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Formulation and Characterization Tests of SCOBY Kombucha Gel

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Abstract

The wound is the damage to body tissues caused by various factors such as accidents, sharp object scratches, etc. Proper care is necessary to accelerate the wound healing process. Topical medications, such as gel preparations, are commonly used for wounds. Kombucha SCOBY is believed to contain bioactive compounds that can accelerate the wound healing process, making it a potential active ingredient in gel preparations. This research aims to determine the characteristics of kombucha SCOBY gel with various concentration variations. SCOBY is obtained from kombucha fermentation using green tea, sugar, and kombucha culture. Preparing kombucha SCOBY gel involves using carbomer 940, methyl paraben, triethanolamine, glycerin, and SCOBY kombucha. The concentration variations of kombucha SCOBY gel include 0%, 2%, 4%, 8%, 10%, and 12%. Each formula undergoes physical characteristic tests including an organoleptic test, hedonic test, homogeneity test, pH test, spreadability test, and adhesiveness test. Data obtained after physical characteristic tests of the gel preparations are analyzed descriptively. Based on the conducted research, it was found that kombucha SCOBY gel preparations with concentration variations of 0%, 2%, 4%, 8%, 10%, and 12% exhibited different characteristics. The higher the gel concentration, the more acidic the gel's aroma, the more liquid the texture, and the more intense the color. SCOBY added to the gel preparation can increase the pH value, adhesiveness, and spreadability of the gel.

Keywords: Gel; Physical Characteristics; SCOBY; Topical Medication; Wound Care.

INTRODUCTION

Wound is the damage to body tissues, such as skin tissue, organs, and others. Wounds can be caused by accidents, sharp or blunt object trauma, surgery, and others (Hidayat et al., 2024). Wounds can be encountered in daily life. According to data from the Indonesian BPS (Badan Pusat Statistik), the number of minor injury victims in Indonesia has increased, with 113.518 cases in 2020, 117.913 cases in 2021, and 160.449 cases in 2022. Wound care commonly used involves topical preparations. Topical medications are a type of medicine applied directly to the surface of the body or skin to produce a local effect in the area. These medications are typically used to treat skin conditions such as infections, inflammation, or wounds and relieve symptoms like itching, pain, or irritation. Generally, the topical medication used for wound care is a gel (Yanhendri & Yenny, 2012).

The gel is one type of pharmaceutical formulation that dissolves and forms a cohesive structure with a semi-solid consistency. The gel consists of large organic molecules and small inorganic particles evenly dispersed in a liquid medium. The gel has many advantages compared to other topical medications (Yanhendri & Yenny, 2012). The benefits of gel include its ability to spread evenly on the skin surface without disrupting physiological functions because it does not clog pores. Gel can also adhere to the skin and tissues without causing discomfort. Also, the gel is cool, easy to clean with water, and has good drug release, and stable viscosity (Kaban et al., 2024). Gel has better stability, releases drugs well, is easy to use, can maintain skin moisture, and does not irritate the skin, thus enhancing the effectiveness of healing. Gel formulation consists of active ingredients dissolved in a gel base. The active ingredients added to the gel preparation have anti-inflammatory, antibacterial, and antiseptic properties. One of the active ingredients that can be used as the base material for wound healing gel is kombucha SCOBY.

Kombucha is a fermented beverage several vitamins, minerals, and organic acids (Riswanto & Rezaldi, 2021). According to history and various observed literature, the process of making kombucha is carried out using a tea solution medium containing sugar as a nutrient source for the bacteria and yeast that play a role in the formation of kombucha and its by-product, SCOBY (Azizah et al., 2020). Symbiotic Culture of Bacteria and Yeast (SCOBY) is a biofilm layer formed during the kombucha

fermentation. SCOBY contains bacteria and yeast, which are crucial for fermentation. These bacteria and yeast are encapsulated by a permeable thin membrane (Riswanto & Rezaldi, 2021). The bacteria and yeast trapped in the biofilm matrix (SCOBY) interact and produce various metabolites (Urbahillah et al., 2021). SCOBY is likely to contain the same compounds as kombucha and can, therefore, be utilized for wound care.

Thus far, the public has only known kombucha as a health drink, and the fermentation by-product called SCOBY is used as a starter for making kombucha. According to Laavanya et al. (2021), the application of SCOBY in new products is minimal. Previous research has focused on the physical characteristics of SCOBY used in textiles and packaging. SCOBY becomes production waste after a specific period of use (Chagas et al., 2024). Based on the studies conducted, there has not been any research that uses SCOBY as the main ingredient in gel preparations for wound healing. Therefore, this study aims to determine the characteristics of kombucha SCOBY gel with various concentration variations. Research on the characteristics of kombucha SCOBY gel preparations with varying concentrations is essential to understanding their potential applications and therapeutic effects.

MATERIALS AND METHODS

Study area

This type of research is experimental research. This research was conducted in December 2023 – January 2024. The research was conducted in the Animal Cell and Tissue Culture Laboratory and Instrumentation Laboratory, Faculty of Science and Technology, UIN Sunan Ampel Surabaya. The tools used in the research were glass containers, cloth, rubber, spoon, blender, knife, spatula, stirrer, beaker, measuring glass, dropper pipette, magnetic stirrer, petri dish, object glass, cover glass, analytical balance, and hot plate. The ingredients used are kombucha starter and SCOBY (Symbiotic Culture of Bacteria and Yeast), green tea, sugar, carbomer 940, triethanolamine (TEA), glycerin, methyl paraben, distilled water.

Procedures

SCOBY Kombucha Preparation

2000 ml of water was boiled, and 200 grams of sugar (10% w/v) and 10 grams of dried green tea (0.5% w/v) were added. After straining, the solution was covered and cooled to room temperature. When the tea reached around 28-37°C, 200 ml of kombucha starter culture (10% w/v) was added to the tea solution. The glass container was tightly covered with cloth and rubber bands then left for 30 days (Nafisah et al., 2023). By the 7th day of fermentation, SCOBY growth was visible, but to achieve optimal physical characteristics, fermentation proceeded to the 60th day. SCOBY, a colony of bacteria and yeast, remained functional even when sliced, cut, or blended. The equipment used had to be sterile and not exposed to extreme temperatures (cold or hot). The refined SCOBY was used as a base material for gel preparation.

SCOBY Gel Preparation

10 grams of Carbomer 940 was weighed and sprinkled into 500 ml of preheated distilled water. Carbomer 940 was stirred quickly in a beaker glass to form a gel mass, and then 10 drops of TEA (triethanolamine) were added. Next, 1 gram of methyl paraben was weighed, dissolved in 25 ml of distilled water, and added to a smaller beaker glass. The mixture was stirred until homogeneous, then poured into the beaker glass containing Carbomer 940 and distilled water. 5 ml of glycerin was added and stirred until the gel base became homogeneous (Rinawati et al., 2022). SCOBY extract concentrations of 0%, 2%, 4%, 8%, 10%, and 12% were prepared by weighing 0 grams, 2 grams, 4 grams, 8 grams, 10 grams, and 12 grams of SCOBY, then added to the gel base to reach a total weight of 100 grams and homogenized.

Characteristics Test of Gel

Organoleptic Test

The organoleptic test on gel includes texture, color, and aroma. The testing of gel texture and color is conducted through visual observation (Kaban et al., 2022).

Hedonic Test

The hedonic test or preference test aims to determine the level of panelists' preference for a product. This test is carried out by measuring, assessing, or testing the quality of commodities using human senses, namely vision, smell, and touch. The preference test method includes product observation, smelling, and touching using fingertips before applying it to the skin. This subjective test involves 20 random panelists (Nealma & Nurkholis, 2020). The panelists understand the sensory properties of the preparation to be evaluated and meet the criteria for panelists.

According to Qamariah et al., (2022), the criteria for being a panelist are:

- The ability to detect, recognize, compare, and differentiate hedonic properties.
- Showing attention to organoleptic aspects.
- Willing to spare or provide time.
- Having the necessary sensitivity.

In this test, the panelists are asked to rate the product based on preference level with indications: like, neutral, and dislike.

Homogeneity Test

The homogeneity test is performed by preparing an object glass, applying the gel, and covering it with another object glass on top. Homogeneity is indicated by

the absence of coarse grains in the preparation (Kaban et al., 2022).

pH Test

The pH test is conducted to ensure that the pH of the preparation is stable and matches the skin's pH. 1 gram of gel was diluted with distilled water to a volume of 10 ml, then the pH value was measured using a pH meter. The skin pH that meets the criteria ranges from 4.5 to 6.5 (Kaban et al., 2022). If the pH of the preparation does not match the skin's pH, it can irritate if too acidic, or the skin becomes scaly if too alkaline (Rohmani & Kuncoro, 2019).

Spreadability Test

0.5 grams of gel was prepared and placed between two petri dishes. The upper petri dish was weighed and left for one minute. After that, a 150-gram weight was placed on top of the covered petri dish, left for one minute, and then the diameter of its spread was measured. This test was conducted to ensure the even distribution of the gel when applied to the skin, with a spreadability value ranging from 5 to 7 cm, meeting the criteria (Kaban et al., 2022). The larger the spreadability value, the longer the contact between the skin surface and the gel, allowing a higher concentration of active ingredients to be absorbed into the skin (Erwiyani et al., 2018). A high spreadability value also made the gel easier to apply on the skin, thus optimizing the absorption of the preparation (Rohmani & Kuncoro, 2019).

Adhesiveness Test

0.25 grams of gel was placed in the central area of an object glass surface, then another object glass was placed on top and weighted with 1 kg for 1 minute. The two attached object glasses were mounted on the test device and given an 80-gram weight. The time needed for the two object glasses to separate was recorded (Kaban et al., 2022). The adhesiveness test aimed to determine how long the preparation could adhere to the skin surface. The longer the preparation adhered, the greater its spread on the skin surface (Rohmani & Kuncoro, 2019).

RESULTS AND DISCUSSION

Result

SCOBY obtained after 60 days of fermentation has a diameter of approximately 9 cm, a thickness of up to 3.5 cm, and a brownish color (Figure 1).

Figure 1. SCOBY produced during fermentation.

Organoleptic Test

Based on the results of the organoleptic observations, it was found that the kombucha SCOBY gel experienced changes in texture, color, and aroma. These changes are influenced by the concentration of SCOBY added to the gel preparation. The higher the concentration of SCOBY used, the more liquid the gel texture, the more brownish the color, and the more acidic the aroma. The kombucha SCOBY gel with various concentrations can be seen in Figure 2 below.

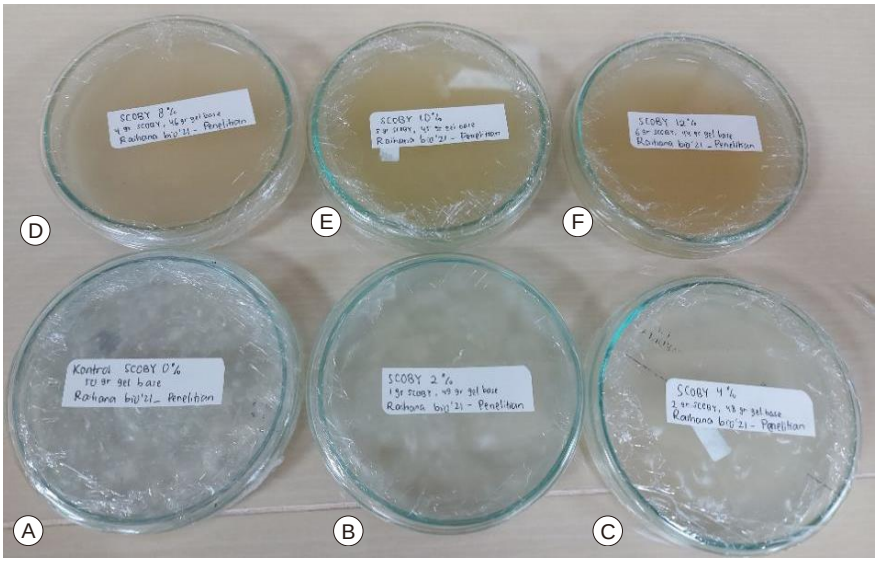

Figure 2. SCOBY Kombucha Gel with Variation of Concentration. A) 0%; B) 2%; C) 4%; D) 8%; E) 10%; F) 12%.

The organoleptic test aims to assess the physical appearance of the gel (Mappa et al., 2013). Organoleptic observations include the color, texture, and aroma of the gel. The aroma is tested using the sense of smell, the color is tested through direct visual observation, and the texture is tested through touch, by applying the gel to the skin and feeling it.

Hedonic Test

The hedonic test for kombucha SCOBY gel was conducted with 20 panelists. The results of the hedonic test can be seen in Figure 3 below.

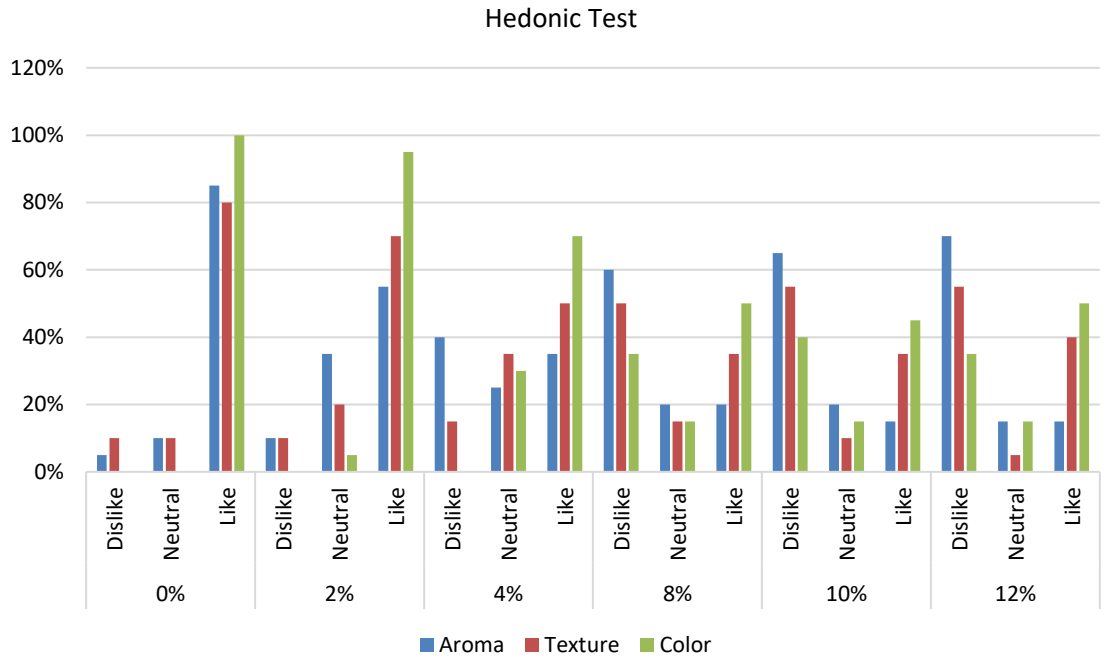

Figure 3. Chart of Hedonic Test Results.

The hedonic test is conducted to determine the level of preference someone has for a product. In this test, individuals who rate the level of preference based on organoleptic observations are called panelists (Triandini & Wangiyana, 2021).

pH Test

The pH value indicates the degree of acidity of a substance. The purpose of the pH test is to determine the pH value of kombucha SCOBY gel or to determine the level of acidity of the gel, which will affect irritation when applied topically (Nurlely et al., 2021). The pH value is measured using a pH meter. The pH test results can be seen in Table 2 below.

Table 2. pH Value of Kombucha SCOBY Gel.

Concentration	pH Value
0%	3.85
2%	3.52
4%	3.45
8%	3.26
10%	3.17
12%	3.11

Homogeneity Test

The homogeneity test aims to ensure that the ingredients in the gel preparation are evenly mixed (homogeneous). Homogeneity is assessed by observing the presence or absence of coarse granules in the gel. Thus, it can be ensured that the active ingredients are evenly distributed in the preparation and that there are no clumped particles, allowing the gel to provide more optimal effects. The determination of homogeneity is done by observing whether or not there are coarse granules in the gel (Mappa et al., 2013).

Table 3. SCOBY Kombucha Gel Homogeneity Test Results.

Concentration	Description
0%	Homogeneous
2%	Homogeneous
4%	Homogeneous
8%	Homogeneous
10%	Homogeneous
12%	Homogeneous

Spreadability Test

The spreadability test aims to assess the ability of kombucha SCOBY gel to spread on the skin surface.

This test is conducted to determine the even distribution of the gel when applied to the skin surface (Mappa et al., 2013). The easier the gel is applied to the skin, the larger the surface area of contact between the active ingredient and the skin, resulting in more optimal absorption of the active ingredient. The spreadability values of the gel for each concentration can be seen in Table 4 below.

Table 4. SCOBY Kombucha Gel Spreadability Test Values.

Concentration	Repetition	Length (cm)	Average
0%	1	5.5	5.5
	2	5.6	
	3	6	
2%	1	5.6	5.6
	2	5.9	
	3	5.2	
4%	1	6	5.8
	2	6	
	3	5.7	
8%	1	6	5.8
	2	6	
	3	5.8	
10%	1	6.1	6.0
	2	6	
	3	6	
12%	1	7.1	7.1
	2	7.1	
	3	6.9	

Adhesiveness Test

The adhesiveness test is conducted to determine how long the gel can adhere to the skin (Forestryana & Rahman, 2020). The results of the adhesiveness test can be found in Table 5 below.

Table 5. SCOBY Kombucha Gel Adhesion Test Values.

Concentration	Repetition	Adhesion Values (s)	Average
0%	1	5	4.7
	2	1.18	
	3	8	
2%	1	3	2.3
	2	2	
	3	1	
4%	1	6	3.0
	2	2	
	3	1	
8%	1	7	5.7
	2	6	
	3	4	
10%	1	9	6.7
	2	7	
	3	4	
12%	1	10	7.7
	2	8	
	3	5	

Discussion

Kombucha is a traditional beverage made from a sweet tea solution fermented by SCOBY (Symbiotic Culture of Bacteria and Yeast), which consists of complex microbes such as acetic acid bacteria, lactic acid bacteria, and yeast (Hamed et al., 2023). In the kombucha fermentation process, the main components involved are SCOBY and the medium. The ingredients required to make kombucha include green tea, kombucha starter, water, sugar, and SCOBY. The physical characteristics of SCOBY are influenced by several factors such as the duration of fermentation, the container used, and the type of tea used. The duration of fermentation affects the thickness of the SCOBY layer; the longer the kombucha tea is fermented, the thicker the cellulose layer formed (Khaerah & Akbar, 2019). SCOBY will grow according to the size of its container, so its diameter matches the diameter of the container used in the kombucha tea-making process. The color of SCOBY depends on the color of the kombucha tea, and the type of tea used in making kombucha affects the color of the SCOBY produced (Riswanto & Rezaldi, 2021). The brown color in SCOBY is caused by the tannin content in teas such as green tea, black tea, and oolong tea, which are as the base for making kombucha tea (Khaerah & Akbar, 2019).

Organoleptic Test

Based on the research conducted, it was found that each concentration of kombucha SCOBY exhibited different physical properties. The test results for each concentration showed changes in the aroma, texture, and color of the gel preparation at each concentration. The changes in the aroma, texture, and color of the gel from the lowest to the highest concentration were due to the active ingredient content in the gel. The highest concentration gel has the most active ingredients, so the most SCOBY was added to the 12% concentration gel. The gel color changed from clear to dark yellow-brown. The gel texture became more liquid, and the aroma became increasingly acidic.

The appearance of SCOBY is influenced by the length of the fermentation time. The longer the fermentation time, the thicker the SCOBY will become. The color of the SCOBY will change to brown or dark brown. This occurs because the tannin compounds in green tea can bind with the cellulose of SCOBY (Khaerah & Akbar, 2019). Thus, the higher the SCOBY content in the gel, the more intense the gel color will be. SCOBY has an acidic aroma, so the more SCOBY is added to the gel preparation, the more acidic the gel aroma will be. According to Soares et al. (2021), the bacterial cellulose present in kombucha has characteristics of high water retention, mechanical resistance, and biocompatibility. Based on research (Chagas et al., 2024), it was found that the water content in SCOBY is high (94.02±0.08 g/100 g). Thus, the more

SCOBY used in gel preparation, the more liquid the gel texture will be.

Hedonic Test

Data in Figure 3 show that most panelists preferred the aroma, texture, and color of the kombucha SCOBY gel at a 0% concentration. At this concentration, there was no addition of SCOBY, so the gel had more neutral characteristics. The 0% kombucha SCOBY gel had a solid texture, transparent color, and a light medicinal aroma. These characteristics provided a familiar and comfortable impression for the panelists, making it more preferred. The graph in Figure 3 shows that most panelists did not like the aroma, texture, and color of the 12% kombucha SCOBY gel. The 12% concentration gel had a slightly liquid texture, a dark yellow-brown color, and a strong acidic aroma. The slightly liquid texture and intense color reduced the visual appeal of the gel. The stronger acidic aroma may have been perceived as unpleasant by the panelists. The results of the hedonic test indicated a relationship between the concentration of kombucha SCOBY gel and the level of acceptance or preference by the panelists. In general, the kombucha SCOBY gel most preferred by the panelists was the 0% concentration gel, which is the gel without added SCOBY. The gel formulation with the most preferred SCOBY addition by the panelists was the 2% concentration kombucha SCOBY gel, while gels with higher concentrations tended to be less liked by the panelists.

pH Test

Based on Table 2, it can be seen that the higher the concentration of kombucha SCOBY gel, the lower the pH value of the preparation. The highest pH value is found in the 0% concentration kombucha SCOBY gel with a value of 3.85, while the lowest pH value is in the 12% concentration kombucha SCOBY gel with a value of 3.11. The pH range that complies with SNI No. 06-2588 is between 4.5 and 6.5, so all concentrations of kombucha SCOBY gel have a pH value below this standard. Although the pH value of kombucha SCOBY gel is low, the hedonic test shows that the gel does not irritate the panelists. Several factors contribute to the low pH not irritating. Kombucha SCOBY gel does not cause skin irritation because the pH value of the gel is close to the natural pH of the skin, thus it can still be well tolerated. The natural pH of human skin is slightly acidic, ranging from 4 to 6.

The decrease in the pH value of the gel preparation is due to the SCOBY content. The higher the concentration of the gel, the more SCOBY is added to the formulation. SCOBY consists of acetic acid bacteria, lactic acid bacteria, and yeast, which produce pellicle-like cellulose on the surface of the fermentation medium through the metabolic activity of acetic acid bacteria. The decrease in pH during fermentation indicates the metabolic activity of bacteria and yeast. During the fermentation process, sucrose is converted into alcohol and other organic acids are formed by the bacteria. The acids formed will release protons and make the pH value decrease (Al-Yousef et al., 2017). Bacteria and yeast metabolize sucrose and sugar during the fermentation process, producing various organic acids. The high sugar content in kombucha tea solution and SCOBY can increase the activity of microorganisms and organic acids. The high levels of organic acids produced by SCOBY, such as acetic acid, lactic acid, gluconic acid, and glucuronic acid, cause the pH value to decrease. Lactic acid is synthesized by lactic acid bacteria, while acetic acid and gluconic acid are synthesized by acetic acid bacteria. Acetic acid bacteria, particularly *Gluconobacter oxydans* and *Komagateibacter xylinus*, produce gluconic acid from the oxidation of D-glucose. Research by Chen & Liu (cited in Antolak et al., 2021) found that during 60 days, the concentration of gluconic acid reached 39 g/L.

Homogeneity Test

The results of the homogeneity test (Table 3) show that kombucha SCOBY gel with concentrations from 0% to 12% is homogeneous because there are no lumps in the preparation. Based on the tests conducted, it can be concluded that there is no difference in homogeneity among the various concentrations of kombucha SCOBY gel. All kombucha SCOBY gels meet the standards of the Indonesian Pharmacopoeia, Edition III, which states that the gel must be homogeneous or appear evenly distributed without the presence of clumped particles when applied to glass or other transparent materials (Rohmani & Kuncoro, 2019). A preparation is considered homogeneous if it does not show the presence of coarse granules that are not mixed. Homogeneity testing is important to ensure that the active ingredients are evenly distributed in the gel, indicated by the absence of clumped particles (Wahyudi & Wulandari, 2022). When a preparation is homogeneous, the ingredients are uniformly dispersed, which ensures optimal release of active components upon application to the skin (Liandharjani & Ratu, 2022).

Spreadability Test

Contact between the medication or active ingredient and the skin will occur more quickly if the spreadability is good (Rohmani & Kuncoro, 2019). Higher spreadability indicates an increased concentration of the active ingredient absorbed by the skin, as the duration of contact between the gel and the skin surface is longer (Erwiyani et al., 2018). Based on the test results (Table 4), kombucha SCOBY gel with concentrations from 0% to 12% shows increased spreadability. According to SNI standards, a good spreadability value for semisolid preparations ranges from 5 to 7 cm (Rohmani & Kuncoro, 2019). Therefore, all kombucha SCOBY gels

meet this standard. The 12% kombucha SCOBY gel has the best spreadability value among all gel concentrations.

The results of the spreadability test (Table 4) show that the 0% kombucha SCOBY gel has the lowest spreadability value. This is because there is no added SCOBY at this concentration, and the gelling agent (Carbomer 940) composition is the highest compared to other concentrations. The 12% kombucha SCOBY gel has the highest spreadability value because the increasing addition of SCOBY with higher concentrations reduces the composition of the gelling agent (Carbomer 940). One of the factors affecting spreadability is the amount and strength of the gel matrix, which is the gelling agent. Spreadability will decrease if the gel matrix increases and becomes stronger. In preparing of kombucha SCOBY gel, the gelling agent used is Carbopol or Carbomer 940. The higher the amount of Carbomer 940 in the gel, the lower the spreadability value because the gel preparation becomes thicker. A high spreadability value indicates that the preparation is easier to apply to the skin (Tambunan & Sulaiman, 2018).

The spreadability test is a test conducted to determine the ability of the speed of spread of the preparation on the skin when applied to the skin. A good spreadability value is 5-7 cm (Tungadi et al., 2023). Good spreadability causes contact between the drug and the skin quickly. The increase and decrease in spreadability are strongly influenced by the consistency of the gel, which is related to the viscosity value of the preparation. If the viscosity value of the preparation is high, the resulting spreadability area is low, and vice versa. This happens because the high viscosity causes the gel to be challenging to flow so, the resulting spreadable area is small. A larger and stronger gel matrix results in reduced spreadability. The component within the gel that is responsible for forming the gel matrix is the gelling agent (Rohmani, 2019). Preparations that are either too difficult to spread or overly spreadable can negatively impact user comfort and the effectiveness of the preparation. Conversely, overly diluted preparations lead to decreased adhesion, thereby reducing the contact time of the active substance with the application site. According to the research by Irianto et al. (2020), higher concentration levels correspond with increased spreadability.

Adhesiveness Test

Based on the table above, it can be seen that each concentration of kombucha SCOBY gel has a different adhesiveness value. The 12% kombucha SCOBY gel has the longest adhesiveness, at 7.7 seconds, while the 2% kombucha SCOBY gel has the shortest adhesiveness, at 2.3 seconds. Good adhesiveness for topical preparations is over 4 seconds (Thomas et al., 2023). Therefore, the study results conclude that kombucha SCOBY gels with concentrations of 0%, 8%, 10%, and 12% have good adhesiveness (more than 4 seconds). Adhesiveness value is inversely proportional to spreadability. Adhesiveness too weak will not provide optimal therapeutic effects (Slamet et al., 2020).

Adhesiveness is influenced by the concentration of the gelling agent (Carbomer 940) in the preparation (Forestryana & Rahman, 2020). The more Carbomer 940 is added, the lower the adhesiveness of the preparation or the quicker it will release. The longer the gel adheres, the better its quality. If the gel easily releases, the effect will not be optimal. The duration of gel adhesion can also be influenced by the concentration of the active ingredient used (Thomas et al., 2023). The higher the concentration of Carbopol or Carbomer 940, the longer the adhesion produced. This is due to the interatomic forces in the preparation, where the thicker the consistency of the preparation, the stronger the forces, resulting in longer adhesiveness (Nurlely et al., 2021).

The higher concentration of the SCOBY gel, the longer the adhesion produced. This is due to the force between atoms in the gel, where a thicker consistency results in stronger forces, thus increasing adhesion duration (Nurlely et al., 2021). This statement is substantiated by Tungadi et al. (2023), who found that formula 1, with varying compositions of astaxanthin ingredients, exhibited the highest spreadability value of 6.40. Conversely, formula 3 displayed the highest adhesion value. These findings demonstrate that greater ingredient concentration enhances adhesion value (Nurlely et al., 2021).

CONCLUSIONS

Based on the research conducted, it can be concluded that kombucha SCOBY gels with concentrations of 0%, 2%, 4%, 8%, 10%, and 12% have different characteristics according to the amount of SCOBY added to the preparation. The higher the gel concentration, the more acidic the gel aroma, the more liquid the texture, and the more intense the color. The pH value of kombucha SCOBY gel decreases with the increasing gel concentration. The spreadability and adhesiveness values of the gel increase with the increasing gel concentration.

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