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Phytochemistry, bioactivity, and medicinal use of *Cannabis sativa* roots: a comprehensive review

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Abstract

Background: Cannabis sativa is among the earliest domesticated plants and has been widely utilized for nutritional, industrial, and medicinal purposes. While its aerial parts, particularly the leaves and inflorescences, have been extensively studied due to their recreational and therapeutic applications, the roots remain comparatively neglected, despite their long-standing use in traditional medicine for treating wounds, burns, and inflammation. Aim: This review aims to summarize the current knowledge on the phytochemical composition and biological activities of C. sativa roots, with emphasis on their pharmacological potential. Results: The roots of C. sativa contain a diverse spectrum of secondary metabolites, including phytosterols, alkaloids, terpenes, and phenolic compounds. These bioactive constituents have been reported to exert antioxidant, anti-inflammatory, and antimicrobial activities. In vivo studies further demonstrate nociceptive and antispasmodic effects, with no evidence of cytotoxicity. Conclusion: C. sativa roots represent an underexplored pharmacognostic resource with significant potential for the discovery of novel bioactive compounds. Their chemical diversity and biological activities provide a strong rationale for renewed scientific attention, supporting future research into this underestimated part of a species of growing medical and economic relevance.

Keywords: Cannabis, Medical; Plants, Medicinal; Phytochemicals; Plant Roots

Introduction

Cannabis sativa was originally domesticated in Eurasia around 2737 BC and was one of the first cultivated plants. Its fibers are widely used to make fabrics, the leaves are used to feed animals, and the seeds are consumed by humans, in addition to the psychoactive use of its flowers[1].

Although currently cultivated on a global scale, this plant exhibits distinct phenotypic variations that are directly influenced by the specific geographical environment in which it develops[2]. Despite ongoing taxonomic debates, the prevailing convention classifies the genus *Cannabis* as a single species, *Cannabis sativa* L.[3]. Since antiquity, this species has been recognized for its therapeutic properties, being extensively utilized in both traditional and modern medicine due to the rich diversity of phytochemicals biosynthesized across various parts of its botanical structure[4].

More than 500 compounds have been identified and most of them are cannabinoids, which were first discovered in this species. Notably, cultivars of this plant also hold other classes of secondary metabolites, such as phenols, flavonoids, alkaloids, terpenes, steroids, and resins[5].

As a medicinal plant, *C. sativa* roots were initially used to relieve pain, heal burns, and treat infected wounds. However, the leaves and inflorescences became the primary focus of scientific inquiry due to the extensive clinical research into the therapeutic properties and pharmacological activity of the cannabinoids concentrated in the plant's aerial parts[6]. In this context, the roots have been the subject of several studies on their phytochemical composition, but few studies have addressed their medicinal potential[7].

This study aimed to conduct a review to identify the bioactive compounds and biological activities described for *C. sativa* roots.

Methods

Searches were conducted in the following databases: Index Medicus Western Pacific (WPRO), Latin American and Caribbean Health Sciences Literature (LILACS), Spanish Bibliographic Index of Health Sciences (IBECS), and SCOPUS, as well as PubMed, Cochrane Library, Web of Science, and Scientific Electronic Library Online (SciELO). The keywords used were: "roots" AND "*Cannabis sativa*" AND ("extract" OR "medicinal use").

Studies published up to December 2024 were included, with no limit on publishing date. Firstly, evaluators checked the titles and abstracts, looking for words that referred to tests for the medicinal use of the roots. Full papers in Portuguese and English were included if they had conducted in vitro and in vivo analyses using *C. sativa* roots extracts for medicinal use or compounds isolated from these extracts. Review articles, duplicate studies, and paid access papers were excluded.

Bioactive compounds

Plants produce various compounds to protect them from microorganisms and other environmental factors. When consumed, these compounds alleviate oxidative stress, inflammatory processes, and prevent various diseases[8]. Table 1 shows the compounds identified in *C. sativa* roots, their isolated amounts, and their biological activities, which will be divided and discussed according to their classes.

Phenolic compounds

Phenolic compounds are a heterogeneous group of phytochemicals found in plants, divided into classes according to their chemical structure and biological function. These metabolites are crucial for the defense mechanisms of the plant and can contribute to human health with its anti-inflammatory, antioxidant, and antimicrobial properties[9]. Phenolic compounds can be divided into groups such as phenolic acids, flavonoids, tannins, and lignans, which have a basic structure containing an aromatic ring with one or more hydroxyls. Their antioxidant capacity can be closely related to the number of free hydroxyls; thus compounds that donate more electrons have a higher antioxidant activity[10].

One of the phenolic compounds isolated from *C. sativa* roots was vanillin, a substance widely used in the industry as a food flavoring. A range of therapeutic properties have been associated to it, such as antitumor, neuroprotective, and antimicrobial activity, as well as being used to potentiate the action of antibiotics such as gentamicin, chloramphenicol, ciprofloxacin, and meropenen against resistant strains of *P. aeruginosa, S. aureus*, and *E. coli*[11].

P-coumaroyltyramine helps to prevent heart and vascular diseases and neurological disorders, and is also effective in antitumor, antibacterial, antiurease, antifungal, and antiviral activity tests[12]. Serinic acid works as a nutraceutical, improving oxidative damage, anti-inflammatory action, thus reducing metabolic risks and dyslipidemia[13]. Cetopinoresinol has anti-tumor activity due to its immunomodulatory and antioxidant capacity[14].

Alkaloids

Alkaloids are nitrogen-based organic compounds that have various biological activities. Due to presenting different chemical structures, they can be divided into isoquinolines, pyridines, quinolines, among others. Such composition enables various actions and effects such as anticancer, anti-inflammatory, antibacterial, and antiviral activities[15,16]. These organic compounds have at least one nitrogen atom in an amine-type structure, which is usually incorporated into a cyclic system. This characteristic allows them to react with acids to form salts[17].

Cannabisativine is an alkaloid that was first isolated from *C. sativa* roots in 1975. By investigating this compound, a study has found analgesic and antiparasitic activities, as well as antipyretic, antiemetic, antitumor, diuretic, and analgesic capabilities[18]. It is a macrolactam, which is a cyclic amide derived from carboxylic amino acids and characterized by a 1-azacycloalkan-2-one structure (or analogues) with unsaturation or

heteroatoms replacing one or more carbon atoms of the ring. Its chemical structure includes three fused rings: a pyridine ring, a piperidine ring, and a 13-membered lactam ring, and it has hydroxyl and amine functional groups[19].

Cannabinoids

This class is not found in large quantities in roots. They have a carbocyclic structure with 21 carbon atoms, generally formed by three rings: cyclopentane, tetrahydropyran, and benzene. The main cannabinoids include Δ^9-tetrahydrocannabinol (Δ^9-THC), cannabidiol (CBD), and cannabinol (CBN)[20].

CBD is the main cannabinoid found in *C. sativa* and is the most studied one, known for its neurological effects, aid in pain alleviation, and treatment of rheumatological diseases and disorders such as anxiety[21-24]. Another cannabinoid found in the roots is tetrahydrocannabivarin, which is very similar in nomenclature to Δ^9-THC. Notably, it has very different characteristics, having been tested as an appetite regulator for the treatment of obesity and diabetes[25]. Cannabichromene has anti-inflammatory activity[26] and shows results in reducing the proliferation of bladder cancer cells, along with other cannabinoids such as cannabivarin[27].

Terpenes

These are hydrocarbons derived from isoprene (C_5H_8) and can be classified according to the number of isoprene units they contain: monoterpenes ($C_{10}H_{16}$), sesquiterpenes ($C_{15}H_{24}$), diterpenes ($C_{20}H_{32}$), among others. Their basic structure is made of multiple isoprene units joined head-to-tail, forming linear chains or complex cyclic structures that have antioxidant, anti-tumor, and anti-inflammatory characteristics[28].

Glutinol is one of the compounds found in *C. sativa* roots, which has shown antitumor action against MCF-7 breast tumor cell lines[29]. Some compounds derived from this terpene have shown antifungal activity against phytopathogenic fungi of the genus *Fusarium*[30]. Also, friedelanol has antitumor and anti-inflammatory properties[31,32]. Friedelin is another triterpene of the same class isolated from roots, presenting antitumor and anti-inflammatory properties, as well as antimicrobial activity against: Gram-positive bacteria, such as *S. aureus, S. epidermidis,* and *Bacillus cereus*; Gram-negative bacteria, such as *Proteus mirabilis, E. coli, K. pneumoniae*; and the fungi *Aspergillus fumigates* and *Trichophyton rubrum*[33].

Phytosterols

Phytosterols are plant sterols structurally similar to cholesterol, characterized by a tetracyclic cyclopentanoperhydrophenanthrene nucleus with a side chain on carbon 17. The most common phytosterols include β-sitosterol, campesterol, and stigmasterol, which have a double bond at position 5 and methyl or ethyl substituents on the side chain at carbon 24[34]. Phytosterols were the most found class in the studies included in this review. They are nonpolar substances found in different plant species and studied for various purposes due to their high antioxidant capacity[35]. β and γ-sitosterol are esters analogous to cholesterol, which have antiviral properties[36] and antitumor activities[37], which are also found in fucosterol[38-40], and antiparasitic

properties when tested against *Plasmodium falciparum*[41].

Oleamide has demonstrated antibacterial properties against the bacterium *P. aeruginosa*[42], and is an important endocannabinoid in sleep regulation[43]. Ethyl palmitate has antiviral[44] and anti-inflammatory properties[45], whereas ethyl linoleate is effective as a wound healer, antimicrobial, antioxidant[46], and anti-inflammatory[47]. Campesterol has emerged as an alternative source of new antimicrobial substances and has been tested against various bacteria with semi-synthesized compounds from campesterol[48].

Studies have indicated antitumor activity of palmitic acid[49,50], Ergosterol peroxide has promising antiviral properties against different viruses[51-53] and is active in tests against MTB[54], while α-linolenic acid has antitumor, anti-inflammatory, and antioxidant activities[55]. Pentadecanoic acid has shown antibiofilm activity against *C. albicans* and *K. pneumoniae*[56], anti-inflammatory, antifibrotic, and anticancer activities via the activation of enzymes such as Adenosine Monophosphate-Activated Protein Kinase (AMPK), and inhibition of the JAK-STAT pathway, which signals cytokines that control the inflammatory process[57].

Different extraction processes were conducted: cold maceration; hot and cold maceration; fermentation and cold maceration; hot maceration with fermentation, and cold maceration. By using these different processes, authors aimed to test the increased effectiveness in obtaining compounds and the antioxidant capacity of each one, proving the effectiveness of obtaining stigmasterol according to the increased complexity of the extraction process[58].

Biological activities

The use of *C. sativa* roots in traditional medicine has led to some research using extracts of this pharmacogen, and tests have been conducted on its antimicrobial, anti- inflammatory, and antioxidant activity in vitro, as well as evaluating other biological activities in vivo, such as antipyretic, antinociceptive, and antispasmodic action.

Antimicrobial activity

The antimicrobial activities of the isolated compounds of the extracts were tested focusing on their medicinal use (Table 2). Two compounds showed promising activity: campesterol and *p*-coumaroyltyramine; The first one was found to hold fungicidal activity against C. neoformans with an IC50 value of 13.7 µg/mL. The latter one showed activity against the Gram-negative bacterium E. coli with an IC50 value of 0.8µg/mL[59]. Campesterol is a phytosteroid present in different plant species, some of which have anti-inflammatory activity[89], and *p*-coumaroyltyramine is known for its antiviral, antimicrobial, and anticoagulant activities[90]. The extracts had inhibitory results when tested against *S. aureus, E. coli,* and *C. albicans.* Note that the concentration used to inhibit Gram-positive bacteria was high (>800 µg/mL)[62].

Another study tested the antimicrobial capacity of Cannabis roots by obtaining silver nanoparticles (AgNPs). The ethanolic extract was used to obtain the AgNPs, which were tested against Gram-positive and Gram-negative bacteria, obtaining the

following minimum inhibitory concentrations: *S. aureus* (65 µg/mL), *E. coli* (70 µg/mL), *P. aeruginosa* (75 µg/mL), and *K. pneumoniae* (60 µg/mL)91. This same study tested the hemolytic capacity and cytotoxic effect of AgNPs, founding no effect. The extract was not characterized. Nevertheless, obtaining and analyzing the AgNPs was promising, because they have emerged as a new alternative treatment for resistant bacteria, acting mainly on the membranes of microorganisms, facilitating the permeability of other compounds or changing the physicochemical properties of this membrane by breaking it[46].

Anti-inflammatory properties

The anti-inflammatory capacity of the *Cannabis* root extract and the isolated compounds, two triterpenes and one phytosterol, showed promising results in both the extract and the terpenic compounds, helping to prevent the expression of inflammation markers such as interleukin IL6 and Tnfα[71]. When measuring the production of IL-6 by liposaccharide stimulation of differentiated human monocytic leukemia (THP-1) cells, a significant result was obtained from the aqueous extract of *C. sativa* roots[62].

In another study, the anti-inflammatory properties of the isolated compounds were tested, in which the six isolated cannabinoids showed anti-inflammatory effects by reducing pro-inflammatory cytokines in an inflammasome model with THP-1 cells. Six of the other non-cannabinoid compounds reduced the expression of the IL1β and TNFα markers[60]. In recent years, the anti-inflammatory and immunomodulatory capacity of terpenes has been widely studied. Notably, they are abundant in various plant species, so they have been increasingly highlighted as anti-inflammatory and immunomodulatory compounds[92]. Phytosterols are similar in structure to cholesterol and have antitumor, antioxidant, and anti-inflammatory properties[93]. Phenols and polyphenols can chelate or annul oxidizing compounds, acting as natural anti-inflammatories[94].

A study evaluated the anti-inflammatory effect of the cannabis roots extracts using RAW264.7 murine macrophage cells, which were treated with liposaccharides. Besides evaluating the anti-inflammatory effect, the authors also investigated the expression of the Nitric Oxide Synthesis Inducing Protein (iNOS), an inflammatory marker. The authors identified that the anti-inflammatory effect was proportional to the complexity of the extraction and the amount of stigmasterol in the sample[95].

Antioxidant properties

The antioxidant activity of the root extract (Table 3) and of the isolated compounds in which the extract performed best (80%), with most compounds being slightly less efficient (65%), was in the 2,2-diphenyl-1-picrylhydrazyl radical (DPPH) test. There was a difference in the chelating capacity between the isolated compounds showing the extract was the most efficient (80%), followed by β-sitosterol (75%), in the Fe+ chelating test. The same results were obtained when tested in cell culture to see if the antioxidant capacity was maintained. Note that when the cytotoxicity and DNA damage capacity of *C. sativa* root extracts were tested, no damage to DNA structures was ideintified[71].

Another study tested antioxidant capacity using the Iron Antioxidant Power (FRAP) and 2,2'-azinobis-3-ethylbenzothiazoline-6-sulfonic acid (ABTS) techniques. The researcher also employed an in vivo technique, using the fungus Saccharomyces cerevisiae to assess the intracellular antioxidant power, obtaining a promising result. However, this capacity cannot be attributed to the triterpenes, since another sample with more triterpenes showed the lowest antioxidant action value, which may be due to the phytosterols[7]. When the antioxidant capacity was tested using the ABTS test, the aqueous extract showed greater antioxidant capacity when compared to the ethanolic and basic acid extracts[62]. An analysis of the antioxidant potential by hydrogen peroxide inhibition (H_2O_2) was conducted, in which the roots showed antioxidant capacity[63]. Secondary metabolites have a high antioxidant capacity and the main ones include phenolic compounds, terpenes, and alkaloids[96].

Biological activities *in vivo*

A study tested the extracts as antipyretics in young Rattus norvegicus males, in addition to testing the antinociceptive, anticonvulsant, and antispasmodic capacity in Mus musculus specimens. The aqueous extract of the roots was able to reduce contortions caused by acetic acid in *M. musculus* at a concentration of 12.5 mg/kg and did not have the same result at higher concentrations. A similar result was observed when the antinociceptive capacity was tested, in which a reduction in pain was observed at a concentration of 12.5 mg/kg. In the hot plate pain latency test, the rodents had an increase in pain latency at all concentrations of the extract (12.5, 25 and 50 mg/kg). No antipyretic or spasmolytic activity was observed with this extract at any of the concentrations[61].

Also in murine models, the action of the aqueous extract of *C. sativa* roots was used to attempt the reduction of abdominal contractions caused by primary dysmenorrhea, which was effective at concentrations of 12.5, 25 and 50 mg/kg, demonstrating an antidysmenorrheal effect at all concentrations and not showing spasmolytic effect[1].

Conclusion

This review highlights the bioactive compounds and medicinal potential of *Cannabis sativa* roots, broadening current understanding of this historically important yet scientifically underexplored plant organ. While *C. sativa* has long been recognized as a medicinal species, research has largely focused on the psychoactive properties of its aerial parts, overshadowing the pharmacological relevance of its roots.

Evidence to date demonstrates that *C. sativa* roots possess antioxidant, anti-inflammatory, antinociceptive, and antispasmodic activities, as well as promising antibacterial and antifungal properties, with no reports of cytotoxicity or genotoxicity. Their rich content of secondary metabolites, including terpenes, phytosterols, phenolic compounds, alkaloids, and cannabinoids, positions the roots as a valuable source of pharmacologically active molecules with potential therapeutic applications.

Strengths, limitations, and future prospects

This review contributes by integrating scattered evidence on the phytochemistry and pharmacological activities of *C. sativa* roots, providing a comprehensive overview rather than isolated discussions of extraction techniques or single therapeutic uses. However, the heterogeneity of geographical origins and environmental conditions across the reviewed studies represents a major limitation, as factors such as climate, soil composition, and harvest time strongly influence phytochemical profiles and complicate comparisons. Despite these gaps, the findings underscore that systematic and standardized studies on *C. sativa* roots may yield novel bioactive compounds with significant pharmacological value.

Future research should prioritize detailed phytochemical characterization, mechanistic pharmacological studies, and controlled *in vivo* and clinical evaluations. Ultimately, the roots of *C. sativa* represent a neglected pharmacognostic resource with considerable potential to contribute to drug discovery and the development of new therapeutic strategies.

Availability of data and materials

Data sharing is not applicable to this article as no datasets were generated or analyzed during the current study.

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TAH designed and wrote the manuscript. LGP, DFR, and CMS contributed to the revision of individual sections. All authors contributed to the revision of the entire manuscript and read and approved the final manuscript.

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Ethics approval and consent to participate

Not applicable.

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Competing interests

The authors declare that they have no competing interests.

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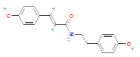
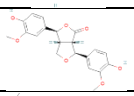
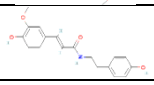
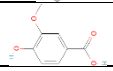
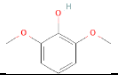
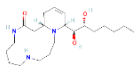
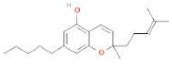
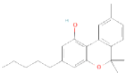
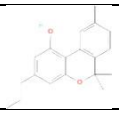
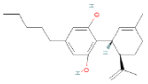
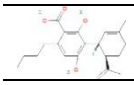
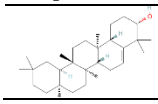
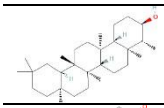
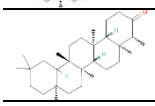
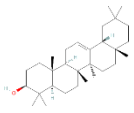
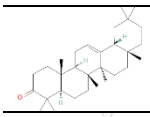
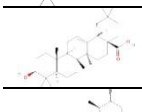
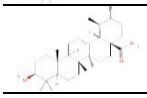
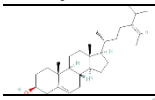
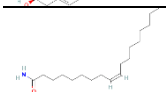
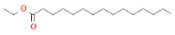
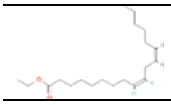
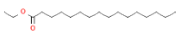
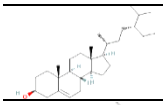
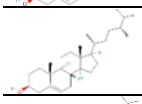
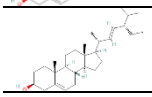
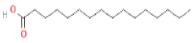
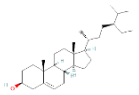
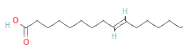
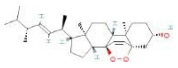
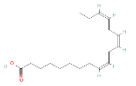
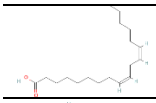
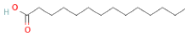
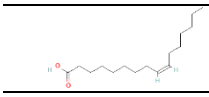
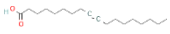
Table 1. Biological activities of compounds found in *C. sativa* roots.

Class	Compound	Quantities([ref])	Biological Activity	Reference
Phenolic compounds				
	Vanillin	0,0076 mg/g[59] 0,0006 mg/g[60]	Antitumor, neuroprotective, antimicrobial	11,59,60
	*p*-Coumaroyltyramine	0,01978 mg/g[59]	Antitumor, antibacterial, antiurease, antifungal, antiviral, neuroprotective and cardioprotective	1,12,59,61
	Serinic acid	0,0011 mg/g[60]	Antioxidant and anti-inflammatory	13,60
	Cetopinoresinol	0,00335 mg/g[60]	Antitumor, antioxidant and immunomodulatory	14,60
	Feruloyltyramine	0,00445 mg/g[60]	Anti-inflammatory, anti-asthmatic	1,61,62
	Dihydrobenzofuran	0,0006 mg/g[60]	Antiparasitic	63,64
	Vanillic acid	0,00625 mg/g[60]	Anti-inflammatory	60
	Syringol	< LOQ[60]	Anti-tumor	60,65
Alkaloids				
	Cannabisativin	< LOQ[1]	Analgesic, antiparasitic, antipyretic, antiemetic, antitumor, diuretic and analgesic	1,18,60-62
Cannabinoids				
	Cannabichromene		Anti-inflammatory and anti-tumor	26,27,60
	Cannabinol	0,0002 mg/g[60]	Antimicrobial, anti-inflammatory, sleep regulator	60,66,67
	Cannabivarin	0,00045 mg/g[60]	Antitumor	27,60
	Cannabidiol	0,0003 mg/g[60]	Neurological effects, rheumatological pain, sleep regulator and anxiety disorders.	21-24,60,66
	Cannabidiolic acid	< LOQ[62]	Antimicrobial, antinausea and antitumor effects	62,68
Terpenes				
	Glutinol	< LOQ[7]	Antitumor and antidiabetic	7,29,69,70

	Friedelanol	0,239 mg/g[71] 0,06 – 0,20 mg/g[7]	Antitumor, anti-inflammatory and antioxidant	7,31,32,59,60,71
	Friedelin	0,42 - 0,71mg/g[7] 0,288 mg/g[71] 0,065 mg/g[60]	Antitumor, anti-inflammatory, antimicrobial and antifungal	7,33,59,60,63,71
	β-Amyrin	< LOQ[7]	Anti-inflammatory, analgesic, antihyperglycemic and nephroprotective	63,72-74
	β-Amirone	< LOQ[7]	Analgesic, antidiarrheal and hypoglycemic	7,75
	Oleanolic acid	0,0014 mg/g[60]	Antitumor, antimycobacterial	49,60,76-78
	Ursolic acid	< LOQ[62]	Antitumor, antimycobacterial	62,78,79
Phytosterols				
	Fucosterol	< LOQ[7]	Antiviral, antitumor, antiparasitic	7,39-41
	Oleamide	< LOQ[7]	Antibacterial and sleep regulation	7,42,43
	Ethyl palmitate	< LOQ[7]	Antiviral and anti-inflammatory	7,44,45
	Ethyl linoleate	< LOQ[7]	Healing, antimicrobial, antioxidant and anti-inflammatory	7,46,47,80
	Ethyl stearate	< LOQ[7]	Anti-inflammatory and neuroprotective	7,81,82
	β-Sitosterol	0,687 mg/g[71]	Antiviral, antitumor, analgesic and antidiarrheal	7,37,59,60,71,75
	Campesterol	0,172 mg/g[71]	Antimicrobial	48,59,63,71
	Stigmasterol	0,202 mg/g[71]	Anti-inflammatory	58,63,71,73
	Palmitic acid	< LOQ[63]	Anti-tumor	50,63,83
	γ-Sitosterol	< LOQ63	Antiviral and antitumor	36,37,63
	Palmitoleic acid	0,03185 mg/g[59]	Antibacterial	59,84,85

	Ergosterol peroxide	0,0007 mg/g[60]	Antiviral and antimycobacterial	51-54,60
	α-linolenic acid	0,00255 mg/g[60]	Antitumor, anti-inflammatory and antioxidant	55,60
	Linoleic acid	0,00125 mg/g[60]	Antioxidant and anti-tumor	60,62
	Dotriacontene	0,0007 mg/g[60]	Anti-inflammatory	60
	Pentadecanoic acid	0,00885 mg/g[59]	Antibiofilm, anti-inflammatory, antifibrotic and antitumor	56,57,60
	Palmitoleic acid	0,03185 mg/g[59]	Anti-inflammatory and antimicrobial	60,86
	Stearolic acid	< LOQ[62]	Anti-parasitic	62,87,88

Caption: < LOQ - Below Limit of Quantification; ([ref]) - Reporting study

Table 2. Antimicrobial results of studies with *Cannabis sativa* roots.

Compound	Microorganism	MIC	ref
Campesterol[1]	*C. neoformans*	13.7 µg/mL	59
p-coumaroyltyramine[1]	*E. coli*	0.8 µg /mL	
AgNPs	*S. aureus*	65 µg/mL	91
	E. coli	70 µg/mL	
	P. aeruginosa	75 µg/mL	
	K. pneumoniae	60 µg/mL	
Aqueous extract[2]	*C. albicans*	180 µg/mL	62
Acid-base extract[2]		120 µg/mL	

Caption: [1] - Isolated compound; [2] - Extract; AgNPs - silver nanoparticles; MIC - minimum inhibitory concentration.

Table 3: Antioxidant analysis of studies on *Cannabis sativa* roots.

Extract/compound	Test performed	Results	Ref
Friedelin[1]	DPPH	832.4 ± 1.7 µg/mL	71
	Fe chelator	883.5 ± 7.2 µg/mL	
β-Sitosterol[1]	DPPH	920.2 ± 3.4 µg/mL	
	Fe chelator	858.8 ± 6.2 µg/mL	
Friedelanol[1]	DPPH	875.1 ± 1.7 µg/mL	
	Fe chelator	547.6 ± 6.3 µg/mL	
Ethanolic[2]	DPPH	420.1 ± 2.1 µg/mL	
	Fe chelator	385.5 ± 3.0 µg/mL	

Ethanolic[2]	FRAP	97.1 ± 3.8	7
	ABTS	89.1 ± 2.5	
	Intracellular oxidation	0.809 ± 0.013	
Methanolic[2]	DPPH	1.556 ± 0.004 mmol/L	63

Caption: [1] - Isolated compound; [2] - Extract; DPPH - 2,2-diphenyl-1-picrylhydrazyl radical; FRAP - Iron Antioxidant Power; ABTS - antioxidant capacity of 2,2'- azinobis-3-ethylbenzothiazoline-6-sulfonic acid.