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Activity of Hand Sanitizer Gel from Coconut Shell Liquid Smoke with a Combination Base of Galactomannan and Carbopol 940 Against *Staphylococcus aureus* Bacteria

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Abstract

Background: Liquid smoke acts as an antimicrobial and antioxidant, this is related to the concentration of compounds namely phenol, carbonyl and acid. Bacteria *Staphylococcus aureus* is classified as a gram-positive bacteria and bacteria which is commonly found on the skin, nasal passages and respiratory tract. Hands sanitizer is an antiseptic in gel form that is often used for washing hands without water. One of the natural polymers used is galactomannan. Galactomannan is a natural polymer, namely a polysaccharide isolated from seeds. The endosperm is mainly from the Arecaceae family which consists of the main chain of mannan and galactose in the side chain. **Objective:** Study of activity test of Hand Sanitizer Gel from coconut shell liquid smoke with a combination of galactomannan and carbopol 940 base against Staphylococcus aureus bacteria. **Method:** the aim of this research formulating a hand sanitizer with the active ingredient liquid shell smoke coconut can kill *Staphylococcus aureus* bacteria. The research was experimental with work stages including: collecting coconut shell liquid smoke, making galactomannan from palm fruit determining the concentration of coconut shell liquid smoke hand sanitizer gel, namely 0.1%, 1%, 1.5%, determining the diameter of the inhibition zone of coconut shell liquid smoke using the well method, organoleptic test, homogeneity test, pH test, spreadability test, viscosity test, preparation stability test, irritation test on volunteers and testing antibacterial activity of hand sanitizer gel preparations with liquid smoke as the active ingredient coconut shell against *Staphylococcus aureus* bacteria. **Results:** Coconut shell liquid smoke can inhibit bacterial growth *Staphylococcus aureus* is greatest at a concentration of 1.5%, which is equal to 12.1 mm and the coconut shell liquid smoke hand sanitizer gel preparation meets the test evaluation. Then a basic combination of galactomannan and carbopol 940 can be obtained used as a base for hand sanitizer gel because it can make hand sanitizer gel becomes thick. **Conclusion:** Coconut shell liquid smoke can be formulated into hand sanitizer gel preparations, galactomannan can be used as a base for hand sanitizer gel.

Keywords: Liquid smoke, *Staphylococcus aureus*, hand sanitizer gel, galactomannan.

INTRODUCTION

Liquid smoke is the result of the condensation of vapor caused by the direct or indirect combustion of materials rich in lignin, cellulose, and other carbon compounds [1], [2]. Liquid smoke acts as an antimicrobial and antioxidant, related to its concentration of phenolic, carbonyl, and acidic compounds. Liquid smoke can be used as a hand sanitizer antiseptic because it can inhibit the growth of bacteria such as *Salmonella, Escherichia coli*, and *Staphylococcus aureus*, with moderate to high inhibitory effects [3].

The skin is highly sensitive to infections or other skin diseases, many of which are caused by the bacterium *Staphylococcus aureus*. *Staphylococcus aureus* accounts for 80% of severe diseases, primarily inhabiting the skin surface. The transmission of *Staphylococcus aureus* bacteria often occurs from hand to hand [4]. This bacterium is also found in the surrounding environment. Infections caused by *Staphylococcus aureus* are characterized by tissue damage followed by pus discharge.

Some infectious diseases caused by *Staphylococcus aureus* include boils, impetigo, and wound infections [5]. *Staphylococcus aureus* is a common skin bacterium found on the skin, nasal passages, and respiratory tract. It is classified as a Gram-positive bacterium. Therefore, one of the ways to prevent or avoid this bacterium is by maintaining hand hygiene through hand washing [6], [7].

A study conducted in Panobasan Village on the relationship between children's handwashing habits and the prevalence of diarrhea statistically demonstrated a significant correlation between handwashing and the incidence of diarrhea. Handwashing with soap and water is the most common method to maintain hand hygiene. Currently, hand sanitizers are widely offered as hand cleaners due to their practical use [8], [9].

Hand sanitizer is a gel-form antiseptic frequently used for handwashing without water. Using hand sanitizer is more efficient and effective than using soap and water, which is why many people prefer it. Hand sanitizers are available in both liquid and gel forms, with gel being more commonly used as it provides a cooling sensation on the skin and dries quickly [10].

Commercial hand sanitizers usually contain alcohol, which functions as a disinfectant and antibacterial agent. Alcohol can dissolve the lipid and sebum layers on the skin, which act as a protective barrier against infections caused by microorganisms. According to a study the antibacterial testing of coconut shell liquid smoke can reduce bacterial colonies with moderate effectiveness and inhibit the growth of Escherichia coli with an inhibition zone of approximately 9.33 mm (high degree) [11], [12].

Hand sanitizers can be made from natural ingredients. An alternative antiseptic compound that can be used as an active ingredient in hand sanitizer gel formulation is natural liquid smoke from coconut shells. Gels can be formulated with various polymers, with natural polymers synthesized from plants being widely developed for gel formulation. The use of natural polymers in pharmaceutical formulations is preferred due to their high biocompatibility, non-toxicity, good water solubility, and high swelling capacity [13].

One natural polymer that can be used is galactomannan. Galactomannan is a natural polysaccharide polymer isolated from seed endosperms, primarily from the Arecaceae family, consisting of a mannan main chain and galactose side chains. Galactomannan is typically derived from four plants: locust bean (*Ceratonia siliqua*), guar (*Cyamopsis tetragonoloba*), tara (*Caesalpinia spinosa-kuntze*), and fenugreek (Trigonella foenum-graecum L.), with locust and guar gum being the most commonly used [14]. Guar gum galactomannan has the ability to absorb large amounts of water and is stable across a wide pH range [15]. For a clear gel, galactomannan can be combined with Carbopol 940, as Carbopol 940 produces a clear gel with high viscosity, providing a comfortable application.

Based on the literature, no research has been conducted on "Formulation and Activity Testing of Hand Sanitizer Gel from Coconut Shell Liquid Smoke (*Cocos nucifera* L) with a Combination Base of Galactomannan and Carbopol 940 Against *Staphylococcus aureus*." Therefore, the researchers are interested in conducting this study with three different formulations and concentrations. The prepared formulations will undergo sensory evaluation, including hedonic tests, homogeneity tests, pH tests, spreadability tests, viscosity tests, stability tests, irritation tests on volunteers, and antibacterial activity tests.

RESEARCH METHODS

Extraction of galactomannan

The kolang-kaling was cleaned and blended for 5-8 minutes with the addition of distilled water in a 1:10 ratio. The mixture was then stored in a sealed container and placed in a refrigerator for 24 hours. Afterwards, the formed precipitate was filtered using a sieve. The obtained precipitate was mixed with 96% ethanol in a 1:1 volume ratio and stored again in the refrigerator for 24 hours. The precipitate was then filtered using a white cloth and soaked in analytical grade ethanol. The precipitate was filtered once more and subsequently dried in a desiccator [16].

Table 1. Gel Formulation of Hand Sanitizer

Material	Formulation			
	F0	**F1**	**F2**	**F3**
Coconut shell liquid smoke	0	0.5	1	1.5
Galactomannan	0.5	0.5	0.5	0.5
Carbopol 940	0.5	0.5	0.5	0.5

Glycerin	10	10	10	10
Propylene glycol	5	5	5	5
TEA	2	2	2	2
Methyl paraben	0.1	0.1	0.1	0.1
Ethanol 96%	5	5	5	5
Bubble gum perfume	q.s	q.s	q.s	q.s
Aquadest	100	100	100	100

Evaluation of Hand Sanitizer Gel Formulation

The evaluation of the formulation includes organoleptic testing, antibacterial assay, pH determination, spreadability test, viscosity measurement, stability test, and irritation test on volunteers.

The antibacterial activity assay was conducted on each concentration obtained using the agar well diffusion method with a sterile metal borer [17]. The base layer of the medium was prepared by pouring 10 ml of Mueller Hinton Agar (MHA) into a sterile petri dish and allowing it to solidify. After solidification, 0.1 ml of the bacterial inoculum suspension was poured onto the surface of the base layer, followed by 25 ml of Mueller Hinton Agar (MHA) as the second layer, and then homogenized. The metal borers were immediately placed and arranged on the surface of the medium at intervals to ensure that the observation areas did not overlap. The metal borers were then carefully removed using sterile tweezers, creating wells in the solidified agar. Test solutions with concentrations of 0.5%, 1%, 1.5%, and a blank control were each added to the wells in 0.1 ml volumes. The petri dishes were immediately covered and left to stand for 30 minutes, then incubated in an incubator at 35±2°C for 24 hours. Observations were made by measuring the clear zones around the wells using a caliper to determine the inhibition zone diameters in millimeters (mm). Data were collected from the best results, with three replicates for each treatment [18].

RESULTS AND DISCUSSION

Organoleptic testing was conducted to evaluate the quality of the hand sanitizer gel formulation using sensory perception by measuring the level of preference or hedonic rating for the physical appearance of the gel, including color, odor, form, and ease of application. The study involved 20 untrained panelists who were asked to assess the form, odor, color, and ease of application through a provided questionnaire.

The hand sanitizer gel formulation was rated less favorably in terms of form and color, attributed to the weak orange color of the gel. The odor was also rated less favorably due to the unpleasant and strong smell of the liquid smoke. However, the gel was favored for its ease of application, as it was easy to absorb and comfortable to use.

The formulated gel, using various concentrations of coconut shell liquid smoke, showed no particulate matter when observed on a glass slide, indicating that the formulation was homogeneous.

The pH of all tested formulations ranged from 5.6 to 6.2, varying with different concentrations and gel bases. Higher concentrations of coconut shell liquid smoke resulted in lower pH values, due to the inherently low pH of the liquid smoke (ranging from 1.5 to 3.7). The pH of a topical formulation should match the skin's pH (4.5-6.5). A highly acidic pH can cause skin irritation. The pH values of the tested gel concentrations were within the safe range for skin application [19].

The spreadability of the gel formulations ranged from 5.4 cm to 6.4 cm, meeting the good criteria for gel formulations. The ideal spreadability for topical formulations is 5-7 cm. A slight increase in spreadability was observed with higher concentrations of coconut shell liquid smoke, although all values remained within the acceptable range [20].

The viscosity of the hand sanitizer gel formulations ranged from 3300 to 5420 mPa.s. One factor affecting the viscosity of the gel was the concentration of coconut shell liquid smoke used. Higher concentrations of liquid smoke resulted in decreased viscosity. The optimal viscosity for hand sanitizer gel formulations is 500-10,000 mPa.s [20].

No adverse effects such as redness, itching, or skin roughness were observed with the gel formulations. This indicates that the hand sanitizer gel formulated with various concentrations of coconut shell liquid smoke as an antiseptic did not cause skin irritation.

The antibacterial activity test using coconut shell liquid smoke showed an inhibition zone of 12.2 mm against *Staphylococcus aureus* at a concentration of 300 mg/ml, categorized as strong (Figure 1).

Antibacterial activity is categorized as follows: inhibition zone diameter less than 5 mm is weak, 5-10 mm is moderate, 10-20 mm is strong, and more than 20 mm is very strong. This demonstrates that increasing the concentration of coconut shell liquid smoke enhances the diameter of the inhibition zone against *Staphylococcus aureus* [21], [22].

The antibacterial effectiveness test of hand sanitizer formulations containing various concentrations of coconut shell liquid smoke against *Staphylococcus aureus* showed that the hand sanitizer containing liquid smoke inhibited bacterial growth at concentrations of 0.5%, 1%, and 1.5% (Figure 1.). Hand sanitizer formulations with 1% and 1.5% concentrations showed strong inhibition against *Staphylococcus aureus,* with inhibition zone diameters of 11.1 mm and 12.1 mm, respectively. At a 0.5% concentration, the inhibition was categorized as moderate, with a diameter of 7.7 mm. Although the inhibition diameters differed from those of commercially available hand sanitizers, both formulations were categorized as strong.

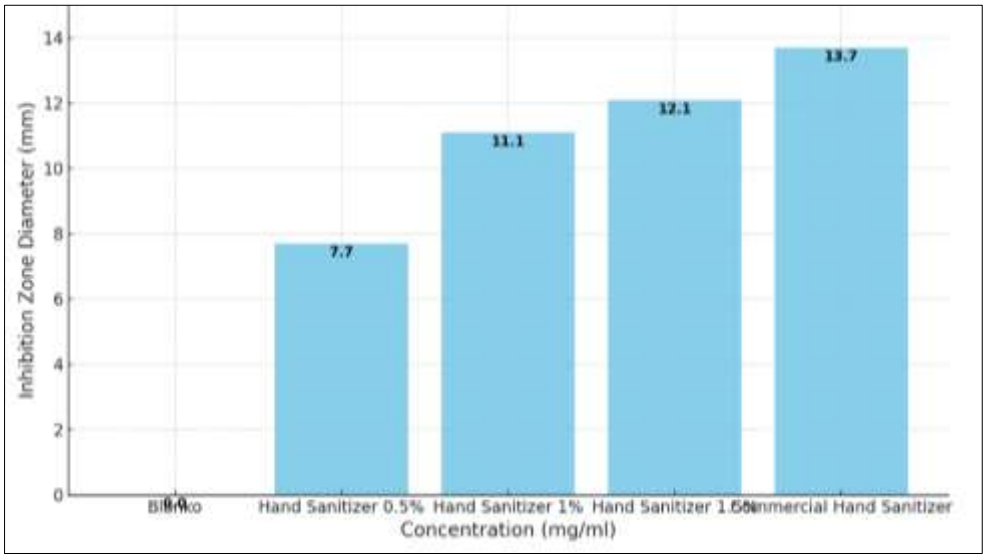

Figure 1. Inhitian Diameter Gel Formulation Coconut Shell Liquid Smoke Against *Staphylococcus aureus*

CONCLUSION

Coconut shell liquid smoke exhibits antibacterial activity, demonstrating the largest inhibition zone diameter of 12.2 mm at a concentration of 300 mg/ml against *Staphylococcus aureus*. Coconut shell liquid smoke can be formulated into a hand sanitizer gel. The hand sanitizer gel containing coconut shell liquid smoke as the active ingredient exhibits substantial antibacterial activity against *Staphylococcus aureus* at a concentration of 1.5%.

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