ANTI-BACTERIAL AND ANTIFUNGAL ACTIVITY OF ALOE VERA GEL EXTRACT

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Abstract
Objective: The present investigation was aimed to examine the antimicrobial potential of DMSO crude extracts of Aloe barbadensis Miller (Aloe vera) gel against the selected pathogens Bacillus subtilis, Salmonella typhi, Escherichia coli, Staphylococcus aureus, Proteus vulgaris, Aspergillus fumigatus, Candida albicans and Penicillium sps.

Methods: The bacteria were identified and confirmed by conventional microbiology procedure. Antimicrobial study was carried out by disc diffusion method against the pathogens by using the crude DMSO extracts of A. vera gel.

Results: The antibacterial activity has been observed in the DMSO gel extracts of A. vera against all the tested bacteria with varied activity. The maximum zone of inhibition 13 mm for E. coli, 12 mm for P. vulgaris, 10.5 mm for S. aureus and 10 mm for B. subtilis were observed. The maximum zone of inhibition 11 mm for C. albicans and 9 mm for Penicillium sps were observed.

Conclusion: It is hoped that this study would lead to the establishment of some compounds that could be used to formulate new and more potent antimicrobial drugs of natural origin.

Keywords: Aloe barbadensis; Aloe vera; Bio-efficacy; Anti-Bacterial; Anti-fungal

1. Introduction
Aloe barbadensis Miller (Aloe vera) belongs to the Liliaceae family, of which there are about 360 species. It is a cactus-like plant that grows readily in hot, dry climates and currently, because of demand, is cultivated in large quantities. The gel of A. vera was used to treat stomach ailments, gastrointestinal problems, skin disease, constipation, radiation injury, inflammatory effect, healing wounds and burns, ulcer and diabetes. A. vera products are mainly for cosmetic, pharmaceutical, nutraceuticals and food industries. The gel stimulates cell growth and enhances the restoration of damaged skin. It moisturizes the skin because it has a water holding capacity. As a drink, it protects the mucous membrane of the stomach especially when irritated or damaged. A. vera juice is considered helpful for relieving many types of gastrointestinal irritation and juice products are widely available. Aloe gel is perhaps the most widely recognized herbal remedy in the United State today; it is used to relieve gastric burn, sunburn and promote wound healing. In addition, research suggests that Aloe gel can help to stimulate the body’s immune system. A. barbadensis Miller (A. vera) possessed a number of therapeutic uses viz., anti-inflammatory, immunostimulatory, antibacterial, antiviral, antifungal and cell growth stimulatory activity. A number of reports are available on the microbial activity of the hexane, ethanolic, acetone, petroleum ether; ethyl acetate extracts A. vera gel and leaves. Although a lot of works have been carried out on the biological activity of A. vera gel, there is a lacuna on the exercise of DMSO as solvent for the phyto-constituents (active compounds) extraction. Dimethyl sulfoxide (DMSO) is an organosulfur compound. It is an important polar aprotic solvent that dissolves both polar and nonpolar compounds and is miscible in a wide range of organic solvents as well as water. It is extensively used as an extractant in biochemistry. With this knowledge, the present study was aimed to examine the DMSO aloe gel extract against the selected pathogens.

2. Materials and Methods:
2.1. Collection of plant Material: Leaves of Aloe vera were collected from the road sides of in and around Nagercoil, Tamil Nadu, India. The plant was authenticated by Dr. M. Johnson and
the specimens voucher was deposited in the St. Xavier’s College Herbarium for further reference.

2.2. **Extraction:** Mature, healthy and fresh leaves of *A. vera* were washed in the running tap water for 5 min and rinsed with sterile distilled water, then dissected longitudinally and the colourless parenchymatous tissue (aloevera gel) was scraped out using a sterile knife without the fibres. The gel was ground with DMSO using the mortar and pestle. The extracts were filtered using Whatman No. 1 filter paper and the filtrate was centrifuged at 5000 rpm for 5 min.

2.3. **Experimental Procedure:** The supernatant was collected and stored in refrigerator at 4°C. Different concentration of *A. vera* gel extract was subjected to antimicrobial studies. Pure bacterial and fungal culture was obtained from Vivek’s Laboratory, Nagercoil. Five bacterial cultures *Bacillus subtilis, Salmonella typhi, Escherichia coli, Staphylococcus aureus* and *Proteus vulgaris* were maintained in potato dextrose agar medium at room temperature and were sub-cultured into newly prepared nutrient agar slants, every two-week. Three fungal cultures of *Aspergillus fumigatus, Candida albicans* and *Penicillium* sps were maintained in potato dextrose agar medium. The selected microorganism were identified and confirmed by conventional and biochemical test. Antimicrobial activity was carried out by disc diffusion method against the selected pathogens. The crude DMSO extracts were used for bioassay against both bacteria and fungi. Sterile discs with 6 mm diameter were loaded with 100, 200, 400 µg/ml of gel DMSO extracts and introduced into the sterile medium with the test organisms. The plates were incubated at 37º C for 24 hours. Antimicrobial activity was evaluated by measuring the zone of inhibition. All the experiments were repeated thrice and results were recorded. DMSO was used as negative control.

3. **Result:**

DMSO gel extracts of *A. vera* were screened for the antibacterial and antifungal activity against the human pathogens and the results are given in the Table 1. The antibacterial activity has been observed in the DMSO gel extracts of *A. vera* against all the tested bacteria with varied activity. The maximum zone of inhibition 13 mm for *E. coli*, 12 mm for *P. vulgaris*, 10.5 mm for *S. aureus* and 10 mm for *B. subtilis* were observed. Similar to antibacterial, the antifungal activity of the *A. vera* gel extracts also varied according to the concentration. The maximum zone of inhibition 11 mm for *C. albicans* and 9 mm for *Penicillium* sps were observed. The *A. vera* gel extracts were failed to show the zone of inhibition against the *A. fumigatus*. All the three different concentrations (100, 200 and 400 µg/mL) of DMSO gel extracts of *A. vera* showed the inhibitory effect on the seven out of eight pathogens with the maximum zone of inhibition (400 µg/mL).

4. **Discussion:**

In the present investigation, *in vitro* antibacterial and anti-fungal activity of the DMSO gel extracts of *A. vera* was quantitatively evaluated on the basis of zone of inhibition. All the three concentration of DMSO gel extracts of *A. vera* studied in the present investigation exhibited varying degree of inhibitory effect against the selected bacterial and fungal pathogens (Table 1). The present study shown the anti-bacterial and anti-fungal property of DMSO gel extracts of *A. vera* against the selected strains of human pathogenic bacteria and fungi and the degree of inhibition varied depending upon the concentration of the extract. Highest concentration of DMSO gel extracts of *A. vera* displayed maximum zone of inhibition (Table 1). The DMSO gel extracts of *A. vera* showed highest degree of activity (7/8) against the selected pathogens.

Ibrahim et al. 20 investigated the phytoconstituents and antimicrobial activity of aqueous, ethanol and acetone extracts of the *A. vera* gel against some human and plant pathogens by disc diffusion method. Among the three extracts, ethanol and acetone extracts recorded significant antimicrobial activity against all test pathogens. Antibacterial and antifungal activity of the acetone extract was found to be quite impressive as compared to ethanol and aqueous extracts. Cock 16 studied the antimicrobial activity of *A. barbadensis* leaf gel components. Methanolic extracts of *A. barbadensis* inner leaf gel were fractionated by RP-HPLC and the resultant fractions were tested for inhibitory activity against a panel of bacteria and fungi. Five fractions were identified as having antimicrobial activity. Of which fraction 1 had the broadest antibacterial activity. Agarry et al. 15 compared the antimicrobial activities of ethanolic extracts of *A. vera* gel and leaf against *S. aureus*, *P. aeruginosa*, *Trichophyton mentagrophytes*, *T. schoeleinii*, *M. canis* and *C. albicans*. Antimicrobial susceptibility test
showed that both the gel and the leaf inhibited the growth of *S. aureus*. Only the gel inhibited the growth of *T. mentagrophytes*, while the leaf possesses inhibitory effects on both *P. aeruginosa* and *C. albicans*. Thiruppathi et al.\(^{18}\) conducted a study to determine the antimicrobial activity of *A. vera* juice with different solvents viz., hexane, ethyl acetate, petroleum ether and ethanol against Gram positive bacteria (*B. subtilis*, *S. aureus*), Gram negative bacteria (*E. coli*, *K. pneumoniae*, *P. aeruginosa*). The result showed that more antimicrobial activity in ethyl acetate (1-9 mm) and ethanol extract (7-12 mm). The least inhibitory effect on petroleum ether extract was 2 mm. Thiruppathi et al.\(^{18}\) prepared the *A. vera* gel crude extracts according to the method described by Ahmad et al.\(^{21}\) with minor modifications. 1 gm gel extract was mixed in 5 mL of ethanol and mixed well and kept it under shaker for overnight.\(^{22}\) After overnight incubation the mixture was filtered through Whatmann No. 1 paper and it was evaporated at room temperature. After evaporation, pellet was resuspended with 0.5 mL of Di Methyl Sulpho Oxide (DMSO) using micro syringe and recollect it for further use. Plant powder residue left after ethanol extraction was sequentially extracted with ethyl acetate, hexane and petroleum ether. In the present study, we extracted the *Aloe vera* gel with DMSO as a solvent. They studied the antibacterial activity of hexane, ethyl acetate, petroleum ether and ethanol extract of *A. vera* gel against Gram positive bacteria (*B. subtilis*, *S. aureus*), Gram negative bacteria (*E. coli*, *K. pneumoniae*, *P. aeruginosa*). But in the present study we studied the antibacterial and antifungal activity against the *B. subtilis*, *S. typhi*, *E. coli*, *S. aureus*, *P. vulgaris*, *A. fumigatus*, *C. albicans* and *Penicillium* sps. In addition, Arunkumar and Muthuselvam\(^{17}\) used three different solvents aqueous, ethanol and acetone to extract the bioactive compounds from the leaves of *A. vera* to screen the antimicrobial activity against selected human clinical pathogens by agar diffusion method. They observed the maximum antibacterial activities in acetone extracts (12±0.45 nm, 20±0.35 nm, 20±0.57 nm and 15±0.38 nm) other then aqueous and ethanol extracts. The maximum antifungal activity was observed in acetone extracts (15±0.73 nm and 8±0.37 nm) when weighed against other extracts. Pawar et al.\(^{23}\) prepared the crude *A. vera* gel extract by hot extraction with acetone, ethanol and methanol in the oven at 80°C for 48 h. In the present study, we prepared the cold *A. vera* extracts by using Dimethyl sulfoxide as a solvent. Pugh et al.\(^{19}\) and Lawless and Allan\(^{24}\) screened the antimicrobial activity of *A. vera* gel against the pathogens viz., *S. aureus*, *B. subtilis*, *K. pneumoniae*, *Streptococcus pyogenes*, *Pseudomonas*, *E. coli*, *Helicobacter pylori* and *S. typhi*. They observed the maximum zone of inhibition against *Bacillus* with 23 mm. They observed the minimum inhibition activity against the pathogen *E. coli*. In contrary in the present study we observed maximum zone of inhibition against the pathogen *E. coli* (13 mm). Alemdar and Agaoglu\(^{25}\) conducted a study to determine the antimicrobial activity of the *A. vera* juice against Gram-positive bacteria (*Mycobacterium smegmatis*, *S. aureus*, *Enterococcus faecalis*, *M. luteus* and *B. sphericus*), Gram-negative bacteria (*P. aeruginosa*, *K. pneumoniae*, *E. coli* and *S. typhimurium*) and *C. albicans* as in vitro. The study showed that *A. vera* juice has antimicrobial activity against *M. smegmatis*, *K. pneumoniae*, *E. faecalis*, *M. luteus*, *C. albicans* and *B. sphericus*, but has no inhibitory effect against the other bacterial strains. The result of the present study supplemented the previous observations on the antimicrobial activity of the *A. vera* gel extracts.

**Conclusion**

It is hoped that this study would lead to the establishment of some compounds that could be used to formulate new and more potent antimicrobial drugs of natural origin. Studies are in progress to identify the bioactive compound and to evaluate the mechanisms of action of *A. vera* gel extracts on some organisms associated with human diseases.

**References**


6. Davis HR. *Aloe vera*: A Scientific Approach Published by Vantage Press, New York, USA.


<table>
<thead>
<tr>
<th>Name of the Pathogens</th>
<th>Conc. of DMSO <em>Aloe vera</em> Gel extract in µg/ml &amp; Zone of Inhibition in mm</th>
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<tbody>
<tr>
<td></td>
<td>100 µg/ml</td>
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<tr>
<td><strong>Bacillus subtilis</strong></td>
<td>7</td>
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<td><strong>Salmonella typhi</strong></td>
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<tr>
<td><strong>Escherichia coli</strong></td>
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<td><strong>Staphylococcus aureus</strong></td>
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<tr>
<td><strong>Proteus vulgaris</strong></td>
<td>10</td>
</tr>
<tr>
<td><strong>Aspergillus fumigatus</strong></td>
<td>Nil</td>
</tr>
<tr>
<td><strong>Candida albicans</strong></td>
<td>8</td>
</tr>
<tr>
<td><strong>Penicillium spp</strong></td>
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