JOURNAL OF BIOLOGY EDUCATION
J O B E

E-ISSN 2656-3436/ P-ISSN 2615-3947
IAIN KUDUS
http://journal.iainkudus.ac.id/index.php/jbe

Characteristics of Foot Sanitizer Containing Coffee and Cinnamon Extract with Variation of Maceration Duration as a Development of Rural Local Potential

***Muhamad Imaduddin[1)], Nurul Farikhah[2)], Ferriana Diean Haq[3)]**

[1)]**Institut Agama Islam Negeri Kudus, imad@iainkudus.ac.id**
[2)]**Institut Agama Islam Negeri Kudus, nurulfarikhah1602@gmail.com**
[3)]**Institut Agama Islam Negeri Kudus, ferrianadiean7@gmail.com**

***imad@iainkudus.ac.id**

ABSTRACT

Coffee is a plant that can grow in tropical and subtropical areas with suitable areas, namely at an altitude of 1,000-2,100 meters above sea level, for example, which is often found in Colo village, Dawe district, Kudus City, Indonesia. This study aims to determine the quality of preparations for foot sanitizer from coffee and cinnamon extracts. The method used in this experiment is the experimental method. Coffee and cinnamon extracts can be obtained by maceration or soaking. The coffee extract was given a variation of maceration for 38 and 46 hours. The materials used in this experiment were coffee extract 60%, cinnamon extract 10%, glycerin 10%, ethanol 19.5%, and coffee essence 0.5%. Evaluation of foot sanitizer preparations was carried out in 3 stages, namely organoleptic tests including shape, aroma, color, texture, dry time on the skin, irritation, and level of preference for the formulation. Physical preparation tests include pH, clarity, stability, and homogeneity tests. The antibacterial test was carried out based on the area of the inhibition zone to determine the variation of the best spray preparation foot sanitizer to inhibit bacteria. It can be concluded that the preparation of foot sanitizer F2 (R. 46 hours) is more effective than the preparation of foot sanitizer F (R. 38 hours) with a higher pH value, color, level of preference, and antibacterial activity. It is hoped that in the future the manufacture of foot sanitizers can be produced and disseminated to the wider community.

Keywords: Coffee, Foot sanitizer, Maceration.

INTRODUCTION

The feet are one of the parts of the body that very easy to even produce sweat. Physical activity that lasts long enough with the feet closed can easily cause the feet to be moist and smelly due to the buildup of bacterial breeding on the feet (Riyanta & Febriyanti, 2018). The

resulting odor also releases a variety of volatile organic compounds (VOCs) from various areas of the body, especially the feet. VOCs produced from the skin surface come from sweat which contains symbiotic bacteria that live on the surface of the skin and metabolize the secreted compounds into a sweat (Shirasu & Touhara, 2011). Bacteria are tiny microorganisms that cannot be seen with the naked eye and require a microscope to see them. Parasitic microorganisms or pathogenic bacteria are more dangerous and can cause infections both endemic and sporadically, such as *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Escherichia coli* (Sridevi & Deswita, 2020).

Several studies have shown that there is a fairly high population density of Staphylococcus bacteria and Coryneform aerobic bacteria which are the main inhabitants of human skin as a producer of isovaleric acid, although, in small quantities, it is associated with the cause of odor (Ara et al., 2006). Foot odor is also known as bad breath and is associated with hyperhidrosis (excessive sweating) of the feet. This is also influenced by gender differences in the use of footwear which will determine the environment around the feet, where men's footwear is more covered than that used by women. The unpleasant-smelling volatiles is produced as a result of bacterial activity, although the type of bacteria that causes it is unknown (Téllez & Eduardo, 2005). Efforts are often made to deal with foot odor is to washing the feet, but this method is less effective because the feet will be closed again in a damp state. Therefore, innovation is needed in the community to produce a product related to foot health. Alternative natural ingredients that can be developed as foot odor removers are coffee and cinnamon, both of which are spice plants and local potential as well as economic resources from rural areas in Indonesia (Maftuhah et al., 2015). Coffee is one of the plants and local potentials from Colo village, Kudus, Indonesia. This rural is a religious-tourism area where one of the objects, namely the tomb and mosque of Sunan Muria (one of the great historical figures of Islam in Indonesia) requires visitors to take off their shoes (Figure 1.).

Figure 1. Conditions for visitors who are required to take off their footwear to enter the grave area (religious tourism area in Colo Village, Kudus, Indonesia, Location: https://goo.gl/maps/eNwiJ7p5soXn1V1KA).

Coffee is one of the plants from the Rubiaceae family, which this plant can live in tropical and subtropical areas. Coffee has been used for more than 1,000 years and is one of the most consumed in the world with more than 400 billion cups each year (Mussatto et al., 2011). Coffee has occupied an important place in society for at least 1,200 years and is the second most valuable commodity worldwide after vegetable oil (Bae et al., 2014). Coffee is accepted among people because it has a distinctive aroma, therefore many people use coffee as a deodorizer. The coffee commodity is a big enough opportunity to be increased international trade commodities (Rahardjo et al., 2020). Most of the coffee plantations in Indonesia are carried out by farmers in rural areas, private plantations, and state-owned plantations with an average cultivated area in 2017 of around 1,253,796 hectares where total coffee production also increases or decreases every year from 2017-2021 (Apriliyanto et al., 2018).

Coffee has a caffeine content of about 1.06% which can be used in the form of daily drinks and food. Coffee also contains other distinctive compounds including quinolic acid, chlorogenic acid, tannins, trigonelline, and other compounds. The content of these biochemical compounds has a beneficial or unfavorable impact on coffee quality (Gimase, J. et al., 2014). The main polyphenol content in coffee is chlorogenic acid, which is one of the strongest antioxidant compounds in coffee. However, this antioxidant activity will vary according to the degree of roasting, and reach maximum antioxidant activity during moderate roasting (Bae et al., 2014). Coffee has the advantage that it has a water content below 12% and has similarities to the properties of activated carbon, namely an adsorbent by reducing moisture on the skin due to the growth of fungi that cause foot odor. In addition, coffee is also efficacious as a detox or detoxifier, improves blood circulation, disguises and eliminates mosquito bites, wounds/irritations on the skin, and improves skin metabolism so that it is healthier and more well-groomed (Riyanta & Febriyanti, 2018). Besides coffee, cinnamon is one of the most abundant commodities in Indonesia (Baguna & Kaddas, 2021). Cinnamon bark produced in Indonesia has a considerable influence on the world market, for example, in 2003 – 2005, Indonesia was able to dominate the world market by 26.10% or around 37,192 tons (Khasanah et al., 2021). Cinnamon is one of the most popular spices used throughout the world not only as an ingredient for cooking but also can be processed and used as a traditional medicine because of its compound content (Rao & Gan, 2014). The benefits of this considerable amount of coffee and cinnamon have been developed into innovation as a foot odor remover in the form of a foot sanitizer.

Foot sanitizer is a liquid that serves to clean the feet with alcohol as the basic ingredient that is used without any rinsing process with water to kill microorganisms that cause foot odor. Foot sanitizer is still rarely known and it is still rare for people to use it. Foot sanitizer is almost the same as hand sanitizer in general, it's just that its use is different, that is, it is applied to the feet. The ingredients used in the manufacture of foot sanitizers in general are

alcohol, glycerol, and moisturizers. The use of coffee as a foot sanitizer is due to the caffeine content in coffee, most of its biological effects are through adenosine receptors. Adenosine, which can later be used to moisturize and smooth the skin, can help accelerate the wound healing process and can function to soothe inflamed skin (Bae et al., 2014).

The use of coffee as a natural product can be developed into a potential innovation with high economic value and knowledge. Bioactive compounds found in natural ingredients, namely coffee, and cinnamon, can be obtained by extraction. Extraction is carried out to separate a substance present in the material according to the different solubility of each material used. Solvent concentration, duration, and temperature of immersion are factors that can affect the content of bioactive compounds in the coffee and cinnamon extracts produced (Juliantari et al., 2018). This study aims to determine the effect of variations in maceration duration on the physical, organoleptic and antibacterial properties of the use of coffee and cinnamon as an active ingredient to remove foot odor and cinnamon as an active ingredient and natural preservative which will be used by respondents. Thus, foot sanitizer needs to be formulated appropriately to overcome the problem of foot odor (Riyanta & Febriyanti, 2018). The initial product of this foot sanitizer can be further developed to optimize the potential of Colo village, Kudus, Indonesia. This product is a solution for tourists who are required to let go of their feet in religious tourism areas located in villages.

METHOD

Experimental methods were used with quantitative research to determine the cause-and-effect relationship of two factors by eliminating or reducing other disturbing factors (Arikunto, 2004), and determining the quality of evaluation and antibacterial potential of foot sanitizer preparations containing coffee extract and cinnamon to minimize the spread of bacteria. The research design to determine the antibacterial potential used a completely randomized design with the independent variable consisting of 2 preparations of foot sanitizer with variations of maceration of coffee extract (38 hours and 46 hours) with the dependent variable being the clear zone formed. The research hypothesis states that there is the ability of foot sanitizer preparations with their active substances in inhibiting the growth and development of test bacteria (Sugiarti et al., 2019). This laboratory research was carried out at the Chemistry Education Laboratory, Faculty of Tarbiyah (Education), IAIN Kudus, Indonesia from September - October 2021.

Sample Preparation

The raw materials include coffee bean extract, cinnamon, essence/coffee fragrance, glycerin, 70% ethanol, bacterial media, nutrient agar, aqua dest, and bacterial culture (in tea water as a bacterial simulation). The tools are maceration vessels or containers, beakers/glassware, funnels, dropper pipettes, stirring rods, filter paper, pH meters, stoves, and spray bottles. Coffee beans are obtained from around Colo Dawe Village, Kudus

Regency. Coffee beans are ground and collected together in a container with no determination.

Maceration Process

The coffee grounds are then extracted by maceration with 70% ethanol (comparison of coffee grounds with solvents 1:5, 15 gr: 75 ml). Maceration was carried out in two variations of immersion with a time of 38 hours and 46 hours and stirring every six hours. The maceration results are then filtered using a filter which is then separated from the pulp. Self-extraction is the first step used to separate the desired natural product from the raw material. Maceration extraction is included in the conventional extraction method which usually uses organic solvents and requires a large volume of solvent and a long extraction time (Zhang et al., 2018). For the manufacture of cinnamon extract, the maceration liquid uses 70% ethanol. Maceration was carried out by soaking 8 grams of cinnamon powder in 40 liters of 70% ethanol or a ratio of 1:5, then stirring for 6 hours with a duration of soaking for 12 hours.

Production of Foot Sanitizer

After 12 hours of maceration, cinnamon was then filtered using a filter and separated from the pulp. Making spray foot sanitizer according to the formula listed in Table 1.

Table 1. Foot sanitizer dosage formula

Ingredients	Formula %	Function
Coffee powder extract	60 %	Active substances & aroma
Cinnamon Extract	10 %	Preservatives & active substances
Glycerin	10 %	Emollient
Coffee Essence	0.5 %	Aroma enhancer
Ethanol (70%)	19.5 %	Solvent

The preparation of the foot sanitizer formula begins with the step of mixing each ingredient such as coffee extract with two variations of immersion of as much as 60% with 10% cinnamon extract added. Next, 10% glycerin is added, 0.5% coffee essence and ethanol up to 19.5% are added, then stirred until all ingredients are mixed or homogeneous. After all the ingredients are mixed, transfer the mixture into a spray bottle and let it sit for some time before being applied. The product or result of foot sanitizer is divided into 2 formulations (F) where each formulation has variations in the duration of maceration in the coffee extract as shown in Table 2.

Table 2. Making foot sanitizer containing coffee extract

Treatment	The volume of Foot sanitizer	The volume of Coffe Extract	Variation
F1	60 mL Foot sanitizer	36 mL	38 hours soak
F2	60 mL Foot sanitizer	36 mL	46 hours soak

Preparation of antibacterial test media for spray foot sanitizer has been carried out by weighing 3.5 grams of agar powder and mixing it with 1 liter of distilled water/sterilized water into a beaker glass. After the two ingredients are mixed, they are heated and stirred using a stirring rod on a hotplate until dissolved and homogeneous. The petri dish which will be used as a place for bacterial breeding is washed, then dried and cleaned using ethanol. After a few minutes, the test media was put into a sterile petri dish, then a little Nutrien Agar (NA) powder was added to the petri dish and homogenized. Evaluation of preparations carried out on foot sanitizers includes organoleptic tests, physical properties tests, and antibacterial activity tests.

Organoleptic Test

The tests carried out included shape, aroma, color, texture, dry time on the skin, irritation, and level of preference in 2 test formulations with 7 untrained respondents. Data collection was obtained in the form of a questionnaire and direct observation.

Physical Properties Test

The tests carried out included tests for pH, clarity, stability, and homogeneity. In foot sanitizer preparations, the pH range must be safe and appropriate for the skin pH, which is 4.5 - 6.5. The collection of physical properties test data is obtained through direct observations that are carried out regularly.

Antibacterial Activity Test

Bacterial testing was carried out based on the area of the inhibition zone to determine the variation of the best spray foot sanitizer preparation to inhibit bacteria. The test bacteria were obtained from tea water that had decayed and was grown in a petri dish containing agar media and nutrient agar. The concentration of coffee extract used was a variation of soaking 38 and 46 hours. The test solution used was in the form of a spray foot sanitizer which was taken as much as 2 mL and was inserted into each test medium. As a spray control, hand sanitizer with trademark "X" was used as a control (+), F(0) or DMSO (Dimethyl Sulfur Oxide) as a control (-) and the formula for spray foot sanitizer was F1 (R. 38 hours) and F2 (R. 46 hours). After that, the test media was incubated for 7 days at 37o C (Rini et al., 2017). The media with the best inhibition zone will be used as a reference for the preparation of spray foot sanitizer that is safe to use.

RESULT AND DISCUSSION

Organoleptic Test

The evaluation was carried out to determine the shape, aroma, color, texture, skin adhesion, irritation, and level of preference in the 2 test formulations, namely F1 (R. 38 hours) and F2 (R. 46 hours) with 7 untrained respondents. Data collection was obtained in the form of a questionnaire and direct observation. If there is a change in the preparation, it can cause a decrease in consumer acceptance interest (Ryanta & Febriyanti, 2018). Based on the results of the assessment given by the respondents, it showed that the quality of the coffee and cinnamon extract foot sanitizers was included in the appropriate category as shown in Table 3.

Table 3. Test the shape, aroma, and color of the coffee extract foot sanitizer preparation

Treatment	Characteristics				
	Form	Aroma	Color	Texture (The texture of the sprayed results)	
				Sticky	Dry
F1 (R. 38 hours)	Liquid	Typical coffee	Black	28.6%	71.4%
F2 (R. 46 hours)	Liquid	Typical coffee	Deep black	14.3%	85.7%
Commercial Hand Sanitizer	Liquid	Typical ethanol	Clear	-	100%

The test results of the coffee extract foot sanitizer preparations in the form have the same results as commercial hand/foot sanitizers, namely liquid, for the aroma of the two preparations F1 (R. 38 hours) and F2 (R. 46 hours) have similarities, namely the distinctive aroma of the coffee, while the F1 color (R. 38 hours) produced a slightly clearer black color and the F2 preparation (R. 46 hours) the color produced was darker black because the longer the maceration process used the more concentrated the color produced. As for the texture after application to the skin, the F1 preparation (R. 38 hours) had a dry texture of 71.4%, and the F2 preparation (R. 46 hours) had a dry texture of 57.1%.

Table 4 shows that both treatments have the same taste after application on the skin, which produces a cool feeling as well as commercial hand sanitizers. For the duration of dry time after being applied to the skin, the F1 preparation (R. 38 hours) requires an average duration of more than one minute or 1 minute 57.99 seconds, while for the F2 preparation (R. 46 hours) it takes a longer average time shorter than the F1 preparation, which is less than

1 minute or 58.80 seconds. However, the duration of dry time is also different for each person, this follows the type or humidity of each person's skin.

Table 4. Test results on the speed of drying on the skin of the coffee extract foot sanitizer preparation

Treatment	Foot Sanitizer Dry Speed Test Observation	
	Taste generated	Dry time duration
F1 (R. 38 hours)	Cold	1 minute 57.99 seconds
F2 (R. 46 hours)	Cold	58.80 seconds
Commercial Hand Sanitizer	Cold	53.99 seconds

The skin irritation test was carried out to see the side effects arising from the use of coffee extract foot sanitizer on the skin of the user's feet. The irritation test was carried out by applying a coffee extract foot sanitizer with variations in the preparations F1 (R. 38 hours) and F2 (R. 46 hours) on the soles of seven respondents. In the irritation test, special criteria are given, including health, no previous injuries or indications of allergies, and the use of materials or cosmetics on the soles of the feet (Putri et al., 2019). Both variations of the preparation did not irritate the skin of respondents whose feet had previously been applied to coffee extract foot sanitizer preparations.

The preference test on the coffee extract foot sanitizer was carried out on seven respondents who had tried to apply the coffee and cinnamon extract foot sanitizer which included shape, aroma, color, texture, and irritation tests. The results showed that the preference test of seven respondents mostly chose the preparation of foot sanitizer with coffee extract with F2 treatment (R. 46 hours). The preference response in F2 showed 42.8%, while in F1 and F2 it was obtained at 28.6% respectively.

Physical Properties Test

The tests carried out included tests for pH, stability, clarity, and homogeneity. In foot sanitizer preparations, the pH range must be safe and appropriate for the skin pH, which is 4.5 - 6.5. The collection of physical properties test data was obtained through direct observation of the 2 test formulations, namely F1 (R. 38 hours) and F2 (R. 46 hours) which were carried out periodically.

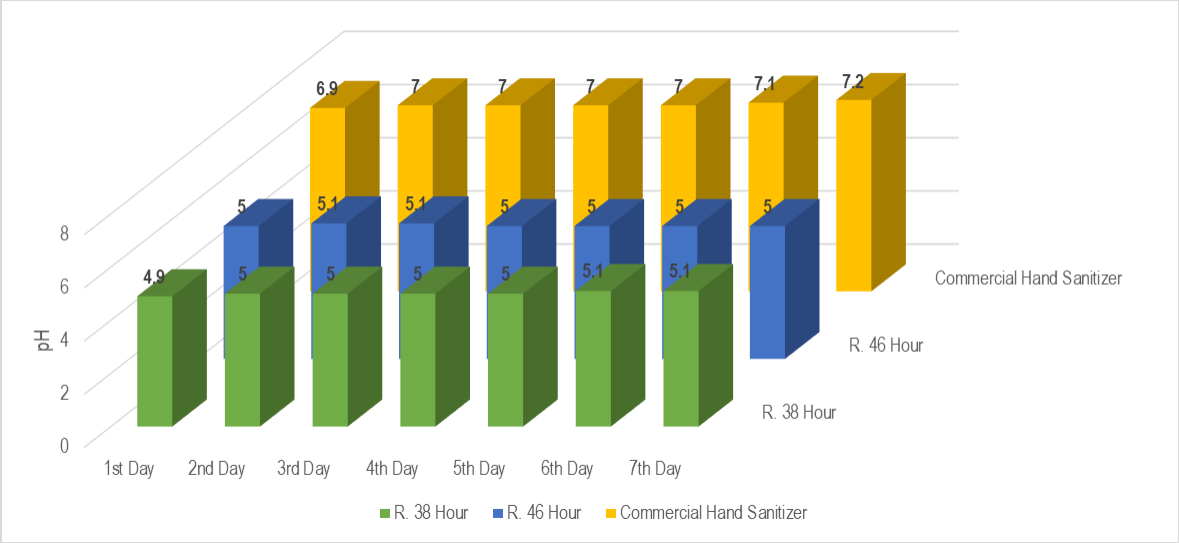


Figure 2. Testing pH on foot sanitizer product preparations.

The pH standard set for the preparation is based on the skin pH, which is 4-6.5 (Riyanta & Febriyanti, 2018). The results of the pH examination for one week in a row showed that the results of the F1 preparation (R. 38 hours) ranged from 4.9-5.1, while the pH of the F2 preparation (R. 46 hours) ranged from 5-5.1 (Figure 2.). This indicates that the foot sanitizer preparation of coffee extract is safe to use because the pH corresponds to the physiological pH of the skin, which is 4.5-6.5 (Ningsih et al., 2016).

The stability test of the coffee extract foot sanitizer preparation was carried out at room temperature for 7 days. The results of the stability examination showed that the foot sanitizer preparation of coffee extract did not undergo phase separation until the seventh day. This is the same as in commercial hand sanitizers.

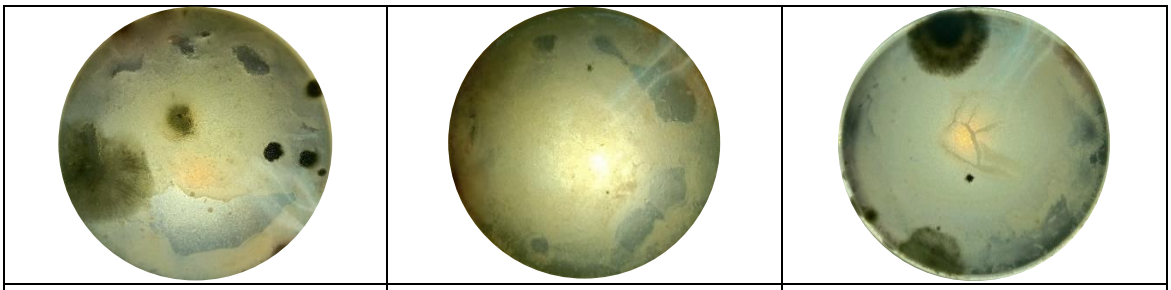
The clarity test on the preparation aims to determine whether the foot sanitizer preparation is clear or not, the foot sanitizer preparation should or should be free of particles. In contrast to commercial hand sanitizers which produce clear colors, foot sanitizer preparations with variations of F1 (R. 38 hours) and F2 (R. 46 hours) preparations produce colors that are not clear. This is because the original particles from the coffee grounds are still being carried and the added color from the addition of essences/dyes.

The homogeneity test on the foot sanitizer preparation was carried out by applying the preparation evenly on a transparent glass within an observation period of 1 week and during that time the extract remained homogeneously dispersed without showing any separation of the extract from the carrier or other materials.

Antibacterial Activity Test

The presence of antibacterial activity in foot sanitizer preparations of coffee and cinnamon extracts can be seen from the formation of a clear zone around the culture medium which is referred to as the inhibition zone (Ashfia et al., 2019). The concentration of coffee extract used was a variation of soaking 38 and 46 hours. The test solution used was in the form of a spray foot sanitizer which was taken as much as 2 mL and was inserted into each test medium. As a control spray foot sanitizer/hand sanitizer X was used as a control (+), F(0) or DMSO as a control (-) and the formula for spray foot sanitizer was F1 (R. 38 hours) and F2 (R. 46 hours). After that, the test media was incubated for 7 days at 37^{o} C (Rini et al., 2017). The media with the best inhibition zone will be used as a reference for the preparation of spray foot sanitizer that is safe to use. The results of the antibacterial test for foot sanitizer preparations as shown in Figure 3.

The results showed that the F1 preparation (R. 38 hours) had an average inhibition zone area of 17.3%, the F2 preparation (R. 46 hours) obtained an average inhibition zone of 30.9%, and the inhibitory zone area was obtained by 11.1% in the control (+), while the control (-) did not get the clear zone area formed. The F2 preparation (R. 46 hours) had the largest inhibition zone compared to the F1 preparation (R. 38 hours). In the F2 preparation (R. 46 hours) the extract was soaked longer than the F1 preparation (R. 38 hours) which was 46 hours so the content in the extract preparation was also greater. This study showed that the duration of maceration significantly affected the area of the inhibition zone of the tested microorganisms. Therefore, it is very important to use the optimal maceration duration in the appropriate combination of preparations to obtain the desired antimicrobial and bacterial compounds from the coffee extract (Yeo et al., 2014).



Zone of inhibition in product preparation of F1 (R. 38 hours).	Zone of inhibition in product preparation of F2 (R. 38 hours).	Zone of inhibition in commercial hand sanitizer (Control)

Figure 3. Example of the display on the inhibition zone formed in each variation of the sanitizer product

Natural antimicrobials used to inhibit bacteria are alkaloids that work by means of the biological activity of these compounds, which is caused by the presence of a nitrogen-containing base group. With the presence of this base group, when in contact with bacteria,

it will react with amino acid compounds that make up the cell wall and bacterial DNA which is the main constituent of the cell nucleus (Nugraha et al., 2016). Cinnamon bark extract has the ability as an antibacterial against *S. pyogenes* and *E. coli*. This is due to the presence of an active substance in cinnamon bark which is thought to have an antibacterial effect, namely eugenol. Eugenol is also found in clove oil and nutmeg oil (Reppi et al., 2016). Other components besides caffeine contained in coffee beans reported that also have antibacterial activity are phenol compounds, trigonelline, and chlorogenic acid (Tanauma et al., 2016). Phenolic compounds are flavonoids found in coffee beans. Flavonoids work by damaging cell walls, damaging cell walls through differences in polarity between the lipids that make up DNA and the alcohol groups in flavonoid compounds so that the cell wall will be damaged and these compounds will enter the nucleus of the bacterial cell (Nugraha et al., 2016).

CONCLUSION

The treatment of variations in maceration time affects the content levels in the preparation. The longer the maceration time, the antibacterial activity of the foot sanitizer increases and the results of the organoleptic and physical tests of the F2 preparation (46 hours) show that the texture, dry time, and preference level of the respondents are better than the F1 preparation (R. 38 hours). So that the F2 preparation (46 hours) is good to use as a reference for spray foot sanitizer preparations that are safe to use and sustainable.

Further research is needed to determine the specific compounds that are efficacious as antibacterial in coffee beans and their antibacterial activity against other pathogenic bacteria. Improvements to the variety and composition of ingredients also need to be made so that the color of the preparation is clearer and more attractive. The need for development that can later be socialized to the wider community about the benefits of coffee as a foot sanitizer.

ACKNOWLEDGEMENTS

We would like to thank the government of Colo village, Dawe district, Kudus regency, Indonesia for facilitating testing activities using local village materials. In addition, we express our appreciation for the program from the Center of Research and Community Service (Lembaga Penelitian dan Pengabdian kepada Masyarakat) of IAIN Kudus which has facilitated activities through a series of research activities based on study programs.

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