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Insights into the Phytochemical and Antioxidant Properties of *Salvia Hispanica L.*- A Potential Crop

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ABSTRACT

Salvia hispanica L. is a highly potential crop. It is annual herbaceous plants. The present review highlighted the significant antioxidants, including quercetin, rosmarinic acid, myricetin, and caffeic acid. These ingredients have helped to improve a number of human health issues, including diabetes, cardiovascular issues, obesity, and many others. Chia seeds also contain mucilage, a fibre made of carbohydrates that is used as an industrial additive.

Keywords: *Salvia Hispanica*; Antioxidans; Organic Compounds; HPTLC

Introduction

Salvia hispanica L., often known as the Chia plant, is a member of the Lamiaceae mint family, which includes 224 genera. The genus Salvia contains over 900 species that are grown for medicinal and culinary purposes. It is an annual herbaceous plant that is indigenous to northern Guatemala and central Mexico. The seeds of the *Salvia hispanica* plant are oval-shaped, 2 mm long and 1mm in diameter. It produces pedicelled, hermaphroditic flowers, which are purple and white in colour and are arranged around a rachis. *Salvia hispanica* plant is light sensitive, can grow up to a height 100 cm tall, and leaves are simple, reverse petiolate, oval and serrated, 8-10 cm long and 3-5 cm wide with hairy surface (Figure 1). The plant can produce 500-600 kg seed per acre of land (Ullah, et al. [1]). It was framed by Mesopotamian culture as a food source until its rediscovery in the middle of the 20th century. The Spanish term «Chian» or «Chien,» which essentially implies greasy, is the source of the English word «chia.» Chia seeds have been the subject of numerous studies that demonstrate its high nutritional value and advantageous effects on health. Omega-3 fatty acids, polyunsaturated fatty acids (PUFA), dietary fibre, protein, vitamins, and minerals, as well as polyphenol and antioxidants, are some of the ingredients. Several significant antioxidants, including quercetin, rosmarinic acid, myricetin, and caffeic acid are present in this potential crop.

These ingredients have helped to improve a number of human health issues, including diabetes, cardiovascular issues, obesity, and many others. Chia seeds also contain mucilage, a fibre made of carbohydrates that is used as an industrial additive. This mucilage can be utilised to create nanocomposites or for the controlled release of pharmaceuticals. Dahham, et al. [2] reported that β-caryophyllene, which his belongs to essential oils, shows antifungal and antibacterial characteristics against bacterial strains, and even some antifungal activity against *Rhizopus oryzae, Trichoderma reesei*. They found that sesquiterpenes, of which caryophyllenes are the most abundant, make up the majority of the essential oil. Antimicrobial experiments showed that some phytopathogenic fungi and bacteria could be controlled by the essential oil found in *Salvia hispanica* seeds.

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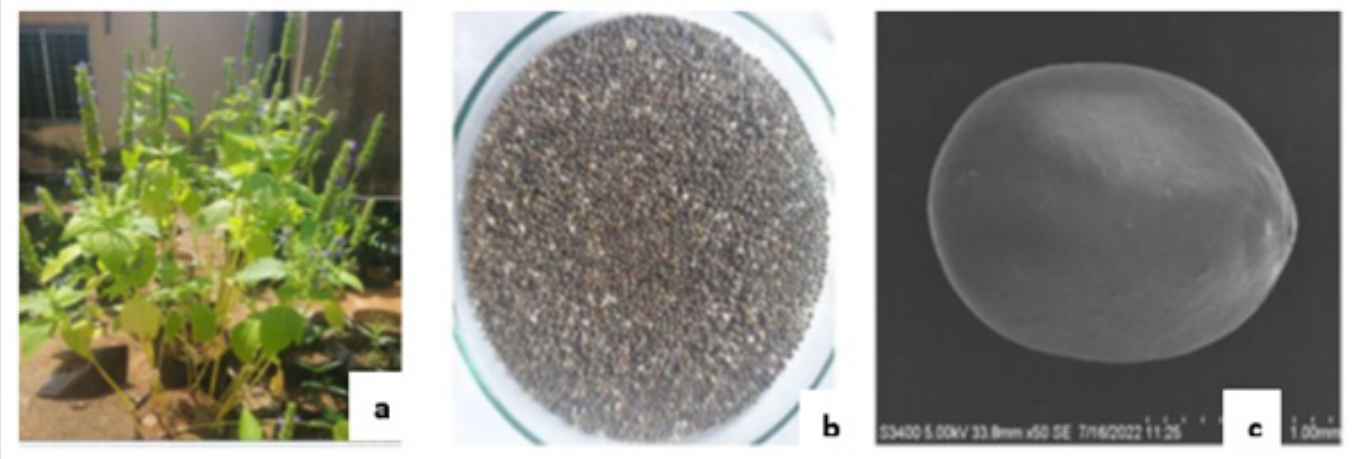

Figure 1:

A. *Salvia hispanica* plant.

B. Seeds of *Salvia hispanica*.

C. Scanning Electron Microscopy (SEM) image of *Salvia hispanica*.

Key Results

Numerous biological investigations have demonstrated that Salvia plants have effective anticancer activity against a variety of tumours, including leukaemia, breast, stomach, and head and neck cancers (Jiang, et al. [3]). The carbohydrate, phenol, protein, and proline contents of seeds and leaves are also reported. The phenolic content of the leaves was higher than that of the seeds. The present study reported that seeds having higher carbohydrate content than leaves. On the basis of FTIR analysis, it was observed that there are several functional groups present in the seeds as well as leaves. Peak banding was examined, and it was discovered that high peaks were associated with protein, pectin (polysaccharides), PUFA (fatty acids), and lipids, among other substances. HPTLC analysis reveals the presence of phytocompounds like polyphenols and caffeic, gallic, and chlorogenic acids. The bioactive components found in leaves are a source of anti-microbial activity. The results of the study demonstrated that there are high antioxidant activity in seeds and leaves. The seeds have a sufficient amount of protein and carbohydrates to be used as a food supplement and a pseudo-cereal. Roohi, [4] reported that there are number of compounds having different activities (Table 1).

Table 1: Different compounds present in *Salvia hispanica* and their activities.

Compounds	Activity
Caffeic acid, chlorogenic acid, quercetin, Omega 6-fatty acid, Omega 3-fatty acid, Ferulic acid	Anti-cancer
Omega 3-fatty acid	Anti-diabetic
Caffeic acid, Quercetin, Chlorogenic acid	Anti-hypertensive
Omega 6-Fatty acid, Apigenin, Gallic acid	Anti-inflammatory
Myricetin, Quercetin, Kaempferol, Caffeic acid, Rosmarinic acid, Chlorogenic acid	Anti-oxidant
Chlorogenic acid, Gallic acid	Cardio-vascular activity
Chlorogenic acid	Anti-obesity
Cinnamic acid, Chlorogenic acid, Apigenin	Anti-microbial

The United States Department of Agriculture (USDA) recommended that the *Salvia hispanica* having high nutritive values including 25% dietary fibre, 20% protein, 34% oils, minerals, and vitamins (niacin, thiamine and riboflavin) (USDA,2019). Seeds have fibres that are good for the digestive system and can help with diabetic management (Ullah, et al. [1]). On the basis of HPTLC analysis showed the separation of major phytochemicals such as chlorogenic acid, gallic acid and caffeic acid at 254nm (Figure 2) [5]. The seed materials having higher percentage of caffeic acid, gallic acid and chlorogenic acid as compared to leaf tissue. The unit area and percentage of unit area were higher and ranged between 72.38 to 99.2 %. The Rf value was higher in case of leaf sample than seed samples. At 254nm assessment, leaf sample has 9 peaks, major peaks being 9th at Rf range from 0.79 to 0.88 with 12064.3 area unit, while the seed sample has 3 peaks, with 3rd peak being the major with the Rf value of 0.58 to 0.88 with an area unit of 91225.7. In case of the standard used , caffeic acid shows 3 peaks with 3rd peak being the major with the Rf value from 0.73 to 0.91 and AU of 39125.9, chlorogenic acid with 3 peaks, 1st one being the major peak and 3rd peak matching the samples with Rf value from 0.81 to 0.88 with AU of 685.9 and finally the gallic acid showed 3 peaks, with 3rd being the major peak with Rf value as 0.69 to 0.87 and AU of 34927.9.

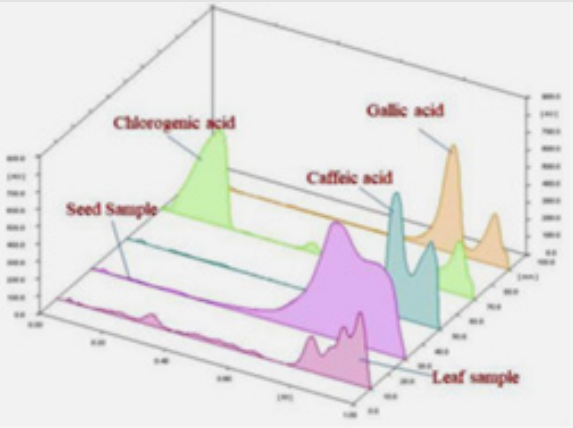

Figure 2: HPTLC analysis of seed and leaf samples of *Salvia hispanica* at 254 nm (Parida, [5]).

On the basis of FTIR (Fourier transform infrared) analysis of leaf, seed and root samples of *Salvia hispanica*, it was observed that different functional groups were obtained in seed, leaf and root samples and its further compared with the reference functional groups (Figure 3). The FTIR spectrum ranged from 3300 cm^{-1} to 2900 cm^{-1}, and the peaks between these bands may be caused by the stretching of O-H groups' vibrations from the hydroxyls of both polysaccharides and proteins. The aromatic rings' -C-H stretching and the presence of the methyl group are responsible for the broad band at range of 2900 cm^{-1} illustrating the fat content. Transmittance at the range of 1300-1400 cm^{-1} reveals ester carboxyl stretches of uronic acids in seed polysaccharides as well as bending vibration of lipid CH2 groups. Alpha-linolenic acids and other PUFAs (Poly unsaturated fatty acids) are visible in the FTIR as high intensity C–C linkages. The presence of alpha linolenic acid is what causes the high unsaturation in the spectra. The existence of c-o-c is shown by the peak at 912.15 -1237.64 cm^{-1} (triglyceride ester linkage). According to the FTIR data, the sample contains significant levels of polysaccharides, lipids, triglycerides, polyunsaturated fatty acids (PUFA), pectin, and other compounds (Table 2) [5].

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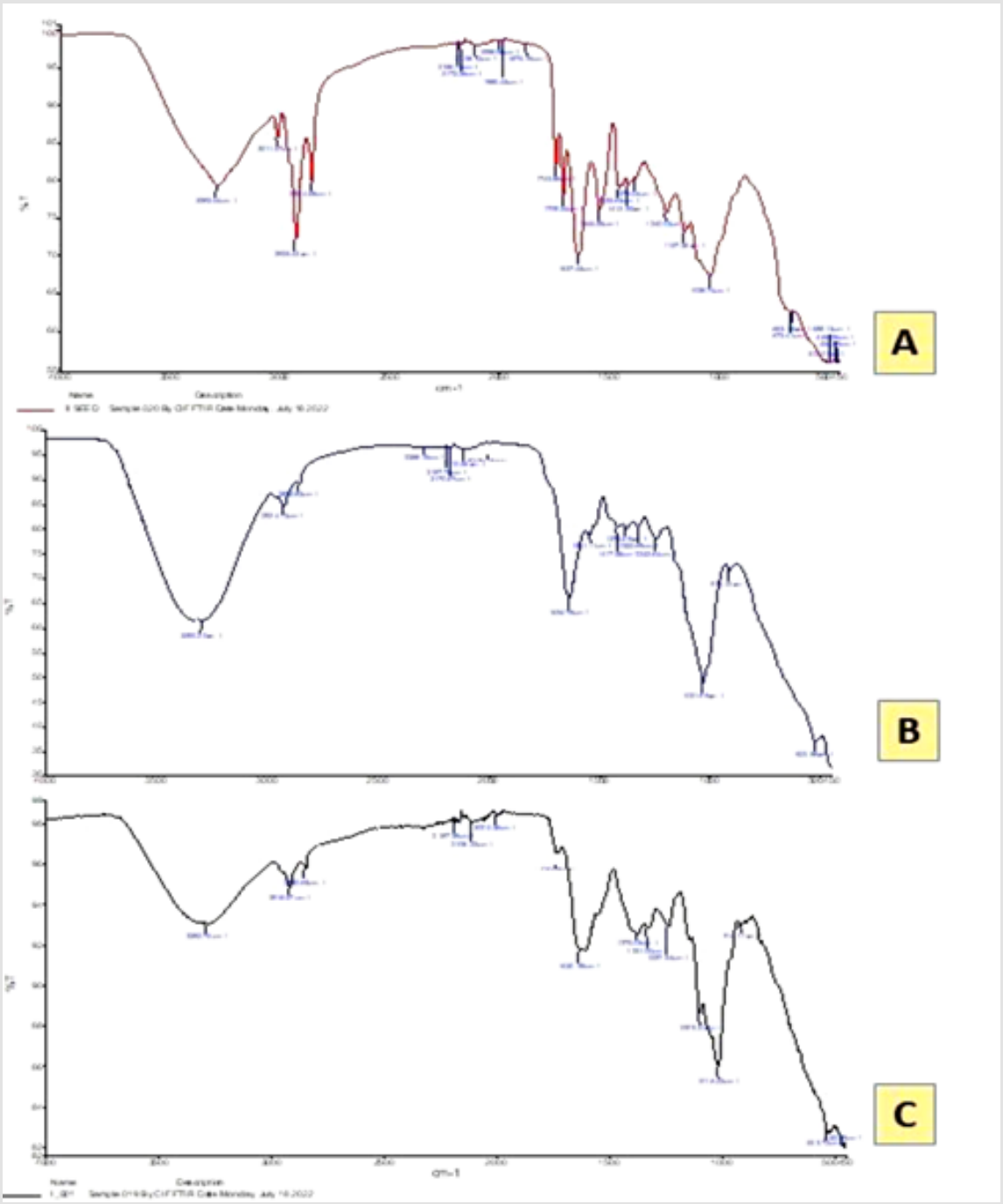

Figure 3: FTIR spectra of leaf, seed and root samples of *Salvia hispanica*.

Table 2: FTIR spectra of leaf, seed and root samples of *Salvia hispanica* and their corresponding annotations (Parida, [5]).

Sr no.	Wave number (cm^{-1})	Transmittance (%)	Stretches	Class of compounds
(A) Leaf				
1	3282.75	93.06	≡C-H, O-H, N-H	Alcohol, Amine
2	2918.57	94.85	-C-H, O-H	Alcohol, Alkyne
3	2108.22	98.12	C≡C	Triple bond in alkyne
4	1735.62	96.57	C=O	Carboxylic acid
5	1630.39	91.76	C=O	Carboxylic acid, Ketone
6	1375.03	92.58	C=C, C-H	Alkene, Alkane
7	1237.64	92.92	C-F, C-O-C	Fluro compound, Ether
8	1016.22	86.01	C-O-C	Ether
9	533.72	82.71	C-Br, ≡C-H	Alkyl Bromide, Alkyne
(B) Seed				
1	3283.44	79.39	≡C-H, O-H, N-H	Alcohol, Amine
2	3011.57	85.74	≡C-H, O-H, N-H	Alcohol, Amine
3	2925.43	72.3	-C-H, O-H	Alcohol, Alkyne
4	2854.68	79.76	-C-H, O-H	Alcohol, Alkyne
5	2108.12	98.04	C≡C	Triple bond in alkyne
6	1743.86	82.12	-C=O	Carboxylic acid, Ketone
7	1709.34	78.01	-C=O	Carboxylic acid, Ketone
8	1637.45	70.22	-C=O	Carboxylic acid, Ketone
9	1545.59	76.25	C=C, C-H	Alkene, Alkane
10	1413.82	79.37	C=C, C-H	Alkene, Alkane
11	1240.03	75.76	C-F, C-O-C	Fluro compound, Ether
12	1039.74	67.37	=C-O-C	Ether
13	672.41	62.52	C-Br, ≡C-H	Alkyl Bromide, Alkyne
14	512.01	55.79	C-Br, ≡C-H	Alkyl Bromide, Alkyne
(C) Root				
1	3290.2	61.66	≡C-H, O-H, N-H	Alcohol, Amine
2	2924.73	84.8	-C-H, O-H	Alcohol, Alkyne
3	2170.67	96.69	C≡C	Triple bond in alkyne
4	1634.78	66.15	-C=O	Carboxylic acid, Ketone
5	1541.11	78.99	C=C, C-H	Alkene, Alkane
6	1031.99	78.26	C-F, =C-O-C	Fluro compound, Ether
7	1242.64	48.92	=C-O-C	Ether
8	912.15	71.78	=C-O-C	Ether
9	523.86	37.28	C-Br, ≡C-H	Alkyl Bromide, Alkyne

Conclusion

The *Salvia hispanica* having various biochemical compounds like esters, polyphenols and flavonoids and also other bioactive compounds can improve the medicinal properties. The leaves also contain biochemical substances that can help with anti-microbial actions, in addition to chia seeds. In conclusion, this plant is viewed as a promising crop and helps encourage researchers to adopt a healthier lifestyle by its consumption as a food alternative.

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Declaration

The authors do not have any competing of interests.

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