Gel Potential of Red Onion (*Allium cepa* L.) Ethanol Extract as Antifungal Cause Tinea Pedis

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**Introduction:** Tinea pedis is a dermatophyte infection of human feet, especially between the fingers and soles of the feet. Tinea pedis is caused by a fungal infection of *Trichophyton rubrum*. Red onion is one of the spices that has been widely known by the community and used as a traditional medicine in the prevention of fungus. The objective of this research was to determine the antifungal activity of gel produced from an extract of red onion on *T. rubrum*. 

**Materials and Methods:** The gel was formulated with various concentration of red onion, F1 with a concentration of extract (5%), F2 (7.5%), and F3 (12.5%). Each formula tested the physical characteristics and antifungal activity toward *T. rubrum*. The antifungal activity was determined by the agar well-diffusion method using Saboroud Dextrose Agar plates. Furthermore, the antifungal activities were assessed by the presence or absence of inhibition zones after the plates were incubated at 28°C for 7 days. 

**Results:** F3 has the greatest inhibitory power than F1 and F2 (*P* < 0.05). Then, F3 has the same inhibitory power as a positive control (*P* > 0.05).

**Discussion:** All gel understudy at various concentrations of red onion was formulated in gel-exhibited antifungal activity. Antifungal activity of red onion occurred because it contained allicin. Therefore, the researchers can use these gels as a natural antifungal in the healing of tinea pedis caused by *T. rubrum*. 

**Conclusion:** The gel from an extract of red onion showed significant antifungal activity against *T. rubrum*.

**Keywords:** Gel, red onion, tinea pedis, *Trichophyton rubrum*

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Red onion is included in the genus of *Allium* often used as cooking spices. In addition, it also has variety of benefits. Mercy et al.[³] stated that the ethanol extract of garlic at a concentration of 12.5% had activity against the fungus of *T. rubrum*. In addition, a study by Nurhasanah et al.[⁴] stated that the red onion juice had activity on the fungus of *Candida albicans*. Antifungal activity of onion bulbs is identified because of the content of the allicin.[⁵]
In line with changes in people's lifestyles that require practicality so that the development of herbal products is still very necessary. This gel is expected to be able to penetrate better on the skin compared to the extract form. So far there are no studies that reported the activity of gel products from onion extract on *T. rubrum*. Therefore, this research needs to be conducted to prove that the gel from the onion extract is efficacious for treating tinea pedis.

**Materials and Methods**

**Plant materials**

*Allium cepa* L. were collected from Gebang Village, Cirebon City, West Java, Indonesia. The leaves of plant were authenticated by Faculty of Biology, Jenderal Soedirman University, Indonesia.

**Microorganisms**

*Trichophyton rubrum* was obtained from the Parasitology Laboratory, Poltekkes Kemenkes, Bandung, West Java. *Trichophyton rubrum* was cultured in Saboround Dextrose Agar (SDA) at 28°C for 7 days.

**Extraction of the plant materials**

The cleaned materials were cut, and the ethanolic extract was prepared using 96% ethanol with maceration method followed with steam evaporation in rotary flask evaporator. The extract was transferred into clean and dried airtight vial and stored until ready to use. A net yield of 75.88 g (11.67% w/w) was obtained by macerating 650 g of the red onion.

**Formulation of gel**

Gel was formulated as given in Table 1, then it was evaluated with cycling test in six cycles (one cycle including temperature of 4°C for 24 h and 40°C for 24 h) and observed physical characteristic change of the gel at the beginning and completion of the cycle covering organoleptic, homogeneity, pH, viscosity, disperse, and adhesiveness test. The pH of gel was determined using digital pH meter, and then the viscosity of the gel was determined using Brookfield Viscometer (LV).

**Antifungal activity determination**

The antifungal activity of red onion gel was determined by the agar well-diffusion method. SDA was prepared by dissolving 65 g in 1000 mL of distilled water; by sterilizing in the autoclave for 15 min at 15 lb pressure (121°C) and by pouring 12 mL of the prepared medium to each petri dish that has a bacterial suspension. Subsequently, the wells were made with a diameter of 6 mm by punched aseptically with a sterile cork borer. Approximately 200 mg of the gel at different concentrations 5%, 7.5%, and 12.5% were loaded into the wells; the positive control was an X-brand antifungal gel and an F0 (no extract of red onion) was used as a negative control.

Each test plate contained five samples of gel at various concentrations of red onion placed about equidistant to each other. After that, the plates were incubated at 28°C for 7 days. The diameter of inhibition zones was measured in millimeter and the study was carried out in triplicate.

**Data analysis**

Statistical analysis was performed using a one-way analysis of variance (ANOVA) to test the difference between inhibition zone of red onion extract gel formula, negative control, and positive control group.

**Results**

The gel was tested for physical characteristics including organoleptic, homogeneity, viscosity, pH, disperse, and adhesiveness. Then, the gel was determined with antifungal activity. The results of this research can be viewed in Table 2.

**Discussion**

**Physical characteristic**

The evaluation of the gel was carried out at the beginning of the preparation and after the cycling test. The results of organoleptic testing on all three formulas were the same; the results of the characteristics are semisolid dosage form, yellow color, and typical smell of red onion. Homogeneity test was used to determine the homogeneity of extracts in gel. Homogeneity of dosage form will affect the antifungal power of gel. This is because of homogeneous gel; the distribution of the active ingredients in gel will be evenly distributed so that the release of the active compound by the base through the test media will be good and the antifungal effect

| Material                | Formulation code (w/w) |
|-------------------------|------------------------|
|                         | F1         | F2         | F3         | F0 (-)     |
| Extract                 | 5          | 7.5        | 12.5       | –          |
| Carbopol 940            | 2          | 2          | 2          | 2          |
| TEA                     | 3.5        | 3.5        | 3.5        | 3.5        |
| Propylene glycol        | 10         | 10         | 10         | 10         |
| Methyl paraben          | 0.2        | 0.2        | 0.2        | 0.2        |
| Propylparaben           | 0.02       | 0.02       | 0.02       | 0.02       |
| Purified water          | ad 100     | ad 100     | ad 100     | ad 100     |

TEA = triethanolamine

F1: gel with 5% extract concentration
F2: gel with 7.5% extract concentration
F3: gel with 12.5% extract concentration
F0: gel with 0% extract concentration as negative control
will be maximized. The difference in the concentration of red onion extract does not affect the homogeneity of gel, because the process or treatment of each formula is the same.

Then, disperse test was conducted to determine the ability of gel's diffusion on the skin. The easier the gel is flattened on the skin, then the gel is in contact with the surface of the skin more widely and active substance will be well distributed. The addition of the extract can decrease the disperse of gel; however, the addition of the extract can increase the viscosity and adhesiveness of gel.

The results of pH test were found that the higher concentration of extract did not affect the pH value of each formula. The pH value of the three formulas still meets the Indonesian National Standard requirements of 4.5–6.5. pH value should not be too acidic because it can cause skin irritation and also it should not be too alkaline because it can cause scaly skin.

The results of the evaluation after the cycling test of six cycles showed that each formula did not change the smell, pH, dosage forms, and homogeneity, but there has been a change in color, viscosity, disperse, and adhesiveness. Nevertheless, the changes in viscosity, disperse, and adhesiveness are still within the standard range of good gel parameters (adhesiveness > 1 s; disperse 5–7 cm; and viscosity 2000–50000 cps). Yati et al.[11] have stated that stable dosage form is still within acceptable limits during the storage period, in which the characteristics are the same as they had when they were made. Unstable gels show irreversible changes in their rheological properties, such as the separation of liquid phase (syneresis) and solid phase (sedimentation).[12]

**Antifungal activity**

In the study, positive control (X-brand gel) produced inhibition zones against *T. rubrum* than the negative control (F0), so there was no zone of inhibition noted for the negative control. Furthermore, the zones of inhibitions are shown by gel of red onion at different concentrations against *T. rubrum* depicted in Table 2. The test results showed that the higher concentration of the red onion, the higher its inhibitory power. Consequently, F3 has the greatest inhibitory power than F1 and F2 (*P* < 0.05). F1 has a weak inhibitory ability (<10 mm), whereas F2 and F3 have moderate-to-strong ability to inhibit *T. rubrum* (10–20 mm).[13] With the findings in this study, the onion can be developed into

| Test                  | F0 (% extract) | F1 (% extract) | F2 (% extract) | F3 (% extract) | F4 (% extract) |
|-----------------------|----------------|----------------|----------------|----------------|----------------|
| **First cycle**       |                |                |                |                |                |
| Organoleptic          |                |                |                |                |                |
| Form                  | Semisolid      | Semisolid      | Semisolid      | Semisolid      | Semisolid      |
| smell                 | None           | Specific       | Specific       | Specific       | Specific       |
| color                 | Transparent    | Light yellow   | Yellow         | Dark yellow    | Transparent    |
| Homogeneity           | Homogen        | Homogen        | Homogen        | Homogen        | Homogen        |
| Viscosity             | 11306.67 ± 220.08 | 10765.33 ± 401.6 | 11260 ± 260 | 11100 ± 420 | 11567 ± 380 |
| Disperse (m)          | 3.78 ± 0.31    | 3.53 ± 0.26    | 3.42 ± 0.21    | 3.36 ± 0.27    | 5.81 ± 0.17    |
| Adhesiveness (s)      | 0.8 ± 0.27     | 0.50 ± 0.11    | 0.72 ± 0.37    | 1.06 ± 0.35    | 4.51 ± 0.12    |
| pH                    | 8              | 6              | 6              | 6              | 6              |
| **Sixth cycle**       |                |                |                |                |                |
| Organoleptic          |                |                |                |                |                |
| Form                  | Semisolid      | Semisolid      | Semisolid      | Semisolid      | Semisolid      |
| smell                 | None           | Specific       | Specific       | Specific       | Specific       |
| color                 | Transparent    | Brown          | Brown          | Brown          | Transparent    |
| Homogeneity           | Homogen        | Homogen        | Homogen        | Homogen        | Homogen        |
| Viscosity             | 11380 ± 75.5   | 11933.33 ± 220.08 | 11556.67 ± 276.47 | 11623.3 ± 203.06 | 11386 ± 246.67   |
| Disperse (m)          | 3.34 ± 0.08    | 3.05 ± 0.13    | 2.86 ± 0.14    | 2.76 ± 0.22    | 5.32 ± 0.13    |
| Adhesiveness (s)      | 0.64 ± 0.17    | 0.39 ± 0.08    | 0.66 ± 0.08    | 0.75 ± 0.17    | 4.32 ± 0.18    |
| pH                    | 8              | 6              | 6              | 6              | 6              |
| Antifungal activity   | 0 ± 0          | 0.51 ± 0.11    | 15.43 ± 1.71   | 20.82 ± 5.83   | 45.53 ± 2.23   |

F0: gel with 0% extract concentration as negative control
F1: gel with 5% extract concentration
F2: gel with 7.5% extract concentration
F3: gel with 12.5% extract concentration
F4: X-brand antifungal gel
an antifungal gel so that it can increase the economic value of the red onion which was originally used only as a spice in the kitchen.

The antifungal activity of gel of red onion can be attributed to the different phytochemicals present in the red onion. There is growing interest in correlating phytochemical constituents of a medicinal plant with its pharmacological activity. Phytochemicals are nonnutritive plant chemicals that may have protective or disease preventive antifungal activities. Because of their structural differences from those of the more studied antibacterial sources, their mode of action may too different.[14]

Allicin, flavonoid, triterpenoid, saponin, tannin, and alkaloid are found to be associated with antifungal effects in various studies. Allicin can inhibit the activity of enzyme in fungi including proteinase cysteine enzyme and alcohol dehydrogenase enzyme, cysteine proteinase enzymes that cause infections and disorders of skin metabolism, whereas alcohol dehydrogenase enzymes that help fungi stay alive and multiply in cells.[15] Flavonoid, saponin, tannin, and triterpenoid have been found to exhibit antifungal activity through mechanisms like interfere with the permeability of fungal cell so that it causes damage to the membrane and causes the release of various important component from inside the fungal cell such as protein, nucleic acid and nucleotides.[13,16,17] And then, the mechanism of action of alkaloids is inhibiting esterase, DNA, and RNA polymerase, and also inhibits cell respiration.[18] These may explain the possible mechanism of plant antifungal activity that has not been studied in this study.

CONCLUSION
This study proves that the gel from red onion extract has activity against *T. rubrum*. Gel with extract concentration of 12.5% has the greatest activity in inhibiting the growth of *T. rubrum*. The findings of this herbal product have become very important in the current era of microbial resistance. Unfortunately, this research has not revealed further about the compounds and mechanisms in inhibiting microbial growth. More research is needed to develop this herbal product.

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Conflicts of interest
There are no conflicts of interest.

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