

Phytochemical and Antioxidant Evaluation of *Senna auriculata*: A Comparative Study of Aqueous vs. Organic Extraction

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Abstract

For centuries, plants have served as the primary foundation for medicinal discovery, acting as a natural goldmine of bioactive ingredients that continue to fuel the development of modern pharmaceutical products. These botanical sources provide essential tools, molecules, and defenses that the human body requires to detect, manage, and treat various illnesses. Senna auriculata is a prominent and well-loved medicinal plant, widely recognized in traditional systems for its antidiabetic, hepatoprotective, and antioxidant properties. This study specifically focused on the healing potential of Senna auriculata leaves to evaluate their therapeutic value by comparing different extraction methodologies.

During the experimental phase, leaf samples were collected , shade-dried, and finely ground into a powder. To effectively isolate the plant's active constituents, a simple aqueous extract was prepared alongside concentrated organic versions utilizing a Soxhlet extractor. The phytochemical profile specifically focusing on phenols, flavonoids, and tannins was quantified through color-based testing and analysis.

Phytochemical screening confirmed a high concentration of health-boosting compounds, including alkaloids and saponins. Quantitative analysis revealed that the aqueous extract contained significantly higher concentrations of phenols, flavonoids, and tannins than its organic counterpart. The higher yield of bioactive compounds in water-based extract supports its traditional use in herbal remedies and underscores its value for future pharmacological development.

INTRODUCTION

1.1 DIABETES

1.1.1 DEFINITION

Diabetes mellitus is a chronic disease that we will have to live with over the years. It occurs when the amount of sugar in the body is excessively increased. This is because the body does not produce insulin or is unable to utilize the available insulin. The pancreas produces insulin that aids the body in utilizing sugar as a source of energy and in utilizing fats and proteins.

In the absence of insulin, when the body fails to utilize it or when it is inadequately utilized, the level of sugar in the blood increases to excessive levels- a condition known as hyperglycemia which is a characteristic symptom of diabetes mellitus. Unless diabetes is well managed, it might cause such severe complications as heart disease, nerve damage, kidney disease and eye problems which may lead to impaired vision.

Diabetes mellitus is a critical condition that requires proper management. With proper treatment and self care, the development of these complications can be slowed or even prevented in diabetes patients. This is why it is so significant that people with diabetes should pay much attention to their state and adhere to their treatment^[1]

1.1.2 TYPES OF DIABETES

- a) Type 1 diabetes
- b) Type 2 diabetes
- c) Gestational diabetes
- d) Maturity onset diabetes of the young (MODY)
- e) Neonatal diabetes
- f) Wolfram Syndrome
- g) Latent Autoimmune diabetes in Adults (LADA)
- h) Type 3c diabetes
- i) Steroid-induced diabetes
- j) Cystic fibrosis diabetes ^[2]

1.1.2.(a) Type 1 diabetes: Type 1 diabetes: The immune system has gone rogue and attacked and killed the pancreatic β -cells which produce insulin and disrupted the entire hormone system. It appears more frequently in children and adolescents than in adults therefore, upon which you must ensure you are not confusing it with type 2 diabetes which is the type of type 2 that presents itself in later adulthood. When you or another person with type 1 misses insulin, the level of blood glucose may skyrocket like a skyrocket, and you may find yourself in diabetic ketoacidosis- very serious and life threatening. In addition to the pumping of insulin, the treatment of type 1 diabetes involves frequent check-ins of blood sugar, education, preparation of meals knowing about what to eat, and maintenance of a healthy lifestyle to ensure that you stick to it..^[3]

1.1.2.(b) Type 2 diabetes: Type 2 diabetes: Type 2 diabetes, the most widespread type of diabetes, arises when blood sugar levels rise excessively because the body either does not produce enough insulin or cannot use it properly. Normally, insulin allows glucose- the body's primary energy source from food- to enter cells for energy, but in type 2 diabetes, glucose accumulates in the blood rather than being absorbed by the cells.^[4]

1.1.2.(c) Gestational diabetes: Gestational diabetes develops when the body cannot produce the additional insulin required during pregnancy. Pregnancy causes hormonal changes and physical adjustments, such as weight gain, which can lead to reduced effectiveness of insulin, known as insulin resistance. While all pregnant women experience some degree of insulin resistance in the later stages of pregnancy, most women can produce enough insulin to compensate. However, women who cannot meet this increased insulin demand may develop gestational diabetes.^[5]

1.1.2.(d) Maturity-Onset Diabetes of the Young (MODY): Maturity-Onset Diabetes of the Young is a genetic, early-appearing form of diabetes that is frequently misidentified; consequently, genetic testing is necessary to inform treatment strategies and assess potential risks.^[6]

1.1.2.(e) Neonatal Diabetes: Permanent Neonatal Diabetes Mellitus is an uncommon form of diabetes occurring in early infancy due to a lack of insulin, with management dictated by the specific genetic etiology.^[7]

1.1.2.(f) Wolfram Syndrome: Wolfram syndrome is an uncommon hereditary condition characterized by early-onset diabetes, sensory impairment, and a progressive deterioration of the neurological system, resulting in a poor prognosis.^[8]

1.1.2.(g) Latent Autoimmune Diabetes in Adults (LADA): Latent Autoimmune Diabetes in Adults is a slowly progressing autoimmune form of diabetes that progressively diminishes beta-cell function; although it might initially be managed with oral medications, it generally requires insulin therapy and is often mistaken for type 2 diabetes.^[9]

1.1.2.(h) Type 3c Diabetes: Type 3c diabetes stems from injury to the pancreas, is frequently misidentified, and involves an increased danger of complications.^[10]

1.1.2.(i) Steroid-Induced Diabetes: Glucocorticoid-induced diabetes manifests when the administration of steroids increases glucose levels, particularly in individuals with a preexisting predisposition for type 2 diabetes.^[11]

1.1.2.(j) Cystic Fibrosis-Related Diabetes (CFRD): Cystic fibrosis-related diabetes originates from pancreatic injury that results in insulin complications, increases in prevalence as patients age, and impacts as many as fifty percent of adults diagnosed with cystic fibrosis.^[12]

1.1.3 SYMPTOMS

Diabetes symptoms vary with respect to the level of sugar in blood. Others may not have any symptoms at all, particularly those prediabetic, gestational, or type 2. In type 1, but, symptoms tend to appear rapidly and tend to be more apparent.

Type 1 and type 2 diabetes have some of the following common signs:

- Experiencing greater thirst than usual.

- Increased frequency of urination.
- Weight reduction without exercise
- Appearance of ketones in the urine (this is formed as a result of burning muscle and fat due to the lack of insulin).
- Feeling tired and weak.
- Irritation or mood swings.
- Blurred vision.
- Slow-healing sores.
- Acquiring numerous infections, such as skin, gum, and vagina.

Type 1 diabetes may manifest at any age, although it is common in children and adolescents. Type 2 is more prevalent and typically manifests itself after 40, but children with type 2 are also increasing.^[13]

1.1.4 DIAGNOSIS

Diabetes is a one of the actual problems that we should take care of. When you are constantly visiting the bathroom, are persistently thirsty, are losing weight, your eyesight is fuzzy, you are constantly tired, or your infections just are not healed, you need to be tested immediately. According to American Diabetes Association, type 2 should be checked every three years after 45 years of age and all overweight people, those intending to have children, and those at risk should have it checked once in three years- preferably once in a year in case of high risk. The US Preventive Services Task Force and the American Association of Clinical Endocrinologists echo the calls for everyone at risk to monitor their glucose level. Diabetes is not a joke, and we have to deal with it.^[14]

1.1.5 TREATMENT

When we are talking about type 2 diabetes, the treatment usually starts with some changes in our lifestyle. We need to change our diet and exercise regularly to lose weight. Many people can control their blood sugar with some pills. They can do this for several years.. Sometimes, they need to take insulin. In some cases, people need to take insulin from the beginning.

On the other hand, people with type 1 diabetes need to take insulin from the start. To control blood sugar, we also need to pay attention to what we eat how much we eat. Take our medications as prescribed. If we eat at the same time every day and follow a meal plan, we can reduce the risk of having low blood sugar.

Some individuals with type 2 diabetes also have levels of bad cholesterol, and we need to treat this too. We should check our blood sugar at home all the time because this helps us

manage our treatment. We want our blood sugar to be between 90 and 120 before we eat and, between 120 and 180 after we eat.^[15]

1.1.6 DIABETES COMPLICATIONS AND RISKS

The impact of diabetes on the body develops gradually and may go unnoticed for a long period. Persistently high blood sugar levels can eventually harm various organs, leading to what are known as diabetes-related complications.

If you have been diagnosed with prediabetes, adopting healthy lifestyle changes can significantly lower your risk of developing these health issues.

- Heart and blood vessel damage
- Nerve damage
- Kidney damage
- Eye damage
- Foot damage
- Skin and mouth conditions
- Osteoporosis
- Alzheimer's disease and dementia^[16]

1.2 MEDICINAL PLANTS IN INDIA



1.2.1 DEFINITION AND CONCEPT

We learn about medicinal plants, herbal medicine, and how they prevent or cure health conditions. According to the WHO, herbal medicines refer to products produced in plants, and they are used either alone in a combination. Over 70 percent of the population in India depends on these medicines. When I and other researchers study these plants, we usually use a pharmacological approach to determine their effectiveness in medicine. India has traditional systems, such as AYUSH, that involve herbal therapies. Nevertheless, fake products and possible side effects are problems that must be closely monitored. To make herbal medicines viable and offer them as alternatives to modern medicine, there should be strong scientific evidence behind

them, however in some cases, it is difficult to engage in clinical trials. Scientists are still testing the safety and effectiveness of medicinal plants. The role of plants in medicine is a continuing research topic and even herbal plants used as a drug source are under investigation.^[17]

1.2.2 HISTORICAL BACKGROUND IN INDIA

India has a long history of using plants for medicinal purpose. There are hundreds or even thousands of plants used in India for purposes. These are found in systems such as Ayurveda and other forms of medicine such as Siddha, Unani, Homeopathy and Sowa-Rigpa. The fact that many plants are used in these systems shows how important they are to healthcare, in India.^[18]

1.2.3 BIODIVERSITY OF MEDICINAL PLANTS IN INDIA

India has many medicinal plants. India has more than 7,000 medicinal plants. Researchers have used many such plants. They are vital to healthcare and incomes of people. In Indian herb trade is also based on medicinal plants. Indians consume a high number of these herbs and the exportation to other nations is also very rapid.^[19]

1.2.4 IMPORTANCE AND USES

Medicinal plants in India play an important role in health. The way their livelihoods varies according to their skills and resources. They are a part of traditional healing systems, such as Ayurveda, Siddha, Unani, and Homeopathy. Medicinal plants play an important role in areas where access to modern medicine is limited. Medicinal plants in India serve purposes beyond traditional healing. They are also used to make medicines, special foods that benefit people, and modern medicines because they have special powers that can help people. In India, medicinal plants such as turmeric, ashwagandha, and neem have been used to prevent and treat various diseases. Many products made from medicinal plants in India are sold to other countries, providing support to people living in rural and tribal areas of India. India is combining traditional knowledge with current scientific findings to use its many different types of plants to improve health, strengthen the economy, and manage resources in an earth-friendly way. Medicinal plants in India hold great importance.^[19]

1.3 SENNA AURICULATA



1.3.1 INTRODUCTION

Cassia of Tanner, *Cassia auriculata* var. *auriculata*, or *Senna auriculata* var. *auriculata*, is native to India and Sri Lanka. It is a traditional Indian medicine (Siddha and Ayurveda) that has been used since ancient times. The plant allegedly acts against fungi and bacteria, prevents the growth of microbes, prevents obesity, fights the cancer, manages diabetes, and fights inflammation. In the past people utilized it for skin, digestive, eye infection, urinary tract and liver problems.

In my research lecture, we were taught that scientists have isolated several compounds from plants, including:

- Flavonoids
- Saponins
- Alkaloids

These chemicals provide the plant with high antioxidant and healing qualities, which is why the cassia of Tanner is applicable in modern and traditional medical situations.

Finally, the value of cassia (*Cassia auriculata* and *Senna auriculata*) as a valuable herb is due to its benefits, and that is one of the reasons why it is still researched today.^{[23][20]}

1.3.2 TAXONOMY AND NOMENCLATURE

Genus	Senna	[21]
Root	Root	
Phylum	Tracheophyta	
Kingdom	Plantae	
Order	Fabales	
Class	Equisetopsida C. Agardh	
Species	Senna auriculata (L.)Roxb.	
Family	Fabaceae	

About *Senna auriculata* Plant:

- **Leaves:** These leaves have pairs, usually 8 to 12 pairs. Each pair has a gland that stands up straight. The leaves are shaped like an oval or a bit like a heart with a base. They have a point at the tip. The leafy parts at the base of the leaf called stipules are big and shaped like a heart. They bend backwards.
- Significance :

- People use the seeds of *Senna auriculata* to help with eye problems.
- The bark of the plant is very good, for making leather because it has tanning properties.^[22]

1.3.5 DISTRIBUTION

These plants are native to India, Maldives, Myanmar, Sri Lanka and, they were introduced into countries like DR Congo, Ghana, Jawa, Nigeria, Pakistan, Sierra Leone, Sudan-South Sudan, Tanzania, West Himalaya.^[23]

1.3.6 PHYTOLOGICAL COMPOUNDS

I have been exploring the studies on *Senna auriculata* leaf extracts, which have been tested on animals and have been proven to reduce blood sugar levels. In the case of the water-based extract, they applied it to rats whose hyperglycemia was caused by Streptozotocin. 400 mg/kg dose of the extract reduced blood sugar in diabetic rats by 13.9% in three weeks. The same 400 mg/kg dose in fact reduced blood sugar by 17.4 percent in three weeks.

They also tested the ethanol-based extract on rats with alloxan-induced high glucose levels. o Two weeks of 150 mg/kg dose reduced glucose levels. This was similar to the antidiabetic medication Glibenclamide.

Some of the bioactive compounds found in the leaves that have demonstrated the potential to reduce diabetes are n-hexadecanoic acid, emodin, and squalene. To conclude, *Senna auriculata* leaf extracts are multicomponent to enhance blood sugar control with obvious antidiabetic activity and decreasing the glucose levels in trials.^{[24][25][26]}

1.3.7 TRADITIONAL AND ETHNOMEDICINAL USES

Senna auriculata is a plant that people have used for a time. It was first written about in the century in a book called KaiyadevaNighantu. People thought *Senna auriculata* was good, for diabetes and other health problems. Different parts of the *Senna auriculata* plant are used for things. The leaves are used to help with pain and swelling. The flowers are used to help with infections and diabetes. The roots are used to help with breathing and stomach problems. The seeds are used to help with diabetes and to clean out the body. The bark and fruit are used to help with toothaches, worms and other health problems.^{[24][27]}

2. MATERIALS AND METHODS

SOXHLET EXTRACTION

Sample preparation for soxhlet extraction the powder of the plant was put in a thimble and was-placed in the soxhlet extractor which is connected to the condenser and a round bottom flask filled with methanol. Methanol was vaporized to its boiling point until vapors are produced, condensed and siphoned on the plant material. The processes continue for 2-4 hours. The extract was obtained, filtered and concentrated.

AQUEOUS SAMPLE PREPARATION

20 g of plant powder is taken in 200 ml of hot distilled water and the heat is allowed to absorb for 30 minutes. The solid residue was separated by filtration after extraction period to remove any solids if there were any to get clear filtrate which was then transferred to sterile container for further analysis.

PHYTOCHEMICAL ANALYSIS

The phytochemical analysis was performed as mentioned by J. B. Harborne

ESTIMATION OF PHENOLS

Standard solution serial dilutions (0.2-3.2 mL, equivalent to 20-320 µg) and two unknown extract volumes (0.5 and 1 mL) were prepared and diluted to 3.5 mL using distilled water. 1.3 mL of Na₂CO₃ solution was added followed by 20 minutes incubation for colour formation after addition of 0.2 mL of Folin-Ciocalteu reagent and 5 minutes of incubation. The absorbance was measured at 760 nm, and the phenolic content of the unknown samples was calculated using a standard curve of concentration and absorbance.

ESTIMATION OF FLAVANOIDS

To figure out how much flavonoids are in something we made solutions with 0.5 to 2.5 milliliters of liquid which is like 50 to 250 micrograms. We also took some sample extracts, which were 0.5 and 1.0 milliliters and made sure they all added up to 2.5 milliliters by adding some distilled water. Then we added a bit of sodium nitrate about 0.2 milliliters and waited for 5 minutes. After that we put in some aluminum chloride, 0.3 milliliters and waited another 5 minutes. To make the color change to pink we added 0.5 milliliters of a liquid called NaOH. Then we measured how much light was absorbed at 510 nanometers and used that to calculate how much flavonoids were in the samples we did not know about using a graph that shows how much stuff is in something based on how much light it absorbs.

ESTIMATION OF TANNINS BY MODIFIED PRUSSIAN BLUE METHOD

To estimate how much tannins are in something we made standard solutions with 0.1 to 0.5 milliliters of liquid which is like 10 to 50 micrograms. We also took some sample extract, which was 0.1 milliliters and made sure it added up to 7 milliliters by adding some distilled water. Then we added some liquids, potassium ferricyanide and ferric chloride to make the color change and measured how much light was absorbed at 700 nanometers. We used a graph that shows how much stuff is in something based on how much light it absorbs to calculate how much tannins were, in the sample we did not know about which is the tannin concentrations of the unknown sample.

3. RESULTS

3.1 SOXHLET EXTRACTION

The solvent (methanol) has repeatedly washed plant sample & accumulated. The extracted substances which are-soluble compounds like alkaloids, phenols, flavonoids, etc

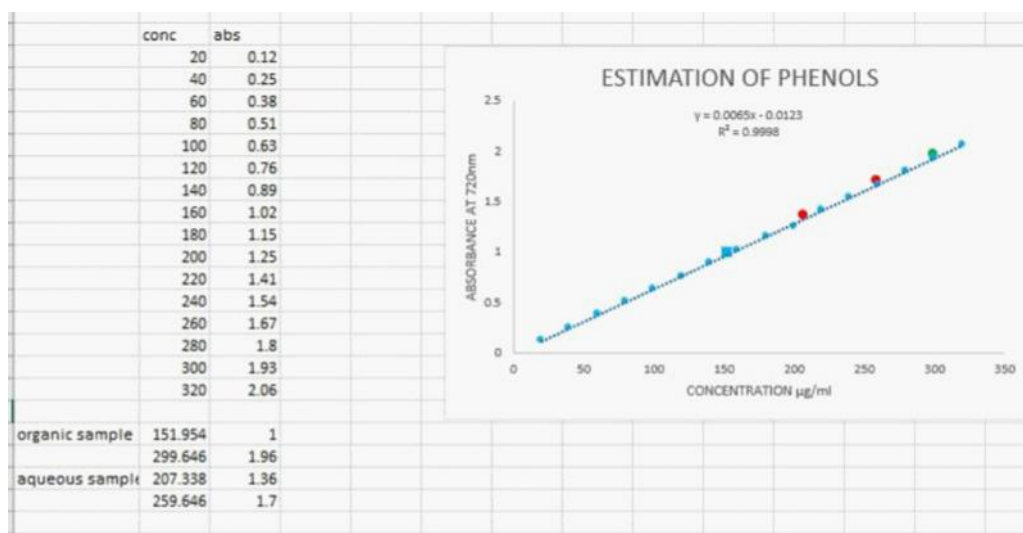
3.2 AQUEOUS SAMPLE EXTRACTION

We obtained the aqueous sample of the plant product that we are going to use for the further analysis of our plant sample.

3.3 PHYTOCHEMICAL ANALYSIS

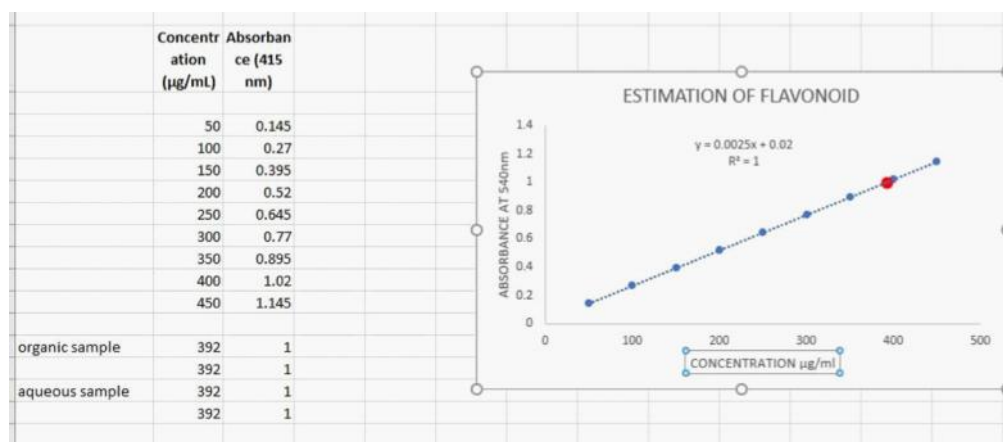
S.NO	TEST	ORGANIC SAMPLE	AQUEOUS SAMPLE
1	Mayer's test	+	+
2	Hager's test	+	+
3	Dragendroff's test	-	-
4	Alkaline reagent test	-	-
5	Lead acetate test (for flavonoids)	-	-
6	FeCl ₃ test (for flavonoids)	+	+
7	Froth test	++	++
8	Foam test	++	++
9	FeCl ₃ test (for tannins)	+	+
10	FeCl ₃ test (for phenolic compounds)	+	+
11	Lead acetate test (for phenolic compounds)	-	-
12	Benedict's test	-	-
13	Fehling's test	-	-
14	Biuret test	-	-
15	Ninhydrin test	-	-
16	Millon's test	-	-

3.4 ESTIMATION OF PHENOLS



The calibration curve of phenol was linear and the concentration of samples ranged from phenols 151.95 to 259.65 µg/mL. The aqueous extract (233.492) was richer in phenolics than the organic extract (225.8).

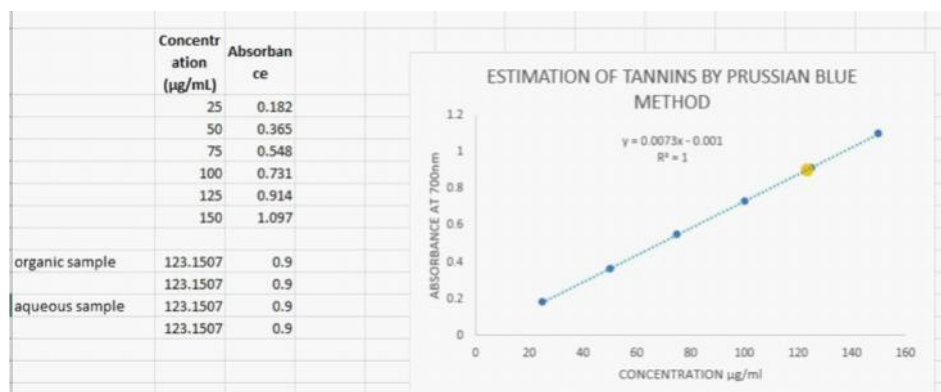
3.5 ESTIMATION OF FLAVANOIDS



The standard curve was linear and the two extracts showed an amount of flavonoids of concentration 392 µg/ml.

3.6 ESTIMATION OF TANNINS

The calibration curve is linear, the sample's tannin content was found to be around 123.15 µg/ml in both extracts.



4. DISCUSSION

This study provides a complete assessment of the extraction yield and chemical profile of *Senna auriculata* leaf extracts, comparing the performance of organic and aqueous extraction methods. This study showed that total yield of the extract and its bioefficacy of the medicinal plant were influenced by the extraction method and the solvent polarity.

PHYTOCHEMICAL ANALYSIS

The secondary metabolites like alkaloids, tannins, flavonoids, saponins and phenolics were identified in both the extracts. In initial investigations polarity of bioactive compounds were identified.

QUANTITATIVE ANALYSIS

PHENOLS: The aqueous extract showed a higher concentration, confirming that polar solvents are more suitable for phenolic recovery.

FLAVONOIDS: The high flavonoid content in both the extracts suggests the sample is rich in flavonoids and both methods worked effectively in recovering them.

TANNINS: The identical tannin values in both the extracts suggest tannins are soluble in both the solvents equally and both the extractions were efficient.

Essentially therefore the temperature and the kind of solvent that you use is crucial in determining the quality of yield that you get in your extractions, basically it determines how soluble, diffusive, and solvent ready your phytochemicals are with respect to the plant material.^[28] It has occurred to me that methanol tends to be more effective than water in extracting a wider variety of compounds since it is more polar and organic, thus capable of extracting both polar and slightly nonpolar molecules.^[29] Extraction of water can also improve with heating, such as pressurized hot water extraction; increased temperature only reduces the viscosity, increases the rate of mass transfer, and solubilizes the heat-stable material, which is all yielding better overall efficiency.^[30] We got the phenols content higher in water as its absorption capacity was maximum

when heated compared to that of methanol. Whereas the flavonoids and tannins are equal in both the extracts.

5. CONCLUSION

This study looked at *Senna auriculata* leaf extracts. It compared the extracts made with water and those made with methanol. The study found that the extracts made with water had greater contents of secondary metabolites in them. These metabolites are important for our health. The study showed that the type of solvent used is very important. It affects how good compounds we can get from the leaves.

The study also checked what was present in the leaf extracts of *Senna auriculata*. It used water and methanol to make the extracts. The study found that both extracts had compounds in them. From this study we understood that methanol is a better solvent for extraction than water however when water is heated it has maximum absorption activity than methanol. The extract made with water had more of these compounds.

Overall the study found that *Senna auriculata* leaves have a lot of secondary metabolites in them. This is why people have been using them for a time. The study also showed that we need to choose the solvent to get the most compounds from the leaves. *Senna auriculata* is an useful plant and we can get more, from it if we use the right methods.

7. REFERENCES

1. Magliano DJ, Boyko EJ; IDF Diabetes Atlas 10th edition scientific committee . IDF DIABETES ATLAS [Internet]. 10th edition. Brussels: International Diabetes Federation; 2021. Chapter 1, What is diabetes? Available from: <https://www.ncbi.nlm.nih.gov/books/NBK581938/>
2. <https://www.diabetes.org.uk/about-diabetes/types-of-diabetes#:~:text=In%20addition%20to%20the%20more,in%20getting%20the%20right%20treatment.>
3. Lucier J, Mathias PM. Type 1 Diabetes. [Updated 2024 Oct 5]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK507713/>
4. <https://www.who.int/news-room/fact-sheets/detail/diabetes?>
5. <https://www.niddk.nih.gov/health-information/diabetes/overview/what-is-diabetes/gestational/symptoms-causes>
6. Nyunt, O., Wu, J. Y., McGown, I. N., Harris, M., Huynh, T., Leong, G. M., Cowley, D. M., & Cotterill, A. M. (2009). Investigating maturity onset diabetes of the young. *The Clinical biochemist. Reviews*, 30(2), 67-74.
7. De León DD, Pinney SE. Permanent Neonatal Diabetes Mellitus. 2008 Feb 8 [Updated 2025 Sep 25]. In: Adam MP, Bick S, Mirzaa GM, et al., editors. *GeneReviews®* [Internet]. Seattle (WA): University of Washington, Seattle; 1993-2026. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK1447/>
8. Urano F. (2016). Wolfram Syndrome: Diagnosis, Management, and Treatment. *Current diabetes reports*, 16(1), 6. <https://doi.org/10.1007/s11892-015-0702-6>
9. Shaikh, K., & Mathew, N. (2024). Latent Autoimmune Diabetes in Adults: A Case Report. *Oman medical journal*, 39(1), e596. <https://doi.org/10.5001/omj.2024.05>
10. Vonderau, J. S., & Desai, C. S. (2022). Type 3c: Understanding pancreatogenic diabetes. *JAAPA : official journal of the American Academy of Physician Assistants*, 35(11), 20-24. <https://doi.org/10.1097/01.JAA.0000885140.47709.6f>

11. <https://www.diabetes.org.uk/about-diabetes/other-types-of-diabetes/steroid-induced-diabetes>
12. Iafusco, F., Maione, G., Rosanio, F. M., Mozzillo, E., Franzese, A., & Tinto, N. (2021). Cystic Fibrosis-Related Diabetes (CFRD): Overview of Associated Genetic Factors. *Diagnostics* (Basel, Switzerland), 11(3), 572. <https://doi.org/10.3390/diagnostics11030572>
13. <https://www.mayoclinic.org/diseases-conditions/diabetes/symptoms-causes/syc-20371444>
14. Nelson M, Dungan KM. Diagnostic Tests for Diabetes Mellitus. [Updated 2025 Feb 7]. In: Feingold KR, Adler RA, Ahmed SF, et al., editors. *Endotext* [Internet]. South Dartmouth (MA): MDText.com, Inc.; 2000-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK278985/>
15. <https://jsshospital.in/diabetes-mellitus-symptoms-treatment-and-prevention/>
16. <https://www.heart.org/en/health-topics/diabetes/diabetes-complications-and-risks>
17. Samal, Janmejaya. Medicinal plants and related developments in India: A peep into 5-year plans of India. *Indian Journal of Health Sciences and Biomedical Research (KLEU)* 9(1):p 14-19, Jan-Apr 2016. | DOI: 10.4103/2349-5006.183698
18. Anmol, Aggarwal, G., Sharma, M., Singh, R., Shivani, & Sharma, U. (2024). Ethnopharmacologically important highly subsidized Indian medicinal plants: Systematic review on their traditional uses, phytochemistry, pharmacology, quality control, conservation status and future prospective. *Journal of ethnopharmacology*, 320, 117385. <https://doi.org/10.1016/j.jep.2023.117385>
19. Introduction | National Medicinal Plants Board|Government of India
20. <https://www.plantsjournal.com/archives/2025/vol13issue3/PartA/13-2-41-833.pdf>
21. <https://indiabiodiversity.org/species/show/231118>
22. [https://www.efloraofgandhinagar.in/shrub/senna-auriculata#:~:text=Botanical%20Name%20:%20Senna%20auriculata%20\(L.,By%20:%20Gujarat%20Forestry%20Research%20Foundation%2C](https://www.efloraofgandhinagar.in/shrub/senna-auriculata#:~:text=Botanical%20Name%20:%20Senna%20auriculata%20(L.,By%20:%20Gujarat%20Forestry%20Research%20Foundation%2C)
23. <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:518328-1#distributions>
24. Nille, G. C., Mishra, S. K., Chaudhary, A. K., & Reddy, K. R. C. (2021). Ethnopharmacological, Phytochemical, Pharmacological, and Toxicological Review on *Senna auriculata* (L.) Roxb.: A Special Insight to Antidiabetic Property. *Frontiers in pharmacology*, 12, 647887. <https://doi.org/10.3389/fphar.2021.647887>
25. Gupta, S., Sharma, S. B., Singh, U. R., & Bansal, S. K. (2011). Salutary effect of *Cassia auriculata* L. Leaves on hyperglycemia-induced atherosclerotic environment in streptozotocin rats. *Cardiovascular toxicology*, 11(4), 308-315. <https://doi.org/10.1007/s12012-011-9120-4>
26. Gupta, S., Sharma, S. B., Bansal, S. K., & Prabhu, K. M. (2009). Antihyperglycemic and hypolipidemic activity of aqueous extract of *Cassia auriculata* L. leaves in experimental diabetes. *Journal of ethnopharmacology*, 123(3), 499-503. <https://doi.org/10.1016/j.jep.2009.02.019>
27. Shanmugasundaram, R., Kalpana Devi, V., TresinaSorris, P., Maruthupandian, A., & Mohan, V. R. (2011). Antidiabetic, antihyperlipidaemic and antioxidant activity of *Senna auriculata* (L.) Roxb. leaves in alloxan induced diabetic rats. *Int. J. Pharm. Tech. Res*, 3(2), 747-756.
28. Gbashi, S., Njobeh, P., Steenkamp, P., Tutu, H., & Madala, N. (2016). The effect of temperature and methanol-water mixture on pressurized hot water extraction (PHWE) of anti-HIV analogues from *Bidens pilosa*. *Chemistry Central journal*, 10(1), 37. <https://doi.org/10.1186/s13065-016-0182-z>
29. Abdulai Turay; Hamza Amin Kargbo. "Solvent Efficiency in Phytochemical Extraction: A Comparative Study of Methanol and Water in *Cassia siamea*." Volume. 10 Issue.5, May-2025 *International Journal of Innovative Science and Research Technology (IJISRT)*, 462-468, <https://doi.org/10.38124/ijisrt/25may064>
30. MohdJusoh, N.H., Subki, A., Yeap, S.K. et al. Pressurized hot water extraction of hydrosable tannins from *Phyllanthusenellus*Roxb.. *BMC Chemistry* 13, 134 (2019). <https://doi.org/10.1186/s13065-019-0653-0>