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Antioxidant Effectiveness of Transparent Solid Soap from Red and White Pomelo (*Citrus grandis* (L.) Osbeck) Extracts

Septi Noiman Lase[1)], Eva Sartika Dasopang[1)], Supomo[2)], Sumardi[3*)]

[1]Fakultas Farmasi, Universitas Tjut Nyak Dhien, Indonesia
[2]Sekolah Tinggi Ilmu Kesehatan Samarinda, Indonesia
[3]Fakultas Farmasi, Institut Kesehatan Medistra Lubuk Pakam, Indonesia

septilase807@gmail.com; evasartikadasopang@yahoo.com; fahmipomo@gmail.com;*sumardi@medistra.ac.id

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Abstract

Background: Pomelo (*Citrus grandis* (L.) Osbeck) contains limonoids, flavonoids, naringin, and lycopene, which enhance the effects of ascorbic acid (vitamin C) in the body. **Objective:** This study aims to determine whether the extracts from red and white varieties of pomelo possess antioxidant properties and can be formulated into transparent solid soap that meets the quality standards set by SNI 3235-2016. **Method:** This experimental research utilized extracts from red and white varieties of pomelo. The research stages included sample preparation, processing of test materials, formulation of transparent solid soap with the addition of the extracts, and evaluation tests including organoleptic tests, pH tests, foam height tests, moisture content tests, and antioxidant activity tests using the DPPH method measured with UV-VIS spectrophotometry at concentrations of 60 µg/ml, 50 µg/ml, 40 µg/ml, 30 µg/ml, and 20 µg/ml. The results showed that both red and white pomelo extracts contain the same groups of compounds, including alkaloids, tannins, steroids, triterpenoids, and ascorbic acid. **Results:** Antioxidant tests indicated that the red pomelo extract has "moderate" antioxidant activity with an IC_{50} value of 185.086 µg/ml, while the white pomelo extract is "inactive" with an IC_{50} value of 564.309 µg/ml. The transparent solid soap exhibited "moderate" antioxidant activity with an IC_{50} value of 206.592 µg/ml. **Conclusion:** The transparent solid soap with red pomelo extract showed "weak" antioxidant activity with an IC_{50} value of 295.531 µg/ml, and the soap with white pomelo extract was "inactive" with an IC_{50} value of 130.207 µg/ml. The evaluation results for the transparent solid soap, including organoleptic properties, pH, foam height, and moisture content, conformed to the standards set by SNI 3235-2016.

Keywords: grapefruit, red and white varieties, fruit juices, antioxidants, transparent solid soap.

INTRODUCTION

Antioxidants are compounds that counteract the negative effects of oxidants in the body. They function by donating an electron to oxidant compounds, thereby inhibiting their oxidative activity. The effects of antioxidants on the body can be direct, such as reducing free radicals in the body, and indirect, by preventing the formation of radical effects [1].

Free radicals are defined as atoms or molecules with one or more unpaired electrons, known for their instability, short lifespan, and high reactivity in stealing electrons from other molecules. Therefore, the body requires antioxidant compounds to prevent diseases, including those damaging to the skin (Wulansari, 2018). Several groups of compounds, such as flavonoids and alkaloids, are reported to protect against UV radiation. Approximately 80% of skin aging is caused by UV radiation, influenced by other environmental factors like smoking, pollution, chemicals, and unhealthy lifestyles [2], [3], [4].

One of Indonesia's natural resources utilized as an antioxidant is pomelo (*Citrus grandis* (L.) Osbeck), containing phytochemical compounds like lycopene, flavonoids, provitamin A, vitamin C, pectin, vitamin B1, vitamin B2, folic acid, energy, water, sugar, protein, fats, carbohydrates, retinol, calcium, and phosphorus [5], [6]. Vitamin C (ascorbic acid) in pomelo is highly effective as an

antioxidant, protecting essential molecules in the body such as proteins, fats, carbohydrates, and nucleic acids from free radical damage even in small amounts [7]. Additionally, pomelo compounds are beneficial for health, preventing cancer, boosting immune function, eliminating acne, improving digestion, and preventing premature aging, all of which are attributed to their antioxidant properties [8].

Therefore, there is a need for suitable products to maintain skin moisture, prevent dryness, dullness, wrinkles, black spots, and premature aging. One such product used for skin care is soap, a well-known cosmetic product used for cleansing the skin and incorporating various pharmacologically beneficial substances, including antioxidants [9]. Soap comes in various forms such as opaque, translucent, and transparent. Transparent soap, with its appealing appearance, provides a unique and special aesthetic impression [10], [11].

Research on transparent soap enriched with plant extracts and fruit essences as active ingredients, as well as studies on red and white pomelo varieties rich in compounds, have been conducted extensively. However, the creation of transparent soap with added red and white pomelo fruit essence as antioxidants has not yet been explored, prompting researchers to explore transparent soap as an antioxidant.

RESEARCH METHODS

Sampling

The sample processing involved the extraction of juice from the red and white varieties of pomelo (*Citrus grandis* (L.) Osbeck). The red and white pomelo fruits were weighed, peeled, and their pulp was extracted using a juicer.

Phytochemical Screening

Phytochemical screening of the red and white varieties of pomelo (*Citrus grandis* (L.) Osbeck) was conducted to identify secondary metabolites, including alkaloids, flavonoids, saponins, tannins, and triterpenes/steroids [12].

Transparent Solid Soap Formulation

The soap was prepared using the hot process method. First, olive oil was heated to 70°C in a beaker on a hot plate. Melted stearic acid was then added while stirring with a magnetic stirrer until homogeneous. A 30% NaOH solution was added at 70-80°C. Once the mixture thickened and formed soap stock, it was transferred to a round-bottom flask with a magnetic stirrer. Ethanol was added and stirred, followed by glycerin, sugar, citric acid, coco-DEA, and NaCl, and stirred until evenly mixed. The mixture was reheated on a hot plate with a condenser at 70°C until a clear and homogeneous transparent soap solution formed. The solution was then cooled to 50-55°C, and the juice of red and white pomelo (*Citrus grandis* (L.) Osbeck) was added and mixed until homogeneous, followed by the addition of fragrance. The mixture was poured into molds and left to set for 24 hours. The soap was then cured for approximately 2 weeks [13], [14].

Antioxidant Activity Testing

Antioxidant activity testing involved the preparation of a DPPH (2,2-diphenyl-1-picrylhydrazyl) standard solution, measurement of the maximum absorption wavelength of DPPH, determination of operating time, and measurement of the antioxidant activity of the red and white pomelo juice, as well as the blank transparent solid soap and the transparent solid soap containing red and white pomelo juice (*Citrus grandis* (L.) Osbeck). The antioxidant activity of the samples was determined by the degree of inhibition of DPPH radical absorption, calculated using the percentage (%) of DPPH absorption inhibition [15], [16], [17].

Evaluation of Transparent Solid Soap

The evaluation of the transparent solid soap included organoleptic tests, pH tests, foam height tests, and moisture content tests [18].

RESULTS AND DISCUSSION

A solution of pomelo (*Citrus grandis* (L.) Osbeck) juice, including 162 ml from the red variety and 160 ml from the white variety, was stored in a well-sealed container. The results of the phytochemical screening of the pomelo juice (*Citrus grandis* (L.) Osbeck) are presented in Table 1.

Table 1. Phytochemical Screening Results of Pomelo Juice (*Citrus grandis* (L.) Osbeck)

No	Screening	Result
1	Alkaloids	+
2	Flavonoids	-
3	Saponin	+
4	Tannin	+
5	Steroids and Triterpenoids	-

Notes: (+) presence; (-) absence

Both the red and white varieties of pomelo juice (*Citrus grandis* (L.) Osbeck) contain the same classes of compounds, namely alkaloids, saponins, and tannins. Research indicates that both red and white varieties exhibit antioxidant properties due to their alkaloid content, making them effective as free radical scavengers. Antioxidant compounds like vitamin C significantly mitigate the adverse effects of reactive species, such as reactive oxygen species, which can cause oxidative damage to macromolecules like lipids, DNA, and proteins, thereby contributing to chronic diseases including degenerative conditions [19], [20].

Antioxidants donate one or more electrons to free radicals, neutralizing them The antioxidant activity analysis of the test samples included measuring the maximum absorption wavelength of DPPH, operating time, DPPH radical scavenging by pomelo juice (*Citrus grandis* (L.) Osbeck) red and white varieties, and transparent solid soap formulated with red and white pomelo juice. Additionally, the IC_{50} (inhibitory concentration) values were determined. The antioxidant properties of the pomelo juice (*Citrus grandis* (L.) Osbeck) red and white varieties, along with transparent solid soap formulations modified with the juice, were tested using the UV-VIS spectrophotometric DPPH (2,2-diphenyl-1-picrylhydrazyl) method. This method is commonly used due to its simplicity, rapidity, sensitivity, and minimal sample requirement [21].

The antioxidant activity of the red pomelo juice (*Citrus grandis* (L.) Osbeck) was measured at 8 minutes, and the white pomelo juice at 4 minutes, based on the reduction in DPPH solution absorption (DPPH radical scavenging) due to the addition of the test solution. The absorption values of the DPPH solution before and after adding the test solution were calculated as the percentage of scavenging.

The IC_{50} value was derived from the linear regression equation obtained from the concentration of the test solution and the percentage of DPPH scavenging as parameters of antioxidant activity. The red pomelo juice (*Citrus grandis* (L.) Osbeck) exhibited moderate antioxidant activity with an IC_{50} of 185.086 µg/ml, while the white pomelo juice showed inactive antioxidant activity with an IC_{50} of 564.309 µg/ml. The transparent solid soap blank had moderate antioxidant activity with an IC50 of 206.592 µg/ml. Transparent solid soap with red pomelo juice showed weak antioxidant activity with an IC50 of 295.531 µg/ml, and transparent solid soap with white pomelo juice was inactive with an IC_{50} of -130.207 µg/ml. The IC_{50} value indicates the concentration of the test sample that achieves 50% antioxidant activity; the lower the IC_{50} value, the more active the compound as an antioxidant.

Antioxidants repair cells and tissues damaged by free radicals. When formulated into transparent solid soap, the IC_{50} value of red and white pomelo juice decreases. Data on the radical scavenging analysis of red pomelo juice (*Citrus grandis* (L.) Osbeck) are shown in Figure 1.

The color of the transparent soap changed after adding red and white pomelo juice. The soap containing red pomelo juice was more transparent compared to the soap with white pomelo juice. IC_{50} (Inhibitory Concentration 50) is a measure of the effectiveness of a substance in inhibiting a specific biological or biochemical function. In this context, it reflects the concentration of the sample required to scavenge 50% of free radicals.

The pH of all test samples met the required pH standards. The pH of both transparent solid soap and transparent solid soap with red and white pomelo juice was within the standard range for bath soap, between 9-11 [22]. The pH of transparent solid soap with red pomelo juice was lower than that of the soap with white pomelo juice and the transparent solid soap blank. The purpose of pH testing is to

determine whether the soap is suitable for use. Soap with an excessively high or low pH can increase skin absorption, leading to irritation. Soap with a highly basic pH can cause roughness, dryness, itching, and redness of the skin [18].

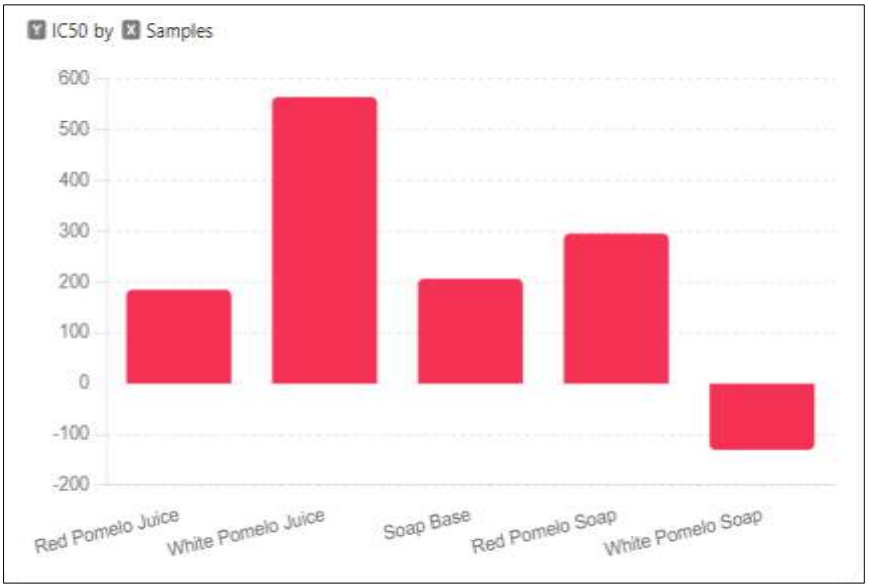

Figure 1. IC_{50} Values of Solid Soap

Foam height measurement is a quality control method for soap products to ensure adequate foaming capability [23], [24]. There is no minimum or maximum foam height requirement for soap formulations, as foam height does not correlate with cleaning ability. It is more related to the psychological and aesthetic preferences of consumers [25], [26], [27]. Data indicate that transparent solid soap with red and white pomelo juice has good foaming properties due to saponin compounds that increase foam production.

The moisture content of transparent solid soap with white pomelo juice was lower than that of the soap with red pomelo juice. The principle of moisture content testing in solid soap involves measuring the weight reduction of the soap after heating at approximately 50°C for 1 hour. Moisture content is important for soap quality, as high moisture content can cause soap to shrink quickly during storage, become soft, and deplete rapidly with use [28]. The moisture content results for transparent solid soap and transparent solid soap with red and white pomelo juice met the standards. Antioxidants neutralize free radicals by donating electrons, thus preventing the radicals from damaging cells. This action is crucial in protecting against oxidative stress, which is implicated in various chronic diseases, including: cardiovascular diseases, cancer, neurodegenerative disorders and aging-related conditions. By conducting these further analyses, a deeper understanding of the antioxidant activity and potential health benefits of pomelo juice and its derivatives can be achieved.

CONCLUSION

The juice of white pomelo (*Citrus grandis* (L.) Osbeck) variety does not contain antioxidant compounds, with an IC_{50} value of 564.309 µg/ml, categorized as "inactive." In contrast, the juice of the red pomelo (*Citrus grandis* (L.) Osbeck) variety exhibits antioxidant activity, with an IC_{50} value of 185.086 µg/ml, categorized as "moderate." Transparent solid soap made from the juice of the red pomelo variety has an IC_{50} value of 295.531 µg/ml, categorized as "weak," whereas the transparent solid soap made from the juice of the white pomelo variety has an IC_{50} value of -130.207 µg/ml, categorized as "inactive."

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