



RESEARCH PAPER

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In vitro antibacterial activity of *Cannabis sativa* leaf extracts to some selective pathogenic bacterial strains

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Abstract

Plant materials are important for animal and human health care and also important for microbial controlling program. This present study has been attempted to determine the antibacterial activity of *Cannabis sativa* leaf extract to some selective pathogenic bacterial strains such as *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Salmonella typhi* and *Klebsiella* by using leaf Ethanol extract and Hot water extract. Antibacterial activity of *Cannabis Sativa* was evaluated by well diffusion methods. The highest zone of inhibition produced by Ethanol extract. The leaf of *Cannabis Sativa* exerted pronounced antibacterial activity (24.1mm) against *Staphylococcus aureus*, (10.3mm) against *Pseudomonas aeruginosa*, (22.2mm) against *Escherichia coli*, (18.1mm) against *Enterococcus faecalis* respectively and inactive against the two strains *Salmonella typhi* and *Klebsiella*. The minimum inhibitory effect of *C. sativa* leaf extract is due to certain compounds present in the *C. sativa*. Further research should be done to identify the compounds responsible for its activity which can be used as medicines to control a wide range of disease in the world.

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Introduction

Antimicrobial activity of therapeutic plants has turned out to be a global concern. This problem is one of the great issues particularly in 3rd world countries because these are one of the major causes of mortality in these countries is due to these infectious diseases. There is a continuous and serious need to discover new antibacterial and anti-fungal compounds for new infectious diseases (Majid *et al.*, 2013).

Cannabis sativa is a dioecious, annual and herbaceous plant belonging to the family Cannabinaceae. *Cannabis sativa* grows well at low temperature, and well-adjusted to moderate climates. The most essential *Cannabis sativa* products in the food and drug trade are whole hemp seed, hulled hemp seed, hemp seed oil, marijuana, and hashish (Adams and Martin, 1996). *Cannabis sativa* are commonly known as marijuana that grows freely throughout the universe. This plant most commonly is known today as a powerful psychoactive substance, but for many years it was cultured primarily for its fibers and these hemp fibers were used in the production of rope, clothes and ship sails (Maisto *et al.*, 1999). This plant is one of the most insufferable, maligned and detested anywhere in the universe and huge sums of money and efforts are being used to thrash its production, supply, marketing and consumption (Ayenigbara, 2012).

Cannabis sativa leaves are best, astringent, tonic, aphrodisiac, alterative, intoxicating, stomachic, analgesic and abortifacient. They are used in convulsions, otalgia, abdominal disorders, malarial fever, dysentery, diarrhoea, skin diseases, hysteria, insomnia, gonorrhoea, colic, tetanus and hydrophobia. Its extreme use causes dyspepsia, cough, impotence, melancholy, dropsy, restlessness and insanity. The bark is tonic, and is useful in inflammations, haemorrhoids and hydrocele. The resin is smoked to allay hiccup and bronchitis. It is useful in insomnia, sick headaches, neuralgia, migraine, mania, whooping cough, asthma, dysuria and in relieving pain in dysmenorrhoea and menorrhagia (Merzouki *et al.*, 2000; Nath *et al.*,

1997; Anonymous, 1996). Therapeutically, Indian hemp has been used in the treatment of diseases and health problems such as HIV/AIDS, glaucoma, eye problems, cachexia, treatment of pain, muscle spasticity, convulsion, insomnia, asthma, hypertension, depression etc. Cannabis is being used as a shampoo and for other cosmetic purposes (Maisto *et al.*, 1999).

Marijuana (*Cannabis sativa*) has been known to contain antibacterial cannabinoids which are cannabidiol, cannabichromene, cannabigerol, Δ^9 -tetrahydrocannabinol and cannabinol. All these compounds showed effective activity against a range of methicillin-resistant *Staphylococcus aureus* (MRSA) strains (Appendino *et al.*, 2008). This plant is known throughout the globe for its good excited and medicinal properties and also its preparations have been used for its good antibacterial studies (Kreji, 1958). The leaf of this plant possesses good antimicrobial activity against *Mycobacterium tuberculosis*, Gram-negative bacteria of the *Escherichia coli*, *Pseudomonas aeruginosa*, *Proteus vulgaris*, *Enterococcus faecalis*, acid-fast bacteria, yeast-like fungi, filamentous fungi and dermatophytes (Turner *et al.*, 1981; Wasim *et al.*, 1995). Cannabinoids have strong antileishmanial activity and are effective in killing *Candida albicans* (Whittaker *et al.*, 2004). The contact of both herpes simplex virus type 1 and herpes simplex virus type 2 to various absorptions of delta-9-tetrahydrocannabinol present a plaque assay utilizing confluent monkey cells that have possible mechanisms for antiviral activity and that this activity is modified by the presence of serum proteins (Lancz *et al.*, 1991; Blevein *et al.*, 1980). The antibactericidal activity of delta-9-tetrahydrocannabinol and cannabidiol for *Staphylococci* and *Streptococci* in broth are in the range of 1-5 $\mu\text{g/ml}$ (Klinger and Ham, 1976).

The present study was conducted to investigate the antibacterial activity of *Cannabis Sativa* leaf extracts against gram positive ATCC (American type cell Culture) bacteria *S. aureus* ATCC®6538, and gram negative bacteria *Escherichia coli* ATCC®25922,

Pseudomonas aeruginosa ATCC®74303 and *Enterococcus faecalis* ATCC®35824.

Materials and methods

This research work was conducted at the research laboratory of Microbiology Department, Hazara University Mansehra, Pakistan.

Collection of Plant Material

Healthy, disease free, mature *Cannabis Sativa* leaves were collected directly from the back side of vice chancellor office garden campus Hazara University Mansehra Pakistan and brought to the research laboratory of Microbiology Department, Hazara University Mansehra. The leaves were cleaned with tap water. After cutting the leaf into small pieces, they were air dried in room temperature for 5-7 days, and then dried leaves were crushed into a fine powder by blender machine.

Preparation of Hot Water and Ethanol extracts

Five grams powdered samples of leaf was soaked in 50ml cold water in 250ml sterile flask and rotated on shaker at 150 rpm for 24 hours at room temperature. The extract was filtered through a muslin cloth and then centrifuge at 4400 rpm for 7 minutes. The supernatant were collected and the pellet was discarded. These steps were repeated three times. The coming supernatant was considered as 100% concentration of extract. The Hot water extracts were evaporated to dryness using a rotary evaporates (Stuart, Barloworld and Model RE 300). Their crude extracts were evaporated in a water bath to give gummy solid residue.

Media Sterilization

All Media were sterilized by using automatic autoclave (SANYO) at 121°C for 15 minutes.

Media Pouring and Drying

Media was poured in pre-sterilized glass Petri plates of 90mm in Laminar Flow Hood which was sterilized by overnight exposure of UV light and disinfected with 70% ethanol solution. Media plates were kept open for half an hour in the Laminar Flow Hood for

drying and solidifying media.

Test Microorganisms

The in-vitro activity of the extracts was assayed against the bacterial strains. All the ATCC (MicroBioLogics) against gram positive bacteria *S. aerious* ATCC®6538, and gram negative bacteria *Escherichia coli* ATCC®25922, *Pseudomonas aeruginosa* ATCC 74303 and *Enterococcus faecalis* ATCC 35824.

Inoculation of Test Organisms

100µl of 1McFarland bacterial suspensions were aseptically introduced and spread using pre-sterilized cotton swabs on surface of MHA plates.

Wells Preparation by Cork Borer

Agar well diffusion techniques as described by Adeniyi *et al.*, (1996). Wells of 6mm diameter with sterile cork borer were aseptically punched in the 90mm MHA agar plates.

Evaluation of Antimicrobial Activity

Antimicrobial activity of *Cannabis Sativa* leaf extract was tested using agar well diffusion method. With the help of sterile micropipette tips *Cannabis Sativa* leaf extract (Hot water) 100µl were poured into the wells. The plates were incubated at 37°C for 24 hours. After incubation, the diameter of the resulting zone of inhibition was measured with the help of Digital Vernier Caliper (Mitutoyo) and the average values were recorded. Each antimicrobial assay was performed three times. Mean values were reported in this report.

Data Analysis

All data were measured average value of three replicates and standard error (\pm). Results were subjected to Microsoft excel 2010.

Results

In the present study, the antimicrobial activity of the Hot water extracts and Ethanol extracts against two gram negative and one gram positive bacterial strains and their potential activity were qualitatively and

quantitatively assessed by the presence or absence of inhibition zones and MIC values.

Antibacterial activity

The extracts of the investigated plant species showed

antimicrobial activities against all tested bacterial strains. Results of the antimicrobial activity obtained using the well diffusion assay is summarized in Table 1 and figure 1, 2, 3 and 4.

Table 1. Activity of Hot water and Ethanol extract of Cannabis Sativa leaf against bacterial strains.

Zone of inhibition of <i>Cannabis Sativa</i> leaf					
Hot water and ethanol extract to bacterial strains					
S.N	bacterial strains	1 st replica	2 nd replica	3 rd replica	Average (\pm)
1	<i>Pseudomonas aeruginosa</i>	25.7mm	24.9mm	25.3mm	25.3mm
2	<i>Escherichia coli</i>	21.9mm	22.2mm	22.5mm	22.2mm
3	<i>S. aerious</i>	11.5mm	10.3mm	9.2mm	10.3mm

Discussion

The goal of this research was to find out the antibacterial activity of Cannabis sativa leaf extracts to some selective bacterial strains. The activity of this plant leaf extract is due the presence of phenyl moiety of cannabinoids which act as a good antimicrobial agent (Appendino, *et al* 2008). The acidic fraction from the ethanolic extract of Cannabis sativa leaf showed activity against both Gram-positive and Gram-negative bacteria (Wasim *et al.*, 1999; Radwan *et al.*, 2009). These reports and presence of Cannabinoid in different extract of Cannabis sativa confirm its potential against all selected pathogenic bacterial strains.

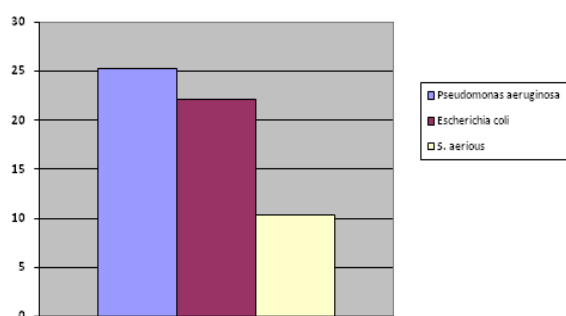


Fig. 1. Activity of Hot water and Ethanol extract of Cannabis Sativa leaf against bacterial strains.

In the present study, the antimicrobial activity of the Hot water extracts and Ethanol extracts against three gram negative and one gram positive bacterial strains and their potential activity were qualitatively and quantitatively assessed by the presence or absence of inhibition zones and MIC values.

The extracts of the investigated plant species showed antimicrobial activities against all tested bacterial strains. Results of the antimicrobial activity obtained using the well diffusion assay is summarized in Table.



Fig. 2. Activity of Hot water and Ethanol extract of Cannabis Sativa leaf against *S.aerious* strain.

The current study suggests that the Ethanol leaf extract of Cannabis Sativa have a broad range of antimicrobial activity, although the degree of susceptibility could different between different microorganisms. The antimicrobial activity found in this present conducted study may be recognized to the presence of secondary metabolites either individually or in combination of various types of chemical composition present in the plant material.

Antibacterial agents currently available in the market are limited due to their toxicity, low effectiveness and prove expensive in case of prolonged treatment. The discovery of a potent therapy from plant origin will be

a great advancement in microbial infection therapies. Therefore, there is needed to develop new antibacterial agents which can satisfy the present demand.



Fig. 3. Activity of Hot water and Ethanol extract of Cannabis Sativa leaf against E.coli strain.



Fig. 4. Activity of Hot water and Ethanol extract of Cannabis Sativa leaf against P.aeruginosa strain.

Conclusion

The minimum inhibitory effect of *C. sativa* leaf extract is due to certain compounds present in the *C.sativa*. Further research should be done to identify the compounds responsible for its activity which can be use as medicines to control a wide range of disease in the world.

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manuscript.

Competing interest

The author and co-authors of this manuscript do not have any conflict and competing interest.

References

Adams IB, Martin BR. 1996. Cannabis pharmacology and toxicology in animals and Humans. *Addiction* **91**, 1585-1614.

<http://dx.doi.org/10.1046/j.13600443.1996.011115852.x>

Adeniyi BA, Odelola HA, Oso BA. 1996. Antimicrobial potentials of *Diospyrosmespiliformis* (Ebenaceae). *African Journal of Medicine and Medical Sciences* **25**, 221-224.

Anonymous. 1996. Pharmacological Investigations of Certain Medicinal Plants and Compound Formulations Used in Ayurveda and Siddha, Central Council for Research in Ayurveda and Siddha, Government of India, New Delhi, 58.

Appendino G, Gibbons S, Giana A, Pagani A, Grassi G, Stavri M, Smith E, Rahma MM. 2008. Antibacterial Cannabinoids from *Cannabis sativa* A Structure-Activity Study, *journal of nature* **71**, 127-130.

<http://dx.doi.org/10.1021/np8002673>

Ayenigbara GO. 2012. Medical Utility of Cannabis Sativa. *Journal of Pharmacy* **2(3)**, 460-463.

Balandrin MF, Klocke JA, Wurtele ES, Bollinger WH. 1985. Natural plant chemicals: sources of industrial and medicinal materials. *Science*, **228**, 1154-1160.

<http://dx.doi.org/10.1126/science.3890182>

Blevins RD, Dumic MP. 1980. The effect of delta-9- tetrahydrocannabinol on herpes simplex virus replication. *Journal of General Virology* **49(2)**, 427-431.

<http://dx.doi.org/10.1080/15287398709531019>.

- Callaway JC, Summers LK, Bradshaw H, Frayn KN.** 2002. Changes in LDL particle composition after the consumption of meals containing different amounts and types of fat. *American Society for Clinical Nutrition* **76**, 345-350.
- Darshan SK, Rudolph IL.** 2000. Effect of fatty acids of w-6 and w-3 type on human immune status and role of eicosanoids. *Nutrition* **16**, 143-145.
- Klingeren VB, Ham TM.** 1976. Antibacterial activity of delta-9- tetrahydrocannabinol and cannabidiol. *Antonie van Leeuwenhoek* **42(1-2)**, 9-12.
- Kreji Z.** 1958. Univ-palacky, Olomouc, Czech, hemp cannabis sativa antibiotic drug II methods and results of bacteriological investigations and preliminary clinical experiences. *Journal of Pharmazi*, **13**, 155-166.
- Lancz G, Specter S, Brown HK.** 1991. Suppressive effect of delta-9- tetrahydrocannabinol on herpes simplex virus infectivity in vitro. *Proceedings of the Society for Experimental Biology & Medicine* **196(4)**, 401-404.
- Majid A, Rahman MU, Shah JA, Khan K, Ali MA, Zamin I, Ullah Z, Ibrar I, Zaman Q.** 2013. In vitro antibacterial activity of *Camellia sinensis* leaf extracts to some selective pathogenic bacterial strains. *International Journal of Biosciences* **3(9)**, 69-75.
<http://dx.doi.org/10.12692/ijb/3.9.69-75>
- Merzoukia, Ed-derfoufi F, Molero J.** 2000. Hemp (*Cannabis sativa* L.) and abortion, *Journal of Ethnopharmacology* **73(3)**, 501-503.
[http://dx.doi.org/10.1016/S0378-8741\(00\)00323-8](http://dx.doi.org/10.1016/S0378-8741(00)00323-8)
- Nath D, Sethim N, Srivastava S, Jain AK, Srivastava R.** 1997. Survey on indigenous medicinal plants used for abortion in some districts of Uttar Pradesh, *Fitoterapia* **68(3)**, 223-225.
- Radwan MM, Elsohly MA, Slade D, Ahmed SA, Khan IA, Ross SA.** 2009. Biologically active cannabinoids from high-potency *Cannabis sativa*. *Journal of Nature Production* **72(5)**, 906-911.
<http://dx.doi.org/10.1021/np900067k>
- Roth MD, Baldwin GC, Tashkin DP.** 2002. Effects of delta-9 tetrahydrocannabinol on human immune function and host defense. *Journal of Chemistry and Physics of Lipids* **121(1-2)**, 229-239.
[http://dx.doi.org/10.1016/S0009-3084\(02\)00159-7](http://dx.doi.org/10.1016/S0009-3084(02)00159-7)
- Turner CE, Elsohly MA.** 1981. Biological activity of cannabichromene, its homologs and isomers. *Journal of Clinical Pharmacology* **21(8-9)**, 283S-291S.
- Wasim K, Ikram H, Ashrafa M.** 1995. Antimicrobial studies of the leaf of *Cannabis sativa*. *Pakistan Journal of Pharmaceutical Sciences*, **8(1)**, 29-38.
- Whittaker K, Roth MD, Salehi K, Tashkin DP, Baldwin GC.** 2004. Mechanisms for impaired effector function in alveolar macrophages from marijuana and cocaine smokers. *Journal of Neuroimmunology* **147(1-2)**, 82-86.
<http://dx.doi.org/10.1016/j.jneuroim.2003.10.017>