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Research Article

O-CITRI Soap: Antibacterial Paper Soap Made from Orange Peel (*Citrus sinensis* L.) and Basil (*Ocimum sanctum* L.)

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Abstract

Basil (*Ocimum sanctum* L.) have a dominant content of citral compounds with antibacterial activity. Another plant have potential antibacterial bioactive components is orange peel (*Citrus Sinensis* L.). The aim of this research is to prove that the combination of orange peel and basil extracts has antibacterial effects against *Staphylococcus aureus*, which can be formulated as paper soap which is named O-Citri. The research methods used include organoleptic tests, foam height tests, pH tests, and antibacterial tests. Organoleptic tests showed that both formulations have similar texture and smell, but a slight difference in color. F2 had a more vibrant yellow color than F1. The hedonic test results indicated an 80% acceptance rate for O-Citri. In the foam height test, F1 started at 0.5 cm and increased to 1.3 cm after 5 minutes. Meanwhile, F2 began at 0.7 cm and reached 1.5 cm after 5 minutes. pH test showed that a value of 8.5 for F1 and 8.0 for F2. The research results show that the combination of orange peel and basil extracts in the paper soap formulation has antibacterial effects. The highest concentration combination for antibacterial activity is F1 with a ratio of orange peel and basil extract at 5%:15%.

Keywords: Antibacterial, Basil, O-Citri, Orange Peel, Paper Soap

O-CITRI Soap: *Paper Soap* Antibakteri dari Kulit Jeruk (*Citrus sinensis* L.) dan Kemangi (*Ocimum sanctum* L.)

Abstrak

Kandungan Daun Kemangi (*Ocimum sanctum* L.) didominasi oleh senyawa sitral yang terkenal sarat akan aktivitas antibakteri. Selain daun kemangi, kulit jeruk (*Citrus Sinensis* L.) juga mengandung komponen bioaktif dengan aktivitas antibakteri yang sangat potensial. Penelitian ini bertujuan untuk membuktikan bahwa kombinasi ekstrak kulit jeruk dan kemangi memiliki efek antibakteri terhadap bakteri *Staphylococcus aureus* yang dapat diformulasikan menjadi sabun kertas bernama O-Citri. Metode penelitian yang digunakan meliputi uji organoleptik, uji tinggi busa, uji pH, dan uji aktivitas antibakteri. Uji organoleptik menunjukkan kedua formula memiliki tekstur dan aroma yang serupa, namun teramati adanya sedikit perbedaan warna. Formula F2 memiliki warna kuning yang lebih cerah dibandingkan F1. Hasil uji hedonik menunjukkan tingkat penerimaan sebesar 80% untuk O-Citri. Pada uji tinggi busa, F1 dimulai dari 0,5 cm dan meningkat menjadi 1,3 cm setelah 5 menit. Sementara itu, F2 dimulai dari 0,7 cm dan mencapai 1,5 cm setelah 5 menit. Uji pH menunjukkan nilai 8,5 untuk F1 dan 8,0 untuk F2. Hasil penelitian menunjukkan bahwa kombinasi ekstrak kulit jeruk dan kemangi dalam formulasi sabun kertas memiliki efek antibakteri. Kombinasi konsentrasi tertinggi untuk aktivitas antibakteri adalah F1 dengan perbandingan ekstrak kulit jeruk dan kemangi sebesar 5%:15%.

Kata Kunci: Antibakteri, Kemangi, Kulit Jeruk, O-Citri, *Paper Soap*

1. Introduction

Indonesia is one of the countries blessed with abundant biodiversity and rich in chemical components with clinical activities beneficial to health. One of the natural commodities with secondary metabolites that can be utilized in health product formulations is basil. Over the decades, the use of basil as a health product has not gained sufficient attention from the public. Generally, basil are often consumed as a complement to dishes. However, essential oil extracted from basil (*Ocimum sanctum* L.) contains predominantly citral compounds with antibacterial activity.[1] The citral content in basil oil is divided into cis-citral and trans-citral. Previous research has proven that basil oil has an inhibitory effect of 23.7 mm against *Staphylococcus aureus* bacteria.[2] In addition, the essential oil in basil is also indicated to contain ursolic acid with similar clinical activity, functioning as an antibacterial agent.[3]

Studies have shown that citral is a powerful antimicrobial agent, effective against a variety of harmful bacteria, both gram-positive and gram-negative, as well as fungus and parasites that can cause health problems.[4] Citral appears to have multiple targets in the bacterial cell, depending on the concentration and number of its components.[5] The antibacterial mechanism of citral is a type of multi-target mode that affects various molecular processes in bacteria, which laid the foundation for further exploitation of citral as a candidate therapy against bacterial infections.[6]

Another plant suspected to contain bioactive antibacterial components is orange. Generally, the flesh of the orange fruit is the part most frequently processed and consumed by the public. However, orange peel (*Citrus Sinensis* L.), often discarded as waste, is also beneficial from a health perspective. Orange peel contains phenolic compounds (phenolic acids, flavonones, and polymethoxylated flavones), carotenoids, and ascorbic acid. Phenolic compounds are known to have several activities such as antimicrobial, antioxidant, anticancer, anti-inflammatory, and anti-allergic.[7] According to Henderson et al.'s research (2018), orange peel extract at a minimum concentration of 15% already exhibits antibacterial activity.[8] The disc diffusion method stands out as a preferred choice for researchers investigating antibacterial activity.[9] Considering the antibacterial potential of the natural commodities mentioned above, their utilization as raw materials for handwashing soap production becomes an interesting prospect. Handwashing soap containing antiseptic and antibacterial properties can inhibit the growth and even eliminate microorganisms on the body surface.[10]

Currently, soap products in the market compete very competitively and are presented in various forms, whether solid or liquid, to meet consumer needs and demands for clinically effective and easily applicable soap. Regularly washing with soap helps shield your skin from infections caused by bacteria and fungus.[11] However, solid or liquid soaps are considered less efficient due to impractical packaging. Paper soap is one unique form of soap, resembling thin sheets of paper. The advantages of paper soap are its convenience in use, hygienic nature, practicality, and ease of carrying anywhere.[12] Therefore, researchers are motivated to design a paper soap product using basil and orange peel as raw materials containing antibacterial activities, named O-Citri. This research is the latest research on making paper soap using community waste which so far has not been utilized sufficiently to become an innovative health product and has been proven through several research tests.

2. Method

2.1. Tools

Tools that has been used in this research includes; autoclave (Hirayama®), calipers (Tricle brand), paper discs, soluble paper, vein, pH meter (Mettler Toledo S-220-Kit), analytical balance (kern ALS 250-4A), laboratory glassware (pyrex), and a hot plate.

2.2. Materials

Sweet orange peel extract, basil extract, olive oil (Bertolli brand), 30% KOH

(Potassium Hydroxide) (Merck brand), HPMC (Hydroxypropyl Methylcellulose) (maximum chemical brand), SLS (Sodium Lauryl Sulfate) (Merck brand), propylene glycol (Merck brand), orange essential oil, distilled water (aquadest), *Staphylococcus aureus* bacteria.

2.3. Methods

2.3.1. Paper Soap Formulation

The paper soap formulation uses a ratio of 2 formulations. The reference formulation used is based on the research journal from Awaluddin et. al. (2022), the use of variations in the concentration of active substances with the aim of finding out the most effective combination of concentrations of active substances that function as antibacterials.[13]

HPMC is added to a beaker and dissolved using hot water, then stirred until it forms a gel. In a separate beaker, olive oil is heated, propylene glycol is added, and the mixture is stirred until homogenous. Next, 30% KOH and distilled water are added, followed by SLS dissolved in distilled water, and stirred until thoroughly mixed. Two drops of essential oil are added, and finally, the active ingredient is introduced. After achieving homogeneity, the mixture is poured into the beaker containing HPMC gel and stirred until homogeneous. The finished soap formulation is then poured into a container. Paper soap is made using soluble paper. Liquid soap is evenly applied to the soluble paper using a brush, then dried in the oven and cut into pieces measuring 3 x 3 cm.

2.3.2. Antibacterial Test

One milliliter of bacterial suspension is added to a sterile petri dish, and Nutrient Agar media is added and stirred until homogenous. Paper discs are dipped into each sample, namely 1 g of paper soap dissolved in 9 mL of distilled water, paper soap formulation (positive control), distilled water (negative control), and 0% soap base (blank). The negative control is prepared by adding distilled water to a paper disc. The paper discs are then placed on the frozen NA media. The petri dishes are then incubated in the incubator for 24 hours. The clear inhibition zones around the paper discs are observed and measured using calipers.[14]

2.3.3. Evaluation of Paper Soap Formulation

a. Organoleptic Test

Also known as sensory evaluation, this test assesses taste, color, aroma, shape, and texture of a product using human senses.[15]

b. Hedonic Test

In this study, the researcher uses a five-point hedonic scale, including dislike very much (1), dislike (2), liked quite a bit (3), like (4), like very much (5). Parameters include panelists preference levels for the form, color, and aroma (Qamariah et al., 2022).

c. Foam Height Test

This test is conducted to assess the foam height produced by the liquid soap according to the Indonesian National Standard (SNI), which is set at 13-220 mm or 1.3 – 22 cm.[16]

d. pH Test

This test is performed on the formulation

Table 1. Formula of Paper Soap

Ingredients	Function	Base	F1	F2
Orange peel extract (g)	Active ingredient		5	15
Basil extract (g)	Active ingredient		15	15
Olive oil (g)	Surfactant	20	20	20
KOH 30% (g)	Saponification agent	10	10	10
HPMC (g)	Gelling agent	1	1	1
SLS (g)	Foaming agent	1	1	1
Propylene glycol (g)	Humectant	15	15	15
Essential oil (ml)	Parfume	1	1	1
Aquades (ml)	Solvent	Ad 100	Ad 100	Ad 100

Table 2. Result of Organoleptic Test

Parameter	F1	F2
Texture	Smooth	Smooth
Smell	Typical orange and basil	Typical orange
Color	Yellowish white	Yellowish white (more concentrated)

to determine its acidity level and ensure it does not cause skin irritation. The pH value for hand washing soap according to the Indonesian National Standard (SNI 06- 4085-1996) is between 6 and 8.[17]

5. Result and Discussion

3.1. Organoleptic Test

Organoleptic test is used to examine the physical appearance of the raw material for (F1 and F2 of paper soap including texture, smell, and color. The organoleptic test was carried out on the same 30 respondents before the hedonic test was carried out. The organoleptic results can be seen in the table 2.

The difference between the two formulations lies in the smell and color. The distinct orange smell in F1 is not as intense as in F2. This is because the amount of extract in F2 is the same as the additional orange essential oil, which dominates the orange smell in F2 more than in F1. Meanwhile, the unique basil smell is only noticeable in F1 due to the higher ratio of the extract used compared to the orange extract. Additionally, the color of F1 and F2 is similar, a yellowish white. However, F2 has a more intense yellowish color than F1 due to the equal ratio of extract used in F2, combined with the added color from the orange essential oil used.

3.2. Hedonic Test

Preference test was conducted by administering a questionnaire containing 4 assessment parameters for each formulation: texture, color, smell, and lots of foam. In this testing, consumer attitudes toward the product based on organoleptic properties were measured.18 The hedonic results can be seen in the table 3.

Based on the above hedonic test results, it is evident that all respondents highly appreciate the texture of the paper soap for being smooth and light. Additionally, respondents also like the smell of the paper soap, with over 80% choosing the option like very much. This could be due to some respondents not favoring the distinctive fresh smell of orange and the slight basil aroma. Moreover, respondents appreciate the color of the paper soap, with 30% choosing the like option and 70% choosing like very much. This color is considered unique and different from the plain white color of typical soaps. Some respondents in this study do not particularly like the foam of the paper soap, with only 77% choosing the like and like very much options. This may be due to individual preferences regarding soap foam.

The questionnaire results indicate that the majority of respondents like the paper soap, with a total acceptance percentage of 80%, where 80% of respondents chose the like very much option and 20% chose the like option. Therefore, positive feedback from each question in this questionnaire suggests that the paper soap product is well-received and liked by the public. Through this test, it is also evident that respondents prefer paper soap with F1 over F2, both in terms of color and aroma.

3.3. Foam heights test

The observed initial foam heights for F1

Table 3. Hedonic Test Result

Parameter	1	2	3	4	5
Texture	0 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (100%)
Smell	0 (0%)	0 (0%)	0 (0%)	5 (17%)	25 (83%)
Color	0 (0%)	0 (0%)	0 (0%)	9 (30%)	21 (70%)
Lots of Foam	0 (0%)	0 (0%)	7 (23%)	6 (20%)	17 (57%)
Total acceptances	0 (0%)	0 (0%)	0 (0%)	6 (20%)	24 (80%)

Table 4. Foam Heights Test Result

	Foam Heights	
	< 5 minutes	**>5 minutes**
F1	0.5 cm	1.3 cm
F2	0.7 cm	1.7 cm

are 0.5 cm and for F2 are 0.7 cm. Meanwhile, the foam heights after 5 minutes for F1 are 1.3 cm and for F2 are 1.5 cm.

The foam height test results indicate that the foam heights of both F1 and F2 meet the criteria, as according to SNI 1996, the required soap foam height is between 1.3 - 22 cm.[13] From the organoleptic observations, the paper soap formulations meet the standards in terms of color, aroma, and foaminess.[16]

3.4. pH Test

Results of pH measurements for paper soap products F1 and F2 yielded a pH of 8.5 for F1 and a pH of 8 for F2.

The difference in pH could be due to errors or variations in treatment. However, these results are still within the normal range, and there is no significant difference. Therefore, the pH results obtained meet the SNI 1994 standard, which specifies a good pH parameter for soap formulations to be between 8 and 11.[13]

3.5. Antibacterial Test

Results of the inhibitory test indicate that the inhibition zone for the positive control shows 11.4 mm in the first replication, 10.6 mm in the second replication, and 15.7 mm in the third replication. The average inhibition zone for the positive control is 12.5 mm, categorizing it as strong. The inhibition zone for F1 with a combination of extract concentrations 5%:15% shows 8.9 mm in the first replication, 10.6 mm in the second replication, and 10.3 mm in the third replication. The average inhibition zone for F1 is 12.3 mm, placing it in the strong category. The inhibition zone for F2 with a combination of extract concentrations 15%:15% shows 7.2 mm in the first replication, 7.9 mm in the second replication, and 8.5 mm in the third replication. The average inhibition zone for F2 is 7.8 mm, categorizing it as moderate. Therefore, the best inhibitory test result is obtained with F1 at a combination of extract concentrations 5%:15%. The negative control (distilled water) was tested by dropping distilled water onto the paper disc, and the result obtained is that the negative control has no inhibitory effect. Measurement is conducted by observing and measuring the clear zones that appear in the petri dish, excluding the paper disc from the measurement. The parameters for the inhibition zone categories, based on Wahyuni and Karim (2020), are as follows: ≤5 mm is considered weak, 6-10 mm is moderate, 11-20 mm is strong, and >20 mm is very strong.[19] The following are the results of the antibacterial test.

In this research, varying concentrations of the active substance are used with the aim of identifying the most effective combination of active substance concentrations that work as an antibacterial agent. The obtained formulations show insufficient foaming capacity, thus it is recommended to add more SLS concentration as a foaming agent to ensure the formulation can produce more and better foam.[20] Additionally, it is suggested to use soluble paper in the production of this paper soap formulation.

6. Conclusion

O-Citri Paper soap made from orange peel (*Citrus sinensis* L.) and Basil (*Ocimum sanctum* L.) has antibacterial effects. The highest concentration combination for

Table 5. Result of pH Test

Formulation	pH
F1	8.5
F2	8

Table 5. Result of pH Test

Formula	Diameter of inhibition zone (mm)			The average diameter of the inhibition zone (mm)	Category
	Replication				
	1	2	3		
K+	11,4	10,6	15,7	12,5	Strong
K-	-	-	-	-	-
F1	8,9	9,6	10,3	12,3	Strong
F2	7,2	7,9	8,5	7,8	medium

antibacterial activity is F1 with a ratio of sweet orange peel and basil leaf extract at 5%:15%.

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