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Hazmat Dress Model Development for Health Service

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ABSTRACT
Hazmat is one of the personal protective equipment (PPE) used by healthcare professionals to combat infections such as Ebola, SARS, MERS, and the current prevalence of COVID-19. There are several things to consider when making this hazmat clothing. That is a type of hazmat material, standardization, and ease of use. Adding an outer layer of hazmat clothing containing betel leaf (Piper Betle. L) extract in an antibacterial and antiviral spray is expected to increase the safety of healthcare professionals and enhance protection from bacteria/viruses. In this course, we apply Research and Development (R&D) methods. The research steps were carried out experimentally in the laboratory by applying a betel leaf (Piper Betle. L) extract in a spray formulation. Spray formulation prepared at a leaf extract concentration; of 0%, 2.5%, 5%, and 7.5% and sprayed on a hazmat suit. Then the hazmat is used by health workers and tested for the number of bacteria in the laboratory. Based on the research, a spray with 7.5% leaf extract concentration showed maximum antibacterial activity in 16 bacterial colonies before the test and one colony after the test.
Keywords*: antiseptic; betel leaf extract; COVID-19; hazmat*

ABSTRAK
Hazmat adalah salah satu Alat Pelindung Diri (APD) yang digunakan oleh para profesional kesehatan untuk melindungi dari infeksi seperti Ebola, SARS, MERS, dan COVID-19 seperti saat ini. Ada beberapa hal yang perlu diperhatikan dalam pembuatan pakaian hazmat. Yakni, jenis bahan atau material hazmat, standarisasi, dan kemudahan penggunaan. Penambahan lapisan luar pakaian hazmat dengan ekstrak daun sirih *(Piper Betle*. L*)* dalam bentuk antibakteri dan antivirus spray diharapkan dapat meningkatkan keselamatan dan perlindungan tenaga kesehatan dari bakteri/virus. Penelitian ini menggunakan metode *Research and Development* (R&D). Langkah penelitian dilakukan secara eksperimental di laboratorium dengan mengaplikasikan ekstrak daun sirih *(Piper Betle*. L*)* dalam formulasi spray. Formulasi spray disiapkan pada konsentrasi ekstrak daun; 0%; 2,5%; 5% dan 7,5% dan disemprotkan pada baju hazmat. Kemudian hazmat tersebut digunakan oleh petugas kesehatan dan diuji jumlah bakterinya di laboratorium. Berdasarkan penelitian, semprotan ekstrak daun dengan konsentrasi 7,5% menunjukkan aktivitas antibakteri maksimum dengan 16 koloni bakteri sebelum pengujian dan 1 koloni setelah pengujian.
Kata Kunci: antiseptik; ekstrak daun sirih; COVID-19; hazmat

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INTRODUCTION

Hazardous material (Hazmat) is one of the Personal Protective Equipment (PPE) that health workers must use in dealing with infectious diseases such as the COVID-19 virus, which is currently a pandemic. Hazmat is an abbreviation of hazardous materials, which means clothing that can protect against hazardous materials (Masudi and Winarti, 2020). Hazmat must be used by all officers worldwide who deal with infectious outbreaks such as Ebola, SARS, MERS, bird flu and COVID-19. Hazmat is made to protect the wearer from harmful substances such as chemicals, biological agents and viruses. Hazmat can protect from hazardous materials because the materials used to make hazmats come from polyethylene, clothspunbond and meltblown, which is waterproof. Certainly, hazardous materials can not touch the wearer (Indarti *et al.*, 2021).

The current COVID-19 pandemic, which has been ongoing since the end of 2019, has caused the need for hazmat clothing to increase. It resulted in textile manufacturers competing to produce the materials used to make hazmat clothing. However, several things must be considered in producing this hazmat clothing, namely the type of hazmat material, standardization and comfort in its use. Manufacture of hazmat are standard by World Health Organization (WHO), American Standard Testing and Material (ASTM), International Organization for Standardization (ISOs), Deutsche Industrie Norm (DIN), American Association of Textile Chemists and Colorists (AATCC), National Fire Protection Association (NFPA) and European Union (EU) standards using DIN EN ISO standardization tests. The Standar Nasional Indonesia (SNI) is used only in Indonesia and follows ISO (World Health Organization, 2020).

In addition, it is necessary to pay attention to the comfort of wearing hazmat clothes. Moreover, these clothes must be used while handling patients, approximately 8 hours a day. Another consideration that is often used in terms of comfort is the user's comfort to move, not causing stress, heat and dehydration. The material used must have circulation or looseness to make it easy to breathe (Kang *et al.*, 2017). Currently, the development of functional textile production has been carried out. One of them is in the finishing process in the form of an addition finishing agent according to needs, such as antimicrobials. The addition of this antimicrobial can

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improve comfort and security for users. The finishing agent that can be used can be in the form of active compounds derived from plants that are added to the textiles (Gustiani, Septiani and Kasipah, 2019). This application can be made in several ways: immersion, pad-dry-cure, spraying/spraying, and laundry. An easy-to-use technique is a spraying technique (Wahyudi *et al.*, 2017). Green betel plant (*Piper betle* L.) is one type of plant that is widely used for treatment. The part of the betel plant used as medicine by the community is the leaves. Several researchers have reported several compounds contained in betel leaf *(Piper Betle*. L*)*. Among the compounds contained and valuable as antibacterial and antiviral are saponins, tannins, flavonoids and phenols. Saponin compounds can work as antibacterial. This compound will damage the cytoplasmic membrane and kill the cell. Tannin and flavonoid compounds are thought to have a mechanism of action to denature bacterial cell proteins, damage cell membranes, and damage lipids in cell membranes by decreasing cell membrane surface tension. The mechanism of phenol as an antibacterial agent acts as a toxin in the protoplasm.

The inhibition test results at the concentration of betel leaf *(Piper Betle*. L*)* extract 8, 10 and 12 ml /100 ml hand sanitizer showed that 12 ml had the most significant bacterial inhibition. Compared to other commercial products that use alcohol as the active ingredient, the product hand sanitizer active ingredient betel leaf *(Piper Betle*. L*)* extract is more effective in inhibiting bacterial growth of *Staphylococcus aureus* (Fathoni, Fadhillah and Kaavessina, 2019). Betel leaf *(Piper Betle*. L*)* extract, which has antimicrobial activity, has not been studied further to be applied to hazmat clothes. Therefore, the development of making hazmat clothes was carried out with extracts from betel leaf *(Piper Betle*. L*)* in the form of a spray. Which is applied by spraying additional spray from betel leaf *(Piper Betle*. L*)* extract is expected to increase safety in using hazmat clothing for health workers.

METHOD

This research design applies research and development methods. Research and development (R&D) is a research-based development model. The research findings are used to design products and new procedures, which are then systematically tested in the field, evaluated and refined. The product is expected to meet the criteria for effectiveness, quality, standards, and validity. This research was conducted in the COVID-19 isolation Room of the Goeteng Purbalingga Hospital and the

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STIKes Ibnu Sina Ajibarang Laboratory. Ethical approval for the research is stated in letter no. 340/EA/KEPK/2021. The stages of research carried out are making spray betel leaf *(Piper Betle*. L*)* extract, applying spray betel leaf *(Piper Betle*. L*)* extract on hazmat clothes, data processing and data analysis.

Spray Betel Leaf (*Piper Betle*. L) Extract

Spray betel leaf extract uses the main raw material derived from betel leaf extract. Betel leaf extract is made by maceration. Betel leaves that have been sliced and dried in an oven are soaked in 96% ethanol for three days and three nights and then filtered. The filtrate obtained was taken, and the residue was soaked with 96% ethanol for three days again. The obtained filtrate is then evaporated using a rotary evaporator to obtain a thick extract of betel leaf (Noventi and Carolia, 2016). The extract that has been obtained will later be used as raw material for manufacturing spray, which will be applied to the hazmat suit. Composition of spray betel leaf extract is betel leaf extract (concentration variations of 0%; 2.5%; 5% and 7.5%), propylene glycol, ethanol 96%, glycerin and aquades are used with the following formulation. Spray betel leaf extract that has been made is then stored in a spray bottle to be applied to hazmat clothes.

Table 1. Formulation of spray betel leaf extract

No.	Ingredient	Concentration			
		0%	**2.5%**	**5%**	**7.5%**
1	Betel Leaf extract	0 gram	2,5 grams	5 grams	7.5 grams
2	Glycerin	10 mL	10 mL	10 mL	10 mL
3	Propylene glycol	20 mL	20 mL	20 mL	20 mL
4	Ethanol 96%	20 mL	20 mL	20 mL	20 mL
5	Aquades	Add 100	Add 100	Add 100	Add 100

Application Spray Betel Leaf (*Piper Betle*. L) Extract

A spray of betel leaf extract made is applied to the hazmat clothes that will be used. A total of 4 variations concentrations were used and applied to health workers. Each concentration was applied to a different nurse with two repetitions for each concentration so that there was eight respondent. Before being applied, the hazmat clothes used are tested swab first to determine the number of microbes in the colony unit before treatment. The test swab uses a cotton swab rubbed into the hazmat shirt. Then the cotton swab is inserted into the nutrient broth media before being

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inoculated on nutrient agar media for 24 hours at 37°C. The number of microbes was calculated using a hemocytometer to determine the number of microbial colonies. After that, spray Betel leaf extract was applied to hazmat clothes used to examine COVID-19 patients. Then after completing the inspection action, the test is carried out swab back to determine the number of microbes after treatment. The same action was carried out for each concentration extract. The examination results were analyzed to determine the relationship between concentration and the most significant microbial inhibition using a comparison of the number of microbes in each concentration variation before and after treatment.

RESULTS AND DISCUSSION

Betel Leaf (*Piper Betle*. L) Extract

Betel leaf has a macroscopic form in a single leaf, short stem, heart-shaped leaf blade slightly oval or wide, 10-15 cm long, 5-7 cm wide, smooth leaf edges. The upper surface is shiny green, and the lower surface has a faded green colour with 5-7 leaf bones (Novita, 2016).

Figure 1. Betel Leaf

Making betel leaf extract begins with making betel leaf simplicia. 4,350 kg of wet betel leaves were sliced into small pieces and dried using a simplicia oven. This slicing aims to reduce the size and expand the surface of the simplicia so that later the maceration process is easier to carry out (Teanpaisan *et al.*, 2017). The dried betel leaves were then macerated using 96% ethanol for three days. Maceration is one of the extraction methods that have the advantage of being in the way of working, the equipment used is simple and easy to use, so it costs little. This method was also chosen because the compounds contained in betel leaf can be dissolved in ethanol (Zamakshshari *et al.*, 2021). The obtained filtrate is then evaporated using a rotary evaporator to obtain a thick extract of betel leaf. The result of thick betel leaf extract obtained was 47.850 grams. Based on the research that has been done, the yield of betel leaf extract is 11% based on calculations with the equation:

$$\%\ yield = \frac{extract\ weight}{wet\ weigth}\ x\ 100\%$$

$$\%\ yield = \frac{47.850}{4350}\ x\ 100\% = 11\%$$

The extract obtained was in the form of a thick paste that was dark green with a distinctive smell of betel. The following are the characteristics of the betel leaf extract.

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Table 2. Characteristics of Betel Leaf Extract

No	Component	Characteristics
1	Colour	Deep green
2	Smell	The distinctive smell of stinging betel
3	Form	Thick pasta
4	Yield	11%

The following is a picture of the betel leaf extract produced after evaporation.

Figure 2. Betel Leaf Extract

Spray Betel Leaf (*Piper Betle*. L) Extract

Spray Betel leaf extract is made with an active ingredient in betel leaf extract with several ingredients additives such as glycerin, propylene glycol, 96% ethanol and aquades. In this research used variations in the concentration of betel leaf extract 0%, 2.5%, 5% and 7.5%. At a concentration of 0%, betel leaf extract was not added. This concentration was used as a negative control. Variations of concentration of betel leaf extract to determine the effect of the concentration of the extract on the number of bacteria. Spray the betel leaf extract obtained was in the form of a dark green solution with a distinctive betel odour. This obtained will later be applied to hazmat clothes used by health workers who will take action on COVID-19 patients in the isolation room of the Goetheng Purbalingga hospital.

Figure 3. Spray Betel Leaf Extract with Concentration Variation of 2.5%; 5% 7.5%

Application Spray Betel Leaf (*Piper Betle*. L) Extract on Hazmat Clothes

Before being treated using spraying, spray betel leaf extract first tested swab microbes to determine the number of microbes before treatment. Figure 4. shows the test process swab microbe on a hazmat suit.

Figure 4. Test Swab Microbe Hazmat Suit Pretest

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Figure 4 is a test process for swab microbes on hazmat clothes before applying spray betel leaf extract. This preliminary or pretest is to determine the number of microbes before treatment. After that, the hazmat suit was sprayed with spray betel leaf extract that had been made. The following is spraying the extract on hazmat clothes using spray betel leaf extract.

Figure 5. The Process of Spraying Hazmat Shirts with Spray Betel Leaf Extract

A nurse who has used a hazmat shirt sprayed with spray the betel leaf extract then took measures to treat COVID-19 patients in the isolation room at the Goetheng Purbalingga Hospital for approximately two hours. After that, the test swab Microbes were returned as a post-test to determine the number of microbes after treatment. Figure 6 shows the test swab microbes after the nurse acts.

Figure 6. Test Swab Microba Hazmat Suit pretest

After the post-test swab test, the hazmat clothes that have been used are disposed of at a waste collection site. The following is a picture of the time of removing the hazmat shirt after treatment.

Figure 7. The Process of Removing The Hazmat Shirt

Test results swab microbes before (pretest) and after treatment (post-test), then compared to determine the concentration of betel leaf extract, which has the most significant antimicrobial activity. Based on the research conducted, the data was obtained at a concentration of 0% or control without adding betel leaf extract, 18 bacterial colonies for sample 1 and 15 for sample 2 in the pretest. After using spray betel leaf extract and performing the action on the patient, the number of colonies was as much as 19 for sample 1

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and 17 for sample 2. Bacterial testing was carried out without identifying the type. The data was processed based on the average colony yield on repetitions 1 and 2. The following graph shows the relationship between the concentration of betel leaf extract on spray on the number of bacteria.

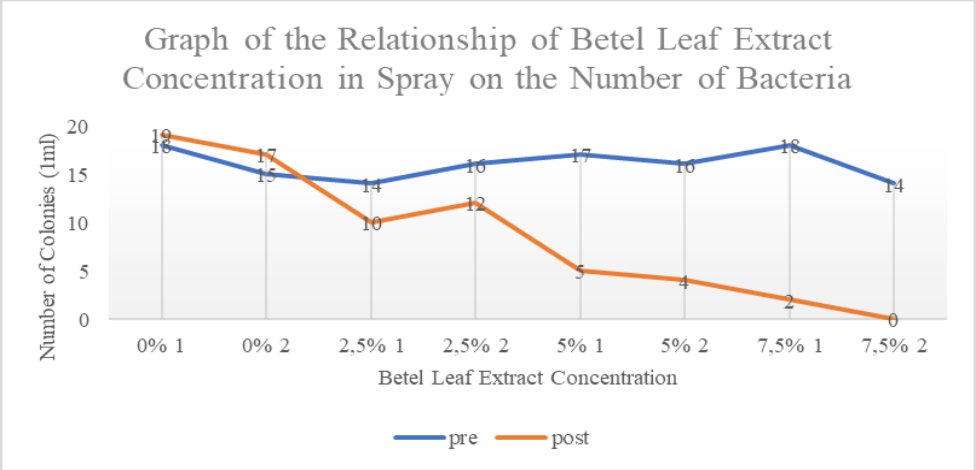

Figure 8. The Relationship Between The Concentration of Betel Leaf Extract on Spray on The Number of Bacteria

Based on figure 8, it can be seen that the greater the concentration of betel leaf extract used in a spray, then the number of bacteria contained in the hazmat shirt will decrease. Even at a betel leaf extract concentration of 7.5%, no bacteria grew after the hazmat suit was worn. The relationship between the concentration of dun betel extract on spray on the number of bacteria after being average can be seen in figure 9.

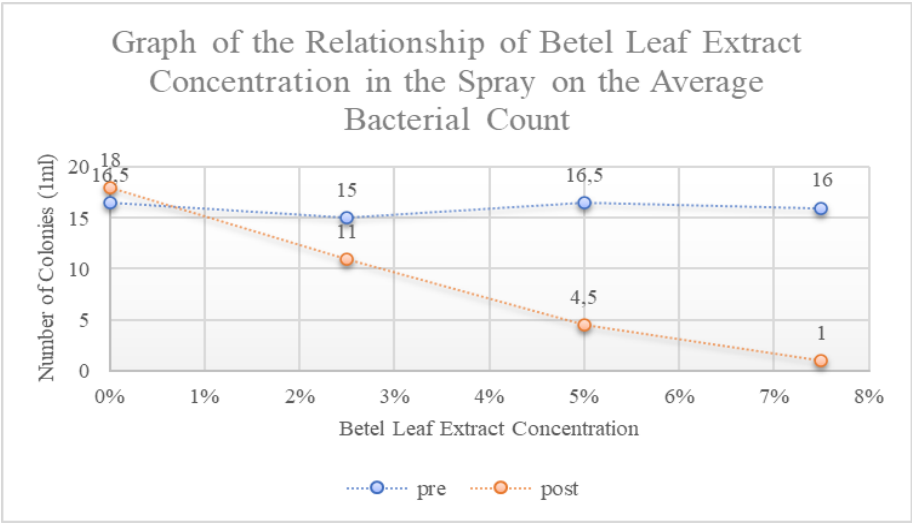

Figure 9. Correlation of Betel Leaf Extract Concentration on Spray on the Average Bacterial Count

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Many studies have been carried out on improving the functionalization of textile materials for antimicrobial activity. As Gustiani, Septiani and Kasipah (2019) did, regarding the addition of finishing agent Antibacterial on cotton cloth that can prevent the growth of bacteria. Based on the research conducted, areca nut extract (*Areca Catechu* L) was applied to the fabric. It is known that the efficiency of preventing bacterial growth *of E. coli* on fabric by 99.5% and on *S. aureus* by 95.1%. Addition finishing agents on fabrics (including hazmat) derived from this active compound can increase protection because it has antimicrobial activity.

According to research by Iswandana and Sihombing (2017), it is stated that green betel leaves contain tannins, saponins, and flavonoids that function as antimicrobials and have antiseptic properties as well as antibiotics. Betel leaf has a distinctive aroma because it contains atsiri oil 1-4.2%, water, protein, fat, carbohydrates, calcium, phosphorus, vitamins A, B, C, iodine, sugar and starch. Natural phenols in essential oils have antiseptic power that is five times stronger than ordinary phenols (Bactericidal and Fungicidal) but are not sporadic (Anas, Kurniawan and Puspitasari, 2018). The mechanism of phenol as an antibacterial agent acts as a toxin in the protoplasm, destroys and penetrates the wall and precipitates bacterial cell proteins (Olla, 2019). In contrast, flavonoids work to inhibit an important phase in the biosynthesis of prostaglandins, namely the cyclooxygenase pathway. Flavonoids also inhibit phosphodiesterase, aldoreductase, monoamine oxidase, protein kinase, DNA polymerase and lipoxygenase. Tannins have anti-inflammatory, astringent, antidiarrheal, diuretic and antiseptic activities (Parfati and Windono, 2016). In contrast, saponins' pharmacological activities have been anti-inflammatory, antibiotic, antifungal, antiviral, hepatoprotection, and antiulcer (Iswandana and Sihombing, 2017).

CONCLUSION

Spray betel leaf extract was made with variations in the concentration of betel leaf extract by 0%, 2.5%, 5%, and 7.5% and had an antimicrobial activity with the most significant bacterial inhibition at a betel leaf extract concentration of 7.5%. Further research needs to be done to separate betel leaf extract so that later it can be obtained a single metabolite compound that has the best activity as an antiseptic. In addition, it is necessary to develop an application method to spray betel leaf extract into a

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better hazmat suit to reduce the resulting green colour.

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