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Effect of Using Natural Liquid Soap on the Effectiveness of *Staphylococcus Aureus* Bacteria Control and Skin Health: A Review

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Abstract: The skin is a protective barrier against environmental disturbances and infections. Staphylococcus aureus is a common bacterium on human skin that can lead to infections. In light of this, the study investigates the effectiveness of natural liquid soaps in controlling *Staphylococcus aureus* while promoting overall skin health. The primary objective is to showcase the advantages of using natural ingredients in liquid soap formulations compared to synthetic chemicals. To achieve this, the researchers conducted a systematic literature review (SLR), utilizing reputable databases such as PubMed and Mendeley to gather relevant studies focused on natural liquid soaps. They carefully selected articles based on inclusion criteria established through the PICO framework, emphasizing the antibacterial effectiveness of these natural products against *Staphylococcus aureus*. The review encompassed ten high-quality studies, revealing that formulations containing natural extracts such as breadfruit leaf, cardamom, aloe vera, and honey exhibited significant antibacterial activity against *Staphylococcus aureus*. These natural ingredients offered effective bacterial control and provided additional benefits, including skin moisturization and reduced irritation, making them preferable to synthetic alternatives. This study introduces a novel perspective by comprehensively reviewing various natural ingredients used in liquid soaps and their comparative effectiveness against *Staphylococcus aureus*. It underscores the potential of plant extracts and essential oils as safer and more effective alternatives to traditional chemical antibacterial agents in skin cleansers. In conclusion, natural liquid soaps effectively reduce *Staphylococcus aureus* on the skin while maintaining skin health. Incorporating natural ingredients ensures antibacterial protection without the adverse effects commonly associated with chemical-based soaps, such as dryness or irritation, thereby advocating a shift towards more natural skincare options.

Keywords: Liquid Soap; Skin; *Staphylococcus aureus.*

Introduction

The skin is an organ that covers the entire outer surface of the body. The skin protects the inside of the human body, so it tends to be protected from various disturbances such as friction, pull, pressure, temperature changes, radiation, or the influence of bright light that can interfere [1]. Soaps are used to cleanse, relax, brighten, and maintain the skin. There are two types: liquid and bar soap [2]. Liquid soap is more straightforward than stick cleaners because it does not need to be lathered or rubbed to create foam and is more effective in killing bacteria [3]. Liquid soap is a sodium compound with unsaturated fats used as a body cleansing agent, foaming, with or without different additions and does not interfere with the skin [4].

Liquid soap has several advantages, including a generally more straightforward production process, relatively low manufacturing costs, and ease of storage and use, so this cleaner can be used effectively without being easily damaged [5]. The use of liquid soap also has a relationship with skin health. Liquid soap is one way to protect the skin from bacterial contamination and prevent skin diseases [6]. Antibacterial from engineered preservatives can prevent contamination, but few have side effects [7].

Skin soap products contain water-soluble cleansers such as vegetable oils, scents, and pH. The pH value of liquid soap is alkaline and is usually in the range of 8 – 11 [8]. Liquid soap can cleanse the skin of soil and microorganisms. On human skin, there are a lot of microorganisms, one of which is the microorganism *Staphylococcus aureus*. *Staphylococcus aureus* is a microscopic organism commonly found on the skin [9]. The characteristics of *Staphylococcus aureus* are round, gram-positive cells, usually arranged sporadically [10]. The environment has an impact on the existence of *Staphylococcus aureus*. About 20-30% of healthy people carry these bacteria on their skin and mucosa [11]. *Staphylococcus aureus* is often dominant in clinical infections, especially those affecting the skin and soft tissues [12].

Staphylococcus aureus can be found on the skin's surface as expected vegetation, especially around the nose, mouth, and face [13]. The microscopic organism *Staphylococcus aureus* can cause abscesses on acne-prone skin [14]. These microorganisms cause contamination of wounds, which are usually abscesses, which are various kinds of fluid in the tissues [15].

In this case, a liquid soap made from natural ingredients such as plant extracts, essential oils, and honey is needed to provide better benefits for skin health compared to soaps with synthetic chemicals. The natural

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ingredients combined with oils are the best solution for all skin types, hence providing instant, round-the-clock action at the back, said the proponents [16]. The core of its natural ingredients feeds organic liquid soap; even within the most delicate skins, its action fits the role of an environmentally friendly product [17].

Research Methods

This study is based on the SLR method, a systematic and structured way of reviewing and refocusing on the literature on specific subjects. Unlike a regular literature review, an SLR is designed to identify all relevant, high-quality research, resulting in a thorough understanding of the topic under study.

This study uses a laptop to access and manage various data sources and conduct research. The gadget would, therefore, be defined as a Chrome application for accessing and searching scientific articles from the different databases mentioned. The primary data source comes from several leading scientific databases, namely Mendeley and PubMed. Mendeley is used not only as a reference management tool but also as a source of a literature search that can be accessed online. Pubmed, which provides access to research articles of a wide variety, is used to access publications related to research topics.

The time for conducting the research conducting the Systematic Literature Review (SLR) will take place in August - October 2024. The data collected in this study are articles that discuss the use of liquid soap and its effects on skin hygiene and health, primarily related to Staphylococcus aureus bacteria. In selecting the articles, keywords were used to facilitate searches in the database, namely Pubmed and Mendeley, listed in Table 1.

Table 1. Keywords used in the process of searching for articles on search engines

Online Articles	Search and terms
PubMed	1. *"Liquid soap" or "Skin" or "Staphylococcus aureus"* = 164
Mendeley	1. *"Liquid soap" or "Skin" or "Staphylococcus aureus"* = 133

Furthermore, from the search results, filtering or filtering data by the inclusion and exclusion criteria according to PICO in Table 2.

Table 2. Inclusion and Exclusion Criteria of PICO

PICO	Inclusion Criteria	Exclusion Criteria
Population	People at risk of developing skin infections from exposure to *Staphylococcus aureus*	People who are not at risk of skin infections from exposure to *Staphylococcus aureus*
Intervention	Use of natural liquid soap	Not all uses of natural liquid soap
Comparison	Using soap or other cleaning agents, such as bar soap and chemical-based liquid soap	Avoid using soap or other cleaning agents like bar and chemical-based liquid soap.
Outcome	Effectiveness of liquid soap from natural ingredients in controlling *Staphylococcus aureus* bacteria	It has no effectiveness in controlling *Staphylococcus aureus* bacteria.

In addition to PICO, the inclusion criteria in this study include journals published in the last 10 years, journals indexed by at least SINTA 4 or international journals based on SCImago Journal Rank (SJR) and DOAJ (Directory of Open Access Journals), and available in full text. Meanwhile, the exclusion criteria include journals published more than 10 years ago, journals that are not indexed by at least SINTA 4 or are not international journals based on SCImago Journal Rank (SJR) and DOAJ (Directory of Open Access Journals), and journals that are not available in full-text format.

The literature screening and selection process follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) approach, consisting of four main stages. The first stage is identification, where keyword searches are conducted across various scientific databases, yielding 297 articles (164 from PubMed, 133 from Mendeley). Then, 14 duplicate journals were eliminated, and 283 articles remained for further screening.

The next stage is screening, where the articles are evaluated based on predetermined exclusion criteria, such as using the PICO framework, publication date (older than 10 years), journal indexing standards (at least Sinta 4 and international journals based on SCImago Journal Rank (SJR) and DOAJ (Directory of Open Access Journals), and the availability of full text. In this stage, the number of articles is reduced to 43, with 240 excluded for not meeting the criteria.

Following this, in the eligibility stage, the remaining articles undergo further assessment based on their titles and abstracts, reducing the number to 13. Full-text eligibility is then evaluated, excluding three more articles, leaving ten articles that meet the criteria.

The final stage is inclusion, where the ten articles that passed the selection are included in the literature review for the study. This process ensures that only relevant and high-quality literature is included in the review by systematically eliminating studies that do not meet the criteria. PRISMA Flow Diagram that describes the literature selection process is shown in Figure 1.

Results and Discussion

Results of several studies that use natural liquid soap in reducing *Staphylococcus aureus* in the skin (Table 3).

Various studies have widely investigated the effectiveness of natural-based liquid soaps in reducing Staphylococcus aureus. Liquid soaps with active ingredients, provisioned with plant extracts or other natural ingredients, have been formulated to be more effective than any regular bar. Basir *et al.* demonstrated that liquid bath soap formulations with breadfruit leaf extract (*Artocarpus altilis*) at concentrations of 5%, 10%, and 15% were effective against the growth of *Staphylococcus aureus* bacteria [18]. The 15% extract concentration showed the highest antibacterial activity, with an average inhibition zone diameter of 20.8 mm, followed by 10% (19.3 mm) and 5% (17.8 mm) [18]. All formulations displayed inhibition zones in the "strong inhibition" category, and there was a direct correlation between the extract concentration and the inhibition zone size.

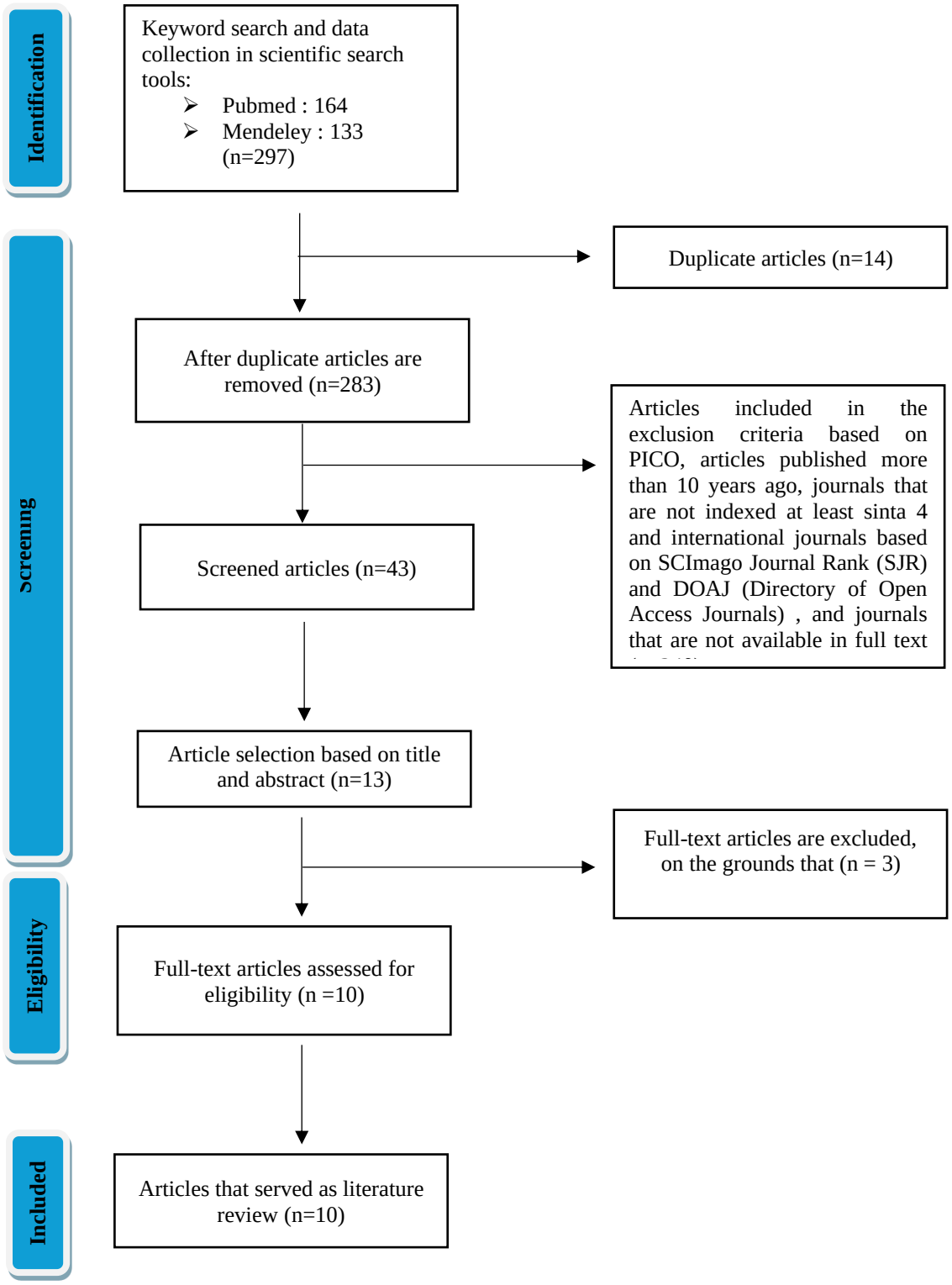

Figure 1. Prisma Flow Diagram

Table 3. Literature Review Result

No	Author	Types of Liquid Soap	Research Design	Impact on Skin Health	Conclusion
1	Basir *et al*. [18].	Liquid soap ethanol extract of breadfruit leaves (*Artocarpus altilis*).	Laboratory experimental methods with practical antibacterial activity tests in fighting Staphylococcus aureus, liquid bath soap, ethanol extract, and breadfruit leaf were used, and the method used was well diffusion to measure the diameter of the inhibitory zone at various extract concentrations.	Reduces the number of *Staphylococcus aureus* bacteria, which can cause infection.	Bath soap leaf extract effective breadfruit ethanol liquid soap inhibits the growth of *Staphylococcus aureus*, with a concentration of 15% showing the highest inhibitory power. The higher the concentration, the larger the inhibition zone produced.
2	Rasyadi *et al*. [19].	Liquid bath soap with cardamom ethanol extract (*Amomum compactum*).	Testing the antibacterial activity of liquid bath soap containing cardamom fruit extract (*Amomum compactum*) with different concentrations against *Staphylococcus aureus* bacteria using agar diffusion.	Destroys bacterial cell walls and protects the skin from infections without side effects.	Bath soap containing cardamom ethanol fruit extract has strong antibacterial activity against *Staphylococcus aureus*.
3	Tyowua *et al*. [20].	Liquid soap hand wash aloe vera extract.	An experimental study formulated a liquid hand soap containing various concentrations of aloe vera extract and evaluated its antimicrobial properties against skin microbes, specifically *Staphylococcus aureus*.	Aloe vera has anti-inflammatory properties, which have the potential to reduce skin irritation.	Crocodile extract can be used as a natural antimicrobial agent in the formulation of liquid hand soap and other related products, as it can fight the bacterium *Staphylococcus aureus*.
4	Jang *et al.* [21].	Liquid soap with 10% linoleic acid from grape seed oil.	A combination of in vitro experiments testing the antibacterial activity of various fatty acid salts and randomized cross-studies containing 10% linoleic acid in ultrapure water.	Has a more favorable effect on skin barrier function and clinical symptoms of dermatitis compared to standard treatment with chlorhexidine acetate.	Linoleic acid salts show antibacterial activity against *Staphylococcus aureus*; treatment with soaps containing linoleic acid in ultrapure water reduces the clinical condition of canine dermatitis.

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5	Bakhri *et al.* [22].	Liquid soaps are based on coconut oil with varying amounts of olive oil.	The experimental research uses a completely random design with one factor: liquid soap formulation.	It can moisturize the skin and inhibit the growth of *Staphylococcus aureus.*	Adding olive oil to coconut oil-based liquid soap does not affect the foaming properties of the soap or its effective antibacterial activity against *Staphylococcus aureus*. Still, it does increase the skin-moisturizing properties of the soap.
6	Raisa *et al.* [23].	Basic bath soap by adding various concentrations of honey, from 0% to 15%.	Experimental studies tested the effectiveness of adding various concentrations of honey (0%, 2.5%, 5%, 7.5%, 10%, 12.5%, and 15%) to basic liquid soap formulations and analyzed the physical and chemical properties of the resulting soaps.	Honey has moisturizing and antibacterial properties that benefit skin health, especially in fighting bacteria such as *Staphylococcus aureus*. Its hygroscopic properties help to keep the skin moisturized, while its antibacterial properties can reduce the risk of skin infections.	The addition of honey at various concentrations also affects liquid bath soap's physical and chemical properties.
7	Idawati *et al.* [24].	Liquid hand soap formulation made from celery leaf extract.	An experimental laboratory study involved the formulation of liquid hand soap with various concentrations of celery leaf extract and tested the antibacterial activity of this formulation against *Staphylococcus aureus* bacteria.	Celery leaf extract contains various active compounds, such as flavonoids, saponins, and tannins, so it can contribute to its antibacterial abilities and skin health.	Hand soap has the most effective *antibacterial activity against Staphylococcus aureus* liquid wash.
8	Martihandini *et al* [25].	Liquid soap ethanol extract of cassava leaves (*Manihot esculenta Crantz*) with cocamide diethanolamine.	I am using systematic research designs such as extraction, screening, and formulation testing to evaluate the potential of cassava leaf extract in producing liquid soap.	Reduces skin irritation and dryness compared to traditional liquid soaps that use Sodium Lauryl Sulfate (SLS) as a surfactant.	Cassava leaf ethanol extract can be formulated into liquid soap with effective antibacterial properties, especially against *Staphylococcus aureus*. Liquid soap formula containing 5% extract (F3) shows the best physical characteristics and protects the skin from bacterial infections.

9	Saryanti and Setiawan [26].	The liquid soap formulation containing sappang wood extract (Caesalpinia sappan L.) was optimized using the D-Optimal method.	The D-optimal method is used to determine the optimal formula of liquid soap containing sappan wood extract (*Caesalpinia sappan L.*), with the main parameters being pH, viscosity, density, and antibacterial activity.	Reduces skin irritation and dryness due to the addition of nonionic surfactant cocamide diethanolamine to counteract the irritating effects of the anionic surfactant Sodium Lauryl Sulfate (SLS).	Liquid soap formulations containing Sekang wood extract formulations have good physical properties, effective antibacterial activity in fighting *Staphylococcus aureus*, and foam stability.
10	Dewi and Mardhiyani [27].	Liquid soap containing ketapang leaf extract (*Terminalia catappa L.*).	They were using experimental design. The researchers formulated a liquid soap with various concentrations of ketapang leaf extract. They tested the antibacterial activity of the formulation against multiple strains of bacteria, using positive and negative controls.	The aim is to avoid any adverse effects from synthetic antibacterial agents like sodium lauryl sulfate and triclosan that tend to sensitize the skin and disturb its protective function.	In addition to meeting physical appearance and other required testing for safety on the skin, the soap liquid extract of ketapang leaves is effective in terminating *Staphylococcus aureus*.

Another study conducted by Rasyadi *et al.* showed that liquid soaps containing cardamom extract in concentrations of 2%, 4%, and 6% exhibited antibacterial solid effect against *Staphylococcus aureus*, with the most significant activity demonstrated by formulations containing 6% extract [19]. This finding affirms that the addition of natural plant extracts to liquid soap increases its impact on bacteria inhibition [19]. Research by Tyowua *et al.* also shows that liquid soap with aloe vera extract has effectively inhibited the growth of *Staphylococcus aureus* with an inhibition zone between 9 to 11 mm [20].

Some studies have also shown that certain combinations of ingredients can enhance antibacterial effects. Jang *et al.* found that linoleic acid salts have strong antibacterial activity against *Staphylococcus aureus*, and their effects are further enhanced when used in ultrapure water [21]. Research by Bakhri *et al.* showed that although the addition of olive oil to coconut oil-based liquid soap did not significantly affect the antibacterial activity, the soap still showed a very strong inhibitory zone (>20 mm) against bacteria [22].

Further research by Raisa *et al.* stated that honey can also be an effective antibacterial ingredient. The optimal concentration of honey added to liquid soap is 10%, at which concentration honey can inhibit the growth of *Staphylococcus aureus* well, even competing with the antibacterial properties of 0.3% triclosan [23]. In addition, Idawati *et al.* found that celery leaf extract at a concentration of 10% in liquid soap provided a very strong inhibitory effect against *Staphylococcus aureus* [24].

Martihandini *et al.* also found that a liquid soap formulation with an extract concentration as low as 1% was able to create an inhibition zone of 13.23 mm against options of *Staphylococcus aureus*, indicating that even very low concentrations can provide adequate antibacterial protection [25]. Separately, a study by Saryanti and Setiawan proved that liquid soap containing sappan wood extract has antibacterial activity with a minimum inhibition concentration of just 0.125% w/v [26]. Work by Dewi and Mardhiyani finds that liquid soap with *Terminalia catappa L.* leaf extract exhibits strong inhibition zones against *Staphylococcus aureus*, with the inhibition zone diameter being 25.1-40.67 mm [27]. The research strengthens the use of various natural ingredients with great prospects for providing an ample basis for antibacterial protection.

For instance, various constituents constitute the main ingredient of liquid soap that establishes skin health. Users receive positive skin benefits if they go naturally with plant extracts, essential oils such as olive oil, and natural antimicrobial agents such as aloe, cardamom, coconut oil, etc. Such materials moisturize and maintain healthy skin and actively fight against pathogens such as *Staphylococcus aureus* [28].

The suitability of liquid soap ingredients for skin conditions should also consider potential hazards or safety [29]. For instance, in liquid soap formulation, preservatives or antimicrobial agents such as chlorhexidine acetate, sodium lauryl sulphate, and triclosan are included to kill bacteria. Still, their inclusion has also caused bacteria to develop immunity and other skin issues. Conversely, with natural ingredients like honey, coconut oil, etc., consumers are offered much safer options for changing skin moistness from infection protection elsewhere [30].

The long-term effectiveness of liquid soap depends upon the choice of the material [31]. Natural ingredients should produce a safe liquid soap without side effects [32]. Long-term use of antimicrobial agents such as chlorhexidine acetate or triclosan might enhance bacterial resistance and upset the skin's microbiota balance. Other soaps with sodium lauryl sulfate (SLS) often dry and rash the skin. Therefore, liquid soap with a safe and well-

balanced composition of ingredients is better in the quest for healthy skin and being free from long-term effects [33].

Conclusion

Using natural liquid soap to wash your hands can reduce the risk of *Staphylococcus aureus* transmission. Natural liquid soap also helps you maintain healthy skin. Several studies confirm that hand soap made from plant extracts or essential oils is more powerful in killing bacteria than soap products containing dangerous chemical ingredients. Natural soap offers better antibacterial protection and does not lead to side effects like irritation or dryness.

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