

INVESTIGATION OF COMPARATIVE ANTIMICROBIAL ACTIVITY OF ALOE VERA GEL AND JUICE

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Summary

Antimicrobial activities and Minimum Inhibitory Concentration (MIC) of aloe vera gel and aloe vera juice were evaluated against *Escherichia coli* (ATCC10418), *Staphylococcus epidermididis* (ATCC29213), *Salmonella typhimurium* (ATCC29922), *Staphylococcus aureus* (ATCC6571), *Bacillus subtilis* (ATCC6633), *Enterococci faecalis* (ATCC29212), *Proteus vulgaris* (ATCC13315), *Pseudomonas aeruginosa* (ATCC1062). Aloe vera juice showed the inhibitory effect against all the microorganisms. Aloe vera gel was only effective against *S. aureus* (10.54±0.43 mm) respectively. MIC was determined only for the aloe vera juice and was found to be more active (89.9%) against *Proteus vulgaris*. This *in vitro* study demonstrated that folk medicine could be as effective as modern medicine to combat pathogenic microorganisms.

Key words: Aloe vera gel, Aloe vera juice, Antimicrobial,

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Introduction

Aloe, is a genus containing about four hundred species of flowering succulent plants belonging to *Liliaceae* family ⁽¹⁾. Aloe vera is a typical xerophyte with thick fleshy, strangely cuticularized spiny leaves. Aloe vera has been promoted for large variety of condition and has come to play a prominent role as a contemporary folk remedy ^{(2) (3)}. The fresh leaves of Aloe vera are used to obtain two components. A bitter yellow latex from peripheral bundles sheath of aloe known for its laxative properties due to presence of anthraquinone glycosides called aloe vera juice or aloes. Aloes contains anthraquinone derivatives (aloe emodin) and their glycosides (aloin), which are known for their cathartic effect ⁽⁴⁾. Secondly a mucilaginous gel from the parenchymatous tissues in the leaf pulp of aloe vera has been used since early time for the topical treatment of burns and wounds ⁽⁵⁾. The gel stimulates cell growth and as such enhances the restoration of the damaged skin. It moisturizes the skin because of its water holding capacity ⁽⁶⁾. As a drink it protects the

mucus membrane of stomach especially when irritated or damaged. Anthraquinones are abundant in sap and rarely occurs in gel.

Aloe vera gel is perhaps the most widely used herbal remedy in U.S. today. It is used to relieve thermal burns, sunburns and promotes wound healing ⁽⁷⁾. Antimicrobial properties of aloe vera are primarily recognized ⁽⁸⁾ however; its effect on microbial growth needs to be evaluated. In the present study the effect of aloe vera juice and aloe vera gel on *Escherichia coli*, *Staphylococcus epidermididis*, *Salmonella typhimurium*, *Staphylococcus aureus*, *Bacillus subtilis*, *Enterococci faecalis*, *Proteus vulgaris*, and *Pseudomonas aeruginosa* was compared to gentamicin and doxycycline.

Materials and Methods

Aloe vera juice was purchased from Besure Inc. Okhla Industrial Area Phase-1, New Delhi 110026 (India), and aloe vera gel was purchased from Nature, Forever Living Products International, Inc., Mumbai, India. Pure cultures of the test organisms *Escherichia coli* (ATCC10418), *Staphylococcus epidermididis* (ATCC29213), *Salmonella typhimurium* (ATCC29922), *Staphylococcus aureus* (ATCC6571), *Bacillus subtilis* (ATCC6633), *Enterococci faecalis* (ATCC29212), *Proteus vulgaris* (ATCC13315), *Pseudomonas aeruginosa* (ATCC1062) were obtained from the Microbiology laboratory of the Allahabad Agriculture Institute – Deemed university, Allahabad, U.P., India. All the organisms were maintained on agar slant stocks and were subsequently sub cultured into newly prepared nutrient agar slants.

Cultures of bacteria were grown on nutrient broth (Hi Media, Mumbai) at 37⁰C for 12–14 h and were maintained on nutrient agar slants (Hi Media, Mumbai) at 4⁰C. The aloe vera juice and gel were dissolved in ethylene glycol and tested for antibacterial activity using disc diffusion method. A concentration of 2000 µg/disc was chosen based on available literature ⁽⁹⁾ ⁽¹⁰⁾. Sterile 6-mm diameter filter paper discs impregnated with ethylene glycol as control and 2000 µg of the sterile test material were placed on to nutrient agar surface spread with 0.1 ml of bacterial culture. The plates were incubated at 37⁰C for 12–14 h. The experiments were carried out in triplicate. The results (mean value n = 3) were recorded by measuring the zone of growth inhibition around the discs. For comparison, standard antibiotics a bacterial cell wall biosynthesis inhibitor gentamicin (30mcg) and a bacterial protein synthesis inhibitor doxycycline (30mcg) ⁽¹¹⁾ was included in the assay.

Statistical Analysis

All values for zone of inhibition (Table 1) & MIC (Table 2) are expressed as means \pm standard error of mean. Statistical analysis was carried out using Graph pad Prism 3.0 (Graph pad software; San Diego, CA). Data analysis was done with Student t test. A 0.05 level of probability was used as criterion for significance.

Results & Discussion

Antibacterial activity

Aloe vera gel and aloe vera juice were tested for the antibacterial activity against gentamicin and doxycycline as positive controls. The zone of inhibition shows that both gel and juice were less active than the positive controls. The data in table I indicate that all the bacteria's except *S. aureus* (9.56 ± 0.89 mm) were resistant to aloe vera gel whereas aloe vera juice have inhibitory effect on the all the tested organisms. The results clearly demonstrated that aloe vera juice possesses higher and broader spectrum of antimicrobial activity than aloe vera gel supporting previous findings⁽¹²⁾. It could be theorized that presence of greater amount of the anthraquinones and phenolic antioxidants in the extract could be responsible for the high and broad spectrum antimicrobial activity of the juice as compared to gel⁽⁸⁾.

Table 1: Zone of inhibition aloe vera gel and juice with gentamicin as a reference standard

Name of drug (→)	Aloe Vera juice	Aloe vera gel	Gentamicin (30mcg)	Doxycycline 30mcg)
Microorganism(↓)	Mean (mm)	Mean(mm)	Mean(mm)	Mean (mm)
<i>E. coli</i>	11.86 ± 0.57	6.00 ± 0.00	15.75 ± 0.89	15.75 ± 0.89
<i>S. aureus</i>	10.54 ± 0.43	9.56 ± 0.89	16.51 ± 0.59	10.51 ± 0.59
<i>P. aeruginosa</i>	9.25 ± 0.31	6.00 ± 0.00	11.15 ± 0.85	11.65 ± 0.69
<i>P. vulgaris</i>	11.56 ± 0.65	6.00 ± 0.00	12.75 ± 0.65	9.15 ± 0.65
<i>E. faecalis.</i>	13.75 ± 0.98	6.00 ± 0.00	19.85 ± 0.98	11.85 ± 0.98
<i>S. epidermididis</i>	12.56 ± 0.97	6.00 ± 0.00	23.59 ± 0.65	13.59 ± 0.65
<i>B. subtilis</i>	13.51 ± 0.56	6.00 ± 0.00	19.58 ± 0.56	10.58 ± 0.56
<i>S. typhimurium</i>	15.56 ± 0.85	6.00 ± 0.00	19.75 ± 0.84	9.75 ± 0.84

Mean- Mean value of diameter of inhibition zone with standard error.

As the diameter of paper disc used was 6 mm, 6 mm diameter included in the table is indicative of no activity.

Minimum Inhibitory Concentration

Data in table 2 shows the minimum inhibitory concentration for aloe vera juice compared with standard antibiotic (Gentamicin) taken as control. When compared to gentamicin, the activity shown by aloe vera juice against *E. coli* was found to be 53.8 %. At 1/10 dilution the activity was reduced to 29.2 %. Furthermore, at 1/100 dilution no significant decrease in the activity was observed. As evident by table 2, no significant change in activity against *S. aureus* was observed at 1/10 dilution (22.5%) although activity decreased to 5.3 % at 1/100 dilution. In *Pseudomonas aeruginosa*, the activity of aloe vera juice was gradually decreased from (52%) to (19.5 %) with dilution and at 1/100 dilution the aloe vera juice was found to be ineffective. *Proteus vulgaris* did not show any significant alteration in the activity with dilution. *Enterococci faecalis* did not show any significant change (42.8%) at 1/10 dilution, although activity decreased to (25.9%) at 1/100 dilution. Against *Staphylococcus epidermididis* aloe vera juice showed 41.1% activity, which decreased to 30.4% & 15.2% at 1/10 & 1/100 dilution. In *Bacillus subtilis*, activity decreased from 36.2% to 25% with subsequent dilution from 1/10 to 1/100. As compared to gentamicin, the activity showed by aloe vera juice against *Salmonella typhimurium* was found to be 61.4%. Although at 1/10 dilution the activity decreased to 32.4% and further decreases to 23.45% at 1/100 dilution.

Table 2: Minimum inhibitory concentration of aloe vera juice with gentamicin as a reference

Name of Drug (→)	Aloe vera juice		Aloe vera juice (1/10 dilution)		Aloe vera juice (1/100 dilution)		Gentamicin (30 mcg)	Ethylene glycol
Microrganism (↓) (1)	Mean (mm)	%*	Mean (mm)	%*	Mean (mm)	%*	Mean (mm)	Mean (mm)
<i>E. coli</i>	11.46±0.12	53.8	8.96 ± 0.23	29.2	8.75±0.12	27.1	16.15±0.45	6.00±0.00
<i>S. aureus</i>	8.22±0.25	23.1	8.16±0.95	22.5	6.51±0.59	5.3	15.61±0.19	6.00±0.00
<i>P. aeruginosa</i>	8.98±0.65	52.0	7.12±0.23	19.5	6.00±0.00	0.0	11.73±0.45	6.00±0.00
<i>P. vulgaris</i>	11.98±0.54	89.9	11.25±0.25	8.91	10.75±0.65	71.4	12.65±0.65	6.00±0.00
<i>E. faecalis.</i>	12.55±0.78	44.1	12.35±0.52	2.8	9.85±0.68	25.9	20.85±0.98	6.00±0.00
<i>S. epidermididis</i>	12.86±0.54	41.1	11.08±0.54	0.4	8.54±0.95	15.2	22.69±0.87	6.00±0.00
<i>B. subtilis</i>	13.51±0.56	60.2	10.52±0.65	6.2	9.12±0.46	25.0	18.48±0.65	6.00±0.00
<i>S. typhimurium</i>	15.56±0.45	61.4	11.05±0.69	2.4	9.65±0.15	23.45	21.56±0.12	6.00±0.00

Mean- Mean value of diameter of inhibition zone with standard error.

As the diameter of paper disc used was 6 mm, 6 mm diameter included in the table is indicative of no activity.

* Percentage was calculated against gentamicin by subtracting the disc diameter

The zone of inhibition shows that both gel and juice were less effective in combating pathogenic microorganisms than the traditional antibiotics. The presence of greater amount of anthraquinones and phenolic antioxidants in the extract could be responsible for the high and broad spectrum antimicrobial activity of the juice as compared to gel. This plant could be a source of new antibiotic compounds. The millenarian use of this plant in folk medicine suggests that it represent an economic and safe alternative to treat infectious diseases.

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