



Antibacterial Activity of Soap Formulated from Garlic (*Allium sativum* L.) Extract

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Authors' contributions

This work was carried out in collaboration between both authors. Author JLB performed the antibacterial activity of Garlic soap and wrote the first draft of the manuscript. Author MCGV performed the statistical analysis and managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JAMB/2021/v21i130320

Editor(s):

(1) Dr. P. Rama Bhat, Alva's College, India.

Reviewers:

(1) Divyang Kantil Solanki, Anand Agricultural University, India.

(2) Neeli Habib, Shaheed Benazir Bhutto Women University, Pakistan.

(3) Kannan Vadakkadth Meethal, University of Calicut, India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/65564>

Received 03 January 2021

Accepted 08 March 2021

Published 16 March 2021

Original Research Article

ABSTRACT

Allium sativum, commonly known as 'garlic' has long been used as an antibacterial agent that can actually inhibits growth of infectious agents and at the same time protect the body from the pathogens. This study was conducted to determine the antibacterial activity of soap from garlic extract using the paper-disc method and Kirby-Bauer antibacterial sensitivity test against *Staphylococcus aureus* and *Escherichia coli*, and to determine the physical properties of garlic soap and the presence of saponin through phytochemical screening. Garlic soap showed antibacterial activity against *E. coli* and *S. aureus*. Mean zone of inhibition was numerically higher in plate extract obtained using garlic soap (14.70mm-18mm), compared to commercial soap. Result of phytochemical screening showed the extract from garlic contains saponin, which is an important ingredient for making soap. Physical properties showed unpleasant odor, dirty white color, smooth texture and pH range of 6.5-7.5. Further studies to determine the potential of garlic soap in the other strains of bacteria.

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Keywords: *Allium sativum*; antibacterial; garlic soap; saponin; zone of inhibition.

1. INTRODUCTION

Allium sativum is a plant species in the onion genus, *Allium*. Because of its strong odor, it is sometimes called the “stinking rose” Its close relatives include the onion, shallot, leek, chive, Welsh onion and Chinese onion. A large number of sulfur compounds contribute to the smell and taste of garlic. Allicin, along with its decomposition products diallyl disulfide and diallyl trisulfide, are the major contributors to the characteristic odor of garlic, with other alliin-derived compounds, such as vinylthiins and ajoene [1]. Taxonomically, this plant belongs to the plant family Amaryllidaceae. It is a perennial flowering plant growing from a bulb and has a tall, erect flowering stem that grows up to 1 meter and a leaf blade that is flat, linear, solid and approximately 1.25-2.5 cm. wide, with an acute apex. Bulb is odoriferous and contains outer layers of thin sheathing leaves surrounding an inner sheath that encloses the clove [2]. Characteristically, garlic contains cysteine sulfoxides (alliin) and the nonvolatile glutamylcysteine peptides which make up more than 82% of the sulfur content of garlic. Allicin, ajoenes and sulfides are degradation products of alliin.

Bulbs of *A. sativum* are reported to contain hundreds of phytochemicals including sulfur-containing compounds such as ajoenes (E-ajoene, Z-ajoene), thiosulfinates (allicin), vinylthiins (2-vinyl-(4H) -1,3-dithiin, 3-vinyl-(4H)-1,2-dithiin), sulfides (diallyl disulfide (DADS), diallyl trisulfide (DATS)) and others that accounted 82% of the overall garlic sulfur content [3]. The phytochemical constituents of garlic have been established in previous studies of [4] Cavallito and Bailey [5], Ankri and Mirelman [6], Prados-Rosales et al. [7].

Garlic has been used for centuries to fight infections [8]. Fresh raw juice of *A. sativum* was used as antiseptic for control of wound suppuration; rubbed over ringworm for soothing effect. Crush clove applied to both temples as poultice for headache, Arthritis, rheumatism, toothaches. Decoction of leaves and bulbs for fever and as hypotensive, carminative, expectorant, antihelmintic, and for tonsillitis. Juice from freshly crushed garlic used for colds, cough, sore throat, hoarseness, asthma and bronchitis; Diluted juice used for earaches and deafness [9].

Antimicrobial properties of garlic were first described by Pasteur in 1958, and since then, research had demonstrated its effectiveness against bacteria protozoa, fungi and some viruses [10]. Previous studies have also indicated that garlic have wide ranging therapeutic properties such as antibiotic, activity, antiseptic, antitoxic, antiviral, bactericide, carminative, hipoholesterolemik, depurative, diuretic, expectorant, fungicide, hypoglycemic, hipotensiv, and stomachic. It is also used in the food and pharmaceutical industries [11].

Hand washing is one of the most important steps to avoid spreading germs. They remove or destroy germs to avoid transmitting them to another person. Germs are microorganisms such as bacteria and viruses that may lead to harmful diseases. They live on the skin, mouth, intestine and breathing passages. They can enter the body through openings such as the nose and mouths and also through breaks in the skin. If they enter the body, they can destroy healthy cells and cause infection. However, application of water alone is ineffective in cleaning the skin because water is unable to remove fats, oils and proteins which are components of organic oil. Therefore, removal of microorganisms from the skin requires the addition of soap or detergents and/or antimicrobial ingredients [12].

Antibacterial soap is a soap which contains chemical ingredients that purportedly assist in killing bacteria (FDA, 2016) and play an important role in removing and killing bacteria. The majority of antibacterial soaps contain triclosan [13] though other chemical additives are also common such as fats and oils which is the general ingredient of soaps [14]. Thus, antibacterial soaps can remove 65 to 85% bacteria from human skin [15]. The present studies were aimed to determine the bactericidal activity/efficacy ginger as an antibacterial soaps and to determine, whether the soaps can kill the bacteria.

2. MATERIALS AND METHODS

2.1 Extraction of the GARLIC

About two kilograms of garlic was segregated and washed with distilled water. This was peeled using a clean sterile knife and coarsely grounded using the electric juicer to extract the juice. To separate the solid from liquid extract, the crushed garlic were filtered, first with the use of

cheesecloth, then with a series of filter papers until a clean filtrate was obtained. The extract was then placed in a sterilized bottle with cover and was opened only during the test for the presence of saponins, and for the preparation of antibacterial soap

2.2 Determination of Saponin

2 mL of garlic extract with 20 mL of distilled water were agitated in a graduated cylinder for 15 minutes. The formation of 1 cm of foam indicates the presence of saponin [16].

2.3 Preparation of Antibacterial Soap

Pour 100 mL of garlic extract into a container. Add 125 mL of Na₂CO₃ (sodium carbonate) until the mixture completely dissolves in water. Place 75 grams of NaOH (sodium hydroxide) to the mixture. Stir completely without spilling the mixture on the skin. Add 125 mL of cooking oil to the mixture and 12.5 mL sodium silicate. Stir until the saponification reaction is complete. Pour the soap slowly and evenly into a cup which will serve as mold. Cooled or dried in a place not exposed to direct sunlight [17].

2.4 Preparation of Culture Media and Sensitivity Discs

Culture media for bacteria was prepared following by dissolving 19g Nutrient Agar (NA) in 500mL distilled water. The mixtures were agitated vigorously to completely dissolve the media and were pressure sterilized at 121^oC at 15psi pressure. Then allowed to cool down to about 50^oC, and aseptically dispensed into individual petri dishes and allowed to solidify at room temperature.

Sensitivity discs were prepared using filter paper (Whatman No. 41) formed into round discs using a puncher. Each disc was placed in petri dish, pressure sterilized at 121^oC at 15psi pressure, and soaked in the garlic soap.

2.5 Determination of the Antibacterial Activity of Garlic Soap

The antimicrobial activity of garlic soap was determined through the modified Kirby Bauer antibacterial sensitivity test [18] against the test microorganisms *S. aureus* (Gram positive bacteria) and *E. coli* (Gram negative bacteria), which was purchased from Department of Science and Technology (DOST) in Tacloban City. Commercial antibacterial soap was used as

positive control for *Staphylococcus aureus* (Gram positive) and *Escherichia coli* (Gram negative). The culture media plates were aseptically inoculated with bacteria, and the filter paper discs soaked in garlic soap were carefully and aseptically placed at the center of each agar plate to maximize the space for bacterial growth and to facilitate measurement of the zone of inhibition. The plates were incubated at 37^oC for 24h for bacteria. The zones of inhibition around the discs, which were measured using a Vernier caliper, indicated that growth of the microorganism had been inhibited by the garlic soap that diffused into the agar from discs. Absence of zone of inhibition indicated the resistance of the microorganisms to garlic soap.

2.6 Evaluation of Physical Properties of Garlic Soap

Determination of Color, Odor, Smoothness: Color was checked by naked eyes against white background, the odor was smelled, and the smoothness by using the sense of touch.

pH: The pH of garlic soap was determined by using digital pH meter. The garlic soap was dissolved in 5 ml of distilled water contained in a beaker. Then, a digital pH meter was dipped into the beaker with garlic soap. After a period of one minute, the reading of the digital pH meter was recorded.

3. RESULTS

3.1 Determination of Saponin

The saponin was positive in the garlic extract. There was a formation of froth measuring 2 cm. This implies that the garlic was positive in saponin that is an important ingredient in making soap.

3.2 Antibacterial Activity of Garlic and Commercial Soap

Garlic soap and commercial soap were screened for their antibacterial resistance and activity. As shown in the Table 1, garlic soap showed a higher zone of inhibition compared to commercial antibacterial soap in both the *Staphylococcus aureus* and *Escherichia coli*. A mean zone of inhibition of 18mm was observed in *S. aureus* and 14mm for *E. coli* in garlic soap. While the commercial soap has a mean zone of inhibition of 16mm for *S. aureus* and 10mm for *E. coli*. Thus, both the soap can be used to stop the bacteria remaining on your skin from replicating.

Table 1. Zone of inhibition (mm) formed in nutrient agar with garlic soap and commercial soap

Soap	<i>Staphylococcus aureus</i>	<i>Escherichia coli</i>
Garlic soap	18 mm	14.70 mm
Commercial soap	16 mm	10 mm

Table 2. Physical properties of garlic soap and commercial soap

Soap	Color	Odor	Smoothness	pH
Garlic soap	dirty white	unpleasant	smooth	7.5
Commercial Soap	white	pleasant	smooth	6.5

3.3 Evaluation of Physical Properties of Garlic Soap

The physical properties of the garlic soap were determined. Properties such as color, odor, smoothness, and pH were tested. As shown in the Table 2, the garlic soap was rated as unpleasant (odor), dirty white (color) and smooth (smoothness). While commercial antibacterial soap was rated as pleasant (odor), white (color) and smooth (smoothness). The garlic soap pH was found in the range of 6.5 to 7.5 which is the desired pH.

4. DISCUSSION AND CONCLUSION

Extracts of *Allium sativum* showed a positive result for the presence of saponin which is an important ingredient in making soap because of its foamy quality when agitated with water. While the Allicin is the major contributors to the characteristic odor of garlic along with its decomposition products diallyl disulfide and diallyl trisulfide, with other allicin-derived compounds, such as vinylthiols and ajoene [1]. Garlic soap exhibited good appearance characteristic with a white color and smooth texture as well as the pH are found to be the desired pH for soap.

With regards to its antimicrobial activity, garlic soap was another choice of natural antibacterial agent that maybe used in healthcare units and household. The formulated antibacterial soap with garlic extract possessed a good ability to decrease skin bacterial population, both in Gram positive bacteria and Gram negative bacteria at accelerated conditions. Thus, if the safety of this antibacterial garlic soap is confirmed, it will be a good candidate of natural antibacterial soap for development as a commercial product in the future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
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