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Development and Evaluation of Effervescent Powder Formulations Combining Red Ginger Extract and Honey

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Abstract

Effervescent powder formulations combining red ginger (Zingiber officinale var. rubrum) extract and honey were developed and evaluated for their physical, chemical, and antibacterial properties. The formulations were prepared using wet granulation method, and their organoleptic properties, moisture content, flow characteristics, dispersibility, foam height, pH, and hedonic responses were assessed. Additionally, the antibacterial activity of the formulations against Streptococcus pyogenes was evaluated using agar diffusion method. The results showed that the formulations exhibited variations in color, odor, taste, and physical form, with formulation F3 containing 10% red ginger extract demonstrating the best sensory attributes. All formulations met the moisture content and flow time criteria, indicating good stability and handling properties. They also displayed rapid dispersibility and proper foam height upon dissolution. The pH values fell within the acceptable range for consumption. However, none of the formulations showed significant antibacterial activity against Streptococcus pyogenes. Further optimization may be required to enhance the formulations' antibacterial efficacy.

Keywords: Effervescent powder, Red ginger extract, Honey, Organoleptic properties, Antibacterial activity, Streptococcus pyogenes.

1. Introduction

Infectious diseases are a significant health problem throughout the world. One type of infectious disease that often occurs is Acute Respiratory Infection (ARI), which has a high prevalence in Indonesia, reaching 9.3%. ARI covers a wide range of conditions from flu to pharyngitis, which often cause significant discomfort for sufferers. Pharyngitis, or sore throat, is a common form of ARI. Symptoms of pharyngitis include sore throat, itching, difficulty swallowing, fever, and cough.

The causes of sore throat can vary, but one of them is infection with the bacteria Streptococcus pyogenes, also known as Streptococcus beta hemolyticus group A. This bacteria is a pathogen that is generally found in the human respiratory tract. It is estimated that around 5-15% of the normal human population has this bacteria in their respiratory tract. When a person's body's defenses are lowered, or when these bacteria are able to penetrate the immune system, they can cause infection. If left untreated, the infection can spread and cause serious complications.

Apart from conventional treatment, several medicinal plants have also long been used to treat bacterial infections, including strep throat. One plant known to have antibacterial potential is red ginger. Red ginger, scientifically known as Zingiber officinale var. rubrum, has been used in traditional medicine because of its active compounds, such as gingerol, shogaol, and trapeinoids, which are believed to have anti-inflammatory, antioxidant, and antibacterial properties.

Previous research has shown that red ginger has the potential to treat bacterial infections, including the bacteria Streptococcus pyogenes. However, more in-depth studies are still needed to understand the mechanism of action and effectiveness of red ginger in treating pharyngitis caused by this bacteria. Therefore, this study aims to evaluate the antibacterial effect of red ginger against Streptococcus pyogenes and its potential as an alternative treatment for pharyngitis.

Apart from red ginger, honey has long been recognized as an effective traditional treatment for ARI symptoms. The pinobankine and vitamin C content in honey has been proven to have antioxidant and antibiotic properties which can help reduce the severity of coughs (Tiencheu et al., 2021). A study by Suman et al. (2021) shows that honey with various concentrations is able to inhibit the growth of Streptococcus pyogenes bacteria, with the inhibition zone increasing as the honey concentration increases.

Not only that, there have been many studies examining the use of a combination of ginger and honey for the treatment of respiratory tract infections. For example, research by Rani et al. (2021) shows that giving a decoction of red ginger and honey can reduce the severity of coughs. To meet practical needs and get a good response from the community, innovations are often made in the provision of this traditional medicine.

One form of innovation is the preparation of effervescent powder. Effervescent powder is a popular choice because it has advantages in terms of attractive packaging, aroma and taste. Compared to other powdered drinks, effervescent powder has the ability to produce carbon dioxide gas which gives a fresh sensation like soda drinks (Ayseli, 2023). Previous research also shows that the gas produced can mask the bitter taste and facilitate the dissolution process without requiring manual stirring (Byeon et al., 2019).

Based on the explanation above, researchers are interested in studying the antibacterial activity of a combination of red ginger extract (Zingiber Officinale var. rubrum) and honey as a treatment for sore throat (pharyngitis) by making an effervescent powder preparation. This research aims to contribute to our understanding of the potential use of traditional medicine in the treatment of bacterial infections of the respiratory tract.

2. Research methods

2.1. Tools and materials

The tools used in this research include a vacuum rotary evaporator (IKA RV 10 Digital) for the evaporation process, a funnel (pyrex), a water bath (BE-ONE DWBC-60L-6H) for temperature regulation, an analytical balance (ABJ-220-4 NM) (German Kern) for accurate measurement of materials, steam cup, test tube (Pyrex), test tube rack, Erlenmeyer (Pyrex), distilled water bottle, tripod + gauze, spirit lamp, beaker (pyrex), round bottom flask , heating mantle, aziotrope scale, boiling stone, condenser, watch glass, baking dish, 10 mL crucible, Muffle Furnace, oven (Memmert), crucible tongs, petri dish, round tube needle, thermometer, measuring cup (Pyrex) , mortar and stamper, incubator (Sakura), autoclave (BIOBASE), micropipette, blue tip, yellow tip, vernier caliper, and perporator (well hole tool).

The materials used in this research include red ginger rhizomes (Zingiber officinale var.rubrum) obtained from the Ciawitali Village area, Urug Subdistrict, Kawalu District, Tasikmalaya City, as well as forest bee honey (Apis Dorsata) originating from the Karangnunggal area, Tasikmalaya Regency.

The bacteria used in this research was Streptococcus pyogenes (ATCC 1965). Other chemicals used include 96% ethanol, distilled water, mg powder, concentrated HCl, anhydrous acetic acid, concentrated sulfuric acid, ether, concentrated ammonia, sulfuric acid (H2SO4), 1% gelatin, FeCl3, Mayer's reagent, dragendroff's reagent , Wagner reagent, amyl alcohol, toluene, chloroform, Muiller Hinton Agar (MHA) medium (KGaA), Nutrient Agar (NA) medium (M001-500G), DMSO (Dimethyl sulfoxide), antibiotic amoxicillin, NaCl 0.9% (Sodium Chloride), filter paper (Whatman), citric acid, tartaric acid, sodium bicarbonate, PVP, sucralose, and lactose. Using these various tools and materials, a series of experiments were carried out to examine the antibacterial activity of a combination of red ginger extract and honey in the form of effervescent powder as a treatment for sore throat (pharyngitis).

2.2. Research Procedure

a. Extraction of Red Ginger (Zingiber officinalle var.rubrum): Red ginger rhizomes are utilized as the plant material. Initially, wet sorting is conducted on collected samples to effectively separate impurities adhering to the raw material. Subsequent steps include thorough washing, precise slicing, meticulous drying, and dry sorting, ultimately resulting in powdered crude drugs. The extraction process is then carried out using the maceration method, which involves soaking the material in 96% ethanol solvent for 3x24 hours.
b. Phytochemical Screening: Phytochemical screening of the samples is performed to identify the various chemical compound groups present in both the crude drug and red ginger rhizome extract (Zingiber officinalle var.rubrum). This comprehensive screening encompasses the examination of alkaloids, flavonoids, tannins, saponins, phenols, and steroids/terpenoids.
c. Antibacterial Activity Test: The antibacterial activity test is executed utilizing the agar diffusion method by well diffusion against Streptococcus pyogenes bacteria. Following this, the diameter of the inhibition zone resulting from the application of red ginger rhizome ethanol extract at various concentrations is measured, with amoxicillin antibiotic serving as a reference. Post-antibacterial activity testing, the Minimum Inhibitory Concentration (MIC)

is determined at concentrations ranging from 1% to 10%, utilizing the same method as the initial antibacterial activity test.

d. Preparation of Combination Effervescent Powder of Red Ginger (Zingiber officinalle var.rubrum) Extract and Honey: The combination effervescent powder comprising red ginger extract and honey is prepared via wet granulation. The formulation design for this effervescent powder, detailing the proportions of red ginger extract, honey, and other components, is illustrated in Table 1.

Table 1: Formulation Design of Effervescent Powder

Full Formula	F0	F1	F2	F3
Red Ginger Extract	-	1%	5%	10%
Honey	-	25%	25%	25%
Na-bicarbonate	25%	20%	20%	20%
Tartaric Acid	20%	10%	10%	10%
Citric Acid	10%	10%	10%	10%
Sucralose	10%	2.5%	2.5%	2.5%
PVP	2.5%	32%	21.5%	17.5%
Lactose	32%	21.5%	17.5%	12.5%

Note:

- F1: 1% concentration of red ginger extract
- F2: 5% concentration of red ginger extract
- F3: 10% concentration of red ginger extract

Evaluation of Combination Effervescent Powder Preparation of Red Ginger (Zingiber officinalle var.rubrum) Extract and Honey Following the preparation of the combination effervescent powder containing red ginger extract and honey, the preparation undergoes evaluation. The evaluation process includes the following assessments:

a. Organoleptic Testing: This involves sensory evaluation to assess the appearance, color, odor, and taste of the effervescent powder.
b. Moisture Content: The moisture content of the effervescent powder is determined to ensure its stability and shelf-life.
c. Flow Rate: The flow rate of the powder is measured to evaluate its ease of pouring and handling.
d. Angle of Repose: This test determines the flowability of the powder by measuring the angle formed between the surface of the powder heap and the horizontal plane.
e. Dissolution Time: The time taken for the effervescent powder to dissolve completely in water is evaluated to determine its dissolution rate.
f. Foam Height: The foam height produced upon dissolution of the effervescent powder in water is measured to assess its effervescence properties.

The antibacterial activity of the effervescent powder preparation is assessed using the agar diffusion method by well diffusion against Streptococcus pyogenes bacteria. Subsequently, the inhibition zone is measured for various formulation preparations, with commercially available fruit juice effervescent serving as a reference for comparison. These evaluations provide valuable insights into the physical characteristics, dissolution behavior, and antibacterial efficacy of the combination effervescent powder containing red ginger extract and honey.

3. Results and Discussion

Before processing the crude drug, the raw materials obtained underwent determination to prevent errors in the main research material collection process. Determination was conducted at the Plant Taxonomy Office, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjajaran, Jatinangor Bandung. The results obtained in accordance with no.47/HB/11/2024 indicated that the sample used in the study was red ginger (Zingiber officinale var.rubrum). This research has been approved by the Health Research Ethics Committee of Universitas Bakti Tunas Husada Tasikmalaya in the Ethical Feasibility Certificate with No.060/E.01/KEPK-BTH/IV/2023.

The extraction process performed on the red ginger rhizome crude drug in this study utilized the maceration method because it can maximize the extraction of chemical compounds from the sample. Additionally, the maceration method was conducted without heating to prevent the possible degradation of heat-sensitive active substances in the sample, ensuring the safe extraction of chemical constituents from the crude drug (Damanis et al., 2020). The maceration of 500 grams of crude drug with 96% ethanol solvent resulted in a dense extract of 71.08 grams and an extract yield of 13.52%.

Phytochemical screening was conducted to analyze the secondary metabolite compounds present in the plant. The results of phytochemical screening on the crude drug powder and red ginger rhizome extract showed positive results for alkaloids, saponins, flavonoids, polyphenols, and triterpenoids. The antibacterial activity testing of the 96% ethanol extract of red ginger rhizome in this study was conducted using the agar diffusion method by well diffusion.

This study aimed to determine the effect of red ginger extract (Zingiber officinale var.rubrum) at different concentrations on inhibiting the growth of Streptococcus pyogenes bacteria. The inhibitory activity of the red ginger extract against Streptococcus pyogenes bacteria can be seen in Table 2.

Table 2: Results of Antibacterial Activity Test of Red Ginger Rhizome Extract (Zingiber officinale)

Sample (%)	Inhibition Zone (mm)	Average ± SD	Trial 1	Trial 2	Trial 3
10	8.1	8.78 ± 0.57	8.75	9.5	9.5
20	9.55	9.81 ± 0.19	9.9	10.3	10.3
30	9.6	10.20 ± 0.53	10.1	10.9	10.9
40	10	10.91 ± 0.71	11	11.75	11.75
50	10.65	11.33 ± 0.64	11.15	12.2	12.2
60	11.25	11.90 ± 0.46	12.2	12.25	12.25
70	12.7	12.95 ± 0.22	12.9	13.25	13.25
80	13.95	13.90 ± 0.34	13.45	14.3	14.3
90	14.15	14.70 ± 0.40	14.85	14.75	14.75
100	15.5	15.35 ± 0.177	15.1	15.45	15.45
(+)	32.4	32.40 ± 0.00	32.4	32.4	32.4

Based on the results presented in Table 2, the antibacterial activity test indicates that the ethanol extract of red ginger rhizome can inhibit the growth of Streptococcus pyogenes bacteria at all concentrations ranging from 10% to 100%. The results obtained from the negative control (DMSO) showed no inhibition zone around the wells, indicating that the inhibition zone of the extract was not affected by the solvent. Thus, the inhibition zones formed represent the pure antibacterial activity possessed by the red ginger rhizome extract against Streptococcus pyogenes bacteria.

The red ginger rhizome extract is deemed effective in inhibiting Streptococcus pyogenes bacteria starting from a concentration of 40% because at this concentration, the inhibition zone produced is strong. The positive control exhibited a greater inhibitory effect compared to the treatment with red ginger rhizome extract and the negative control using DMSO. This is because the positive control, which is amoxicillin antibiotic, is a broad-spectrum antibiotic that has been accurately tested in inhibiting bacterial growth.

The presence of antibacterial activity in the red ginger rhizome extract is attributed to the secondary metabolite compounds contained in the extract, namely flavonoids, saponins, polyphenols, and alkaloids. The antibacterial activity of ginger extract depends on its chemical content. Gingerol is a phenol derivative compound that interacts with bacterial cells through adsorption processes involving hydrogen bonding. Following the antibacterial activity testing with various concentrations, the Minimum Inhibitory Concentration (MIC) testing was conducted. MIC testing aims to determine the smallest concentration of red ginger rhizome extract (Zingiber officinalle var.rubrum) capable of exhibiting antibacterial activity against Streptococcus pyogenes bacteria.

The production of effervescent powder from red ginger extract (Zingiber officinale var.rubrum) and honey was carried out using the wet granulation method. There are three types of ingredients in the effervescent mix used in this study: citric acid and tartaric acid, which are acidic, and sodium bicarbonate, which is basic. The use of a combination of two different acids in this formulation aims to produce better effervescent powder because powder produced with a single acid tends to feel stickier and clump together easily. Additionally, the use of single acids can inhibit the foaming process. Meanwhile, sodium bicarbonate as a base serves to neutralize both acids, produce foam, and release carbon dioxide. Sodium bicarbonate is also chosen because it can dissolve completely in water. (Vaidyanatahan et al., 2023).

The evaluation of effervescent powder aims to ensure that each formulation meets the preformulation requirements of the preparation (Sidiq, 2023). The evaluation of effervescent powder includes organoleptic testing, moisture content testing, flow rate testing, angle of repose testing, dissolution time testing, and foam height testing. Organoleptic test was conducted to evaluate whether the different concentrations of red ginger extract and honey affect the color, taste, and aroma. The organoleptic test results of the four formulas can be seen in Table 3.

Table 3: Organoleptic Evaluation Results of Effervescent Powder Formulations

Formula	Color	Odor	Taste	Form
F0	White	Odorless	Slightly sour	Coarse powder
F1	Yellow	Ginger-like	Sour	Coarse powder
F2	Light brownish-yellow	Ginger-like	Slightly warm sour	Coarse powder
F3	Brownish-yellow	Ginger-like	Sour and warm	Coarse powder

Table 3. presents the organoleptic evaluation results of different formulations of effervescent powders containing red ginger (Zingiber officinale var. rubrum) extract and honey. Organoleptic evaluation is crucial in assessing the sensory characteristics of a product, including its color, odor, taste, and physical form. In Formula F0, the powder appears white and has no discernible odor, with a slightly sour taste. This formulation results in a coarse powder

texture. Moving on to Formula F1, the powder takes on a yellow color resembling ginger, accompanied by a ginger-like aroma and a sour taste. The texture remains coarse.

Formula F2 exhibits a light brownish-yellow color, similar to ginger, with an aroma reminiscent of ginger as well. The taste is slightly warm and sour, and the powder maintains a coarse texture. Finally, in Formula F3, the powder turns brownish-yellow with ginger-like color and aroma. It offers a combination of sour and warm taste notes, and the texture remains coarse. Overall, the addition of red ginger extract and honey influences the sensory attributes of the effervescent powders, resulting in variations in color, aroma, taste, and texture across different formulations. These sensory characteristics are essential for consumer acceptance and overall product quality.

4. Conclusion

Based on the comprehensive evaluation of the effervescent powder formulations containing red ginger (Zingiber officinale var. rubrum) extract and honey, several conclusions can be drawn:

a. Organoleptic Evaluation: The formulations exhibited variations in color, odor, taste, and physical form. Formulation F0 appeared white with no odor and a slightly sour taste, while F1-F3 displayed yellow to brownish-yellow hues with ginger-like aromas and sour tastes. All formulations had a coarse powder texture.
b. Moisture Content: The moisture content of the effervescent powders ranged from 1.33% to 1.75%, meeting the acceptable range of less than 4%. Proper moisture content is crucial for stability and shelf life.
c. Flow Properties: The flow time of the powders ranged from 2.60 to 2.86 seconds, meeting the standard of less than 3 seconds. Good flow properties ensure ease of handling during processing and packaging.
d. Bulk Density: The bulk densities of the formulations varied, indicating differences in particle packing and porosity. Formulation F3 exhibited the highest bulk density among the tested formulations.
e. Dispersibility: The effervescent powders demonstrated rapid dissolution, with dissolution times ranging from 3.02 to 4.80 minutes. Higher concentrations of red ginger extract resulted in longer dissolution times.
f. Foaming: The effervescent powders produced foam heights within the acceptable range of 3-5 cm upon dissolution, indicating proper effervescence.
g. pH: The pH values of the solutions ranged from 3.88 to 4.38, falling within the moderately acidic range suitable for consumption without causing gastric irritation.
h. Hedonic Testing: Formulation F3 received the highest preference scores in terms of color, aroma, taste, and overall liking among the panelists, suggesting its superior sensory appeal.
i. Antibacterial Activity: The effervescent powders did not exhibit significant antibacterial activity against Streptococcus pyogenes, possibly due to low concentrations of red ginger extract or insufficient solubility of active compounds.

In conclusion, the evaluation indicates that Formulation F3 with 10% red ginger extract offers the best sensory attributes and dissolution properties among the tested formulations. However, further optimization may be required to enhance antibacterial efficacy.

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