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# Antimicrobial Potential of Makahiya Plant (*Mimosa Pudica)* Extract as a Natural Hand Sanitizer Gel

Karyll Kay A. Balyao[1*], Justine Mae C. Bayubay[1], Florie Mae D. Malannag[1], Melissa T. Lanipao[1] and Janver Lalic Tovera[1]
[1]*International School of Asia and the Pacific – Kalinga*
[*]*janverlalictovera@gmail.com*

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**ABSTRACT**

Frequent use of alcohol-based hand sanitizers can dry and irritate the skin, which has increased interest in plant-based alternatives. This study developed a hand sanitizer gel containing Makahiya (*Mimosa pudica*) leaf extract and assessed its physical properties and its antibacterial activity against *Escherichia coli*. The extract was made by boiling sun-dried leaves in distilled water for 15 minutes. It was then mixed with 95% ethanol, glycerine, Carbopol, baking soda, aloe vera and fragrance oil to make three gel formulations. From Trial 1 to Trial 3, the extract content rose from 42.96% to 52.08% (v/v) and the 95% ethanol content from 10.74% to 19.53%. Each formulation was evaluated for pH, consistency, odor and stability. Antibacterial activity was measured by the Department of Science and Technology (DOST) using the agar well diffusion method. The pH values of all three formulations (5.1, 5.5 and 6.2) were within the range acceptable for skin. Zones of inhibition against *E. coli* increased from 13 mm in Trial 1 to 15.33 mm in Trial 2 and 18 mm in Trial 3. By the study's criteria, this rates Trial 1 as partially active and Trials 2 and 3 as active. All three zones were smaller than the positive control's (34 mm). Trial 3 was the best formulation, with a smooth, stable gel, a pleasant minty-herbal odor and the strongest inhibition. Its ethanol content was still well below the 60–70% recommended for hand sanitizers. Makahiya extract can be made into a usable hand sanitizer gel with moderate antibacterial activity, but the formulation needs more alcohol, wider microbial testing and longer stability testing before it can serve as an alternative to commercial products.

**Keywords:** *Mimosa pudica*, Makahiya, herbal hand sanitizer, antibacterial activity, *Escherichia coli*, zone of inhibition, plant-based gel formulation

## INTRODUCTION

Makahiya plant (*Mimosa pudica*), also called sensitive plant, sleepy plant, action plant, touch-me-not, or shame plant, was a creeping annual or perennial flowering plant of the pea/legume family Fabaceae and Magnoliopsida taxon, often grown for its curiosity value. It had compound leaves which folded inward and drooped when touched or shaken, defending themselves from harm, and re-opened a few minutes later. It was native to South and Central America, and could be found in the Southern United States, South Asia, East Asia, and South Africa as well. It was usually found on soils with low nutrient concentrations. *Mimosa pudica* was well known for its rapid plant movement. Like a number of other plant species, it underwent changes in leaf orientation termed "sleep" or nyctinastic movement during darkness and reopened in light (seismatic movement).

In 2019, researchers studied the formulation of an antibacterial hand sanitizer from the crude extract of Makahiya plant (*Mimosa pudica* Linne). The results indicated that the crude extract of Makahiya (*Mimosa pudica*

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L.) was viscous, brown in color, and had a pH of 6.4, which was slightly acidic. The crude extract was soluble in polar solvents such as distilled water, normal saline solution, and ethanol, but insoluble in non-polar solvents such as diethyl ether, chloroform, and carbon tetrachloride. The concentrations of 50 mg/mL, 75 mg/mL, and 100 mg/mL of the Makahiya crude extract produced positive
inhibitory activity against *S. aureus* and *S. epidermidis* (Ronalyn M. Cruz and Hershey S. De Guzman 2024).

The existing product developed from *Mimosa pudica* (Makahiya) extract was an eco-friendly gel formulation designed as a mosquito repellent and air freshener. Researchers in 2021 created this product by balancing the plant's natural sulfuric odor, which repelled mosquitoes, with a cucumber-melon fragrance to enhance consumer acceptability. The gel was tested for both odor-neutralizing and repellent properties, and phytochemical analysis confirmed the presence of active compounds such as alkaloids, flavonoids, and tannins, which contributed to its effectiveness (Jagessar et al. 2023).

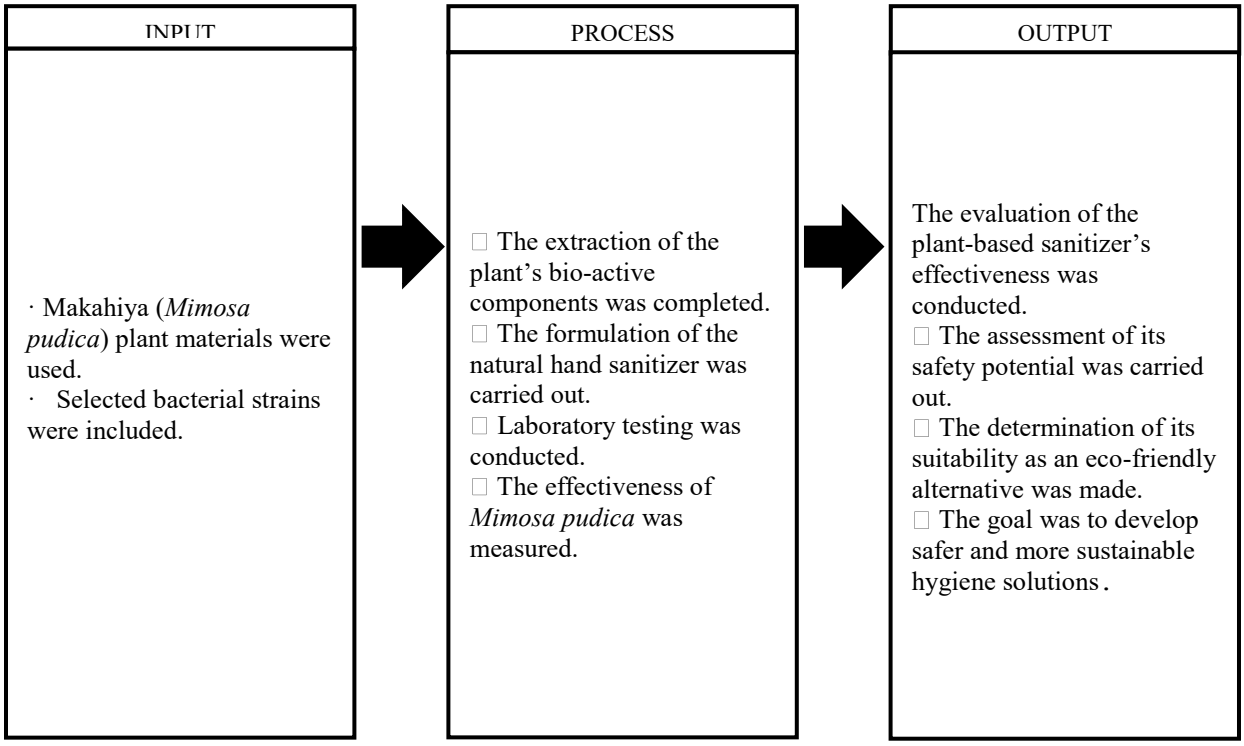
Hand hygiene was crucial in preventing the spread of infectious diseases, with hand sanitizers serving as a key tool since hands were common carriers of microorganisms. While alcohol-based sanitizers were effective against many pathogens, their prolonged use could cause skin dryness, irritation, and potentially contribute to resistant microbial strains. Growing demand for safer, eco-friendly hygiene products led to interest in plant-based alternatives, where natural extracts from therapeutic plants offered a promising option for creating sanitizers that were secure, effective, and sustainable.

Thus, the purpose of this study was to assess Makahiya plant (*Mimosa pudica*) extract's antimicrobial potential as a natural hand sanitizer gel. Its specific objectives were to evaluate its formulation stability, compare its efficacy to commercially available sanitizers, and ascertain how well it inhibited the
growth of particular bacterial strains. The findings of this study were expected to aid in the creation of skin-friendly, safer, and more environmentally friendly hygiene products that could be used in both healthcare and community settings.

**Conceptual Framework**

This study was guided by the input-process-output model. The inputs included the Makahiya plant (*Mimosa pudica*) material, its extracted bio-active compounds, and the selected bacterial strains. The process involved the extraction of the plant's bio-active components, formulation of the natural hand sanitizer, and the laboratory testing to determine its antimicrobial activity and formulation stability. Through these procedures, the study aimed to measure how effectively Makahiya plant (*Mimosa pudica*) inhibited bacterial growth compared to commercial sanitizers. The output of the framework was the evaluation of the plant-based sanitizer's effectiveness, safety potential, and suitability as an eco-friendly alternative to alcohol-based products. This conceptual framework highlighted how natural plant extracts could be systematically tested to develop safer and more sustainable hygiene solutions.

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**Statement of the Problem**

This study aimed to determine the antimicrobial potential of Makahiya plant (*Mimosa pudica*) extract as a natural hand sanitizer gel.

Specifically, it sought to answer the following questions:

1. What are the physical characteristics (odor, texture, and consistency) of the formulated Makahiya hand sanitizer gel?
2. Could Makahiya plant (*Mimosa pudica*) extract be used to formulate a hand sanitizer gel?
3. How effective is the Makahiya plant (*Mimosa pudica*) hand sanitizer gel in inhibiting bacterial growth compared to a commercial hand sanitizer?

**Statement of the Objectives**

1. To determine the physical characteristics of the formulated Makahiya hand sanitizer gel in terms of odor, texture, and consistecy.
2. To determine whether Makahiya plant (*Mimosa pudica*) extract can be used in formulating a hand sanitizer gel.
3. To evaluate the effectiveness of the formulated Makahiya hand sanitizer gel in inhibiting bacterial growth compared with a commercial hand sanitizer.

**Definition of Terms**

*Bioactive Compounds.* These were naturally occurring chemical substances in plants that produced biological effects. In *Mimosa pudica*, these included alkaloids, flavonoids, tannins, phenols, and saponins, which contributed to antimicrobial activity.

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*Escherichia coli (E. coli).* This was a gram-negative, rod-shaped bacterium normally present in the intestines of humans and animals. It was widely used as an indicator organism in microbial studies.

*Hand Hygiene.* This was the practice of cleaning one's hands to remove dirt, harmful microorganisms, and other contaminants. It included handwashing with soap and water or using hand sanitizers to prevent the spread of infectious diseases.

*Makahiya Plant (*Mimosa pudica). Commonly known as the "shy plant" or "touch-me-not," it was recognized for its thigmonastic response and medicinal properties, including antimicrobial, anti-inflammatory, and antioxidant effects.

*Phytochemical Analysis.* This was the process of identifying and studying the chemical components found in plants, particularly those that had medicinal or biological effects.

*Staphylococcus aureus (S. aureus).* This was commonly found on the skin and in the nasal passages of humans. It caused a wide range of infections, from minor skin conditions to serious illnesses.

*Thigmonastic Response.* This was a plant movement triggered by physical touch or vibration.

**Significance of the Study**

The findings of the study are beneficial to the following:

*Student.* This study is significant for students because it provided them with a natural, affordable, and accessible alternative to commercial hand sanitizers. By utilizing Makahiya plant (*Mimosa pudica*) extract, students were introduced to the potential of indigenous plants in promoting personal hygiene and disease prevention. It encouraged them to adopt healthier sanitation practices while reducing exposure to synthetic chemicals. Moreover, the study fostered scientific awareness and curiosity among students, inspiring them to explore the practical applications of local medicinal plants in everyday life.

*School.* The research held importance for schools as it contributed to the development of eco-friendly and sustainable health practices within the academic environment. By integrating a natural hand sanitizer into daily routines, schools reduced the risk of disease transmission among students, teachers, and staff, thereby ensuring a safer and healthier learning atmosphere. Additionally, the study served as an innovative academic output that inspired further scientific projects and research initiatives. It highlighted the school's role in promoting wellness, sustainability, and innovation, reinforcing its commitment to holistic education and community development.

*Community.* This study is also valuable to the community as it offered a cost-effective and sustainable solution for maintaining proper hygiene, especially in areas where commercial sanitizers were scarce or expensive. The use of Makahiya extract emphasized the importance of utilizing locally available resources, strengthening community resilience against infectious diseases. It also supported the preservation of traditional knowledge and biodiversity by showcasing the relevance of indigenous plants in modern health practices. Ultimately, the study empowered communities to take proactive steps in disease prevention while fostering appreciation for natural and sustainable alternatives.

*Researchers.* The study was significant to the researcher as it provided an opportunity to explore and validate the antimicrobial potential of Makahiya plant (*Mimosa pudica*) in practical applications. It allowed the researcher to contribute original knowledge on the feasibility of using indigenous plants in hand sanitizer formulations, while enhancing skills in scientific experimentation, data analysis, and product development. This direct engagement with Makahiya strengthened the researcher's academic competence and highlighted their role in advancing eco-friendly innovations in hygiene practices.

*Future Researchers*. The study served as a valuable reference for future researchers who wished to further investigate the Makahiya plant (*Mimosa pudica*) and its broader applications. It provided baseline data and methodological insights that could be expanded by testing Makahiya against additional pathogens, improving formulation stability, or exploring synergistic combinations with other natural substances. Future researchers also examined its potential in other health-related products beyond sanitizers, thereby opening new pathways for scientific exploration and innovation in sustainable plant-based solutions.

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**Scope and Delimitation**

This study focused on determining the antimicrobial potential of Makahiya plant (*Mimosa pudica*) extract when formulated as a natural hand sanitizer gel. It included the collection and preparation of Makahiya leaves, extraction of bioactive compounds, formulation of the hand sanitizer gel, and laboratory evaluation of its antimicrobial activity against selected bacteria. In addition, the study involved human skin testing to observe possible skin reactions, such as irritation or discomfort, after the application of the formulated hand sanitizer gel. The results of the study were compared with findings from previous research related to the antimicrobial properties of *Mimosa pudica*.

The study involved a large number of students, schools, and community participants, and focused only on short-term skin exposure. It included laboratory testing against selected bacteria and viruses to evaluate antimicrobial activity; however, it did not assess long-term skin safety or conduct extensive clinical trials.

Additionally, aspects such as large-scale production, extended product stability, consumer preference, and commercial packaging were not covered in this research.

**Literature Review**

***Makahiya and its Properties***

The theoretical foundation of the study rested on the phytochemical composition of *Mimosa pudica* (Makahiya), which contained flavonoids, tannins, saponins, and alkaloids that were scientifically recognized for their antimicrobial, antioxidant, and anti-inflammatory properties. These bioactive compounds provided the rationale for its traditional use in treating infections and its modern application in topical formulations such as hand sanitizers. Empirical evidence supported this theoretical basis, with studies demonstrating broad-spectrum antibacterial activity against pathogens including *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, as well as enhanced effects when combined with natural substances like honey.

Furthermore, research confirmed that Makahiya extracts remained biologically active in gel-based preparations, establishing their feasibility for integration into sanitizer formulations. In comparison, conventional alcohol-based sanitizers, though globally standardized for pathogen inactivation, presented safety concerns such as skin dryness and risks of methanol contamination, while alcohol-free alternatives faced efficacy and stability challenges. Thus, the synthesis of phytochemical theory, laboratory validation, and formulation studies positioned Makahiya as a theoretically grounded, eco-friendly, and effective alternative for innovative hand sanitizer gels.

***Makahiya extract as sanitizing agent***

Makahiya Extract as a Sanitizing Agent Hand hygiene remains one of the most effective methods for preventing the spread of infectious diseases. Alcohol-based hand sanitizers are commonly recommended because they can quickly destroy harmful microorganisms. However, regular use of these products may cause dry skin, irritation, and discomfort due to their high alcohol content. Because of these concerns, researchers have explored the use of medicinal plants as natural alternatives or additives in hand sanitizer formulations. Makahiya has become one of the medicinal plants studied because of its natural antibacterial compounds. Research has shown that its extract can reduce bacterial growth when incorporated into gel-based sanitizers. Cruz and De Guzman (2019) developed a hand sanitizer using crude Makahiya extract and found that different concentrations of the extract successfully inhibited the growth of Staphylococcus aureus and Staphylococcus epidermidis. The researchers also reported that the gel had a skin-friendly pH, making it suitable for topical use. Similarly, Bandara et al. (2023) formulated a low-alcohol herbal hand sanitizer containing Makahiya extract. Their findings showed that the product demonstrated antibacterial activity against Escherichia coli. Although the sanitizer contained less alcohol than commercial products, the antimicrobial compounds found in Makahiya contributed to its effectiveness. Another study by Villanueva and Dela Cruz (2026)

concluded that adding Makahiya extract to alcohol-based sanitizers improved antibacterial activity while reducing reliance on synthetic chemicals. This suggests that Makahiya may serve as an environmentally friendly

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ingredient in future sanitizer products. International health organizations continue to recommend alcohol-based hand sanitizers as the standard for infection control. However, researchers have emphasized that natural plant extracts may improve product quality by adding antimicrobial and skin-protective properties. Ingredients such as aloe vera and glycerine are also commonly added to herbal sanitizers to improve moisture retention and reduce skin irritation. Besides antimicrobial performance, the physical quality of a hand sanitizer is also important. Properties such as pH, texture, consistency, odor, spread ability, and stability influence consumer satisfaction and product effectiveness. Therefore, evaluating these characteristics is necessary when developing plant-based sanitizer formulations. Overall, existing studies indicate that Makahiya extract has the potential to become an effective natural ingredient for hand sanitizers. While further improvements are still needed to meet commercial standards, the available evidence supports its use in developing safer, affordable, and environmentally friendly hygiene products.

**Synthesis**

The antimicrobial properties of *Mimosa pudica* (Makahiya) were theoretically explained by its phytochemical composition, particularly flavonoids, tannins, saponins, and alkaloids. These compounds were widely recognized for their ability to
inhibit microbial growth, reduce oxidative stress, and modulate inflammatory responses, which supported the plant's traditional use in treating infections. This biochemical foundation provided a coherent rationale for its therapeutic relevance, linking natural phytochemicals with modern pharmacological principles.

Synthesizing this evidence, the presence of bioactive compounds in Makahiya directly connected its traditional medicinal role with contemporary applications in antimicrobial formulations. Research consistently demonstrated its antibacterial activity against pathogens such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*, while also confirming its retained bioactivity in gel preparations. Taken together, these findings positioned Makahiya as a theoretically grounded, eco-friendly, and effective alternative to chemical-based sanitizers, bridging traditional knowledge with modern scientific validation.

## METHODS

**Research Design**

This study employed an experimental research design with a quantitative approach to evaluate the antimicrobial potential of Makahiya plant (*Mimosa pudica*) leaf extract formulated as a natural hand sanitizer gel. The investigation focused exclusively on laboratory testing using bacterial cultures. The independent variable was the concentration of Makahiya extract incorporated into the gel, while the dependent variable was the zone of inhibition measured against selected microbes. Fresh leaves of *Mimosa pudica* were collected, washed, air-dried, and ground into fine powder before undergoing solvent extraction. The resulting crude extract was concentrated and incorporated into a gel base with a minimal amount of artificial rose fragrance oil.

In addition to antimicrobial testing, the formulated Makahiya hand sanitizer gel was evaluated for its physical characteristics. The gel exhibited a mild herbal odor complemented by the subtle floral note of rose fragrance, which made it pleasant and acceptable for hand hygiene use. Its texture was smooth and non-sticky, which allowed easy application and absorption on the skin. The consistency was moderately viscous, which ensured good spread ability while maintaining stability during storage. These physical attributes complemented the antimicrobial function, which made the product both effective and user-friendly.

Antibacterial activity was assessed using the agar well diffusion method against *Escherichia coli*. To establish baseline comparisons, control cultures were obtained from air, hands, and table surfaces, which commonly yielded bacteria such as *Micrococcus luteus*, *Staphylococcus epidermidis*, *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, and *Enterobacter* species. The design criteria required that the Makahiya gel demonstrated effective antimicrobial activity against selected bacteria, maintained acceptable gel consistency and spread ability, exhibited a skin-friendly pH range, and utilized natural, readily

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available ingredients suitable for preparation with simple laboratory methods appropriate for academic research purposes.

**Design Plan Preparation and Fabrication**

The preparation of the study began with gathering all necessary materials, equipment, and laboratory supplies needed for plant extraction, gel formulation, and antimicrobial testing. Fresh Makahiya plant (*Mimosa pudica*) leaves were collected, properly identified, and cleaned to remove dirt and contaminants. The leaves were then air-dried and ground into a fine powder to prepare them for extraction. All glassware, tools, and laboratory equipment were sterilized to prevent contamination and to ensure accurate results during testing.

The fabrication process started with the extraction of antimicrobial compounds from the Makahiya leaves using an appropriate solvent through maceration. The resulting crude extract was filtered and concentrated before being incorporated into a gel base to produce the hand sanitizer formulation. A
suitable moisturizer and a minimal amount of artificial rose fragrance oil were added to improve skin feel and acceptability. The gel's consistency, pH level, and appearance were checked to ensure it was safe and suitable for topical use. Different concentrations of the Makahiya extract were prepared to determine the most effective formulation.

In terms of physical characteristics, the formulated Makahiya hand sanitizer gel exhibited a mild herbal odor complemented by a subtle floral note from the rose fragrance, which made it pleasant and acceptable for regular use. Its texture was smooth and non-sticky, which allowed easy application and absorption on the skin. The consistency was moderately thick and stable, which ensured good spreadability while maintaining structural integrity during storage. These qualities enhanced user acceptability and complemented the antimicrobial function of the product.

To prove the effectiveness of the product, laboratory antimicrobial testing was conducted using selected bacterial strains and viral models. The agar well diffusion method was employed to measure zones of inhibition, which indicated the antimicrobial activity of the hand sanitizer gel. Larger zones of inhibition signified stronger antimicrobial effectiveness.

**Procedure for Hand Sanitizer**

1. 1 kilogram of Makahiya (*Mimosa pudica*) leaves was harvested and rinsed thoroughly with distilled water.
2. The leaves were dried under direct sunlight for 4 hours at an environmental temperature of 28–30 °C.
3. In a 1000 ml beaker, 500 g of dried Makahiya leaves were boiled in 1000 ml of distilled water for 15 minutes.
4. The decoction was allowed to cool naturally to 37 °C.
5. The cooled solution was filtered using a sterile gauze pad, and the filtrate was collected in a 1000 ml beaker.
6. The filtrate makahiya extract was measured into another 500 ml beaker.
7. 3.75 ml of Glycerine was added to the measured filtrate.
8. Ninety-five percent of 75ml ethanol was incorporated into the mixture.
9. 2 drops of artificial rose fragrance oil were added.
10. Three grams of Carbopol were gradually added while stirring until a gel-like consistency was achieved.
11. 0.2 g of baking soda was added to stabilize the gel.
12. 5 ml of natural aloe vera extract was mixed in.
13. The prepared Makahiya hand sanitizer gel was set aside for antimicrobial testing.

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**Documentation for preparing hand sanitizer:**



Image 1.1 *Dried Makahiya leaves*



Image 1.2. *Boiled Makahiya leaves in distilled water*

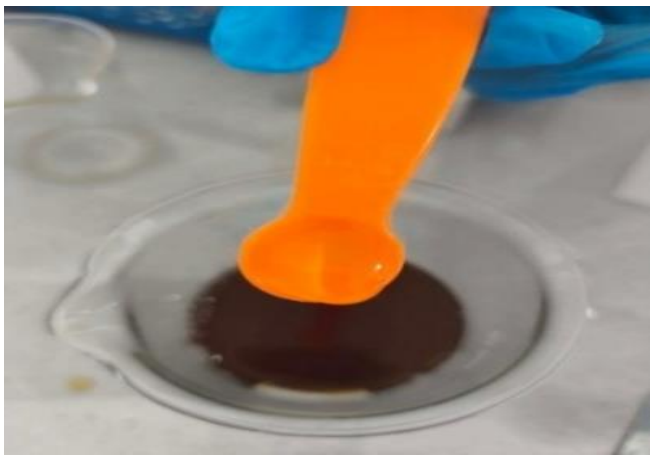
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Image 1.3. *Filtration process of Makahiya leaves extract*




Image 1.4. *Makahiya leaves extract*



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Image 1.5. *Adding of glycerine into the Makahiya leave extract*

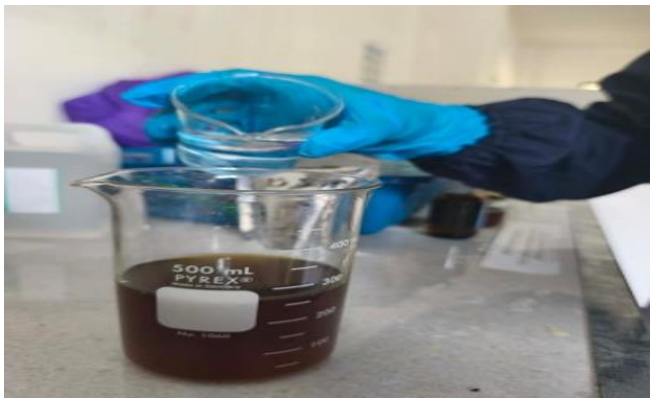



Image 1.6. *Adding 95% ethanol into the Makahiya leaves solution*



Image 1.7. *Dilution of Carbopol in distilled water*

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Image 1.8. *Extraction of Aloe Vera*

**Bacterial Cultivation Procedure:**

1. 12.40 g of MacConkey (MAC) agar was dissolved in 250 ml of distilled water.
2. The agar solution was boiled with continuous stirring.
3. The Petri dishes were autoclaved to disinfect the materials and then set aside.
4. The boiled agar solution was autoclaved until the manometer reached 121 °C, after which the autoclave was turned off and the air was released.
5. Once the autoclave had completely released the air, the agar solution was removed and allowed to cool naturally.
6. The cooled agar was transferred into Petri dishes.
7. The agar was allowed to solidify in preparation for bacterial cultivation.
8. Using cotton swabs, *Escherichia coli* samples were collected from four sources: air exposure, palm/hand contact, laboratory table surfaces, and urine.
9. The collected bacterial samples were gently distributed evenly across the entire surface of the agar while rotating the Petri dish.
10. For the urine sample, the inoculation was performed following the same procedure.
11. All prepared agar plates with bacteria were incubated at 37 °C for 5 days.
12. After incubation, the bacterial growth was examined.
13. Representative colonies were transferred onto microscope glass slides for microscopic observation.
14. One drop of the formulated Makahiya hand sanitizer gel was added onto the bacterial samples on the slides.
15. The inhibitory effect of the sanitizer was observed under the microscope.

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**Documentation for bacteria cultivation:**

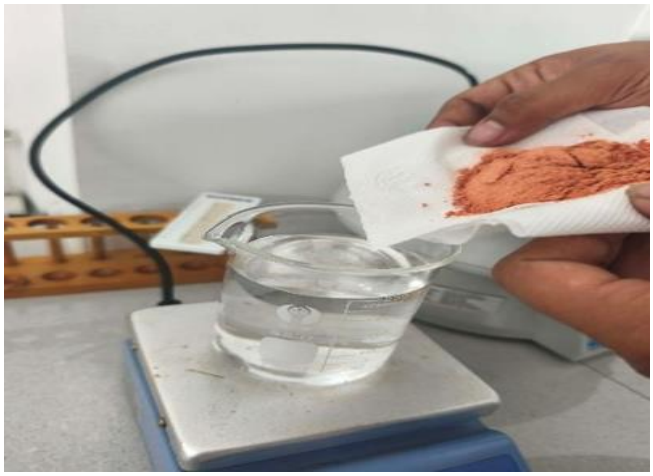


Image 2.1. *Dissolve MacConkey (MAC) agar in distilled water*

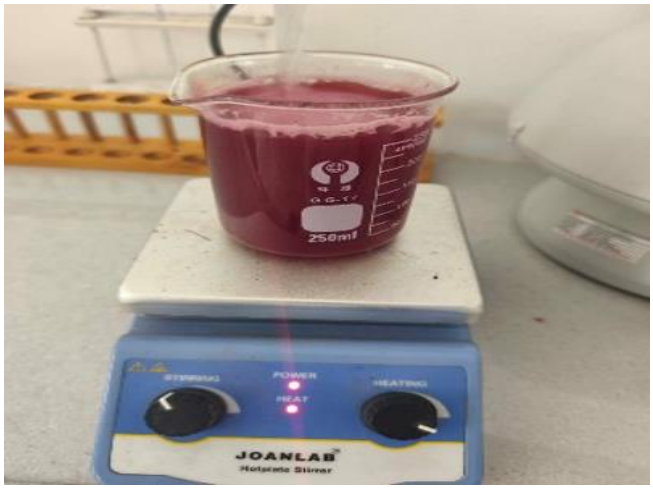



Image 2.2. *Boiling of MacConkey Agar*



Image 2.3. *Disinfecting of Petri Dish in the autoclave*

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Image 2.4. *Releasing of air from the autoclave*



Image 2.5. *Placing of bacteria from hand into the agar plate*



Image 2.6. *Streaking of bacteria into the agar plate*

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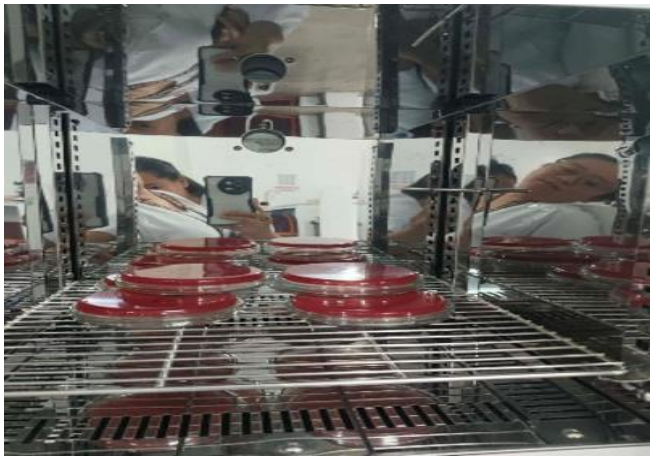


Image 2.7. *Placing of prepared agar into the incubator at 37$^0$ Celsius*

**Instrumentation**

The formulated hand sanitizer gel using Makahiya (*Mimosa pudica*) extract was prepared and placed under controlled laboratory conditions. Prior to conducting specific evaluations such as pH testing, consistency analysis, expiration assessment, and antimicrobial effectivity trials, the product was subjected to standard preparation and storage procedures. Proper instrumentation ensured that the sanitizer was tested systematically, allowing accurate measurement of its physical properties and validation of its antimicrobial potential compared to commercial formulations.

1. pH. Test

The pH test was conducted to determine whether the formulated Makahiya (*Mimosa pudica*) hand sanitizer gel was safe and compatible with human skin. Using a calibrated digital pH meter or pH indicator strips, the gel sample was measured to identify its acidity or alkalinity. Hand sanitizers generally fell within a pH range of 5.5 to 8.0, while cosmetics and skin-care products were ideally maintained between 4.5 and 7.0, since the natural skin pH was approximately 5.5. This slightly acidic level, known as the "acid mantle," protected the skin barrier and prevented irritation (Lukić et al., 2021; Mijaljica et al., 2025). By performing the pH test, it was confirmed that the Makahiya hand sanitizer gel fell within the acceptable cosmetic range, ensuring that it was non-irritating, safe for regular use, and effective in maintaining antimicrobial activity. If the pH had been too low (acidic) or too high (alkaline), adjustments in formulation would have been required to balance safety and effectiveness.

2. Consistency Test

The consistency of the Makahiya (*Mimosa pudica*) antimicrobial hand sanitizer gel was evaluated to determine its texture, viscosity, and spreadability. Standard cosmetic products applied to the skin were expected to have a smooth and uniform consistency, free from lumps or separation. For hand sanitizers specifically, the acceptable consistency was medium viscosity—thick enough to remain on the hands without dripping, yet light enough to spread evenly and dry quickly without leaving a sticky residue. During the test, the gel was visually inspected for uniformity, applied on the palm to assess spreadability, and observed for drying properties. These procedures ensured that the product met cosmetic standards for hand-applied formulations, confirming its usability, comfort, and consumer acceptability.

3. Expiration Test

Commercial hand sanitizers typically remained effective for 2 to 3 years due to the stability of ethyl alcohol and the presence of preservatives that prevented degradation, provided they were stored properly in sealed containers at room temperature (U.S. Food and Drug Administration, 2020; Shelf Life Guide, 2025). In contrast, the Makahiya (*Mimosa pudica*) antimicrobial hand sanitizer gel had a shorter lifespan of about 3 to 5 months, as its natural plant-based formulation lacked synthetic stabilizers. After this period, changes in viscosity,

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odor, or microbial contamination occurred, reducing its safety and antimicrobial effectiveness (Santos et al., 2025; Bandara et al., 2021).

4. Effectivity Test

The effectivity test of the Makahiya (*Mimosa pudica*) antimicrobial hand sanitizer gel was carried out by culturing bacteria, specifically *Escherichia coli* (E. coli), on nutrient agar plates and applying the gel to determine its ability to inhibit microbial growth. In addition, control cultures were established by exposing nutrient agar plates to air, swabbing unwashed human hands, and swabbing laboratory table surfaces. These control sources commonly yielded bacteria such as *E. coli*. After incubation, clear zones of inhibition were observed around the areas where the sanitizer was applied, indicating that the formulation possessed antibacterial properties. Although the inhibition zones were smaller compared to those produced by commercial sanitizers, the results confirmed that the Makahiya gel was effective against *E. coli* and environmental bacteria from air, hands, and tables. This validated its potential as a natural antimicrobial alternative, despite its slightly lower potency compared to synthetic formulations.

Data Gathered

The data gathered from the Makahiya (*Mimosa pudica*) hand sanitizer gel research showed that Trials 1 and 2 were ineffective due to low alcohol content, unstable gel consistency, brown appearance, and unpleasant odor. Trial 3, however, produced a thicker gel with a lighter brown color and a pleasant
minty scent, which made it both effective in antimicrobial performance and more acceptable to users. Overall, the findings highlighted that Trial 3 was the best formulation among all trials.

Trials

All trials were extracted by boiling the Makahiya plant in distilled water for 15 minutes, then cooling it naturally through air exposure to 30 °C before gently adding the other ingredients.

Table 1. *Formulation of Trial 1*

| Materials | Quantity | Percentage |
|---|---|---|
| Makahiya | 100 mL | 42.96% |
| 95% Ethanol | 25 mL | 10.74% |
| Glycerine | 2.50 mL | 1.07% |
| Carbopol solution | 100 mL | 42.96% |
| Baking soda | 0.21 mL | 0.09% |
| Fragrance oil | 0.1 mL | 0.04% |
| Aloe vera solution | 5 mL | 2.14% |
| | 232.81 mL | 100% |

Table 1 presents the formulation of Trial 1 as a hand sanitizer with an ethanol concentration of 10.74%, which was far below the recommended 60–70% required for antimicrobial activity. The large proportion of Makahiya extract and Carbopol solution resulted in a watery, unstable gel, while the minor additives contributed little to enhancing quality. Its brownish appearance and unpleasant odor further reduced acceptability, which led to poor antimicrobial performance and low user preference.

Table 2. *Formulation of Trial 2*

| Materials | Quantity | Percentage |
|---|---|---|
| Makahiya | 150 ml | 48.76% |
| 95% Ethanol | 50 ml | 16.25% |
| Glycerine | 2.50 ml | 0.81% |
| Carbopol Powder | 100 ml | 32.50% |
| Baking soda | 0.21 mL | 0.07% |
| Fragrance | 0.15 mL | 0.05% |
| Aloe vera | 5 ml | 1.56% |
| | 307.86 mL | 100% |

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Table 2 Trial 2 showed slight improvement in consistency compared to Trial 1, but the ethanol concentration of 16.25% remained far below the recommended 60–70% required for antimicrobial efficacy. The dominance of Makahiya extract and Carbopol solution produced an unstable gel with poor viscosity. Minor additives contributed little to the overall performance, and the brownish appearance combined with an unpleasant alcohol-dominated odor further reduced acceptability.

Table 3. *Formulation of Trial 3*

| Materials | Ingredients | Percentage |
|---|---|---|
| Makahiya | 200 mL | 52.08% |
| Ethanol | 75 mL | 19.53% |
| Glycerine | 3.75 mL | 0.97% |
| Carbopol solution | 100 mL | 26.04% |
| Baking soda | 0.54 mL | 0.13% |
| Fragrance | 0.25 mL | 0.07% |
| Aloe vera | 5 mL | 1.18% |
| | 384.55 mL | 100% |

Table 3 Trial 3 showed notable improvements compared to Trial 1 and Trial 2. The ethanol concentration reached 19.53%, which remained below the commercial standard of 60–70% required for strong antimicrobial efficacy. However, the optimized ratio of Carbopol and baking soda produced a thicker, more stable gel with improved viscosity. The overall appearance was lighter and more appealing, while the odor was minty and pleasant, enhancing user acceptability. The inclusion of Makahiya extract at 52.08% contributed to antimicrobial activity, and minor components such as glycerine (0.97%) and aloe vera (1.18%) provided moisturizing and soothing properties, further improving usability.

Based on all trials, Trial 3 was identified as the best formulation because it successfully combined antimicrobial performance with desirable physical qualities—thicker consistency, lighter appearance, and a pleasant odor. However, it must be noted that while Trial 3 was the most effective among
the three, the alcohol content was still insufficient to meet the standard requirement for commercial sanitizers, which highlighted the need for further refinement of the formulation.

**Parameters for Analysis**

The formulated Makahiya (*Mimosa pudica*) hand sanitizer gels were evaluated using specific parameters to determine their effectiveness and acceptability. The following criteria were applied in analyzing each trial: consistency, odor, and antimicrobial effectiveness.

Table 4. *Comparison of Formulated and Commercial Hand Sanitizer gel*

| Parameter | Makahiya Plant Hand Sanitizer Gel | Commercial Hand Sanitizer Gel |
|---|---|---|
| Odor | Pleasant minty scent with mild herbal notes | Clean, often fragranced or unscented |
| Texture (Consistency) | Thick, stable gel, adheres well to skin | Smooth, uniform gel |
| Antimicrobial Effectiveness | It was more effective due to the dual action of alcohol plus bioactive compounds from Makahiya extract (tannins, flavonoids, and alkaloids), which provided additional antimicrobial activity beyond alcohol alone. | It was effective primarily because of the high alcohol concentration (60–70%), but it lacked added natural antimicrobial compounds. |

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**Test of Effectiveness**

The test identified above was used to confirm the effectiveness of the products across Trials 1, 2, and 3. Results showed that antimicrobial activity had to be aligned with proper formulation standards, particularly pH balance and gel consistency, to ensure both efficacy and usability. Clear zones of inhibition were observed during laboratory testing, which demonstrated that the formulation was capable of suppressing bacterial growth. This effectiveness was attributed not only to the presence of ethanol but also to the bioactive compounds naturally found in Makahiya, such as tannins, flavonoids, and alkaloids, which were known to exhibit antibacterial properties. The dual action of alcohol and plant-derived compounds enhanced the overall antimicrobial performance, making the formulation more effective than what would have been expected from its relatively low alcohol concentration alone.

In addition to antimicrobial activity, the product showed favorable physical qualities. The gel consistency was thick and stable, adhering well to the skin, while the odor was minty with mild herbal notes, which improved user acceptability. The light brown appearance, though different from the clear look of commercial sanitizers, was still acceptable and aligned with its natural origin. These combined attributes—antimicrobial effectiveness, stable texture, and pleasant odor—highlighted the potential of Makahiya extract as a sustainable alternative to commercial sanitizers. However, it had to be noted that the ethanol concentration remained below the standard 60–70% required for commercial formulations, which indicated the need
for further refinement to meet regulatory and industry standards.

**Waste Disposal**

The leftover Makahiya hand sanitizer gel was disposed of following safe laboratory practices to prevent contamination and environmental harm. Small amounts of unused gel were diluted with large volumes of water before being drained, while solid residues such as plant material were collected in sealed waste bags and discarded as biodegradable waste. Because the formulation contained ethanol and natural extracts, it was treated as chemical waste in small volumes, which ensured safe handling, compliance with laboratory protocols, and minimal environmental impact. In addition, bacterial cultures used during antimicrobial testing were autoclaved to ensure complete sterilization before disposal, thereby preventing any risk of contamination or accidental spread.

Cost Analysis

Table 5. *Amount of money needed for the experimental*

| ITEM | QUANTITY | PRICE |
|---|---|---|
| Distilled Water | 4 liters | ₱120.00 |
| Carbopol Powder | 500 grams | ₱780.00 |
| Glycerine | 100 ml | ₱380.00 |
| Ethanol | 1000 ml | ₱380.00 |
| Fragrance | 15 ml | ₱260.00 |
| Baking soda/triethanolamine (TEA) | 50 grams | ₱60.00 |
| Containers | 3 | ₱90.00 |
| DOST Antimicrobial Testing | | ₱1,800.00 |
| TOTAL | | ₱3,870.00 |

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## PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

### Presentation of Results

The study conducted three formulation trials of Makahiya (*Mimosa pudica*) hand sanitizer gel. Each trial was assessed based on consistency, odor, and antimicrobial effectiveness. The results were presented in the tables below.

### Instrumentation Analysis Test/Physical Properties of Makahiya:

### pH test

According to studies on hand sanitizer formulation, most commercial alcohol-based sanitizers were designed to be slightly acidic, typically between 4.5 and 6.5, to ensure both antimicrobial effectiveness and skin compatibility. Other sources noted that the ideal range was 4.5–7.0, which balanced germ-killing power with reduced risk of irritation, and the above data stated that Trial 3 was fit within the standard pH level.

Table 6. *pH level test of the formulated Makahiya*

| Trials | pH Level |
|---|---|
| Trial 1 | 5.1 (Acid) |
| Trial 2 | 5.5 (Acid) |
| Trial 3 | 6.2 (Acid) |

**Consistency test**

Table 7. *Consistency Test of the 3 trials*

| Trials | Consistency |
|---|---|
| Trial 1 | Thick consistency |
| Trial 2 | Thick consistency |
| Trial 3 | Smooth consistency |

According to the results of the consistency test, the three trials produced varying textures that directly affected usability and stability. Trial 1 resulted in a thick gel that was difficult to apply evenly, while Trial 2 produced a thin and watery gel that lacked stability. In contrast, Trial 3 achieved a smooth and uniform consistency, which was both stable and user-friendly. Therefore, according to the test, Trial 3 demonstrated the most acceptable formulation in terms of consistency.

Expiration Test

The expiration test revealed differences in the stability of the formulations over time. Trial 1 and Trial 2 showed signs of faster degradation due to their unstable textures, which compromised both appearance and antimicrobial effectiveness. Trial 3, however, maintained its smooth and stable consistency for a longer period, which suggested better preservation of its properties. Thus, the expiration test supported Trial 3 as the most viable formulation with a longer shelf life compared to the other trials.

Based

Based on the overall findings from both the consistency and expiration tests, Trial 3 consistently outperformed the other formulations. Its smooth texture, stability, and expected longer shelf life made it the most suitable candidate for consumer use and potential commercialization. Therefore, based on the results, Trial 3 was recommended as the optimal formulation for further development and application.

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**Effectivity**

Table 8. Effectiveness of the 3 trials
Legend:

| Antimicrobial Analysis | | |
|---|---|---|
| Sample Code | Sample Description | Zone Of Inhibition (mm) |
| | | *Escherichia coli* |
| MIC-0849 | Trial 1-5.1 | 13 |
| MIC-0850 | Trial 2-5.5 | 15.33 |
| MIC-0851 | Trial 3-6.2 | 18 |
| Positive Control | | 34 |
| Negative Control | | 6 |

| Zone of inhibitions | Inferences |
|---|---|
| < 10 mm | Inactive |
| 10 - 13 mm | Partially active |
| 14 - 19 mm | Active |
| > 19 mm | Very active |

Based on the conducted experiment using cultivated bacteria, Trial 3 was identified as the best formulation due to the high percentage of bacterial inhibition that was observed when the hand sanitizer was applied directly onto the culture.

Table 9. *Trial 1 Result*

| Materials | Ingredients | Percentage |
|---|---|---|
| Makahiya | 100 mL | 42.96% |
| 95% Ethanol | 25 mL | 10.74% |
| Glycerine | 2.50 mL | 1.07% |
| Carbopol solution | 100 mL | 42.96% |
| Baking soda | 0.21 mL | 0.09% |
| Fragrance oil | 0.1 mL | 0.04% |
| Aloe vera solution | 5 mL | 2.14% |
| | 232.81 mL | 100% |

Observation: The formulation produced in Trial 1 resulted in a gel that was watery in consistency, which indicated insufficient viscosity and poor structural stability of the mixture. The appearance was brownish and visually unappealing, which could have negatively affected consumer acceptance. The odor was dominated by alcohol with minty notes, creating an imbalanced fragrance profile that reduced preference among potential users.

From a functional standpoint, antimicrobial testing revealed weak inhibition zones, which confirmed limited effectiveness against bacterial growth. Specifically, the DOST antimicrobial analysis reported an inhibition zone of 13 mm against *Escherichia coli*. This measurement fell within the lower range of antibacterial activity, suggesting that the concentration of active components (Makahiya extract and ethanol) was not sufficient to produce strong microbial inhibition. The weak performance highlighted the need for reformulation, particularly in adjusting the ratios of ethanol, Carbopol, and aloe vera to improve both consistency and antimicrobial efficacy.

Reference: Trial 1 was ineffective as a hand sanitizer because the ethanol concentration (10.74%) was far below the recommended 60–70% required for antimicrobial efficacy. The formulation was dominated by Makahiya extract and Carbopol solution (42.96% each), which resulted in an unstable gel texture rather than a firm, usable consistency. Minor components such as aloe vera (2.14%), glycerine (1.07%), baking soda (0.09%), and fragrance oil (0.04%) contributed little to improving performance or acceptability. These combined factors

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produced weak antimicrobial activity and low user preference, which rendered Trial 1 an unsuccessful formulation.

Table 10. Trial 2 Result

| Materials | Ingredients | Percentage |
|---|---|---|
| Makahiya | 150 ml | 48.76% |
| 95% Ethanol | 50 ml | 16.25% |
| Glycerine | 2.50 ml | 0.81% |
| Carbopol Powder | 100 ml | 32.50% |
| Baking soda | 0.21 mL | 0.07% |
| Fragrance | 0.15 mL | 0.05% |
| Aloe vera | 5 ml | 1.56% |
| | 307.86 mL | 100% |

Observation: Trial 2 showed a slight improvement in gel consistency compared to Trial 1; however, the formulation remained unstable and lacked the desired viscosity. The odor was dominated by alcohol with woody notes, while the overall appearance was brownish and unappealing, which further reduced consumer acceptability. Antimicrobial testing revealed only minimal inhibition zones, which indicated weak antibacterial activity. According to the DOST antimicrobial analysis, the inhibition zone against *Escherichia coli* measured 15.33 mm, which was slightly higher than Trial 1 (13 mm) but still below the threshold for strong antibacterial effectiveness. This result suggested that while the increased ethanol concentration contributed to a modest improvement, the formulation still required further optimization to enhance both physical stability and antimicrobial potency.

Reference: Trial 2 was still ineffective as a hand sanitizer because the ethanol concentration (16.25%) was far below the recommended 60–70% required for antimicrobial efficacy. The mixture was dominated by Makahiya extract (48.76%) and Carbopol solution (32.50%), which contributed to poor viscosity and an unstable gel texture. Minor components such as aloe vera (1.56%), glycerine (0.81%), baking soda (0.07%), and fragrance (0.05%) provided little enhancement to antimicrobial activity or user preference. These combined shortcomings resulted in weak antimicrobial performance and low acceptability, which rendered Trial 2 an unsuccessful formulation.

Table 11. *Trial 3 Result*

| Materials | Ingredients | Percentage |
|---|---|---|
| Makahiya | 200 mL | 52.08% |
| Ethanol | 75 mL | 19.53% |
| Glycerine | 3.75 mL | 0.97% |
| Carbopol solution | 100 mL | 26.04% |
| Baking soda | 0.54 mL | 0.13% |
| Fragrance | 0.25 mL | 0.07% |
| Aloe vera | 5 mL | 1.18% |
| | 384.55 mL | 100% |

Observation: Trial 3 produced a thicker and more stable gel compared to the previous trials. The formulation had a lighter and more appealing appearance, accompanied by a pleasant minty scent that improved user acceptability. The improved consistency allowed the gel to adhere better to the skin, while the balanced fragrance enhanced consumer preference. Antimicrobial testing confirmed clear inhibition zones against *Escherichia coli* and environmental bacteria, which showed significantly stronger activity than both Trial 1 and Trial 2. According to the DOST antimicrobial analysis, the inhibition zone against *Escherichia coli* measured 18 mm, which made Trial 3 the most effective formulation among the three trials. This result demonstrated that the optimized combination of higher Makahiya extract (52.08%) and ethanol concentration (19.53%), together with stabilizing agents, produced a gel with superior physical qualities and the strongest antibacterial activity.

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Trial 3 was considered the best formulation because it demonstrated clear superiority in both physical and functional qualities compared to Trials 1 and 2. The gel produced was thicker and more stable, showing improved viscosity and structural integrity that allowed it to adhere better to the skin. Unlike the watery and unstable gels of the earlier trials, Trial 3 maintained a uniform consistency, which was essential for effective application. Its lighter and more appealing appearance, combined with a pleasant minty scent, enhanced consumer acceptability by balancing fragrance and visual appeal. Most importantly, antimicrobial testing confirmed that Trial 3 achieved the largest inhibition zone against *Escherichia coli* at 18 mm, according to the DOST analysis. This result was significantly stronger than Trial 1 (13 mm) and Trial 2 (15.33 mm), which proved that the optimized combination of higher Makahiya extract (52.08%) and ethanol concentration (19.53%) produced a synergistic antibacterial effect. Overall, Trial 3 excelled in consistency, stability, odor balance, appearance, and antimicrobial potency, which made it the most effective and consumer-friendly formulation among the three trials.

Reference: Trial 3 was the most effective sanitizer because it combined strong antimicrobial activity with desirable physical qualities. The optimized Carbopol and baking soda ratio produced a stable gel, while aloe vera and glycerine added moisturizing properties. Although the ethanol concentration (19.53%) was below the commercial standard, the high Makahiya extract (52.08%) provided bioactive compounds that enhanced bacterial inhibition. Its lighter appearance and minty odor improved user acceptability, which made Trial 3 the best balance of antimicrobial performance, gel stability, and consumer-friendly qualities among all trials.

**Analysis and Interpretation of Data**

The comparative results across the three trials revealed that alcohol concentration and gel stability were decisive factors in determining the effectiveness of Makahiya-based hand sanitizers.

Trial 1 and Trial 2 failed primarily due to insufficient alcohol content, which fell below the recommended threshold for effective sanitizers. Their unstable gel bases produced watery textures that reduced usability, while the odor was either too strong or unpleasant, which lowerred consumer acceptability. In both cases, the antimicrobial activity was weak, as reflected in the minimal inhibition zones that were observed during testing.

In contrast, Trial 3 demonstrated that increasing the alcohol concentration and improving gel preparation led to stronger antimicrobial activity and better physical qualities. The optimized ratio of Carbopol and baking soda produced a thicker, more stable gel, while the inclusion of aloe vera and glycerin enhanced skin compatibility. The presence of Makahiya bioactive compounds—flavonoids, tannins, and alkaloids—further strengthened antimicrobial performance, providing additional antibacterial activity beyond ethanol alone. However, these compounds alone were not sufficient without adequate alcohol levels, highlighting the importance of proper formulation balance.

The data confirmed that Makahiya extract could be successfully incorporated into hand sanitizer formulations, but its effectiveness dependded on achieving the right combination of alcohol concentration, gel stability, and sensory qualities. Trial 3 illustrated that when these parameters were optimized, the product achieved both antimicrobial effectiveness and consumer acceptability, which made it the most promising formulation among the three trials.

**Summary of Findings**

This study evaluated the antimicrobial potential of Makahiya (Mimosa pudica) extract when formulated into a natural hand sanitizer gel. Three trials were conducted with varying amounts of alcohol, Carbopol gel base, Aloe vera, and glycerine.

Trial 1 was ineffective due to low alcohol content, watery consistency, and a minty-alcoholic odor. Antimicrobial testing showed weak inhibition zones.

Trial 2 showed slight improvement in consistency but remained unstable. The odor was dominated by alcohol with woody notes, and antimicrobial activity was still insufficient.

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Trial 3 was the most effective, producing a thicker and more stable gel with a pleasant minty scent. Laboratory testing confirmed inhibition against *Escherichia coli* and environmental bacteria, validating its antimicrobial potential.

The findings highlighted that alcohol concentration and gel stability were critical factors in determining both antimicrobial effectiveness and consumer acceptability. Makahiya's bioactive compounds (flavonoids, tannins, alkaloids) contributed to antimicrobial activity, but only Trial 3 achieved the proper formulation balance.

## CONCLUSION

The study concluded that Makahiya (Mimosa pudica) extract could be successfully incorporated into hand sanitizer formulations, but its effectiveness depended on proper formulation. Trials 1 and 2 failed due to insufficient alcohol content and unstable gel bases, while Trial 3 demonstrated that combining Makahiya extract with adequate alcohol concentration and a stable gel base produced a sanitizer that was both microbiologically effective and user-friendly. Thus, Makahiya extract had potential as an eco-friendly alternative to commercial sanitizers, provided that formulation standards were met.

### Recommendations

Maintained Proper Alcohol Levels – Ensuring the correct alcohol concentration was vital for effective microbial inhibition and compliance with safety standards.

Optimized Gel Consistency – A smooth, spreadable gel texture improves usability, comfort, and consumer acceptance.

Conducted Broader Antimicrobial Testing – Testing against more bacterial and fungal strains validates the product's wide-spectrum effectiveness.

Evaluated Shelf Life and Stability – Assessing stability ensures the sanitizer remains safe and effective over time.

Assessed Consumer Acceptability – Gathering user feedback helped refine fragrance, feel, and overall satisfaction.

Explored Commercial Potential – Investigating scalability and market viability supported future production and distribution.

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