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THE EFFECTIVENESS OF OREGANO AND ALOE VERA EXTRACT CONCENTRATION ON THE ANTIMICROBIAL ACTIVITY OF A BODY-HEAT DISSOLVING DUAL-ACTION SANITIZER-SOAP CAPSULE

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ABSTRACT

This study developed and evaluated a body-heat–dissolving, dual-action sanitizer-soap capsule as an alternative hand-hygiene product. The capsule used a gelatin–glycerin film designed to rupture under body-temperature friction. Three formulations containing castile soap, aloe vera, and diluted oregano essential oil (25%, 50%, and 75%) were prepared. Dissolution tests using heated silicone hands showed that all capsules successfully dissolved, with only minor variations in rupture speed and shell consistency. Antimicrobial activity was assessed with the Kirby–Bauer disk diffusion method against Staphylococcus aureus, using ciprofloxacin as a positive control. All formulations indicated measurable antibacterial activity, with the 75% concentration producing the largest inhibition zone, followed by 50% and 25%, while the positive control remained significantly stronger. These findings suggest that the sanitizer-soap capsule has potential as a portable, single-use sanitation option that dissolves under body heat and provides antibacterial effects. Further improvements in gelatin include refining shell making, sealing stability, enhancing formulation consistency, and expanding future testing to additional bacterial strains, standardized neutralization methods, and optimized capsule-forming techniques.

Keywords: *Calamansi, stain remover, oxidizable, greasy, enzymatic, natural cleaning agent, eco-friendly*

INTRODUCTION

Background of the Study

Nothing in this world is truly devoid of bacteria. Everyday, our hands make contact with objects and surfaces that are prone to bacteria, making our hands one of the most exerted parts of a person's body. As stated in a study conducted in 2020 by Khairnar et. al, "Hands are the most common medium for initiation and spread of infection in clinics." For this reason, maintaining cleanliness and bringing portable sanitizers is necessary, taking into consideration that there is not always a water source nearby.

However, instead of always purchasing alcohol bottles or carrying bulky soaps, capsules offer a more portable and convenient solution for hand hygiene. This study aims to assess the effectiveness of capsules containing oregano and aloe vera extract in becoming a dual-action sanitizer-soap.

Oregano (Origanum vulgare) is a herb known for its medical and potential antibacterial properties, which is primarily attributed to its essential oil components. According to Tao et al. (2025), oregano essential oils (OEOs) that were extracted from wild and cultivated oregano with white or purple flowers showed strong antibacterial effects.

The study recognizes that carvacrol, an important component of oregano, demonstrates a low MIC value (0.005–0.04 mg/mL) against both Gram-positive and Gram-negative bacteria. Moreover, the study also shows that combining carvacrol with tybocramin had a mutual effect, indicating that a component in oregano can increase the effectiveness of other antimicrobial agents.

Besides its bacterial effects, Yuan et al. (2023) found that oregano essential oil (OEO) also contains an antifungal action against clinically isolated oral Candida strains. It has a strong potential for the prevention and treatment of Candida-associated denture stomatitis, which is the most common fungal infection among denture wearers.

As per Arbab et al. (2021), Aloe vera is known to have medicinal attributes. Historically, it has been utilized in the treatments of an extensive range of disorders including light fever, burns and wounds, gastrointestinal infections, diabetes, sexual potency and infertility issues to cancer, immune system modulation, AIDS, and several skin diseases.

Aloe vera (Aloe barbadensis miller) belongs to the cactus-like xerophytes family of plants, and around 360 species have been discovered. It is utilized in the treatment of a number of skin conditions (dermatitis, acne and skin irritation, burns, wound) and has also been used to cure exposure of the skin to ultraviolet as well as gamma radiation. A number of studies document the effective utilization of this plant when used topically to heal burns, sunburns, inflammatory dermal diseases, and wounds.

Although Aloe vera and oregano are well known for their antibacterial and skin-soothing qualities, not much is known regarding how well they work together in a dual-action solution.

Additionally, there is only a limited amount of research done on the effective use of body-heat dissolving capsules as a sanitizer-soap product.

Furthermore, there are still a few unanswered problems regarding how stable the body-heat dissolving capsule is, what its dissolution rate is, and how effective it is to release active ingredients so as to use it as a delivery system for hand hygiene products. However, they have not been well investigated yet. In comparison, information on whether such a system could match or surpass the antimicrobial efficacy and user safety of the product. This deficiency emphasizes the necessity of studies that carefully investigate concentration effects, capsule performance, and actual antimicrobial results. This gap highlights the need for the overall effectiveness in practical hand hygiene application.

Objectives of the Study

The researchers aim to determine the effect of varying concentrations of oregano (Origanum vulgare) and Aloe vera (Aloe barbadensis Miller) extracts on the antimicrobial activity of a body-heat dissolving dual-action sanitizer-soap capsule. The three main objectives for this study are: (1) To develop a dual-action sanitizer-soap capsule with oregano and aloe vera extracts as an alternative hygienic solution. (2) To analyze the effect of different extract concentrations (25%, 50%, 75%) on antimicrobial effectiveness by using the Kirby-Bauer Disk Diffusion Test. (3) To assess the dissolution performance of the capsule body temperature.

Related Literature

Antimicrobial Properties of Oregano *(Origanum vulgare)*

Oregano (Origanum vulgare), a common culinary herb, has been recognized as more than just a flavoring agent; it is also valued for its strong antimicrobial properties. Its antibacterial properties come from carvacrol and thymol, which are present in oregano extracts. These compounds can damage the cell walls of bacteria, hinder enzyme activity, and prevent the formation of biofilms, therefore making oregano effective against different types of harmful microbes.

Moghrovyan and Sahakyan (2024) stated that oregano essential oil, which contains thymol and carvacrol demonstrates antibacterial activity by changing membrane permeability, disturbing ion transport, and delaying biofilm growth. These mechanisms were effective against both resistant and non-resistant strains, including Escherichia coli, Staphylococcus aureus, and Pseudomonas aeruginosa. Their study highlights the molecular-level pathways through which oregano compounds weaken bacteria, providing more understanding into its biological activity.

In contrast, Soltani et al. (2021) highlighted the effectiveness of oregano's antimicrobial components.. Instead of focusing mainly on molecular pathways, they also showed how oregano extract can also be applied as a natural substitute for chemical-based antimicrobials. Their findings support oregano's role in addressing the growing concern of antimicrobial resistance by demonstrating its constant activity against problematic pathogens such as Staphylococcus aureus.

Similarly, Li et al. (2025) provided quantitative evidence by determining low minimum inhibitory concentrations, such as 3.13 µL/mL for S. aureus and 6.25 µL/mL for Bacillus cereus. Using gas chromatography, mass spectrometry, and transcriptomic analysis, they confirmed that oregano compounds could not only damage bacterial cell structures but also interfere with important metabolic processes. This data-based perspective strengthens the study of oregano's effectiveness even at small concentrations, making it efficient for the formulation of antimicrobial products.

In support of this, Nurzyńska-Wierdak and Walasek-Janusz (2025) pointed out that oregano is rich in thymol and carvacrol, making it very useful not only for antibacterial purposes but also for its anti-inflammatory and therapeutic benefits. Their review spanned on oregano's established role in traditional medicine and how its growing in terms of application in cosmetics, antiseptics, and preservatives. They also noted that thymol and carvacrol can work both individually or together, therefore improving oregano's overall antimicrobial effectiveness.

In summary, oregano has been shown to be a powerful natural antimicrobial agent. While Moghrovyan and Sahakyan (2024) explained the scientific basis of oregano's antibacterial activity, Soltani et al. (2021) shared its applied potential against resistant pathogens, and Li et al. (2025) added quantitative proof of its effectiveness at low concentrations. In similarity to these, Nurzyńska-Wierdak and Walasek-Janusz (2025) emphasized oregano's known therapeutic properties. When taken together as a whole, these findings further support oregano's growing potential as an effective and sustainable alternative to chemical antimicrobials.

Medicinal and Dermatological Applications of Aloe vera *(Aloe barbadensis Miller)*

Aloe vera is commonly known as a green cactus-like plant which can be used for medicinal as well as cosmetic purposes. The gel of the plant has a cooling and healing effect, which is applied to heal burns, cuts, and even rashes on the body. It is beneficial in skin issues such as acne, ulcers, and dermatitis, and it is also employed in the cosmetic industry as a moisturizer, sunscreen and anti-aging substance. Its healing properties are evident from plants' natural healing.

Zhu et al. (2024) stated that Aloe vera (AV) has been recognized for its safety and effectiveness in treating various medical conditions for centuries. Its anti-tumor, anti-diabetes, and immune-boosting properties have been noted, along with significant benefits for skin health, including its bactericidal and anti-inflammatory effects, ability to induce wound healing, and antioxidant benefits.

Based on Mondal et al. (2020), Aloe vera is one of the oldest plants with 200 biologically active ingredients, of which acemannan is the main active ingredient that gives it its medical qualities. Acemannan is a long-chain polysaccharide with strong antibacterial, antifungal, antioxidant, and immunomodulating properties that make it a "healing plant." This study highlights the capabilities and adaptability of health and skin-contact products.

As mentioned by Matei et al. (2025), the Aloe vera plant *(Aloe barbadensis Miller)* contains bioactive compounds that are rich in polysaccharides. This study stated that it is traditionally known for its antimicrobial, anti-inflammatory, antioxidant, and tissue-regenerating properties. The benefits of it are valuable for biomedical applications, skin repair, antiviral applications, and tissue engineering scaffolds.

Sánchez et al. (2024) highlighted that new activities have been explored in Aloe vera and active constituents with a special emphasis on its potent utility as a cytotoxic, antitumoral, anticancer, and antidiabetic compound. It is to be particularly noted that between in vitro studies, there is a great number of studies comparing Aloe vera's protective effects in bone disorders like osteoporosis.

Aloe vera, as noted in the research conducted by Zhu et al. (2024), can cure skin and other diseases as it is anti-diabetes and anti-tumor which can cure skin ulcers, dermatitis, and acne vulgaris by the antibacterial, anti-inflammatory, and antioxidant action.

Soap and Hand Sanitizers in Promoting Proper Hand Hygiene Practices

Hand hygiene is one of the most important practices in order to stop the spread of infectious diseases. The most commonly used products for hand hygiene are soap and alcohol-based hand sanitizers.

These two share the main goal of cleaning and sanitizing, however, they have varying aspects to each other. Soap removes dirt, grease, and a wide range of microbes by using it with a washing action and the help of water. On the other hand, sanitizers provide a fast and convenient alternative whenever water is not available.

Soap and sanitizer use usually depends on the context even if both are trusted for reducing microbial risks, as per Hoffman et al. (2021). In the study, about 70% of respondents considered soap the "most reliable" option because it removed the visible dirt and gave a feeling of complete cleanliness. On the other hand, hand sanitizers were valued for convenience, especially in situations like traveling or when water was unavailable.

However, the study also showed that nearly 40% of participants are worried about skin dryness from continued sanitizer use. The findings suggest that more common habits and accessibility in social environments strongly influence preference, as people were more likely to choose whichever option was most available in their immediate surroundings.

Similarly, Duane et al. (2022) increased this understanding by looking at the sustainability and health implications of soap versus sanitizers. Their study emphasized that even if sanitizers are highly effective against a wide range of pathogens, overuse of this raises concerns regarding chemical exposure.

In addition, Duane et al. also noted the environmental burden of single-use plastic sanitizer bottles and the reliance on chemical production, which may not be sustainable long term. On the other hand, soap was identified as a more environmentally friendly and sustainable option, provided that water is available, since it requires less chemical processing and generates fewer ecological risks.

From these insights, a literature review by Belgis, B. & Algadrie, Z. in 2024 focused on how teenagers are particularly vulnerable during this stage of life due to ongoing physical and emotional development, as well as increased social interactions. While handwashing with soap and water effectively removes germs, hand sanitizers are often used as a more convenient alternative.

The aim of this study was to compare the effectiveness of hand sanitizers and handwashing among teenagers. A literature review was conducted using secondary data from publications between 2007 and 2024, ultimately using eight studies that fit their criteria. The findings were mixed. Three studies indicated that hand sanitizers are more effective than handwashing, while five studies concluded that handwashing is more effective.

The studies favoring handwashing emphasized that hand sanitizers may leave residual germs, do not reach the deeper layers of the skin, and can cause skin dryness and irritation with prolonged use due to their high alcohol content. In conclusion, based on the evidence, teenagers should prioritize handwashing with soap and running water over the use of hand sanitizers for better hygiene and infection prevention.

Adding further support, Susilaningrum et al. (2021) explained that soap, especially antibacterial soap, is better at cleaning and killing germs on the hands than just using water or hand sanitizer. Liquid soaps are popular because they are easy to use, more hygienic, and better at removing dirt and germs, especially when combined with the scrubbing action of washing.

Compared to hand sanitizers, Susilaningrum et al. (2021) stated that washing hands with soap and water does a better job of removing germs. While hand sanitizer is useful for quick disinfection, washing hands with soap and water is more effective in removing a wider range of microorganisms and dirt, especially viruses, due to its ability to physically dislodge microbes. Hand sanitizer is a convenient option when handwashing facilities are unavailable as it is effective in killing germs and preventing microorganism growth on the skin.

However, using insufficient quantities reduces effectiveness. Soap works by physically loosening and washing away bacteria, while hand sanitizers mainly kill germs with alcohol. If the alcohol level is low, hand sanitizers become less effective. Therefore, washing with soap and water is generally the most effective way to clean hands and keep germs away.

The collective studies highlight that both handwashing with soap and water and the use of hand sanitizers are valuable tools for maintaining hygiene and preventing infection, each offering unique advantages. But, although hand sanitizers offer a convenient and quick alternative, especially when water is unavailable, they may be less effective in eliminating certain microbes and leave residual germs, cause skin dryness, and have environmental and health concerns related to chemical use and sustainability.

In contrast to this, soap is highlighted as a safer, more environmentally friendly option that effectively reduces microbial load, making it preferable for long-term hygiene practices. Therefore, while both methods play roles in infection prevention, prioritizing soap and water is good for optimal hygiene, with hand sanitizers serving as a supplementary option in circumstances where handwashing is not feasible.

Research Framework

Phytochemical Theory

This study adopts the Phytochemical Theory to further investigate the antibacterial effect of oregano and Aloe vera when used in a sanitizer-soap capsule. The theory states that plants produce secondary metabolites (e.g. phenols, flavonoids, terpenoids, and saponins) which are complex organic molecules that can serve as an instrument for its interaction with the environment, including protection and defense for itself (Ashraf et al., 2023). These compounds have been studied for their antimicrobial potential and are often being used in pharmaceutical and hygienic products (Khare et al., 2021).

A study by Hochma et al. (2021) showed that compounds in oregano, specifically carvacrol and thymol, have promising antimicrobial properties.

Similarly, aloe vera possesses healing and antimicrobial effects due to its natural compounds like anthraquinones, saponins, and flavonoids. The study is based on the idea that these natural compounds can be used effectively in hygiene products like a

sanitizer-soap capsule, with their strength varying depending on the concentration used.

Conceptual Framework

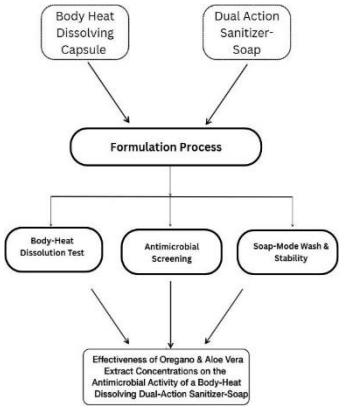

Figure 1. Conceptual framework of the study

This research focuses on developing a Body-Heat Dissolving Capsule Dual-Action Sanitizer-Soap through the concentrational extracts of Oregano and Aloe vera. The framework begins with two main inputs: the body heat dissolving capsule which dissolves when coming in contact with body heat, and the dual-action sanitizer-soap which is designed to function as both a sanitizer and a soap.

These two components will undergo a formulation process to ensure that the product dissolves properly with body heat while maintaining its dual action component. Once the product is formulated, it will undergo three types of tests: (1) First, the heat activated capsules will be tested on a heated silicone hand with a temperature of 36–37 °C and rubbed to simulate hand friction. The researchers will measure the time on how long it will last for the complete dissolution. (2) Then, an antimicrobial activity test will be done. The researchers will undergo different concentrations of oregano and aloe vera extracts (25%, 50%, 75%) that will be tested against S. aureus. Methods include measuring inhibition zones and agar well/disk diffusion. These tests will help determine how effective the Oregano and Aloe vera extracts are in fighting against *S. aureus*.

Afterwards, the soap-mode process will be tested by applying the capsule with water to simulate handwashing. This test will compare the effect against S. aureus which is to be achieved by the sanitizer-soap with water-only washing.

The final step will be to evaluate the overall effectiveness of the extract concentrations on the antimicrobial activity of the sanitizer-soap. This will show whether the product is truly effective as a natural and dual-purpose hygienic solution.

Scope and Limitations

This study will assess how Aloe vera and oregano will be used as antibacterials and their effectiveness when combined in a dual-action sanitizer-soap capsule that is a solution for hand hygiene. This study will be conducted under laboratory tests that will determine how these extracts fight specific bacteria, without evaluating other antimicrobial agents or formulations. The results will indicate the overall efficacy of Aloe vera compared to usual antibacterial agents and the combined effects of using both extracts to combat bacterias. The study will also explore how body heat activates the sanitizer-soap capsule to enhance the sanitizing process.

However, the research will not consider the long-term stability of the sanitizer-soap capsule or any potential skin irritation for different individuals in actual conditions. It will only focus on the dual-action sanitizer-soap capsule and the effectiveness of the Aloe and oregano extracts, without testing other natural products. The research does not include how the researchers' sanitizer-soap capsules may affect users with sensitive skin or the effects of long-term use. The research does not include how the researchers' sanitizer-soap capsules may affect users with sensitive skin or the effects of long-term use against sensitive skin. The focus will remain on the antibacterial properties of the extracts and how they contribute to the effectiveness of the sanitizer-soap capsule.

METHODOLOGY

Research Design

This study will adopt a developmental research design, specifically utilizing a non-iterative (single-cycle) approach to test, evaluate, and determine the effect of oregano and aloe vera extract concentration on the antimicrobial activity of dual-action sanitizer soap with body heat capsules. This approach is appropriate for assessing the initial effectiveness of the extracts and avoiding alterations, thus allowing concentrated analysis of their effects at one stage of development by testing the processes created (Maidment, 2020). A design will collect sufficient data on how aloe vera and oregano concentrations affect antimicrobial activity as a dual-action sanitizer-soap.

In line with recent laboratory practices, the study will utilize silicone hand models as controlled testing surfaces for antimicrobial evaluation. Silicone replicas are recognized as practical substitutes for human skin because they offer thermal stability, safety, and consistent conditions suitable for product testing (Althumayri et al., 2024). Although they do not replicate full skin features, their ability to maintain body-like temperature and provide a reproducible testing surface makes them appropriate for this developmental research design.

This study aims to give us knowledge about the effectiveness of plants as sanitizer soap and how body heat capsules make your life easier as portable sanitizer, and this research intends to provide useful information that can help future researchers.

Furthermore, having body heat-activated capsules in the soap formulation provides an additional unique method for longer preservation and steady antimicrobial action. This quality of the product illustrates its convenience in sanitizing product, on-the-go sanitizing solution, and the primary needs for such a product are the unavailability of standard sanitizers and washing facilities.

The scope of this study is to evaluate the combination of plant-derived antimicrobial ingredients with contemporary personal care products to find out whether such products will serve as substitutes to synthetic chemical sanitizers. The findings will also demonstrate the practical feasibility of the product idea and are expected to assist other researchers and product designers working on natural active ingredients for personal care and health safety in the hygiene products domain.

Procedure

The materials used in this study include unflavored gelatin (10 g), distilled water (20 mL), vegetable glycerin (3 mL), Castile soap base, aloe vera extract, oregano essential oil (as a substitute for oregano extract), ethanol, xanthan gum, Mueller-Hinton Agar (MHA) plates, blank discs, ciprofloxacin discs, and parchment paper. The equipment utilized consists of a digital scale, beakers and labeled containers, a hot plate, stirring rod, measuring dropper, silicone molds, pH meter or strips, incubator set at 37 °C, autoclave, vernier caliper, and silicone hands.

To prepare the capsule shell, 10 g of gelatin was first sprinkled over 20 mL of cold distilled water and allowed to bloom for 5–10 minutes until fully swollen. The bloomed gelatin was then heated in a water bath at 50–60 °C and stirred until completely dissolved. Afterward, 3 mL of vegetable glycerin was added and mixed thoroughly until a uniform solution was achieved. The warm mixture was poured onto parchment paper and spread into a thin film. This film was left to dry until it became firm, flexible, and non-sticky, after which it was carefully peeled off.

For the capsule core, three labeled beakers corresponding to 25%, 50%, and 75% concentrations were prepared. Each beaker contained 7.5 mL of Castile soap, 3 mL of aloe vera extract, and 0.6 mL of vegetable glycerin. Since oregano extract was unavailable, oregano essential oil was diluted in ethanol to create the antimicrobial solution. The diluted oregano solution was then added to each beaker according to the designated concentration levels, with 25% as the least, 50% as moderate, and 75% as the highest concentration. If the mixtures appeared too runny, a small amount of pre-dissolved xanthan gum in warm water was added to slightly thicken the solution, followed by continuous stirring until smooth.

For capsule assembly and sealing, the dried gelatin film was cut into uniform circular pieces and gently pressed into molds to form capsule halves. Approximately 0.5 mL of the prepared core mixture was dispensed into each capsule half using a dropper. Another gelatin piece was placed on top, and a heated cutter mold was used to seal the edges by slightly melting the gelatin, ensuring the capsule was securely closed without burning it. The sealed capsules were then allowed to dry at room temperature and stored in a clean, covered container until further testing.

To evaluate antimicrobial properties, the Kirby-Bauer disk diffusion test was conducted using Staphylococcus aureus as the test organism. Mueller-Hinton Agar plates were prepared, and blank discs were soaked with the 25%, 50%, and 75% capsule core solutions, with three discs per concentration. The agar plates were streaked with the bacterial culture, and the soaked discs, along with ciprofloxacin discs as the control, were placed evenly on the agar surface. The plates were incubated at 37 °C for 24 hours. After incubation, the zones of inhibition were measured in centimeters using a vernier caliper, and the results were recorded.

For the body heat dissolution test, silicone hands were placed on a hot plate and adjusted to approximate human body temperature. A capsule was placed on the warmed surface, and a timer was started while gently rubbing the capsule. Observations were made on the time required for the capsule to rupture and spread. This procedure was repeated at least three times to ensure accuracy and consistency.

Lastly, for soap mode testing, the silicone hands were again heated to body temperature. A capsule was placed on the surface and rubbed with water using a handwashing motion. The dissolution time, residue, and visual cleanliness were recorded. This process was repeated at least three times for comparison and reliability of results.

Research Instrument

This observation sheet will document the results from the antimicrobial efficacy test and the capsule's ability to dissolve with body heat. It will provide sections for recording data from the Kirby-Bauer Disk Diffusion Test, and Soap-mode Test with Water, ensuring consistent measurement of bacterial reduction, inhibition zones, and cleaning effectiveness under controlled conditions. By utilizing this, the researchers can guarantee that the data is organized efficiently, providing an easier way to check accuracy and track the overall performance of the antimicrobial body-heat dissolving capsule and its components.

Statistical Treatment

In the study, descriptive statistical methods were used to process and analyze the data gathered from the Body-Heat Dissolution Test, the Kirby–Bauer Disk Diffusion Test, and the Soap-Mode Wash Test. The measures computed included the mean to determine the average performance of each concentration, the standard deviation to describe the variability of the results, and the kurtosis to identify the distribution pattern of each set of values. All statistical computations were carried out using Jamovi, which provided an organized and accurate summary of the recorded data. These descriptive measures were applied to support the interpretation of the outcomes presented in the Results section.

Ethical Considerations

During the making of the product, the researchers are guided by the following ethical considerations:

No Human and Animal Testing. The researcher made sure that no humans or animals were used in testing the sanitizer soap capsule. Instead of real hands, silicone fake hands were used to simulate (the testing) to avoid biological risk. With this, it protects the living subjects while ensuring accurate and safe experimentation.

Accountability with Results. All data collected while doing the experiment were recorded accurately and reported directly. This ensures the reliability of this research regarding the findings on the antimicrobial activity and aloe vera extract concentration.

Sustainable Material Use. The study prioritizes the use of sustainable materials, including the natural extracts of oregano and aloe vera. To reduce waste, laboratory equipment was carefully selected and used effectively. This dedication supports sustainability throughout the research process.

Safety During Work. Proper laboratory safety protocols were strictly followed during the experiment to prevent any accidents or contamination that might occur. The researchers wore protective equipment and maintained a controlled workspace to ensure a safe environment where the researcher developed and tested the sanitizer-soap capsule.

RESULTS AND DISCUSSION

Dissolution with Body Heat Test (Sanitizer Mode)

In the Body Heat Dissolution Test, proving that the formulation was both practical and sensitive to standard skin heat. Compared to the 25% and 75% concentrations, the 50% concentration revealed the most stable dissolving performance, with a mean dissolution time of 25.67 seconds and the lowest standard deviation (4.93). This means that the capsule's most stable structural balance might have been achieved at the 50% concentration. The 75% concentration showed more variability, which indicates that both lower and higher extract levels may have an effect on the capsule's physical behavior, even if the 25% concentration dissolved a little more slowly and inconsistently.

The formulation of the plant extracts may be the reason for the differences. While oregano has concentrated bioactive components like carvacrol and thymol, aloe vera contains polysaccharides like acemannan, which are recognized for their gel-like and moisture-retaining qualities. Aloe vera has a variety of physiologically active compounds that support healing, antibacterial activity, and viscosity, according to Mondal et al. (2020) and Matei et al. (2025). These components may make the capsule mixture denser or thicker at higher concentrations, which could account for the 75%

concentration's less consistent dissolution even if it was effective. As a result, the ideal balanced effect between heat sensitivity and capsule stability could be considered found at the 50% concentration.

Table 1. Body Heat Dissolution Test

Observation No.	25%	50%	75%
1	22s	29s	24s
2	19s	20s	45s
3	48s	28s	21s
Mean	29.67s	25.67s	30.00s
SD	15.95	4.93	13.08
Kurtosis	-1.50	-1.50	-1.50

Kirby Bauer Disk Diffusion Test

The 75% concentration indicated the best antibacterial activity against Staphylococcus aureus among the experimental groups, indicated to the Kirby-Bauer Disk Diffusion Test results. It consistently provided the most significant mean zones of inhibition in both trials, even somewhat surpassing the ciprofloxacin control in Trial 1. This indicates that the product's antibacterial potential was improved by adding more oregano and Aloe vera extract.

Oregano essential oil indicates antibacterial activity by interfering with ion transport, changing bacterial membrane permeability, and slowing biofilm formation, according to Moghrovyan and Sahakyan (2024). Oregano is effective against bacteria like Staphylococcus aureus because these mechanisms inhibit bacterial survival and reproduction. In the same manner, Li et al. (2025) discovered oregano compounds can disrupt vital bacterial metabolic processes and are effective even at low concentrations. Higher concentrations most likely contained more of these active antimicrobial substances, which helps explain why the 75% concentration in the current analysis exhibited the biggest antimicrobial zones.

Additionally, Aloe vera is shown to have antibacterial, anti-inflammatory, antioxidant, and wound-healing qualities, which makes it ideal for skin-contact hygiene products (Zhu et al., 2024). The antibacterial and antifungal properties of Aloe vera are also attributed to acemannan, one of the plant's primary bioactive chemicals, according to Mondal et al. (2020). This indicates the barrier against S. aureus. The antibacterial efficacy of the capsule may have been improved by the combination effect of oregano and Aloe vera extracts.

In both experiments, the 50% concentration exhibited the weakest zones of inhibition while the 75% concentration exhibited the strongest antibacterial activity. It indicates that higher levels in concentration does not always result in a perfectly linear enhanced efficiency in performance under every circumstance. The diffusion rate of active chemicals into the agar, rather than only their actual antibacterial power, may have been shaped by the interaction between the two plant extracts and the capsule medium. To put it another way, even if a sample contains potent antibacterial chemicals, the inhibition zone may still be smaller if the compounds are not as effective in spreading through the test medium. This illustrates how crucial it is to interpret disk diffusion results as indicators of compound dispersion and release behavior in addition to its efficacy.

Table 2. Disk Diffusion Test (Trial 1)

Observation No.	CIP	25%	50%	75%
1	3.575cm	2.985cm	2.340cm	3.525cm
2	3.250cm	3.165cm	1.970cm	3.000cm
3	3.175cm	2.850cm	1.465cm	3.460cm
Mean	3.34cm	3.10cm	1.92cm	3.47cm
SD	0.16	0.18	0.38	0.36
Kurtosis	-1.23	-1.46	-1.53	-1.13

Table 3. Disk Diffusion Test (Trial 2)

Observation No.	CIP	25%	50%	75%
1	3.475cm	3.00cm	2.390cm	3.710cm
2	3.325cm	3.310cm	1.645cm	3.140cm
3	3.210cm	3.290cm	1.690cm	3.980cm
Mean	3.34cm	3.10cm	1.92cm	3.47cm
SD	0.16	0.18	0.38	0.36
Kurtosis	-1.23	-1.46	-1.53	-1.13

Dissolution with Water (Soap Mode)

All concentrations properly cleaned the silicone hand model in the Soap Mode Wash Test, but higher concentrations showed better performance. The 75% concentration had the shortest mean wash duration (7.00 seconds), followed by 50% (9.00 seconds) and 25% (13.33 seconds). Qualitative observations further showed that the 25% solution produced weaker foam and less surface coverage, while the 50% and 75% concentrations generated more lather and left minimal residue.

These findings align with existing research. Susilaningrum et al. (2021) noted that soap effectively removes dirt, oils, and microbes, while Hoffman et al. (2021) found that users perceive soap as more reliable due to its visible cleaning action. Similarly, the dual-action capsule combined sanitizer convenience with the mechanical benefits of soap, particularly at higher concentrations. The results also support the potential of plant-based formulations, as oregano has recognized antimicrobial properties (Soltani et al., 2021), and aloe vera provides anti-inflammatory and skin-soothing benefits, enhancing safety and user acceptance (Duane et al., 2022).

Overall, concentration had an influence on different aspects of performance. The 50% formulation demonstrated the most consistent dissolution, suggesting better physical stability, while the 75% concentration showed the highest antibacterial and cleansing efficacy. This indicates that the optimal concentration depends on the intended priority—balanced performance or maximum effectiveness. In conclusion, concentration plays a critical role in enhancing the performance of dual-action sanitizer-soap capsules, and the successful incorporation of oregano and aloe vera supports the viability of plant-based alternatives in hygiene product development.

Table 4. Soap Mode Wash Test (Wash Duration)

Observation No.	25%	50%	75%
1	14s	3s	2s
2	10s	12s	9s
3	16s	12s	10s
Mean	13.33s	9.00s	7.00s
SD	3.06	5.20	4.36
Kurtosis	-1.50	-1.50	-1.50

CONCLUSION

The results of the study demonstrate that the dual-action body-heat dissolving sanitizer-soap capsule successfully met the research objectives. The product dissolved effectively at body temperature, exhibited measurable antibacterial activity, and showed functional cleansing performance across all concentrations tested. In the two trials, the 75% concentration displayed the strongest antibacterial efficacy, while the 50% concentration proved to have the most consistent and reliable dissolution results. Though all formulations were usable, the Soap-Mode Wash Test revealed that the 25% concentration presented drawbacks, that includes weak lather formation and a sticky residue. Overall, the medium to high concentrations (50%–75%) produced the best balance between dissolution, cleansing ability, and antimicrobial effectiveness, with higher concentrations delivering superior antibacterial action

This research demonstrates the practical potential of combining plant-based extracts specifically oregano and aloe vera with a body-heat dissolving way. At a time when hygiene, accessibility, and sustainable alternatives to chemical sanitizers are increasingly important, this study offers a promising natural solution that can function both as a sanitizer and a soap. The findings contribute to the growing body of evidence supporting herbal antimicrobial agents and introduce a capsule that may benefit communities with limited access to traditional hygiene products.

However, the study is not without limitations. It did not test long-term product stability or performance under real-world environmental conditions, nor did it evaluate possible skin reactions over extended use. These aspects provide valuable directions for future research.

Lastly, the dual-action sanitizer-soap capsule offers a practical, creative, and eco-friendly method of maintaining personal hygiene. This study presents a workable solution with significant promise by fusing the natural antibacterial qualities of oregano and aloe vera with a dissolving capsule technology, one that demonstrates both scientific creativity and a dedication to enhancing routine health practices.

Recommendations

Based on the findings and limitations observed in the study, several recommendations are proposed for future researchers to improve the accuracy, reliability, and overall performance of similar studies. These suggestions aim to enhance testing procedures, strengthen product formulation, and ensure more consistent and valid results. Future studies are encouraged to include testing on additional bacterial strains, such as *Escherichia coli*, to further validate antimicrobial effectiveness. Evaluating the capsule against both Gram-positive and Gram-negative bacteria will provide a more comprehensive assessment of its antimicrobial properties. In addition, the use of manual capsule-filling devices is recommended to improve consistency in capsule shape, minimize sealing issues, and prevent deformation or leakage, thereby increasing production efficiency compared to manual gelatin capsule formation.

Furthermore, improvements in the gelatin formulation are suggested to produce stronger and more stable capsule shells. Refining the gelatin-to-glycerin ratio or incorporating stabilizing agents may help reduce stickiness and enhance capsule hardness, allowing the capsules to better maintain their form during handling and dissolution testing. It is also recommended that future experiments utilize standardized temperature-control methods, such as infrared thermometers or regulated heating devices, to ensure consistent testing conditions during dissolution trials. This approach will help increase accuracy and minimize variability caused by fluctuations in temperature.

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