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Research Article

Effect of Carbomer Concentration on the Characteristics of Peel-Off Gel Mask Containing Fragrant Citronella Leaves (*Cymbopogon nardus* L. Rendle) and Antibacterial Activity Test Against *Staphylococcus aureus*

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ABSTRACT
Citronella leaves are efficacious as antibacterial because they contain flavonoids, so they have the potential to be developed into a peel-off gel mask for anti-acne treatment. Peel-off gel masks can be formulated in the presence of a gelling agent. Carbomer was chosen as a gelling agent because it does not irritate the skin. The research method used experimental, as well as One Way ANOVA and LSD data analysis. Results: FI, FII, FIII organoleptic test with semisolid gel form, greenish brown in color, characteristic odor; homogeneity test FI, FII, FIII homogeneous preparations; pH test FI, FII, FIII there is a significant difference in LSD; the FI, FII, FIII dispersion test showed a significant difference in LSD; the FI, FII, FIII adhesion test showed a significant difference in LSD; dry time test FI, FII, FIII there is a significant difference in LSD; irritation acceptability test and liking there was no significant difference in Kruskal-Wallis; Test activity FI, FII, FIII there is a significant difference in LSD. Conclusion: There is an effect of variations in carbomer concentration on the characteristics of the preparation and the antibacterial activity test on *Staphylococcus aureus* bacteria, and there is no effect of variations in the concentration of carbomer on the acceptability test of irritation and preference tests.

Keywords: antibacterial; Carbomer; Citronella leaf extract; Peel-off gel mask; *Staphylococcus aureus*

INTRODUCTION

Acne is a skin disease that occurs due to inflammation of the pilosebaceous glands and an increase in sebum production, which causes blockage of the sebum flow. The occurrence of acne is influenced by several factors, one of which is bacterial colonization. Bacteria that commonly infect acne include *Staphylococcus aureus*, *Propionibacterium acnes*, and *Staphylococcus epidermidis* (Ruchiatan et al., 2023). Acne treatment can be carried out by administering antibiotics; however, long-term use of antibiotics can cause bacterial resistance, skin irritation, and immunohypersensitivity (Mohsin et al., 2022). The use of alternative antibacterial agents can be done by utilizing natural ingredients that have antibacterial activity to treat acne (Chaudhari & Bele, 2024). One of them is the citronella leaf plant.

Citronella leaves (*Cymbopogon nardus* L. Rendle) are plants that grow easily in tropical regions, including Indonesia. This plant is known to have antifungal, anti-inflammatory, and antibacterial activities and is used to treat acne. The plant contains flavonoids, compounds recognized for their antibacterial properties, which work by disrupting the structure of the cell membrane through protein denaturation. Furthermore, it is also known to suppress the growth of Staphylococcus aureus bacteria (Tahya et al., 2022).

Based on the benefits found in citronella leaves (*Cymbopogon nardus* L. Rendle), they have the potential to be developed into anti-acne preparations. One of these is a facial mask preparation, which is a cosmetic product that has been developing quite rapidly among the public. There are various forms of mask preparations, one of which is a peel-off gel mask. This type of mask is very practical because its mechanism of action allows it to remove residual dirt from the surface of the skin when it dries (Khedkar et al. 2025).

A gelling agent is a very important component in the formulation of a peel-off gel mask. The gelling agent used is carbomer. Carbomer is chosen as the gelling agent because it is known not to cause irritation. In addition, carbomer produces a gel with higher viscosity, resulting in better adhesion (Houlleberghs et al., 2022). Based on these considerations, a study was carried out to evaluate how variations in carbomer concentration influence the characteristics of a peel-off gel mask formulation containing citronella leaf extract.

METHODS

The design used in this study was an experimental laboratory study. The collected data were subsequently analyzed using statistical methods, specifically One-Way ANOVA and the LSD (Least Significant Difference) test.

Tools

Porcelain dish, measuring cylinder, mortar and pestle, spatula, stirring rod, test tubes, maceration container, Erlenmeyer flask, analytical balance, Petri dish, pH meter, caliper, oven, horn spoon, filter paper, autoclave, incubator, forceps, inoculating loop (ose needle), spatula, Bunsen burner, gel container (gel pot), UV LAF (Laminar Air Flow), graduated glass plate, object glass, cotton, aluminum foil, micropipette, and water bath.

Materials

Ethanol extract of citronella leaves (Cymbopogon nardus L. Rendle), Carbomer 940, Polyvinyl Alcohol, Propylene Glycol, Triethanolamine, Methyl Paraben, distilled water (aquadest), 96% ethanol, Nutrient Agar (NA) medium, 1% clindamycin gel, water for injection (sterile aquadest), McFarland solution, Sodium Broth, Mannitol Salt Agar (MSA), and Staphylococcus aureus bacterial isolate.

Preparation of Crude Extract

The dried citronella leaves (*Cymbopogon nardus* L. Rendle) that had been prepared and previously determined were weighed as much as 1 kg, then macerated using 96% ethanol solvent totaling 10 liters with a ratio of 1:7 for 3 days. The procedure was then repeated to perform remaceration with a ratio of 1:3 using the same solvent. The extract was then concentrated using a water bath at 50°C (Setyowati et al., 2025).

Ethanol-Free Test

The concentrated extract was then subjected to an ethanol-free test. This test was carried out by adding concentrated H_2SO_4 to the extract, followed by the addition of CH_3COOH, and then heating the mixture. If no characteristic ester or ethanol odor is detected, the result indicates a negative test for ethanol (Purnamasari et al., 2021).

Phytochemical Screening

Saponin Test

A total of 3 mL of the sample was placed into a test tube, then 10 mL of hot water was added. After cooling, the mixture was shaken vigorously for 10 seconds. The presence of foam with a height of 1–10 cm that remains stable for approximately 10 minutes and does not disappear after adding 1 drop of 2 M hydrochloric acid indicates the presence of saponins (Akhsanitaqwim, 2025).

Flavonoid Test

A total of 1 mL of the test sample was placed into a test tube, then 0.5 g of magnesium powder and 10 drops of concentrated HCl were added. A positive result is indicated by the formation of an orange, pink, or red color, which shows the presence of flavonoids (Bhernama, 2020).

Table 1. Peel-off gel mask formulation

Ingredient	Function	Range (%)	Formula		
			F1 (%)	F2 (%)	F3 (%)
Citronella leaves extract	Active Ingredients		20	20	20
Carbomer	Gelling Agent	0,5-2	0,5	0,7	0,9
PVA	Film Forming	10-16	10	10	10
Propyleneglycol	Humectant	5-30	10	10	10
TEA	Alkalizing Agent	0,5-4	0,5	0,5	0,5
Methyl Paraben	Presevative	0,2-0,3	0,1	0,1	0,1
Aquadest	Solvent		ad 100	ad 100	ad 100

***Alkaloid Tests** (Harahap, 2023)*

Dragendorff's Reagent Test

A 1 mL sample was transferred into a test tube, followed by the addition of 2–3 drops of Dragendorff's reagent. The presence of alkaloids is indicated by the formation of an orange precipitate.

Wagner's Reagent Test

A 1 mL sample was mixed with 10 drops of 2 N H_2SO_4, then Wagner's reagent was added. A positive result is indicated by the appearance of a brown coloration.

Mayer's Reagent Test

The sample was treated with 3 drops of concentrated HCl, then 5 drops of Mayer's reagent were added. A positive reaction is indicated by the formation of a white precipitate.

Peel-off Gel Mask Formulation

Formulation for preparation of peel-off gel mask preparations ethanol extract of fragrant citronella leaves using different concentrations of carbomer as listed in Table 1.

Physical Quality Evaluation

Organoleptic Test

Conducted through visual observation of the preparation, including its form, color, and odor (BPOM RI, 2023).

Homogeneity Test

Performed by visually observing the uniformity of the preparation using a glass slide (Febrianti, 2025).

pH Test

Carried out to observe any changes in the pH of the preparation during storage using a pH meter (Febrianti, 2025).

Spreadability Test

Conducted by placing 0.5 g of the preparation on a graduated glass surface, then left for 1 minute. After that, a 50 g load is applied for 1 minute, and the diameter of the spread is observed. The procedure is repeated with incremental loads of 50 g (Febrianti, 2025).

Adhesion Test

Performed by placing the preparation on a glass slide, then another glass slide is placed on top. A load of 1 kg is applied for 5 minutes while the slides are positioned on the testing apparatus. Then, an 80 g load is released, and the time taken for the slides to separate is recorded (Febrianti, 2025).

Drying Time Test

Conducted by applying the preparation to the skin and observing the time required to dry. The acceptable drying time ranges from 20–30 minutes (Sadli et al., 2023).

Irritation Test

Performed on several respondents with assessment parameters including whether the preparation causes irritation (Sadli et al., 2023).

Antibacterial Activity Test

Antibacterial activity against *Staphylococcus aureus* was evaluated using the diffusion method with a well technique (Potti et al., 2022).

RESULTS AND DISCUSSION

Determination Results

The sample used in this study was collected from Jombang, East Java, and identified at Materia Medica Batu in Malang, East Java. The identification confirmed that the sample was citronella leaves (*Cymbopogon nardus* (L.) Rendle).

Table 2. Identification results of Peel off in the extract of citronella leaves (*Cymbopogon nardus* (L.) Rendle)

Identification	Reagent	Result	Conclusion
Saponin	Hot Aquadest and 2 M Hydrochloric Acid	Orange	Positive
Flavonoid	Magnesium powder and concentrated HCl	A stable foam is present and does not disappear	Positive
Alkaloid	Dragendorff's Reagent	An orange precipitate	Negative
	Wagner's Reagent	A white precipitate	Negative
	Mayer's Reagent	A chocolate precipitate	Negative

Results of Extract Yield Preparation of Citronella Leaves (*Cymbopogon nardus* (L.) Rendle)

The calculation of extract yield was carried out to determine the amount of extract produced; the higher the yield value, the greater the amount of extract obtained. In this study, the extract obtained had a weight of 108.68 grams, resulting in a yield of 10.8%.

Identification Results of Secondary Metabolite Compounds in the Extract of Citronella Leaves (*Cymbopogon nardus* (L.) Rendle)

The identification results of secondary metabolite compounds in the extract of citronella leaves (*Cymbopogon nardus* (L.) Rendle) are presented in Table 2. The ethanol extract of citronella leaves that had been obtained was then subjected to phytochemical screening tests. In this study, screening was carried out for flavonoids, saponins, and alkaloids.

The phytochemical screening for flavonoids showed positive results, indicated by a color change to orange. This occurs due to a reaction between Mg metal and HCl, which reduces the benzopyrone nucleus present in the flavonoid structure (Kusparmanto et al., 2024). The reaction between Mg and concentrated HCl produces flavilium salts, resulting in an orange color in flavonoids (Wowor et al., 2022).

The phytochemical test for saponins also showed positive results, indicated by the formation of stable foam that does not disappear. This is due to the hydrolysis of glycosides in saponins into sugars and aglycones, which leads to foam formation (Sabdoningrum et al., 2021).

Alkaloid screening using Mayer's reagent showed negative results, indicated by the absence of a white precipitate. This may be due to the nitrogen in the alkaloids not reacting with K^+ metal ions from potassium tetraiodomercurate (II) in Mayer's reagent, so potassium–alkaloid complexes are not formed. Phytochemical screening of alkaloids using Dragendorff and Wagner reagents also showed negative results, as indicated by the absence of orange and brown precipitates. This may occur because K^+ metal ions do not form covalent bonds with alkaloids, resulting in no precipitate formation. In addition, this may be influenced by the low concentration of secondary metabolite compounds. Biologically, it can be affected by plant variety, season, and weather conditions in the growing area, causing alkaloid levels to be undetectable (Siregar et al., 2025).

Results of the Ethanol-Free Test of Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The Ethanol-Free Test Results of Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) showed that the extract was negative for ethanol, indicated by the absence of the characteristic ethanol odor. Ethanol has antibacterial activity, so it is necessary to test for ethanol-free extracts to prevent false-positive results in antibacterial activity testing (Zhang et al., 2024).

Organoleptic Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The organoleptic test on the Gel Peel-Off Mask preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) showed that formulations I, II, and III were in the form of a semi-solid gel. The viscosity increased with higher variations of carbomer, the color appeared brownish-green, and the mask had the characteristic citronella scent (Prasongko et al., 2005).

Homogeneity Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

Based on the results of the homogeneity test conducted on the peel-off gel mask formulation containing citronella leaf extract (*Cymbopogon nardus* (L.) Rendle), the results showed that none of the three formulations exhibited coarse particles or phase separation. This indicates that variations in carbomer base concentration did not affect the physical quality of homogeneity (Prasongko et al., 2005).

pH Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The pH test results on the Gel Peel-Off Mask preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) are presented in Table 3. The pH test results showed that formulations I, II, and III met the required range of 4.6–6.5. The data were then analyzed using LSD, which showed significant differences among the three formulations (sig < 0.05). This is due to variations in carbomer concentration as a gelling agent. Carbomer tends to be acidic, with a pH around 3, so higher concentrations result in lower pH values. Therefore, triethanolamine is needed to neutralize the pH of carbomer (Ergashev, 2021).

Spreadability Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The spreadability test results on the Gel Peel-Off Mask preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) are presented in Table 3. In this study, the preparation was somewhat viscous, resulting in spreadability test values for formulas I, II, and III that did not meet the required range of 5–7 cm, as the average spreadability obtained was less than 5 cm. Preparations showing a spread diameter of less than 5 cm are classified as semistiff (Prasongko et al., 2005).

Based on these data, an LSD analysis test was conducted, yielding significant values (sig < 0.05) for formulas I, II, and III. These results indicate that there are significant differences among the three formulations. This is due to the fact that carbomer, as a gelling agent, produces high viscosity even at low concentrations, which leads to reduced spreadability (Ozon et al., 2025). Therefore, increasing variations in carbomer concentration in formulas I, II, and III result in higher viscosity, causing the spreadability to decrease.

Adhesion Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The adhesion test results on the Gel Peel-Off Mask preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) are presented in Table 3. Based on the test results, the average adhesion time was more than 4 seconds, thereby meeting the required specification for adhesion, which is greater than 4 seconds (Prasongko et al., 2005). The data were subsequently analyzed using a post hoc LSD test. The results for formulas I, II, and III indicated significant differences, with p-values less than 0.05. These findings indicate significant differences among the treatment groups. This is attributed to the variation in carbomer concentration as a gelling agent in formulas I, II, and III. Increasing the carbomer concentration raises the viscosity of the peel-off gel mask formulation, leading to a longer duration of adhesion (Nakii et al., 2025).

Table 3. Results of physical quality of Peel-Off Gel Mask

Formulation	Average ± SD			
	pH	Spreadability	Adhesion	Drying Time
F1 (Formulation with Carbomer 0,5%)	5.1 ± 0.1	4.8 ± 0.1	5.38 ± 0.05	15.50 ± 0.02
F2 (Formulation with Carbomer 0,7%)	4.8 ± 0.1	4.8 ± 0.1	4.8 ± 0.1	23.25 ± 0.02
F3 (Formulation with Carbomer 0,9%)	4.5 ± 0.1	4.5 ± 0.1	4.5 ± 0.1	24.51 ± 0.03

Table 4. Antibacterial activity results of secondary metabolite compounds in the extract of citronella leaves (*Cymbopogon nardus* (L.) Rendle)

Formulation 1 (Formulation with Carbomer 0.5%)				
Replication	F1	K+	K-	B
1	14.27	22.38	0.00	0.00
2	14.30	22.40	0.00	0.00
3	14.35	22.39	0.00	0.00
Average ± SD	14.29 ± 0.01	22.39 ± 0.01	0.00 ± 0.00	0.00 ± 0.00
Formulation 2 (Formulation with Carbomer 0.7%)				
Replication	F2	K+	K-	B
1	12.76	22.36	0.00	0.00
2	12.79	22.32	0.00	0.00
3	12.78	22.35	0.00	0.00
Average ± SD	12.77 ± 0.02	22.34 ± 0.02	0.00 ± 0.00	0.00 ± 0.00
Formulation 3 (Formulation with Carbomer 0.9%)				
Replication	F1	K+	K-	B
1	11.37	22.42	0.00	0.00
2	11.35	22.43	0.00	0.00
3	11.33	22.40	0.00	0.00
Average ± SD	11.35 ± 0.02	22.41 ± 0.01	0.00 ± 0.00	0.00 ± 0.00

Drying Time Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The drying time test results on the Gel Peel-Off Mask preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) are presented in Table 3. The drying time test results met the required drying time criteria for peel-off gel mask preparations, which is 15–30 minutes (Nakii et al., 2025). The results of the post hoc LSD test for formulas I, II, and III showed significant values (sig < 0.05). Based on these results, there are significant differences among the three formulations. This is due to the fact that higher carbomer concentrations reduce the drying rate. Carbomer 940 has the ability to attract and retain water molecules, resulting in higher consistency, which reduces water evaporation from the preparation. Consequently, higher carbomer concentrations lead to a longer drying time (Ozon et al., 2025).

Irritation Test Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The irritation test was conducted by applying the preparation to the upper arm under occlusive conditions for 24 hours (Lucida & Ema, 2017). The results of the irritation test on the three formulations, involving 10 panelists, showed that none of the formulations caused any irritation response. This indicates that variations in carbomer concentration did not affect the skin irritation response.

Antibacterial Activity Results of the Gel Peel-Off Mask Preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle)

The antibacterial activity results on the Gel Peel-Off Mask preparation from Citronella Leaf Extract (*Cymbopogon nardus* (L.) Rendle) are presented in Table 4. The inhibition zone results for FI, FII, and FIII ranged from 10–20 mm, while the positive control showed a result categorized as very strong (>20 mm). The negative control and the base without extract did not produce any inhibition zone. This indicates that the inhibition zones observed were solely due to the active compounds in the peel-off gel mask containing Citronella leaf extract, and not influenced by the solvent or the base. The data were then analyzed using a post hoc LSD test. The results showed significant values (sig < 0.05) for all formulations and controls, indicating significant differences among the formulations. This may be attributed to the fact that increasing the concentration of the gelling agent affects the viscosity of the preparation, which in turn interferes with the diffusion of active compounds through the medium. As a result, the antibacterial activity decreases (Wisudyaningsih & Lidya, 2022).

CONCLUSION

Based on the findings from the study on peel-off gel mask formulations containing citronella leaf extract with different carbomer concentrations (0.5%, 0.7%, and 0.9%), the following conclusions can be made:

1. The variation in carbomer concentration affects the properties of the peel-off gel mask containing citronella leaf extract (*Cymbopogon nardus* L. Rendle), including pH, spreadability, adhesion, and

drying time.

2. Variations in carbomer concentration do not influence the acceptability of Citronella leaf peel-off gel mask formulations, as indicated by irritation and preference assessments..
3. Variations in carbomer concentration affect the antibacterial activity of peel-off gel masks containing Citronella leaf extract (Cymbopogon nardus L. Rendle) against *Staphylococcus aureus*, resulting in a bacteriostatic inhibition zone.

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