IJPST
Indonesian Journal of Pharmaceutical Science and Technology

Research Article
Vol. 12 No. 2 (2025): 178-183
https://doi.org/10.24198/ijpst.v12i2.45186

Effectiveness Test of Spray Gel Hand Sanitizer with Carbomer 940 as a Preventive Product in Emergency Conditions

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Abstract
Hand sanitizer is known for its ability to kill germs quickly due to its alcohol content, making it more effective than washing hands with soap and water. However, excessive use of alcohol-based sanitizers can cause skin irritation and dryness. Alcohol is polar and volatile, leading to rapid skin dryness and reduced effectiveness. To address this, gelling agents like Carbomer 940 are added to spray gel formulations. Carbomer 940 offers high stability and low toxicity, thereby enhancing the gel's antibacterial properties. This study aims to develop an innovative spray gel hand sanitizer using Carbomer 940. The research method used was a pure experiment, evaluating the % inhibition of microbial growth on agar media. Results showed that the spray gel with 0.05% Carbomer 940 had superior effectiveness, with 60.77% inhibition, compared to the control group using the WHO formula, which achieved 33.11%. Additionally, the spray gel had a pH of 6.5 ± 0.2, a viscosity of 135.10, and an average spray weight of 0.027 ± 0.000 g, demonstrating optimal physical quality. In conclusion, the spray gel hand sanitizer with 0.05% Carbomer 940 was more effective at inhibiting microbial growth than the WHO standard formula.

Keywords: carbomer 940, effectiveness test, hand sanitizer, spray gel

Article History:
Submitted 7 February 2023
Revised 6 September 2023
Accepted 30 July 2024
Published 30 June 2025

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Citation:
Sutiswa, S.I.; Aji, N.; Yulia, N. Effectiveness Test of Spray Gel Hand Sanitizer with Carbomer 940 as a Preventive Product in Emergency Conditions. Indonesian Journal of Pharmaceutical Science and Technology. 2025: 12 (2), 178-183.

Uji Efektivitas Hand Sanitizer Spray Gel dengan Carbomer 940 sebagai Produk Preventif pada Kondisi Darurat

Abstrak
Hand sanitizer dikenal karena kemampuannya membunuh kuman dengan cepat karena kandungan alkoholnya, sehingga lebih efektif daripada mencuci tangan dengan sabun dan air. Namun, penggunaan hand sanitizer berbahan dasar alkohol secara berlebihan dapat menyebabkan iritasi dan kekeringan pada kulit. Alkohol bersifat polar dan mudah menguap, yang menyebabkan kulit cepat kering dan mengurangi efektivitasnya. Untuk mengatasi hal ini, agen pembentuk gel seperti Carbomer 940 ditambahkan ke dalam formulasi gel semprot. Carbomer 940 menawarkan stabilitas tinggi dan toksisitas rendah, sehingga meningkatkan kinerja antibakteri gel. Penelitian ini bertujuan untuk mengembangkan hand sanitizer gel semprot inovatif menggunakan Carbomer 940. Metode penelitian yang digunakan adalah eksperimen murni, yaitu mengevaluasi % penghambatan pertumbuhan mikroba pada media agar. Hasil penelitian menunjukkan bahwa gel semprot dengan 0,05% Carbomer 940 memiliki efektivitas yang lebih unggul, yaitu sebesar 60,77% penghambatan, dibandingkan dengan kelompok kontrol yang menggunakan formula WHO, yaitu sebesar 33,11%. Selain itu, gel semprot memiliki pH 6,5 ± 0,2, viskositas 135,10, dan berat semprotan rata-rata 0,027 ± 0,000 g, yang menunjukkan kualitas fisik yang optimal. Sebagai kesimpulan, gel semprot pembersih tangan dengan 0,05% Carbomer 940 lebih efektif dalam menghambat pertumbuhan mikroba daripada formula standar WHO.

Kata Kunci: carbomer 940, uji efektivitas, spray gel, hand sanitizer

1. Introduction

Hand sanitizer is one of the antiseptics that is often used by the public as a practical means of hand cleaning. The use of hand sanitizer is more practical, effective, and efficient than using soap and running water, especially during emergency conditions. Hand sanitizer can kill germs relatively quickly because it contains alcohol compounds. The compounds contained in hand sanitizers have a mechanism of action that involves denaturing and coagulating microbial cell proteins.[1] However, antiseptics or hand sanitizers that contain alcohol are used excessively and continuously, and can be harmful and cause irritation, leading to burning on the skin. This is due to the basic ingredients of the antiseptic, which are alcohol, a polar and volatile compound, causing the skin to dry quickly and reducing its effectiveness.[2]

One of the efforts to reduce irritation and evaporation of alcohol contained in antiseptic hand sanitizer products is to innovate these products in the form of spray gel preparations. Spay gel is a gel dosage form with the appropriate type and concentration of gelling agent to produce a gel preparation that can be applied using a spray bottle (spray).[3]

The gelling agent often used in spray gel preparations is carbomer 940, as it exhibits high stability and low toxicity, thereby enhancing the effectiveness of the gel as an antibacterial agent.[4] The purpose of this study was to determine the characteristics and effectiveness of hand sanitizer preparations in the form of spray gel preparations using the gelling agent Carbomer 940 and the WHO basic formula.

2. Materials and methods

2.1. Tools

The tools used in this study include digital scales (MRC), pH meter (Hanna), colony counter (MRC), incubator (Memmert), autoclave (Labtech), Brookfield viscometer, hot plate (Favorite), petri dish, vial, object glass, gel spray bottle, standard glassware.

2.2. Materials

The materials used in this study are 96% ethanol (DPPH), Nutrient Agar (Himedia), 30% hydrogen peroxide (DPPH), carbopol 940 (DPPH), propylene glycol (DPPH), triethanolamine (DPPH), glycerin (DPPH), sterile water, and distilled water.

2.3. Methods

2.3.1. Formulation of Hand Sanitizer Gel

The basic formula used is an alcohol-based hand sanitizer, as recommended by the World Health Organization, with the addition of a gelling agent, Carbomer 940. The formulation was created with five variants of Carbomer 940 concentration; the complete formula is presented in Table 1.[5,6]

2.3.2. Test of dosage characteristics

Hand sanitizer spray gel preparations were further characterized, including:

Organoleptic

Organoleptic preparation involves examining the physical appearance of the preparation by observing its color, aroma, and texture. Organoleptic testing in this study used 10 panelists to assess. This research has received ethical approval from KEPK Poltekkes Kemenkes Tasikmalaya No. 2021/KEPK/PE/VI/00142. The criteria for selecting panelists were that they be untrained, adult, and physically healthy. Good criteria for organoleptics are that the resulting spray preparation is clear or transparent, not cloudy, and there are no air bubbles.[7,8]

Homogeneity

The homogeneity test was conducted to determine whether the spray gel preparation was homogeneous or not by dispersing 500 mg of the spray gel on a glass object. The preparation must exhibit a homogeneous composition, with no coarse grains visible.[9]

Table 1. Spray Gel Hand Sanitizer Formula

Materials	Ingredient (%)				
	Formula 1 (%)	Formula 2 (%)	Formula 3 (%)	Formula 4 (%)	Formula 5(%)
Etanol 96% (v/v)	83,30	83,30	83,30	83,30	83,30
Gliserin 98 % (v/v)	14,50	14,50	14,50	14,50	14,50
H2O2 3% (v/v)	41,70	41,70	41,70	41,70	41,70
Carbomer 940 (b/v)	0	0,05	0,10	0,15	0,20
Trietanolamin (b/v)	----------qs----------				
Air (v/v)	ad 100	ad 100	ad 100	ad 100	ad 100

pH

Samples of spray gel preparation were taken and weighed up to 1 g, then dispersed in 20 mL of distilled water, and measured using a digital pH meter three times.[10]

Spraying Pattern and Weight

In the spraying pattern test, the preparation was sprayed from the bottle at distances of 3, 5, and 10 cm on a sheet of plastic mica, and the diameter of the pattern formed was observed three times.[11] The spraying weight test was carried out by weighing the preparation in the container, then spraying it five times, and then weighing the preparation again after the spraying process. After that, the delivery volume of each spray was calculated using an equation.[3]

$$A_L = \frac{(Wt - Wo)}{Da}$$

Viscosity

The viscosity of the spray gel formulation was assessed using a Brookfield viscometer. A total of 75 mL of the spray gel was placed in a cup, followed by the installation of spindle No. 3. The viscosity values were recorded once the viscometer displayed a stable reading. The measurement process was repeated three times for accuracy.[12]

Antimicrobial Effectiveness Test

The number of subjects for experimental research was determined based on the Federer equation: (t-1) (n-1) > 15. The number of groups (t) in this study was five formulas, so the number of subjects per group (n) was at least four respondents (Federer, 1963). The inclusion criteria for the respondents are: adults (20-60 years old), untrained individuals, and physically healthy individuals.

The exclusion criteria of this study are: participants who are not willing, and those with wounds or infections on the skin of their hands. The respondents were quarantined in an isolated room. During treatment, they were asked to wash their hands first and then left for one hour. Respondents were allowed to interact according to health protocols during the pandemic. Before being examined, the two palms of the respondents were rubbed together so that the bacterial content in both palms was homogeneous. Then, a sterile cotton swab moistened with a 0.9% NaCl solution is applied or wiped firmly on the respondent's palm, in the opposite direction to the palm line. The cotton swab is then applied evenly and thoroughly to a Nutrient Agar media plate in a petri dish. The Petri dish was then incubated at 37°C for 24 hours. After that, the growing bacterial colonies were counted and recorded.[9,13]

After the above experiments were carried out, the respondents' palms were immediately cleaned with a spray gel hand sanitizer preparation, following the instructions for use on each test product. After 35 seconds, a sterile cotton swab moistened with 0.9% NaCl solution is applied firmly to the cleaned palm of the respondent, in the opposite direction to the line of the palm. The cotton swab was then applied evenly and thoroughly over the Nutrient Agar media plate in a petri dish. The Petri dish was then incubated at 37 °C for 24 hours. The incubation results were observed, and the growing bacterial colonies were counted and recorded.[14]

3. Result

The results of organoleptic testing show that the addition of Carbomer 940 to the four formulas produces a clear, slightly cloudy color, a typical alcoholic odor, and a dosage form in the form of a slightly thick liquid gel. This preparation yields a gel-like liquid that is organoleptically stable at room temperature (28°C).
The homogeneity test is used to determine whether

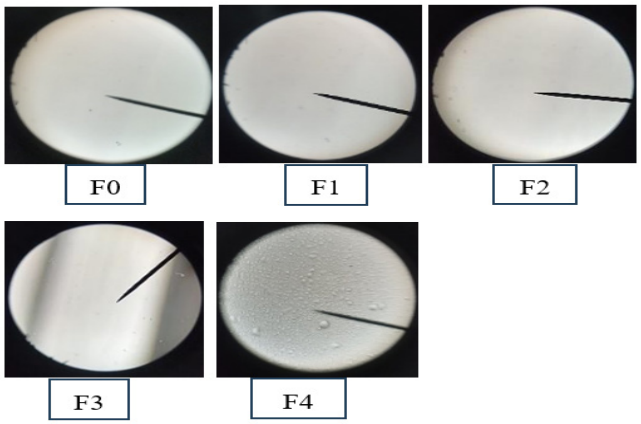

Figure 1. Organoleptic test results

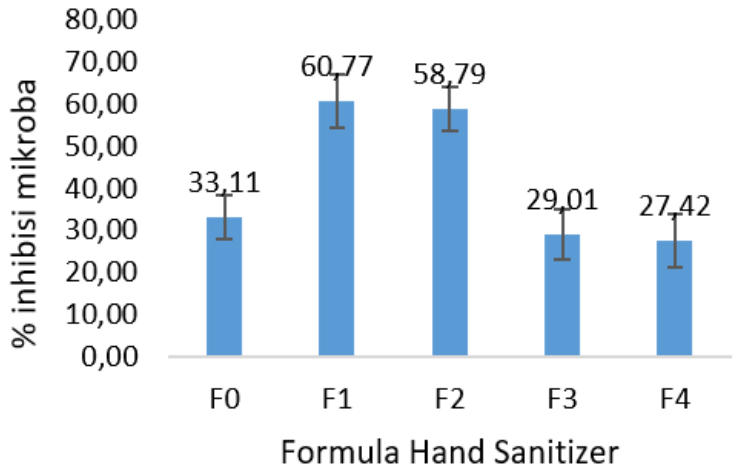

Figure 2. Antimicrobial effectiveness test results of hand sanitizer formulas in vitro

a preparation is homogeneous, which is one of the requirements for gel preparations. Homogeneity testing is performed by spraying the gel preparation onto a glass plate and viewing it visually. The test results indicate that each formula yields homogeneous results, with no solid particles present in the spray gel preparation, as shown in Figure 1.

The evaluation of the physical characteristics of the hand sanitizer spray gel formulation was conducted by assessing several key parameters. These parameters included organoleptic properties, which involve the appearance, color, and odor of the preparation, as well as the pH level to ensure its compatibility with the skin. Additionally, measurements of spray weight and viscosity were performed to determine the formulation's consistency and ease of application. Furthermore, the antimicrobial effectiveness of the spray gel was analyzed to assess its ability to eliminate or inhibit microbial growth. A comprehensive summary of these test results is provided in Table 2.

Based on the graph of the percentage microbial inhibition of the hand sanitizer preparations studied, it is evident that hand sanitizer preparations made in the form of spray gel using Carbomer 940 with concentrations of 0.05% and 0.10% provide greater microbial inhibition compared to the control preparation.

4. Discussion

Spray gel hand sanitizer made with the addition of carbomer 940 produces homogeneous characteristics. This follows the requirements of homogeneity, which must not contain rough materials that can be felt.[12,15]

Table 3 shows that the pH of the preparation still falls within the pH range of the skin, which is 4.5-7.0.[16] The pH of skin preparations is one of the requirements that must be met, as an excessively acidic pH can cause the skin to wrinkle and become damaged or irritated. If the pH of the preparation is too alkaline, it can cause the skin to dry and peel.[1,16,17] A comparison of the pH values of each spray gel preparation formula with the control preparation is shown. It can be observed that the pH value of the spray gel increases with an increase in the concentration of Carbopol 940.
The results of spraying pattern testing for each formula yield varying outcomes, as shown in Table 2. The variation in spraying patterns formed from spray gel preparations is influenced by the spraying distance and the viscosity of the preparation.[3,7,11] The greater the spray distance, the greater the spray pattern produced. This proves that the spray distance is directly proportional to the diameter of the spray pattern. Spraying patterns F1 and F2 produce a diffuse spray pattern shape, while F3 and F4 tend to be less diffuse.

Table 2. Hand sanitizer characteristic results

Parameter	Caracteristic				
	F0	F1	F2	F3	F4
Organoleptic	Clear, liquid	Clear, slightly thick liquid and not sticky	Clear, slightly thick liquid and not sticky	slightly cloudy, thick, and slightly sticky	Slightly cloudy, thick, and sticky
pH	5,8 ± 0,3	6,5 ± 0,2	6,5 ± 0,3	7,1 ± 0,1	7,1 ± 0,1
Spraying weight (g)	0,036 ± 0,006	0,027 ± 0,000	0,028 ± 0,003	0,030 ± 0,007	0,034 ± 0,007
Viscosity (cPs)	59,43 ± 0,00	135,10 ± 0,00	269,33 ± 0,00	478,50 ± 0,00	513,33 ± 0,00
% Microbial inhibition	33,11 ± 5,33	60,77 ± 6,24	58,79 ± 5,29	29,01 ± 5,85	27,42 ± 6,43

This is because the greater the concentration of Carbomer 940 used, the greater the viscosity of the spray gel preparation. Increasing the concentration of Carbomer 940 can increase viscosity, resulting in a greater pressure requirement for spraying the spray gel preparation. This will lead to less spread-out spray results, but the weight of the preparation exiting the applicator will be increased.

The results of the spray weight test showed that in F3 and F4, the spray weight was heavier than in Formulas 1 and 2. This is because the concentration of Carbomer 940 is increasing, resulting in increased viscosity, but a less spread-out spray pattern. Whereas in F0 or control, the spray weight is significant, but the resulting spray pattern is also spread.

The weight and spray pattern, apart from being influenced by viscosity, can also be influenced by the applicator used. The effectiveness of the applicator used to deliver a certain amount of spray gel preparation per spray can also be seen from the standard deviation of the average weight per spray.[3] Viscosity is a term for the resistance of a liquid to flow. The higher the viscosity of the flow, the greater the resistance.[14] The viscosity of the spray gel preparation describes whether the spray gel can be delivered through the spray applicator or whether it is easier to pour into the container. A good spray gel viscosity value is less than 150 cP.[11] From Table 5, it can be seen that there are differences in the viscosity of each preparation, where the greater the concentration of Carbomer 940 used, the greater the viscosity value of the preparation. This indicates that the increase in viscosity is directly proportional to the increase in concentration and type of polymer used.[9,18-20]

Viskositas F1 (135,10) menujukkan viskositas yang baik untuk sediaan spray gel karena kurang dari 150 cP. Pada F0 walaupun tidak menggunakan Carbomer 940, tetapi terdeteksi memiliki viskositas karena pada formula control mengandung gliserin yang merupakan cairan kental yang berfungsi sebagai humektan dan emollient.

Test the antimicrobial effectiveness by measuring the percentage microbial inhibition of each formula. Testing the antimicrobial effectiveness of hand sanitizer preparations is carried out in vitro and involves 20 respondents, with each formula tested using four respondents.[9,13]

The test results demonstrate that the development of formulation technology can enhance the effectiveness of the preparation.

In this study, the volatile liquid hand sanitizer preparation was modified into a spray gel hand sanitizer preparation by adding specific ingredients. Carbomer 940 gelling agent can suppress the evaporation rate of alcohol in hand sanitizer, thereby increasing the contact time of the preparation. This results in a more optimal antimicrobial effectiveness of hand sanitizer made using spray gel preparations with Carbomer 940 gelling agent.[1,21]

5. Conclusion

The conclusion of this study reveals that spray gel hand sanitizer containing 0.05% Carbomer 940 is more effective in inhibiting the growth of microorganisms, with a percentage inhibition of 60.77%, compared to the WHO standard formula control, which achieves only 33.11%.

Conflict of Interest

The authors declare no conflicts of interest.

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