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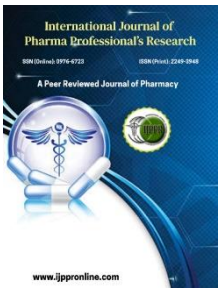

Cannabis sativa L. - An Important Medicinal Plant: A Review of its Phytochemistry, Pharmacological Activities and Applications in Sustainable Economy

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ABSTRACT:
Since the beginning of time, medicinal plants have served as a source of healing for almost all cultures. Cannabis sativa Linn. also known as Hemp is an herbaceous, anemophilous plant in the Cannabaccae family. Cannabis sativa L. is a unique natural medicinal plant holding a lot of phytochemicals such as cannabinoids, non-cannabinoids phenols, alkaloids, terpenes, and flavonoids. Each category of phytochemicals holds a lot of different compounds used in various forms of disease such as epilepsy, pain, bowel diseases, appetite stimulator, and many other neuro and GIT diseases. It was very popular as a medication in the treatment of COVID-19 and utilized in a sustainable economy. It contributes to the sustainable economy as bio-fuel, car parts, paper, food, apparel, building materials, ropes, carpets, and so on. The numerous therapeutic characteristics and phytochemical studies, as well as their use in a sustainable economy, demonstrate its value as a useful medicinal plant.

Introduction:

Hemp, often known as *Cannabis sativa* L., is an herbaceous, anemophilous plant in the Cannabaceae family. It is one of the oldest plants that have been domesticated, and because of this, it is challenging to pinpoint its precise origin. Most scientists agreed that this plant species originated in central Asia and was introduced to Europe as a cultivated and domesticated agricultural plant during the Bronze Age (roughly from the 22nd to the 16th century BC), according to phylogenetic studies based on molecular analysis and studies on sequence homology of ancient and modern DNA extracted from archaeobotanical and modern samples, respectively.[1] Cannabis is often a hermaphrodite plant (male and female flowers grow on the same plant); however, it is occasionally seen as a dioecious plant (male and female blooms appear on separate plants). When there is a short

photoperiod (less than 12 hours of light), it blooms, and during the longer photoperiod days, it continues to grow vegetatively. The plant's diverse natural components make it a species with a complicated chemical makeup.[2]

Cannabis plants create cannabinoids, a particular chemical class, in the glandular trichomes of the plant. Tetrahydrocannabinol (also known as 9 THC), which is naturally found in the plant in the form of an acid (also known as 9 - tetrahydrocannabinolic acid, or 9 -THCA), is the primary psychoactive ingredient. The pharmacologically active 9 - tetrahydrocannabinol is produced by decarboxylation of the acid with time or heat. Another cannabinoid of interest at the moment is cannabidiol (CBD), which is said to be effective in treating epilepsy, especially intractable pediatric epilepsy. Four more significant cannabinoids have been found in C. sativa in addition to 9-THC and CBD: tetrahydrocannabivarin (THCV), cannabinol (CBN), cannabigerol (CBG), and cannabichromene (CBC). According to current research, Phyto cannabinoids' pharmacological effects come from their capacity to interact with cannabinoid receptors and/or other pharmacological targets, such as non-cannabinoid receptors. More than 500 elements of cannabis have been identified so far, 125 of which are cannabinoids. Non-cannabinoid phenols, flavonoids, terpenes, alkaloids, and other substances are among the non-cannabinoid components.[3]

Due to the cannabis plant's therapeutic value, legalization for research and medical use began to spread throughout the world.[4] Each component of the cannabis plant has historically been used primarily to treat pain, inflammation, and mental problems. For instance, cannabis root has been suggested as a treatment for infections, gastrointestinal activities, hard tumors, postpartum hemorrhage, difficult child labor, fever, inflammation, gout, and joint pain. Cannabis inflorescence and leaf material may contain enough cannabinoids, mono- and sesquiterpenoids, and flavonoids for medicinal uses because quantities above 0.05% are pharmacologically intriguing. Additionally, important flavonoids (prenylflavonoids) are cannabinoids A and B, which have medical potential because of their anti-inflammatory, anti-neoplastic, antioxidant, neuroprotective, anti-parasitic, and anti-viral properties. Additionally, it has been hypothesized that long-term COVID-19-related anxiety and PTSD could be treated with CBD in light of the mounting evidence for its anxiolytic benefits.[5]

Hemp grows exceptionally well without the use of fungicides or herbicides. It's a particularly flexible factory for use in commerce thanks to its lack of acid and dwindling resistance to rodents, fungi, and numerous other types of weeds. Due to the characteristics and microstructural complexity of this miscellaneous factory, which is a compound system in and of itself, the factory was turned into multitudinous useful goods with the advancement of wisdom and technology. Hemp is therefore viewed as a possible volition for husbandry erected on synthetic accouterments by the food, medicinal, cloth, paper, structure, and energy diligence. The global request for hemp-derived products is anticipated to grow significantly over the coming several years, and hemp may once again recapture its status as a feasible raw resource and a high illustration of sustainable husbandry.[6]

We focused on phytochemicals, mainly found in *Cannabis sativa* L., and their pharmacological activities, beneficial in many diseases such as Parkinson’s, COVID-19, Inflammatory Bowel Diseases, Pain, Nausea, and Vomiting and Epilepsy. We also focused on the role of *Cannabis sativa* L. in the sustainable economy, which is very good for our environment as well as for us.

Origin And Botanical Description of C. Sativa

The word "cannabis" comes from the Latin word sativa, which means "sown," indicating that the plant is grown from the seed rather than the roots. It is referred to as hemp, marihuana, *Cannabis sativa* L., ganja, bhang, and al-bhango among other popular names in other languages.[7] It is prevalent throughout Africa and is thought to have originated in Asia.[8] The putative natural origins of the domestication of the Cannabis genus are in central and southeast Asia.[9] According to botanists, there are various varieties of cannabis depending on their size, shape, and resin content (breeding and selection). Two key elements determine the cannabis phenotype (its observable qualities or characteristics, such as its leaf shape and flower color): its genetic makeup (genotype) and the surrounding environment.[10]

Its roots are typically branching and extend 30 to 60 cm beneath the surface of the ground. Each leaf axil produces a cannabis inflorescence, which consists of several flower heads on long, green stalks. Each bloom produces a single brownish fruit that is 2 to 5 mm long and has a single seed that is securely encased in a tough shell.[7] The fruit is multiplied by birds, and the seed takes 8 to 12 days to germinate. The plant's leaves, bracts, and stems are abundant in trichrome, a variety of structures that contain the secondary metabolites (terpenoids and phytocannabinoids) in charge of defense, plant relationships, and distinctive fragrance.[11]

Table 1. Botanical Classification of *Cannabis sativa* L.

Category	Botanical Classification
Kingdom	Plantae – Plants
Sub-Kingdom	Tracheobionata – Vascular Plants
Superdivision	Spermatophyta – Seed Plants
Division	Magnoliophyta – Flowering Plants
Class	Magnoliopsida – Dicotyledons
Sub-Class	Hamamelididae
Order	Urticales
Family	Cannabaceae
Genus	Cannabis
Species	*Cannabis sativa* L.

Phytochemicals Of *Cannabis Sativa L.*

Cannabis sativa L. has both cannabinoids and non-cannabinoids among its numerous ingredients. Both cannabinoids and non-cannabinoids come in a wide variety. Cannabinoids are classified into 11 cannabinoid sub-classes, namely: cannabichromene (CBC), cannabidiol (CBD), cannabielsoin (CBE), cannabigerol (CBG), cannabicyclol (CBL), cannabinol (CBN), cannabinodiol (CBND), cannabitriol (CBT), (−)-Δ 8 -trans-tetrahydrocannabinol (Δ8-THC), (−)-Δ 9 -trans-tetrahydrocannabinol (Δ 9 -THC), and miscellaneous-type cannabinoids. Alkaloids, Flavonoids, Terpenes, and Phenols are the different categories of non-cannabinoids found as phytochemicals in *Cannabis sativa* L.[12]

Cannabinoids

A class of substances known as cannabinoids has a distinctive C21 terpenophenolic backbone. The parent cannabinoids, cannabinoid derivatives, and transformation products can all be referred to using this nomenclature. There are 11 cannabinoid (Table 2) subclasses into which these cannabinoids can be further divided.

Table 2. Types of Cannabinoids

S. No.	Cannabinoids
1.	(−)-Δ 9 -Trans-Tetrahydrocannabinol (Δ 9 -THC)
2.	(−)-Δ8-Trans-Tetrahydrocannabinol (Δ 8 -THC)
3.	Cannabigerol (CBG)

4.	Cannabidiol (CBD)
5.	Cannabinodiol (CBND)
6.	Cannabielsoin (CBE)
7.	Cannabicyclol (CBL)
8.	Cannabichromene (CBC)
9.	Cannabinol (CBN)
10.	Cannabitriol (CBT)
11.	Miscellaneous Cannabinoids

(−)-Δ 9 -Trans-Tetrahydrocannabinol (Δ 9 -THC) Type (25 Cannabinoids)

Goani and Mecholum reported on the insulation of pure(-)-9-trans-tetrahydrocannabinol(9-THC, 1) from a hexane excerpt of hashish employing column chromatography over florisil and alumina in 1964. THC was first converted into a crystalline nitrophenylurethane outgrowth, which was also further purified using mild alkaline hydrolysis. Its chemical structure was clarified using IR and NMR spectroscopic styles.[13]

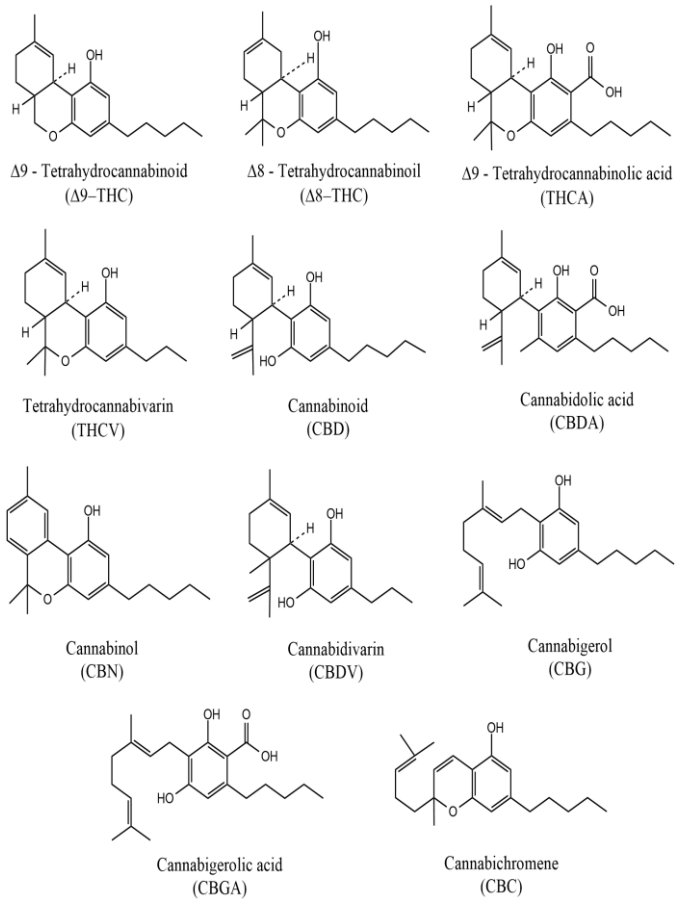

Figure 1. The Chemical Structure of Cannabinoids

(−)-Δ8-Trans-Tetrahydrocannabinol (Δ 8 -THC) Type (Five Cannabinoids)

The year 1966 saw the isolation of the cannabinoid (-)-8-trans-tetrahydrocannabinol (Δ 8-THC) from the leaves and flowers of marijuana growing in Maryland. Through the use of benzene and an eluent in silicic acid column chromatography, 8-THC was isolated from the petroleum ether extract.[14]

Cannabigerol (CBG) Type (16 Cannabinoids)

Using florisil chromatography, cannabigerol (CBG) was extracted from cannabis resin in 1964. Synthesis was used to confirm the chemical structure of (E)-CBG. The 1975 isolation of cannabigerolic acid (CBGAA) and its monomethyl ether (CBGAM) demonstrated that CBGA is the first cannabinoid synthesized in the 9-THCAA biosynthesis pathway.[13,15]

Cannabidiol (CBD) Type

An ethanolic extract (red oil) of Minnesotan wild hemp was used to isolate the cannabinoid (CBD). It was refined into a crystalline derivative of bis-3,5-dinitrobenzoate.[16]

Cannabinodiol (CBND) Type

Hashish was found to contain cannabinodivirin (CBND) in 1972 when it underwent GC-MS analysis.[17] Using silica-gel column chromatography, cannabinodiol (CBND-C5) was extracted from Lebanese hashish in 1977. The 1H-NMR method was used to determine the structure of CBND-C5, and the phytochemical conversion of cannabinol into cannabinodiol served as confirmation.[18]

Cannabielsoin (CBE) Type

Cannabielsoin (CBE-C5) was discovered in Lebanese hashish's ethanolic extract in 1973. The extract underwent counter-current distribution before being subjected to GCMS analysis.[19] Its

configuration was identified as 5aS, 6S, 9R, and 9aR in 1974.[20]

Cannabicyclol (CBL) Type

Cannabicyclol (CBL) was extracted from cannabis by Krote and Sieper using thin-layer chromatography, but Mechoulam and Gaoni properly determined its structure in 1967 using spectrum data.[21,22] In 1970, an X-ray study was used to determine the relative configuration of CBL.[23]

Cannabichromene (CBC) Type

In 1966, utilising column chromatography (florisil column) and the hexane extract of hashish, cannabichromene (CBC) was extracted.[24]

Cannabinol (CBN) Type

Seven cannabinol derivatives' chemical composition and separation information were reported in 1980.[25] In 2009, the high-potency strain of *Cannabis sativa L.* was used to separate 8-hydroxycannabinol and 8-hydroxy cannabinolic acid A, which were then chemically characterised via NMR and high-resolution mass (HR-MS) analysis.[26]

Cannabitriol (CBT) Type

Nine CBT-type cannabinoids, including (−)-trans-CBT-C5 (87), (+)-trans-CBT-C5 (88), (±)-cis-CBT-C5 (89), (±)-trans-CBT-C3 (90), CBT-C3-homologue (91), (−)-trans -CBT-OEt-C5 (92), (-)-trans -CBT-OEt-C3 (93), 8,9-Di-OH-CBT-C5 (94), and CBDA-C5 9-OH-CBT-C5 ester, have been identified from cannabis. Cannabitriol was first discovered in Japanese hemp in 1966[27], but its chemical composition wasn't fully understood until 1976.[28]

Miscellaneous Types Cannabinoids

Thirty different types of cannabinoids, including dehydrocannabifuran (DCBF-C5), cannabifuran (CBF-C5), 8-hydroxy-isohexahydrocannabivirin (OH-iso-HHCV-C3), 10-oxo-6a(10a)-tetrahydrocannabinol (OTHC), cannabicitran), and (-)-9-cis--tetrahydro-cannabinol (cis-Δ9-THC), cannabicoumaronone (CBCON-C5), cannabiripsol (CBR), cannabitetrol (CBTT), cannabichromanone-C5 (CBCN-C5), cannabichromanone-C3 (CBCN-C3),(±)-Δ7-cis-isotetrahydrocannabivarin-C3 (cis-iso-Δ7-THCV), (-)-Δ7- trans-(1R,3R,6R)-isotetrahydrocannabi- varin-C3 (trans-iso-Δ7-THCV), and (-)-Δ7- trans-(1R,3R,6R)-isotetrahydrocannabinol-C5 (trans-iso-Δ7-THC). After micropreparative GC and TLC, the cyclohexane methanol excerpt of Afghan hashish handed dehydrocannabifuran(DCBF-C5), cannabifuran(CBF-C5), OTHC, and cannabichromanone- C5(CBCN- C5). Mass and NMR spectroscopy analyses were used to identify their chemical compositions.[29]

Non-Cannabinoids

More than 400 non-cannabinoid components of the cannabis plant, in addition to cannabinoids, have been separated and/or identified. These non-cannabinoids fall into a number of chemical categories.[30]

Table 3. Types of Non-Cannabinoids

S. No.	Non-Cannabinoids
1.	Non-Cannabinoid Phenols
	Spiro-Indans
	Dihydrostilbenes
	Dihydrophenanthrenes
	Simple Phenols
2.	Flavonoids
3.	Terpenes
	Monoterpenes
	Sesquiterpenes
	Diterpenes
	Triterpenes
	Miscellaneous Terpenes

4.	Alkaloids

Non-Cannabinoid Phenols (42 Compounds)

Numerous chemical groups, such as spiro indans, dihydrostilbenes, dihydrophenathrenes, and simple phenols, are included in the category of non-cannabinoid phenols.

Spiro-Indans (16 Compounds)

From cannabis, 16 spiro-indan-type chemicals were discovered. In 1976, a cannabis strain from India yielded compound 126, which was identified as cannabispiran using silica gel column chromatography.[31]

Dihydrostilbenes (12 Compounds)

From C. sativa, twelve dihydrostilbenes were extracted and identified. Four novel dihydrostilbenes were identified by Turner et al. in their review [20]. These are 3-[2-(4-hydroxyphenyl)-ethyl] compounds. The compound 3-[2-(3-hydroxy-4-methoxyphenyl)-ethyl] -5-methoxyphenol, 3-[2-(3-isoprenyl-4-hydroxy-5-methoxy-phenyl)-ethyl]] both canniprene and 5-methoxyphenol. Chemical and spectral analysis were used to establish their chemical structures.[32]

Dihydrophenanthrenes (Seven Compounds)

Cannabis from Thailand was used to isolate two dihydrophenenathrens,
cannabidihydrophenanthrene (cannithrene 1) and (cannithrene 2) [33]. By employing numerous chromatography and analytical techniques, more dihydrophenanthrenes were gradually extracted from various ways.

Simple Phenols (Seven Compounds)

Five straightforward phenols, including eugenol, methyleugenol, iso-eugenol, trans-anethol, and cis-anethol, were found in the cannabis essential oil and identified by GC/MS.[25]

Flavonoids (34 Compounds)

From C. sativa, 34 flavonoids were extracted, and they could be divided into seven different chemical categories according to how they are methylated, glycosylated (using C or O glycosides), prenylated, or geranylated. The flavonoid aglycones have the following seven chemical structures: orientin, vitexin, isovitexin, apigenin, luteolin, kaempferol, and quercetin. Turner et al. evaluated the specifics of the separation and chemical structures of 19 flavonoids that were extracted from C. sativa in 1980.[30,34]

Terpenes (120 Compounds)

We found 120 terpenes in all while looking for those with the proper chemical structures. There are 61 monoterpenes (C10 skeleton), 51 sesquiterpenes (C15 skeleton), 2 diterpenes (C20 skeleton), 2 triterpenes (C30 skeleton), and 4 other compounds out of the 120 terpenes.

Monoterpenes (61 Compounds)

Twenty-one monoterpenes from cannabis have been identified. They can be divided into monoterpene hydrocarbons and oxygenated monoterpenes, two separate types. Cannabis monoterpenes can be linear, bicyclic, or cyclic in nature.[35]

Sesquiterpenes (51 Compounds)

An investigation into the higher boiling point portion of Egyptian hashish was carried out in 1942, and the sesquiterpene -caryophyllene (-humulene) was identified as a result.[35] Sesquiterpenes were soon discovered in large quantities (51 Compound).

Diterpenes

Only two triterpenes, phytol and neophytadiene, have been identified in C. sativa. They were recognised using GC-MS.[3]

Triterpenes

Cannabis contains two triterpenes that have been recognized. Through spectrum analysis and

comparison with actual materials, two triterpenes, friedelin (friedelan-3-one) and epifriedelanol, were identified in 1971 after an investigation of the ethanolic extract of cannabis roots.[36]

Miscellaneous Terpenes

There are a total of four different terpenes that have been found in cannabis. Vomifoliol and dihydrovomifoliol, two of them, are isophorone-like substances that were identified in Dutch hemp.[37]

Alkaloids

There are just two spermidine alkaloids known to exist in C. sativa. First reported in 1975, There are just two spermidine alkaloids known to exist in C. sativa. The first spermidine alkaloid, known as cannabisativine, was initially discovered in 1975 from a methanolic preparation of cannabis roots from a Mexican strain growing in Mississippi. Over the past few decades, numerous more alkaloid varieties of *Cannabis sativa* L. have been found.[38,39]

Pharmacological Actions

Cannabis sativa L. is used pharmacologically in numerous ways. It is said that, over the years, numerous ailments have been treated with its ingredients. However, they should only be utilized as a last resort because more clinical trials must be conducted.

Antimicrobial And Against Multidrug-Resistant Microorganisms

Antibiotics are used to prevent or slow down bacterial growth, but their indiscriminate application has increased the development of antibiotic resistance in bacteria, often known as "multidrug resistance." One of the most serious and challenging problems facing the world today is antibiotic resistance. Additionally, the situation gets worse when bacterial pathogens become multidrug-resistant bacteria and develop resistance to a variety of drugs.[40] Researchers that examined the antibacterial effectiveness of C. sativa leaf extracts against MRSA found that they are successful against both community- and hospital-acquired MRSA.[41]

Once again, several researchers looked at the probiotic strain growth impacts of Bifidobacterium and Lactobacillus spp. as well as the antibacterial and antibiofilm properties of C. sativa seed extract against Staphylococcus aureus. According to the research, C. sativa extract shows specific antibacterial action against pathogenic strains while having no inhibitory effects on the emergence of probiotic strains. The C. sativa extract also inhibited the S. aureus ATCC 35556 strain, which produces biofilms.[42]

Epilepsy

Cannabis has been used as an antiepileptic since ancient times. It is widely acknowledged that CBD has a role in the anticonvulsant effects of cannabis. The mechanism by which CBD works to treat epilepsy, however, is not well understood. The mechanism is indicated as being GPR55 antagonism, an orphan G-protein-coupled receptor. Recent research has demonstrated that CBD considerably lowers the frequency of seizures. Furthermore, it appears that relatively minor negative effects take place. Among these, elevated liver enzyme levels are reduced or improved with continued medication. However, it should be noted that CBD is frequently included in research alongside conventional antiepileptic therapy, making it challenging to determine whether it has antiepileptic effects or merely amplifies the effects of conventional medications.[43]

Sclerosis Multiplex

There is optimism that cannabinoids extracted fr
om *Cannabis sativa* L.
could be utilised to treat chronic pain and spastic
ity, according to a number of clinical and preclin
ical research. Preclinical studies have also
demonstrated the potential use of
endocannabinoids' neuroprotective properties

and partial inhibition of disease progression.[44] Spasticity is thought to be treated with nabiximols, THC, and oral cannabis extract, although Sativex® is the only medication that has been licenced for this use.[45]

Vomiting And Nausea Prevention

Studies have shown that THC activation of the CB1 receptor can decrease the frequency of nausea and vomiting.[46] Oral cannabis formulations are superior to a placebo in the treatment of CINV (chemotherapy-induced nausea and vomiting). Studies come to contrasting conclusions when compared to other antiemetics. Some of them claim that THC is superior, while others claim that they are equally effective, and still others demonstrate that the best results come from mixing cannabinoids with conventional medications.[47]

Pain

Cannabis can be used to treat pain because the endocannabinoid system is involved in its regulation.[48] Cannabis is most frequently used to treat pain, although not all forms of pain respond to it in the same way. It most likely originates from many mechanisms that cause pain to form. Cannabinoids cannot treat acute pain, according to studies, and they only partially alleviate chronic pain.[49]

Anti-Oxidant

The antioxidant activity of the FRAP assay (r 2 = 0.04), the ABTS assay (r 2 = 0.001), and intracellular oxidation (r 2 = 0.006) were not linearly correlated with the concentration of the target triterpenoids. The antioxidant activity in *Cannabis sativa* L. extracts, which have been observed to have a moderate antioxidant capacity, can therefore be believed to be caused by other secondary metabolites, such as phytosterols.[50]

Increasing Appetite

Numerous studies on animals have also shown that the injection of cannabis increases appetite and food intake. Studies conducted in the 1970s revealed that smoking marijuana increased calorie intake. It seems essential that medical marijuana has antiemetic and appetite-boosting benefits for cancer patients.[51] The medicine Marinol® has been approved for use in patients with cancer and AIDS to increase appetite.[52]

Oxidative Stress and Inflammation

Similar to the antioxidant action of vitamins E and C, THC and CBD both have the ability to scavenge free radicals, reduce metal ions, and guard against oxidation processes.[53] The non-olivetolic fragments of THC and CBD contain unsaturated bonds and phenolic groups that can easily oxidise to quinoid forms, which may be the cause of their antioxidant abilities.[54] Numerous in vitro and in vivo research on cannabinoids have shown that they have potent anti-inflammatory effects.[55]

Inflammatory Bowel Diseases

Cannabis has been used for enteritis since the dawn of time, but sadly, research on this topic is limited. According to survey research, individuals self-medicate with cannabis to treat symptoms of inflammatory bowel illness like diarrhoea, appetite loss, and abdominal pain.[56]

Parkinson's Diseases

Motor functions and dopamine activity are regulated by endocannabinoid system components. In order to treat mobility and neurodegenerative illnesses, cannabis appears to be a promising therapeutic approach.[57]

Tourette's Syndrome

Many patients are looking for alternatives to their conventional therapy or additional supplements to reduce their symptoms because the treatments now available for Tourette's syndrome frequently fail to produce the intended outcomes or have major adverse effects.[58] Small clinical trials are the only source of the scant evidence supporting

THC's effectiveness in treating Tourette's syndrome symptoms.[59]

Schizophrenia

Long-term cannabis use alters neural synchronisation in a manner similar to how schizophrenia affects its sufferers. Cannabis use has a negative impact on good symptoms and increases the frequency of relapses following remission. Cannabis use, however, was proven to ameliorate the undesirable effects.[45]

Glaucoma

Studies employing medical marijuana administered orally, intravenously, or inhaled have demonstrated that 9-THC lowers intraocular pressure, a risk factor for glaucoma. The intraocular pressure is reduced by 25% in patients (60–65%).[60]

COVID-19

THC and CBD, two components of cannabis, can also block T-helper type 1 (Th1) cytokines and/or stimulate a Th2 immune response both *in vitro* and *in vivo.* In COVID-19, Th1 and the inflammatory immune response profile are predominant. While certain viruses may benefit from host inflammation, others may have the opposite effect. Cannabis is a unique immunomodulatory substance. In patients with COVID-19, its mode of delivery through smoking is contraindicated. To improve patient safety, oral administration or inhalation of extracts should be taken into consideration.[61] Unfortunately, valid human research demonstrating CBD's efficacious anti-inflammatory dosages is lacking.[61]

The Utilization of *Cannabis Sativa* L. in a Sustainable Economy

Hemp (*Cannabis sativa* L.) is one of the earliest domestic species of use to humans, having been domesticated for thousands of years.[62-63] Since ancient times, hemp has been grown extensively in China as one of the five most widely used grains for the manufacture of clothes, rope, paper, oil, sails, and other products.[64] The plant fiber obtained from the stem is extremely durable and has been used to create the toughest ropes, pots, nets, ropes for clothing, sails, etc.[65] It is eaten as food, crushed to make cooking oil, and used as medicine in a variety of herbal preparations.[66] Since hemp has been used by humans for so long, it is impossible to pinpoint when it first appeared in writing. Even before appropriate documents and archival records were created, its usage and consumption were widespread.[67]

Cannabis sativa L. as a new bio-composite

An excellent strategy for creating sustainable bioproducts is to reinforce *Cannabis sativa* L. fibers to create its bio-composites.[68] These bio-composites can be found in a variety of shapes, including film membranes, fibers used in molding coatings, and foams. 14.4% of the applications come from them.[69] Among all the other bio-composites, press-mounding bio-composites are well-liked and have a variety of high-quality applications.[70]

Cannabis sativa L. in Hempcrete Technology

To create hempcrete, a material resembling concrete, lime binder, and hemp hurds or shiv are mixed. Hemp was used by the ancient Indians to make plaster at the Ellora Caves in the sixth century, or over 1500 years ago. This suggests that hemp use in construction was known to the ancient Indians. Additionally, the longevity of the building material is demonstrated by the fact that structures constructed in France hundreds of years ago are still standing.[71]

Cannabis sativa L. as food

Cannabis sativa L. has been utilised as food for around 3,000 years, when the Chinese and Nepalese used it as a staple food source.[72] Although its psychotropic effects attracted more attention and its production was made illegal, hemp finally lost its significance as a food source. As nutritionists conducted research, hemp was rediscovered as a particularly wholesome food

source. Edestin, a hemp seed protein, is what gives the food its distinctive nutritious quality. Hemp seeds have the most of this protein in the entire plant kingdom. In especially for individuals who don't eat fish or eggs, it is the richest source of alpha-linolenic acid (ALA) and a very good supply of healthy fat.[73]

Medicinal uses of Cannabis sativa L.

Even prior to the formal documentation, the medicinal use of hemp has been well known for centuries. For more than 6,000 years, people have recorded their experiences with hemp in writing. The dissemination of information about its medical usage has greatly benefited from these dssssssss. Cannabis use was originally documented in medical writings like the "Sushrita" around 1000 BC. In addition, hemp is mentioned in Indian literature like Tajnighuntu and Rajbulubha for its usage in treating a variety of issues connected to phlegm clearance and flatulence expulsion. These publications also discuss the use of cannabis as a general tonic, an appetite stimulant, a way to treat gonorrhoea, and a way to promote mental clarity and eloquence.[74,75]

Cannabis sativa L. in the automotive industry

Waste management is a huge problem when it comes to disposing of old, used cars because 25% of their weight in waste is made up of plastics, fibres, foam, glass, and rubber remnants. The globe has finally resolved to take the proper action to save the environment from the internal combustion engine and for the benefit of waste management. Henry Ford, the founder of Ford Motor Co., created a hemp-based vehicle plant in 1940, which is where the idea for employing hemp in the automotive business came from.[76] With technological improvements, the automotive sector has shown a lot of interest in employing hemp fibres to create goods that can be moulded and are a good alternative to fiberglass.[77]

Cannabis sativa L. seed, Cannabis sativa L. oil and it's nutritional potential

There are numerous uses for whole seeds, dehulled seeds, and seed oil. Of the overall production, 73.2% is used for whole seeds. It is the most affordable and minimally processed product. Among the remaining 73.2%, 67.2% is utilised as fish and bird feed, while 5.1% is used as human food.[78] Only 2.2% of the total 11.7% used for the manufacturing of dehulled seeds is used for animal feed, with the majority being used for human consumption at 9.5%. The most expensive product, hemp oil, accounts for 15.7% of all hemp production costs. 15.4% of the 15.7% are used to prepare human food, 0.3% are used to make cosmetics, and 0.3% are used to feed animals.[79] 20–25% of the proteins, 20–30% of the carbohydrates, and 10%–15% of the insoluble fibres in whole *Cannabis sativa* L. seeds.[80] These seeds also contain significant levels of phosphorus, potassium, magnesium, sulphur, and calcium, as well as trace amounts of iron and zinc, in addition to these important nutritional components.[81]

Cannabis sativa L. use in papermaking

Cannabis sativa L. has long been used to make or create paper. Hemp paper was first produced using old ropes, sails, garments, fishing nets, and rags. 75–80% of the world's entire paper manufacturing up until the 19th century came from the processing of hemp fibre. Paper made of *Cannabis sativa* L. was mainly and frequently used. The US Constitution and the Declaration of Independence were both written on *Cannabis sativa* L. paper because it was so widely used, and they were afterwards reproduced on parchment.[82] A unique plant for creating paper is *Cannabis sativa* L. The plant is made up of 80% bast, or roughly 50–77% cellulose, and 20% fibres. The cellulose concentration and amount make the fibres the strongest natural fibres in the world, making them ideal as raw material for making paper.[83] Current global production of papers made

from *Cannabis sativa* L. includes archives papers, safety papers, papers for filtering for technical and scientific research, sealing papers, greaseproof papers, filters for coffee and bags for tea, handcrafted papers, biblical papers, and an assortment of specialty art papers.[84]

Cannabis sativa L. in Textile Industries

Cannabis sativa L. has long been prized for its superior fibre. Since ancient times, the fibre has been valued for its distinctiveness and toughness. *Cannabis sativa* L. provided the strength that sailors needed to support their ships and sails. Documentation indicates that Christopher Columbus sailed to America on a ship that had been outfitted with *Cannabis sativa* L. According to 8000 BC tomb archaeological discoveries, textiles manufactured from *Cannabis sativa* L. were utilised in the tombs6. Besty Ross originally stitched the American flag from *Cannabis sativa* L.[85] Unlike any other material, it offers excellent durability, softness, warmth, and a cool feeling. Hemp's primary quality is comfort, followed by toughness. With wear, the fabric gradually softens. It has a built-in resistance to mould and UV rays. Because it is porous, it absorbs perspiration and water and allows for easy breathing in the heat.

Cannabis sativa L. in Cosmetic products

In recent years, hemp-based cosmetic products have gained a significant market share. The success of the *Cannabis sativa* L. sector in terms of new herbal product trends is due to the crucial characteristics the plant possesses for giving the consumer healthy skin. With a solid foundation to build on, *Cannabis sativa* L. cosmetics are emerging as a viable choice for customers who have embraced herbal items. *Cannabis sativa* L.'s abundance in moisturising omega-3, omega-6, and omega-9 fatty acids aids in the reduction of skin inflammation, the control of acne, the regulation of natural oils, and the calming of the skin.[86,87]

Cannabis sativa L. in Essential Oil

The volatile monoterpenes and sesquiterpenes in hemp are where the essential oil gets its scent.[88] There are a total of 58 monoterpenes and 38 sesquiterpenes known.[89] Additionally, an essential oil functions as a preventative with an insect repellent action. Commercial hemp items, including cosmetics, soaps, shampoos, lotions, oils, fragrances, and edibles, all have an aroma thanks to the essential oil.[90]

Cannabis sativa L. based Plastics

Plastics made from *Cannabis sativa* L. offer a practical way to keep plastics functional while reducing our environmental impact. These bioplastics are readily available, created from a composite of natural fibres, and can be used in place of products that rely on oil. The *Cannabis sativa* L. plant's stalks supply the high cellulose count needed to make plastic, hence, the stalks are used to make the bioplastic. In comparison to cotton (up to 90%), flax (65-75%), and wood (40%), hemp (65–70%) has the highest cellulose concentration. Plastics benefit from the stalks' strength and durability. The low cultivation input and advantageous growing features of *Cannabis sativa* L. are its primary distinguishing characteristics.[91,92]

Cannabis sativa L. in the production of biofuel

Henry Ford used hemp to create biofuels in 1941. He was a pioneer in developing a car that used hemp biofuel. Hemp-based fuel, or petrol, was used to power his Tin Lizzie model.[93] However, once crude oil was discovered, his ambition to develop a sustainable plant-based automobile became hazy throughout the course of the 20th century. With the exception of kinematic viscosity and oxidation stability criteria, which may be rectified by adding chemical additives like antioxidants, hemp seed oil-based biofuels display exceptional fuel quality. They are environmentally friendly and low-emission substitutes for fuels derived from petroleum.[94]

Hemp can primarily produce two different forms of fuel: hemp ethanol or methanol and hemp biodiesel, which are both generated from the oil of pressed hemp seeds.

Conclusion

The phytochemical, pharmacological, and sustainable applications of the Hemp Plant were discussed in this review study (*Cannabis Sativa* L). It is fair to propose that they are safely used in many neuro diseases without hazardous effects. *Cannabis sativa* L. has a high therapeutic value due to the presence of cannabinoids, non-cannabinoids phenols, alkaloids, flavonoids, and terpenes. The data imply that with the discovery and separation of active components, *Cannabis sativa* L. might be a viable commercial medicine for the treatment of epilepsy, GIT diseases, pain, and many neuro diseases. It is also very helpful in COVID-19. Thus, because we mentioned phytochemistry, pharmacology, and the sustainable contribution of *Cannabis sativa* L. in this review, it may be useful for future research because it supports the claims of various traditional systems of medicine.

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