

Evaluation of Bio-Based Polymer Composites Containing Guava Leaf Extract for Antimicrobial Functionality

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Abstract

This study explores the formulation of an herbal soap using guava leaf extract as a primary ingredient. Guava leaves are a rich source of biopolymers like pectin and cellulose, which may contribute to the binding properties in the soap. The antimicrobial activity of the soap was evaluated against common skin pathogens (Staphylococcus aureus, Trichoderma spp., Aspergillus spp.). The formulated soap exhibited inhibitory effects against all tested pathogens. The weight, foaming capacity, and yield of the soap were also determined. While the natural biopolymers from guava leaves offer potential benefits, future research directions could involve incorporation of synthetic or biocompatible polymers to enhance the mechanical properties and durability of the soap. Additionally, characterization techniques like Fourier-transform infrared spectroscopy (FTIR) could be employed to analyze the interaction between guava leaf biopolymers and other soap components. Herbal soap is prepared to utilize guava leaf as a primary ingredient, numeric as a coloring agent, and lemongrass as a flavoring agent in the laboratory. The soap was subjected to physicochemical and microbiological analysis. The antimicrobial activity of the soap was evaluated against some common skin pathogens Staphylococcus aureus, Trichoderma spp. Aspergillus spp. herbal guava soap was formed to have had inhibitory effect against Staphylococcus aureus, Trichoderma spp. Aspergillus sp. The weight of the soap was 40.45. the foaming capacity of the soap was 22 minutes. The percentage of the yield of soap was found to be 86.52%. soap was found to be good. However, more studies regarding the formation and antimicrobial antifungal properties should be carried out.

Keywords: Biopolymers, pathogens, biocompatible polymers, herbal soap, polymeric linkage

INTRODUCTION

Soap is produced from the sodium or potassium salt of fatty acids through a saponification reaction,

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which involves the use of sodium or potassium hydroxide. [1] Acting as an anionic surfactant, soap possesses chemical characteristics that render it efficient for skin and clothing cleansing and laundering. These attributes comprise moisture content, total fatty acids (TFM), pH level, free alkali content, and percent chloride. Guava leaf extract is acknowledged for its versatile uses in natural cosmetics, soap, toothpaste, hair and skincare products, emulsions, liquors, ointments, and medicinal cosmetics [2]. Hence, the objective of this study is to utilize guava leaf extract as an affordable source of fatty material with inherent antibacterial properties.

Herbal Soap

Many commercial soaps contain chemicals that may be detrimental to skin health, making natural herbal soap a favorable alternative. Herbal soaps

are crafted using natural herbs and ingredients, ensuring a healthier option for skincare. High-quality herbal soaps are typically composed of certified organic olive, coconut, palm, soybean, castor, and almond oils, along with additions such as cocoa butter, shea butter, and essential oils [3].

Polymers as Viscosity Modifiers

The viscosity of a soap product is crucial for its application and consumer acceptability. Polymers have been extensively used to modify the rheological properties of soap formulations. Studies have demonstrated the effectiveness of these polymers in controlling the viscosity of soap bases, leading to improved product texture and consistency [4].

Polymers as Emulsifiers

Emulsifiers play a critical role in stabilizing oil-in-water emulsions in soap formulations. While traditional surfactants are commonly used, polymers can enhance emulsification properties. Research has explored the use of polymeric emulsifiers in soap formulations, highlighting their ability to improve stability and prevent phase separation [5].

Polymers as Foaming Agents

Foam generation is a crucial aspect of soap performance. While surfactants primarily contribute to foaming, polymers can influence foam stability and texture. Studies have investigated the impact of different polymers on foam characteristics, providing insights into the formulation of high-foaming soaps [6].

Antimicrobial Activity

Guava is known for its potent antimicrobial properties. Extracts derived from guava leaves have been found to effectively reduce cough symptoms due to their anti-cough activity [7]. Various extracts of guava leaves, including aqueous, chloroform, and methanol extracts, have demonstrated the ability to inhibit the growth of different bacteria. Given its effectiveness in alleviating cough symptoms, guava leaf extract is often recommended for individuals suffering from cough-related conditions [8].

Guava leaves exhibit potent antibacterial activity in their extract, effectively inhibiting the growth of *S. aureus*. Methanolic extracts derived from the leaves and bark of *P. guajava* demonstrate significant antimicrobial activity, capable of inhibiting *Bacilli* and *Salmonellae*. The methanolic extract of guava demonstrates notable antimicrobial properties, particularly effective against various strains of *Bacilli* and *Salmonellae*. Furthermore, the presence of active flavonoid compounds in guava extract contributes to its anti-plaque activity [9].

Flavonoid compounds and their derivatives can be extracted from guava, displaying the capability to hinder the growth of diverse bacteria across varying dilutions. Aqueous extracts of guava leaves contain terpinene and pinene, both of which exhibit antimicrobial properties [10]. These extracts are utilized medicinally for their bacteriostatic effects against pathogenic bacteria, making them effective treatments for conditions such as cough, diarrhea, oral ulcers, and swollen gums. While aqueous and ethanol extracts display low antimicrobial activity, the methanol extract shows a higher Minimum Inhibitory Concentration (MIC), indicating greater effectiveness. Moreover, this extract demonstrates activity against haemolysis. Guava leaves harbor multiple compounds recognized as fungistatic and bacteriostatic agents, as documented in a 2012 study, underscoring their wide-ranging spectrum of antimicrobial characteristics.

Guava extracts possess antiviral properties, effectively inhibiting the growth of various bacteria and controlling viral infections such as influenza virus. They can also combat viral resistance. The anti-viral activity of guava is attributed to its pesticide degradation capability. Furthermore, the essential oil derived from guava demonstrates activity against *Salmonella* and *S. aureus*, while guava is also renowned for its antioxidant properties [11]. Both aqueous and methanol extracts of guava leaves

demonstrate significant antibacterial activity, resulting in a remarkable zone of inhibition. Methanol and water extracts exhibit maximum Minimum Inhibitory Concentration (MIC), while ethanol extract shows the least anti-fungal activity. In conclusion, guava leaves, seeds, skin, and pulp display remarkable antimicrobial activity [12].

The presence of these compounds enhances the nutritional importance of guava. It is evident that both aqueous and methanol extracts of guava leave effectively inhibit bacterial growth, leading to a significant zone of inhibition. In conclusion, guava leaves, seeds, skin, and pulp exhibit remarkable antimicrobial activity. The aim of this study is to utilize guava leaf extract as an economical source of fatty material with antibacterial and antifungal properties.

MATERIALS AND METHODS

Collection of Sample

Guava leaves, lemongrass was collected from Ashta (Tal-walawa, Dist- Sangli), costic soda, oil, turmeric powder was purchased from local market.

Preparation of Soap [3].

50gms of fresh green guava leaves and 15 ml of coconut oil boiled in 200ml of distilled water for 30mins. The whole mixture was filtrated under muslin cloth. The filtrate was collected in a cooled beaker. A 2% solution of caustic soda was added to the filtrate with constant stirring, followed by the addition of 1 gram of colouring agent. The mixture was continuously stirred until it reached a concentrated state. Once concentrated, the solution was poured into small Petri plates and left to sit overnight in darkness. Next day soap was observed, weighted and subjected to further analysis.

Physicochemical and microbiological analysis of soap.

Determination of colour

The color was observed visually.

Determination of smell

The smell of the soap was felt by smelling.

Determination of texture

The texture of soap judged by hand.

Determination of pH [13].

Two grams of the powdered soap sample were precisely weighed and dissolved in 20 ml of distilled water in a 100 ml volumetric flask. Subsequently, this solution was diluted to create a 10% soap solution. The pH of the resulting solution was determined using a pH meter.

Determination of Foaming Capacity of Soaps

In a series of conical flasks, 5 grams of the provided soap granules are measured and added to each flask along with 50 ml of distilled water. The conical flasks are heated for several minutes to ensure complete dissolution of the soap granules. Next, a clean and dry test tube is placed in a test tube stand. One millilitre of the soap solution from one of the conical flasks is poured into the test tube, followed by the addition of 10 ml of distilled water. The test tube is then vigorously shaken five times to generate foam in the empty space above the solution. A stopwatch is immediately started, and the time taken for the foam to disappear is noted.

Antimicrobial Activity: [14]

Evaluation of antibacterial activity

The spore suspension of 24 hrs old culture of staphylococcus aureus was prepared in a sterile saline test tube. 1ml of suspension of staphylococcus aureus was mixed with 10ml of 2% soap solution. The tube was kept at room temperature for 5 min 0 1ml from the mixture was spread inoculated on nutrient agar plate.

1ml of suspension of staphylococcus aureus was inoculated in 10ml of sterile saline and 0.1 ml from this was spread inoculated on nutrient agar plate. The plate was maintained at ambient temperature for 48 hours. Following the incubation period, the plates were observed for any signs of growth.

Evolution of Antifungal Activity [15].

Trichoderma species

The spore suspension of 24 hrs old culture of Trichoderma was prepared in a sterile saline test tube. 1ml of suspension of Trichoderma was mixed with 10ml of 2% soap solution. The tube was kept at room temperature for 5 min. 0.1ml from the mixture was spread inoculated on saboard's dextrose plate. 1ml of suspension of Trichoderma was inoculated in 10ml of sterile saline and 0.1ml from this was spread inoculated on sabouraud's dextrose plate. The plate was maintained at ambient temperature for 48hrs. After the 48hrs the plates was observed for growth.

Aspergillus species

The spore suspension of 24 hrs old culture of Aspergillus was prepared in a sterile saline test tube. 1ml of suspension of Aspergillus was mixed with 10ml of 2% soap solution. The tube was kept at room temperature for 5 min. 0.1ml from the mixture was spread inoculated sabouraud's dextrose plate.

1ml of suspension of *Aspergillus* was inoculated in 10ml of sterile saline and 0.1ml from this was spread inoculated on sabouard's dextrose plate. both the plate were maintained at ambient temperature for 48hrs. After the 48hrs the plates was observed for growth.

RESULT

Preparation of Herbal Soap

Guava leaf extract soap was prepared. The weight of the soap was found to be 40.45gm

Table 1. Results of the determination of physicochemical properties of the Guava leaves extract soap.

S.N.	Test	Result
1	color	Sandle colour
2	Smell	Pleasant smell (lemon grass smell)
3	Texture	Soft
4	pH	8
5	Foaming capacity	22 minutes
6	Percentage of yield	86.25%

The color of the soap is sandal color. The smell of soap was pleasant. The texture of the soap is soft. The pH of herbal soap is 8. The foaming capacity of herbal soap is 22 minutes. The percentage of yield is 86.52%. (Table 1, Figure 1, Figure 2)



Figure 1. Herbal soap.



Figure 2. Foaming capacity of guava extract soap.

Table 2. Result of the antimicrobial activity of guava leaves extract soap against test organism.

S N.	Test microorganisms	Growth	
		Control	Soap + suspension
1	<i>Staphylococcus aureus</i>	Growth was observed	Growth was not observed
2	<i>Trichoderma spp.</i>	Growth was observed	Growth was not observed
3	<i>Aspergillus spp.</i>	Growth was observed	Growth was not observed

The antimicrobial activity of soap was evaluated against *Staphylococcus aureus*, *Trichoderma*, and *Aspergillus*. Soap shows the antimicrobial activity. Guava leaf extract soap showed high antimicrobial activity against *Trichoderma*. (Table 2, Figure 3, Figure 4, Figure 5)



Figure 3. Antimicrobial activity against bacterium (*Staphylococcus aureus*).



Figure 4. Antimicrobial activity against fungus (*Aspergillus spp.*).



Figure 5. antimicrobial activity against fungus (*Trichoderma spp.*).

CONCLUSION

Herbal soap is prepared to utilize guava leaf as a primary ingredient, numeric as a coloring agent, and lemongrass as a flavoring agent in the laboratory. The soap was subjected to physicochemical and microbiological analysis. Physicochemical analysis was done by determining the color, smell, texture, p. foaming capacity, and percentage of yield of the soap. The antimicrobial activity of the soap was evaluated against some common skin pathogens staphylococcus aureus, Trichoderma spp, and Aspergillus spp. Herbal guava soap was formed to have an inhibitory effect against staphylococcus aureus, Trichoderma spp, and Aspergillus spp. The color of the soap was sandal color. The smell of the soap was pleasant (lemon grass smell). The texture of the soap was soft. The pH of the soap was 8. The weight of the soap was 40.45 gm. the foaming capacity of the soap was 22 minutes. The percentage of the yield of soap was found to be 86.52%. soap was found to be good. However, more study regarding the formation and antimicrobial properties should be carried out.

REFERENCES

1. Thorpe, Jenalyn. "Waste Vegetable Oil Properties with Usage and Its Impact on Artisan Soap Making." (2018).
2. Mahran GH. Recent Research on Medicinal Plants in the African Region. The Medicinal Plant Industry. 2017 Jul 12:209-22.
3. Jacob, Blessy, and V. Ciyamol. "Formulation and Evaluation of Herbal Soap." *A Journal of Pharmacology* 9, no. 2 (2019): 22-29.
4. Martini A, Ramasamy US, Len M. Review of viscosity modifier lubricant additives. Tribology Letters. 2018 Jun;66:1-4.
5. Hu M, Russell TP. Polymers with advanced architectures as emulsifiers for multi-functional emulsions. Materials Chemistry Frontiers. 2021;5(3):1205-20.
6. Monie F, Vidil T, Grignard B, Cramail H, Detrembleur C. Self-foaming polymers: Opportunities for the next generation of personal protective equipment. Materials Science and Engineering: R: Reports. 2021 Jul 1; 145:100628.
7. Barbalho, Sandra M., Flávia MV Farinazzi-Machado, Ricardo de Alvares Goulart, Anna Cláudia Saad Brunnati, A. M. Otoboni, and B. J. M. A. P. Ottoboni. "Psidium guajava (Guava): A plant of multipurpose medicinal applications." *Med Aromat Plants* 1, no. 4 (2012): 1-6.
8. Vogelberg, Christian, Francisco Cuevas Schacht, Christopher P. Watling, Laura Upstone, and Georg Seifert. "Therapeutic principles and unmet needs in the treatment of cough in pediatric patients: review and expert survey." *BMC pediatrics* 23, no. 1 (2023): 34.
9. Rusmiany, Putu, and Thomas Jonathan Senduk. "GUAVA (Psidium guajava L.) LEAF EXTRACTS CAN AS A GROWTH INHIBITOR Staphylococcus aureus." (2021).
10. Naseer S, Hussain S, Naeem N, Pervaiz M, Rahman M. The phytochemistry and medicinal value of Psidium guajava (guava). Clinical phytoscience. 2018 Dec;4(1):1-8.
11. Babbar, Neha, Harinder Singh Oberoi, and Simranjeet Kaur Sandhu. "Therapeutic and nutraceutical potential of bioactive compounds extracted from fruit residues." *Critical Reviews in Food Science and Nutrition* 55, no. 3 (2015): 319-337.
12. Yaun, Emma A., and Brian A. Vasquez. "Antibacterial activity of formulated Psidium guajava (guava) hand sanitizer gel on Staphylococcus aureus." *University of the Visayas-Journal of Research* 11, no. 1 (2017): 1-6.
13. Babel, Sudha, and L. Sanchiher. "Finishing of cotton fabric with Psidium guajava herbal extract and testing its antimicrobial activity." (2020).
14. Rafiq, Shaik Jasmine Shahina. "Formulation of herbal soap against acne causing bacteria." *Asian Journal of Biological and Life Sciences* 10, no. 3 (2021): 609.
15. Suwendar, S., L. Wahidah, Y. Krisnamurti, M. L. Ridwan, W. Lestari, D. Mardliyani, and N. Fitriani. "Development of Feminine Area Cleansers with Anti-fungal Properties Using Apple Rose Leaves as an Active Ingredient." *KnE Life Sciences* (2022): 219-224.