxidant effects of sennosides A and B are derived from the plant's immature pods and leaves. It is possible for this plant to reach a height of half a meter to two meters with its spreading branches. A plethora of delicate, feathery leaves bear long, oval-shaped leaflets. These two species are very closely related. Among the several Senna species, *Senna hebecarpa* is known as Northern Wild Senna. The *Senna alata* Linn plant originally hails from tropical Asia and India; the Nigerians call it gungoroko. *Senna hirsute* L. and *Senna obtusifolia* L., two kinds of woody annual plants or undershrub herbs native to Africa, are known for their active medicinal properties. The current research demonstrates the ecological flexibility and reproduction of *Senna angustifolia* in the Vindhya, Madhya Pradesh especially in the Sidhi, Rewa and Satna districts, with regard to the ecological significance and potential medicinal use of the plant.

References

1. Absar, Nilofer & Singh, Anjali & Singh, Anil & Singh, Saudan. (2018). Impact of sowing and harvest times and irrigation regimes on the sennoside content of *Cassia angustifolia* Vahl. *Industrial Crops and Products*. 125. 482-490. 10.1016/j.indcrop.2018.09.025.
2. Bagwe, Akshay & Bangi, Saima & Nete, Sayali & Maiti, Dr & Ragade, Vinod. (2019). Evaluation of *Cassia angustifolia* Vahl as an Immunomodulatory Agent. *World Journal of Pharmaceutical Sciences*.
3. Bhatti, Shameem. (2020). Phytochemical analysis and antibacterial properties of *Cassia Senna alata*. *Rawal Medical Journal*. 45. 223-226.
4. Ghori, Muhammad & Wang, Xingbin & Zhang, Hui & Hussain, Sajid & Qaisar, Muhammad naeem & Hayat, Khezar & Saqib, Fatima & Zhang, Xin-Xin & Zhan, Guanqun & Guo, Zengjun. (2020). The genus *Cassia* L.: Ethnopharmacological and phytochemical overview. *Phytotherapy Research*. 35. 2336-2385. 10.1002/ptr.6954.

5. Khan, Sajid & Verma, Susheel. (2024). Extra-stigmatic pollen germination and pistil elongation: a novel strategy towards reproductive assurance in *Dodonaea viscosa* subsp. *angustifolia*. *Australian Journal of Botany*. 72. 10.1071/BT22062.
6. Khare, Pragati & Kishore, Kamal & Sharma, Dinesh. (2017). A study on the standardization parameters of *Cassia angustifolia*. *Asian Journal of Pharmaceutical and Clinical Research*. 10. 329. 10.22159/ajpcr.2017.v10i7.18394.
7. Kumar, Dilip & Jain, Ankit & Verma, Amit. (2017). Phytochemical and Pharmacological Investigation of *Cassia Siamea* Lamk: An Insight. *The Natural Products Journal*. 7. 10.2174/2210315507666170509125800.
8. Lal, R K & Chanotiya Frsc, Chandan S & Kumar, Ashish. (2023). The prospects and potential of the horticultural and pharmacological medicinal herb senna (*Cassia angustifolia* Vahl.): A review. *Technology in Horticulture*. 3. 10.48130/TIH-2023-0020.
9. Mahanthesh, M.C. & Manjappa, Arehalli & Shinde, Mayuresh & Disouza, John & Sherikar, Amol. (2019). Biological Activities of *Cassia Occidentalis* Linn: A Systematic Review. *World Journal of Pharmaceutical Research*. 8. 400-417. 10.20959/wjpr20199-15430.
10. Săvulescu, Elena & Georgescu, Mihaela & Popa, Vlad & Luchian, Vasilica. (2018). Morphological and Anatomical Properties of the Senna Alexandrina Mill. (*Cassia Angustifolia* Vahl.). "Agriculture for Life Life for Agriculture" Conference Proceedings. 1. 305-310. 10.2478/alife-2018-0045.
11. Shah, Afsheen & Sm, Wassan & Bhatti, Shameem & Ghanghro, Allah & Ih, Ghanghro. (2020). Screening and quantitative estimation of phytochemical and biochemical components of *cassia senna* (linn.) Grown at tharparkar. 9. 2399-2405. 10.31032/IJBPAS/2020/9.1.4849.
12. Sivakumar, Param Sivam & v, Karunakaran & Prabha, T. & Chitra, M. & Selvaraj, Vijai & Jahanmohan, K. (2024). *Cassia angustifolia* Vahl. 10.1007/978-3-031-75661-0_6.
13. Vijayasekhar, V.E. & Prasad, M. & Joshi, D.S.D. & Narendra, Kumara & Satya, A. & Sambasiva Rao, K.R.S. (2016). Assessment of phytochemical evaluation and in-vitro antimicrobial activity of *cassia angustifolia*. 8. 305-312.

14. Zeeshan, Umar & Barkat, Qasim & Khalid, Hafiz. (2018). Phytochemical and antioxidant screening of cassia angustifolia, curcuma zedoaria, embelia ribes, piper nigrum, rosa damascena, terminalia belerica, terminalia chebula, zingiber officinale and their effect on stomach and liver. Matrix Science Pharma. 2. 15-20. 10.26480/msp.02.2018.15.20.
15. Zibae, Elahe & Javadi, Behjat & Sobhani, Zahra & Akaberi, Maryam & Farhadi, Faegheh & Amiri, Mohammad Sadegh & Baharara, Hamed & Sahebkar, Amirhossein & Emami, Seyed Ahmad. (2023). Cassia species: A review of traditional uses, phytochemistry and pharmacology. Pharmacological Research - Modern Chinese Medicine. 9. 100325. 10.1016/j.prmcm.2023.100325.