International Journal of Research and Review
Volume 11; Issue: 11; November 2024
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Screening and Formulation of Hand Sanitizer with Herbal Extracts of Aloe Vera and Cinnamon

Shruthi Sridhar

Dept. of Zoology, Jyoti Nivas College, Autonomous, Bangalore, India

DOI: https://doi.org/10.52403/ijrr.20241103

ABSTRACT

Sanitizers are liquid solutions formulated to reduce microbial growth on the hands, typically featuring alcohol as a primary component. However, various plant-derived bioactive compounds exhibit antimicrobial properties that can benefit the skin without adverse effects, enhancing its softness and overall health while providing a natural glow. This study explores the antimicrobial potential of plants such as tulsi, neem, lemon, and eucalyptus. An herbal sanitizer was developed using Aloe Vera and cinnamon extract, with the Microtiter Plate Technique employed to identify the optimal concentrations for effective use. Results revealed that both Aloe Vera and cinnamon extracts were effective in inhibiting microbial growth at a concentration of 1 mg. Notably, the combination of these extracts showed enhanced effectiveness, suppressing microbial growth at 0.5 mg. The formulated sanitizer using this combination inhibited specific microorganisms at 0.75 mg, while demonstrating a remarkable inhibitory effect on hand microbes at just 0.09 mg. These findings underscore the effectiveness of combining Aloe Vera and cinnamon in sanitizers. Additionally, the natural extracts incorporated into the formulation offer prolonged antimicrobial activity and contribute to maintaining skin health.

Keywords: Sanitizer, herbal extract, Aloe Vera, cinnamon, Microbes.

INTRODUCTION

The rise in infections caused by opportunistic microorganisms has become a major concern, with many pathogens developing multidrug resistance (Sunanda and Kolhapure, 2004). Pathogens such as meticillin-resistant *Staphylococcus aureus* (MRSA) and *Escherichia coli* persist in high-risk environments like healthcare and the food industry (Elizabeth and Sally, 1990), spreading through physical contact, contaminated surfaces, and food (Kimura et al., 2004). Hands harbor resident and transient flora. Resident flora, like *Staphylococcus aureus* and *Staphylococcus epidermis*, affect deeper skin layers and are harder to remove, whereas transient flora affects the skin surface temporarily (Imaël and Juliani, 2012). Pathogenic microbes on hands contribute to respiratory and gastrointestinal diseases (Kimura et al., 2004), as human skin offers favorable growth conditions (Coogan et al., 2008). Hand hygiene through sanitization is essential to prevent disease spread.

Alcohol-based sanitizers, while effective in killing 99.9% of bacteria (Kojo & Qian, 2004), can cause skin irritation and pathogen resistance (Joshi et al., 2008). To address these issues, herbal-based sanitizers have been introduced, leveraging plant extracts with antimicrobial, analgesic, and anti-inflammatory properties (Salma and Zeeshan, 2013; Behrooz et al., 2013; Nguefack et al., 2004). Eucalyptus, neem, and lemon extracts show antimicrobial activity (Dipti and Kamna, 2019; Satoru et al., 2000), while herbs like *Coleus*

vettiveroides, *Coriandrum sativum*, and *Vetiveria zizanioides* enhance sanitizer formulations (Supinya et al., 2003). Aloe vera and cinnamon extracts also exhibit antimicrobial and pharmacological effects (Philip, 1998; Marjorie, 1999), making them valuable alternatives to chemical sanitizers combined with quaternary ammonium compounds (EI Kamali et al., 2005). Thus, the present study was aimed to screen Aloe Vera and cinnamon extracts for their antimicrobial properties (using minimum inhibitory concentration) against various microbes and their use in the formulation of herbal based hand sanitizer.

MATERIALS AND METHODS

Collection of samples

Samples of Aloe Vera pulp and cinnamon barks were collected. It was taken care that the samples were without any debris and contamination.

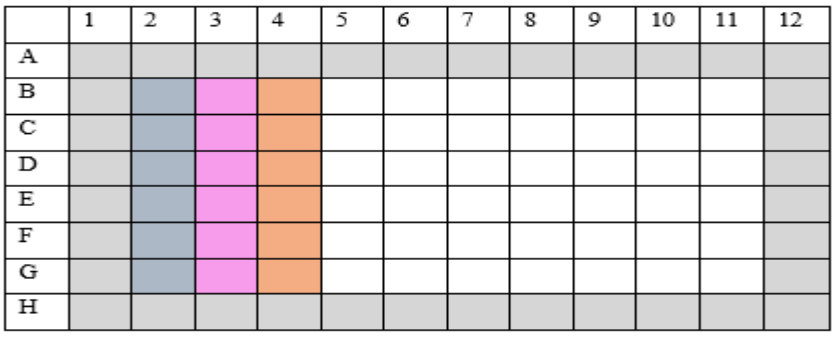
Extraction of herbal phytochemicals.

2.5g of Aloe Vera and 5g of Cinnamon were mixed separately with 500ml of absolute ethanol in 2 glass jars. The jars were incubated at 40°C for 96 hrs until the content in each jar was reduced to 250ml, so as to get the final concentration of 10mg/ml of Aloe Vera and 20mg/ml of cinnamon extracts respectively.

Determination of Minimum Inhibitory Concentration (MIC) of phytochemicals using microtitre plates

Separate cultures of microorganisms Salmonella typhi, Escherichia coli and Staphylococcus aureus were grown in LB broth and were kept ready for MIC screening. 30 ml of LB Broth was prepared by adding tryptone 0.3g, NaCl 0.3g, yeast extract 0.18g, distilled water 30ml. The broth was then autoclaved. 20ml of Resazurin dye was taken; it was used as an indicator for the growth of microorganism which can be visualised by the change in colour. Appearance of a pinkish red colour indicates the growth of microbes. Whereas if the blue colour of the dye is retained, it means there is no growth of microbes in that well.

Fig 1: Wells in the Micro titer plate



From fig 1, wells A1 –A12, B1 – H1, H2 – H12 and B12 – G12 were filled with autoclaved water to prevent the dehydration of the plates. Wells B2 – G2 were maintained as the control. They were filled with 100µl broth and 100µl Resazurin dye only. Wells B3 – G3 were maintained as the negative control. They were filled with 100µl broth, 100µl organisms and 100µl dye. Wells B4 – G4 were incubated with 100µl broth, 100µl organism, 100µl absolute ethanol and 100µl dye as another control in order to study the comparative inhibition of the respective extracts. Wells B5 – G5 were filled with 100µl broth, 100µl organism and 100µl of the extract and serially diluted to the adjacent wells. From these wells, 100µl of the contents were pipetted into the adjacent well upto the last. 100µl from the last well (column 11) was pipetted out and discarded. The serially diluted concentrations were 1000 µg, 500 µg, 250 µg, 125 µg, 62 µg, 31

µg and 15 µg respectively. Then 100µl dye was added to all the wells. The inoculation of microorganisms was done as follows: Rows B and C – *Escherichia coli;* Rows D and E – *Salmonella typhi* ; Rows F and G – *Staphylococcus aureus.* This was performed for pure (Aloe Vera and Cinnamon) extracts as well as for combinations of the extracts (Aloe Vera + Cinnamon) to estimate the minimum effective concentration of the extract. The plates were observed after incubation and the minimal inhibitory concentration were recorded.

Preparation of sanitizer

After screening MIC, the most effective concentration as found, was selected for the formulation of the sanitizer.

Screening of formulated sanitizer with various microbes.

The prepared formulation was tested and screened for the antimicrobial activity against various microbes. This was done on Micro titre plates. The exact same procedure was followed. Instead of the extract, sanitizer samples were taken and serially diluted. This was screened through the following organisms: *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cersus*, *Streptococcus mutans*, *Staphylococcus aureus* and Hand microbes. The plates were incubated and the results were observed.

RESULTS

MIC results of the individual extracts

Aloe Vera showed inhibition against *E. coli* at 1 mg dilution, *Salmonella typhi* at 1 mg dilution however there was no inhibition against *Staphylococcus* (Table 1). Cinnamon showed inhibition against *E. coli* at 1mg dilution, *Salmonella typhi* at 1mg dilution and *Staphylococcus* at 1mg dilution concentration (Table 2). Aloe Vera & Cinnamon combination showed inhibition against *E. coli* at 1mg dilution, Salmonella typhi at 0.5mg dilution and *Staphylococcus* at 0.5mg dilution concentration (Table 3).

Thus, the combination of Aloe Vera and Cinnamon was found to be the most effective in comparison to individual extracts of Aloe Vera and as the minimum inhibition of cinnamon was seen at 0.5mg against the microbes. The Aloe Vera and Cinnamon extracts were mixed to produce a net concentrated extract of 15 mg/ml.

Table 1: MIC of Aloe Vera Extract

Organisms	Duplicates	Minimum Inhibitory Concentration						
		1mg	0.5 mg	0.25mg	0.125mg	0.062 mg	0.031mg	0.015 mg
Salmonella typhi	1	+	-	-	-	-	-	-
	2	+	-	-	-	-	-	-
Staphylococcus aureus	1	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-
Escherichia Coli	1	+	-	-	-	-	-	-
	2	+	-	-	-	-	-	-

Table 2: MIC of Cinnamon Extract

Organisms	Duplicates	Minimum Inhibitory Concentration						
		1 mg	0.5 mg	0.25mg	0.125 mg	0.062 mg	0.031mg	0.015 mg
Salmonella Typhi	1	+	-	-	-	-	-	-
	2	+	-	-	-	-	-	-
Staphylococcus Aureus	1	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-
Escherichia Coli	1	+	-	-	-	-	-	-
	2	+	-	-	-	-	-	-

Table 3: MIC of Aloe Vera and Cinnamon Extract

Organisms	Duplicates	Minimum Inhibitory Concentration						
		1 mg	0.5 mg	0.25mg	0.125mg	0.062 mg	0.031mg	0.015 mg
Salmonella Typhi	1	+	+	-	-	-	-	-
	2	+	+	-	-	-	-	-
Staphylococcus Aureus	1	+	+	-	-	-	-	-
	2	+	+	-	-	-	-	-
Escherichia Coli	1	+	-	-	-	-	-	-
	2	+	-	-	-	-	-	-

MIC results of sanitizer samples

The MIC results were obtained for the sanitizer samples after preparation of aloe vera and cinnamon combination. The formulated sanitizer was shown to be effective against most of the microbes tested. The observed values are as follows: Inhibition against *Salmonella* was seen at 0.75mg, against *E. coli* at 1.50mg, against *Bacillus* at 0.75mg and against *Pseudomonas* at 0.75mg. No Inhibition was seen against *Staphylococcus* and *Streptococcus.* Inhibition against Hand microbes was seen at 0.09mg. Sanitizer with combination of Aloe Vera and Cinnamon showed effective inhibition at concentration 0.75mg on most the tested microorganisms as shown in Table 4.

Table 4: MIC of Aloe Vera and Cinnamon Hand Sanitizer Extract

Organisms	Duplicates	Minimum Inhibitory Concentration				
		1.5 mg	0.75 mg	0.37 Mg	0.18 mg	0.093 mg
Staphylococcus Aureus	1	-	-	-	-	-
	2	-	-	-	-	-
Salmonella Typhi	1	+	+	-	-	-
	2	+	+	-	-	-
Escherichia coli	1	+	-	-	-	-
	2	+	-	-	-	-
Bacillus ceresus	1	+	+	-	-	-
	2	+	+	-	-	-
Pseudomonas Aureginosa	1	+	+	-	-	-
	2	+	+	-	-	-
Streptococcus Mutant	1	-	-	-	-	-
	2	-	-	-	-	-
Hand Sample 1	1	+	+	+	+	+
Hand Sample 2	2	+	+	+	+	+

On the contrary to our study the studies by Mohammad Mehdi *et al.,* 2012 on Aloe Vera was found to have an average MIC of 25- 50 µg from Micro titer assay. The study conducted by Liesel Brenda *et al.,* 2008 showed the minimum inhibitory concentration of cinnamon to be 25- 50 µg. Cinnamon is found to be an effective antimicrobial agent based on several tests against 20 microbes and was reported as the best herbal product to be used (Masoumian *et al.,* 2017). Successful results have also been reported at concentrations of neem, tulsi, mint, lemon etc. ranging from 10-50µg. Addition of lavender and jasmine essential oils were also found to show inhibitory action along with a pleasant fragrance to the product.

In consideration with the samples used, equipment and lab ambience that were available, the results obtained in the current study are sufficient enough to support the fact that the combination of Aloe Vera and Cinnamon in sanitizers is very effective. Further advanced techniques and

methodologies could be employed to get more precise and effective results.

CONCLUSION

Sanitizers provide an effective alternative to hand washing with soap and water, but alcohol-based sanitizers can cause skin dryness and irritation, with their effect lasting only until the alcohol evaporates. Herbal sanitizers, however, offer extended protection as their natural extracts remain on the skin even after alcohol evaporation. Phytochemicals such as alkaloids, phenolics, terpenoids, and tannins in herbal formulations contribute antimicrobial, anti-inflammatory, and immunity-enhancing properties. In this study, a herbal sanitizer formulated with ethanolic extracts of aloe vera and cinnamon showed significant antimicrobial activity. The combination of aloe vera and cinnamon proved more effective against tested microorganisms and hand microbes than either extract alone. Therefore, the combination of these herbal ingredients enhances the overall efficacy of the sanitizer, making it a more effective option than traditional alcohol-based sanitizers.

Declaration by Author

Acknowledgement: None
Source of Funding: None
Conflict of Interest: No conflicts of interest declared.

REFERENCES

1. Amar S, Resham V, Saple DG. Aloe Vera: a short review. Indian J Dermatol. 2008;53(4):163–6.
2. Behrooz AB, Farideh TY, Ali M, Fatemeh Z, Mohammad MG, Alireza V. Effect of aqueous and ethanolic extract of *Eucalyptus camaldulensis* L. on food infection and intoxication microorganisms in vitro. J Paramed Sci (JPS). 2013;4(3):2008–4978.
3. Cogen AL, Nizet V, Gallo RL. Skin microbiota: A source of disease or defence? Br J Dermatol. 2008;158(3):442–55.
4. Dipti S, Kamna S. Formulation of an herbal substitute for chemical sanitizer and its evaluation for antimicrobial efficiency. Int J ChemTech Res. 2019;12(3):114–20.
5. Elizabeth S, Sally FB. The survival and transfer of microbial contamination via cloths, hands and utensils. J Appl Bacteriol. 1990; 68:271–8.
6. EI Kamali HH, Hamza MA, EI Amir MY. Antibacterial activity of the essential oil from *Cymbopogon nervatus* inflorescence. Antiseptic. 2005;76(5):446–9.
7. Elmastaş M, Gülçin İ, Işildak Ö, İbaoğlu K, Aboul-Enein HY. Radical scavenging activity and antioxidant capacity of bay leaf extracts. J Iranian Chem Soc. 2006; 3:258–66.
8. Fatima XG, Sowmya KV, Darsika C, Arul J, Shanmuganatham S. Polyherbal hand sanitizer: formulation and evaluation. Indian J Pharm Pharmacol. 2015;2(2):143–4.
9. Imaël HNB, Juliani HR. Essential oils in combination and their antimicrobial properties. Molecules. 2012;17(4):3989–96.
10. Joshi MG, Kamat DV, Kamat SD. Evaluation of herbal handwash formulation. Nat Prod Radiance. 2008;7(5):413–5.
11. Kalaivani R, Bakiya Lakshmi. A study on evaluation and effect and its anti-bacterial activity. Int J Trends Sci Res Dev. 2019; 2:48–54.
12. Kimura AC, Johnson K, Palumbo MS, Hopkins J, Boase JC, Reporter R, et al. Multistate shigellosis outbreak and commercially prepared food, United States. Emerg Infect Dis. 2004;10(6):1147–9.
13. Kojo E, Qian H. Aloe Vera: a valuable ingredient for the food, pharmaceutical, and cosmetic industries: a review. Crit Rev Food Sci Nutr. 2004;44(2):91–6.
14. Liesel GB, Ignazio F, Rosalía F, Martín JE. Antimicrobial activity of cinnamon (*Cinnamomum zeylanicum*) essential oil and its main components against *Paenibacillus larvae* from Argentina. J Appl Microbiol. 2008; 12:76–89.
15. Marjorie MC. Plant products as antimicrobial agents. Clin Microbiol Rev. 1999;12(4):564–82.
16. Masoumian M, Zandi M. Antimicrobial activity of some medicinal plant extracts against multidrug-resistant bacteria. Zahedan J Res Med Sci. 2017; 19:11–23.
17. Mendel F, Philip RH, Robert EM. Bactericidal activities of plant essential oils and some of their isolated constituents against *Campylobacter jejuni*, *Escherichia*

coli, *Listeria monocytogenes*, and *Salmonella enterica*. J Food Prot. 2002; 65:1545–60.
18. Mohammad mehdi F, Jamshid K. Inhibitory activity of Aloe Vera gel on some clinically isolated cariogenic and periodontopathic bacteria. J Oral Sci. 2012;54(1):15–21.
19. Nguefack GJ, Budde BB, Jakobsen M. Five essential oils from aromatic plants of Cameroon: their antibacterial activity and ability to permeabilize the cytoplasmic membrane of *Listeria innocua* examined by flow cytometry. Lett Appl Microbiol. 2004; 39:359–400.
20. Pascal JD, Kareen S, Benoit G, Giuseppe JM. Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oils. Int J Food Microbiol. 2002;74(1-2):101–9.
21. Philip A. Aloe Vera revisited. Br J Phytother. 1998; 4:176–83.
22. Raharivelomanana PJ, Terrom GP, Bianchini JP, Coulanges P. Study of the antimicrobial action of various essential oils extracted from Malagasy plants. Arch Inst Pasteur Madag. 1989; 56:261–71.
23. Rutuja SP, Nayna C. Formulation of herbal sanitizers and determining their antimicrobial activities against skin pathogens. Int J Innov Sci Res Technol. 2018;3(8):26–33.
24. Salma K, Zeeshan A. Herbal disinfectants: a review. World J Pharm Res. 2013;3(1):258–73.
25. Satoru K, Yasuhiko T, Eriko K, Kazunori O, Masamichi Y, Meisaku K, et al. Quantitative study of flavonoids in leaves of Citrus plants. J Agric Food Chem. 2000; 48:3865–71.
26. Sunanda M, Kolhapure SA. Evaluation of the antimicrobial efficacy and safety of PureHands herbal hand sanitizer in hand hygiene and on inanimate objects. Antiseptic. 2004;101(2):55–7.
27. Supinya T, Hirotsugu M, Norio N, Masao H, Takuya K, Toru O, et al. HIV-1 integrase inhibitory substances from *Coleus parvifolius*. Phytother Res. 2003;17(3):232–9.
28. Thomas JS, Elsie MT, Mei-Chiung S, Elissa AR, Grace ML, Dennis R, et al. A randomized, controlled trial of a multifaceted intervention including alcohol-based hand sanitizer and hand-hygiene education to reduce illness transmission in the home. Pediatrics. 2015;116(3):587–94.
29. Tomas H, Juan G. Tetrahydro-beta-carboline alkaloids occur in fruits and fruit juices. Activity as antioxidants and radical scavengers. J Agric Food Chem. 2003;51(24):7156–61.

How to cite this article: Shruthi Sridhar. Screening and formulation of hand sanitizer with herbal extracts of aloe vera and cinnamon. *International Journal of Research and Review*. 2024; 11(11): 20-25. DOI: *https://doi.org/10.52403/ijrr.20241103*

******