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Literature Review: Pharmacological Activity and Characteristics of Red Onion (Allium cepa L.)

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ABSTRACT

Shallot skin (Allium cepa L.) is a household waste that is still rarely utilized, even though it contains secondary metabolites such as flavonoids, anthocyanins, saponins, tannins, and other phenolic compounds that have pharmacological potential, especially as antioxidants and antibacterials. This study evaluates shallot skin's specific and non-specific pharmacognosy parameters through literature studies. Specific parameters include organoleptic, microscopic tests, and identifying active compound content using TLC, while non-specific parameters include water, ash, and contamination. The literature search method was done through Google Scholar, PubMed, and ScienceDirect, using the criteria of articles from 2015 to 2025. The study results indicate that flavonoid content, especially quercetin, contributes significantly to the antioxidant and anti-inflammatory effects. Shallot skin also shows effective antibacterial and antimicrobial activity against pathogenic strains such as Staphylococcus aureus, Escherichia coli, and Salmonella typhi. In addition, the mechanism of inhibition of α-amylase and α-glucosidase enzymes shows potential as an antidiabetic agent. Anticancer activity is supported by the active compounds' ability to induce apoptosis and inhibit cancer cell proliferation. With its abundant bioactive compound profile, shallot skin has the potential to be developed.

Key words: Allium cepa L; pharmacological; activity; literature review

INTRODUCTION

In Indonesia, many plants are frequently used by the public as food and medicine. However, plant waste is still rare. One example is red onion peel waste, which is often generated from household waste. Previous research has shown that red onion peel extract contains chemical compounds with potential antioxidant properties, namely flavonoids, which can prevent the development of free radicals in the body and repair damaged cells (Narsa et al., 2022).

Shallots (Allium cepa L.) are a horticultural crop with high economic and functional value, particularly in Southeast Asian countries like Indonesia. While the bulbs are widely used as a cooking spice and traditional medicine, the skins are often considered waste and underutilized. However, studies have shown that shallot skins contain secondary metabolites such as flavonoids (especially quercetin).

Standardization stages are required to develop natural ingredients as traditional medicines to ensure product quality, safety, and consistency. Pharmacognosy analysis is critical in standardizing plant-based raw materials, namely the study of the morphological, microscopic, and chemical properties of medicinal plants and simples. This analysis is divided into two main groups: specific parameters, which relate to the identity and unique characteristics of simplexes, and non-specific parameters, which relate to their purity and cleanliness from contaminants. (Sulthon Aziz et al., 2019). antostanin, saponin, tannin, and other phenolic compounds that have the potential as an anti-inflammatory, antimicrobial, and natural anti-inflammatory (Sarı Pertala et al., 2022)

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Specific parameters include microscopic organoleptic tests and chromatography (TLC), while non-specific parameters include moisture content, ash content, microbial contamination, and heavy metals. This standard refers to guidelines issued by the WHO and the Indonesian Herbal Pharmacy. By analyzing these parameters, shallot skin can be used to determine its suitability as a raw material for standardized phytopharmaceutical preparations or traditional medicines (Sulthon Aziz et al., 2019). Through this research, a comprehensive pharmacognosy analysis of shallot skin was carried out to evaluate specific and non-specific parameters that can be used as a reference in standardization and utilization of this organic waste as a potential drug ingredient.

MATERIAL AND METHODS

The method used is a literature search collected from the Google Scholar, PubMed, and ScienceDirect databases with keywords: "shallot skin", "Allium cepa L.", "secondary metabolites", "simple pharmacognosy", "specific and non-specific parameters", and "shallot skin TLC". Inclusion criteria include articles in Indonesian or English published between 2015 and 2025 and discussing phytochemical analysis and/or pharmacognosy evaluation.

RESULT AND DISCUSSION

Table 1. Results of the review of the pharmacological activity of shallots

Table 2. Results of the Review of the Characteristics of Shallots

Antioxidant Activity

Shallot skin is known to have high antioxidant activity due to its content of bioactive compounds such as flavonoids (especially quercetin), polyphenols, and tannins. Flavonoids act as free radical scavengers by inhibiting cell-damaging oxidation processes. Research by Rahayu et al. (2015) showed that the ethyl acetate fraction of shallot skin contains flavonoids of the flavonol group, which can act as natural antioxidants. Research by Hikmah & Anggarani (2021) also detected antioxidant activity using the DPPH test, although the IC_{50} value indicated its antioxidant potential was weak (>200 ppm). Meanwhile, in another study using the maceration method, shallot skin extract had an IC_{50} of 29.9 ppm, which is categorized as a powerful antioxidant. (Rahayu et al., 2015).

Antibacterial Activity

Bioactive compounds such as flavonoids, tannins, and saponins in shallot skin also show potential as antibacterial agents. A study by Badriyah et al. (2022) showed that extracts using ethanol-water solvents yielded high yields and contained flavonoids and alkaloids, which play a role in antibacterial activity. Zone of inhibition tests against Staphylococcus aureus yielded a significant inhibition zone diameter. Flavonoids damage bacterial cell walls, inhibit essential enzymes, and disrupt bacterial DNA synthesis. (Badriyah et al., 2022).

Anti-inflammatory Activity

The anti-inflammatory activity of shallot peels is primarily derived from quercetin, one of the main flavonoids contained in the extract. Quercetin works by inhibiting the enzymes lipoxygenase (LOX) and cyclooxygenase (COX), reducing the expression of pro-inflammatory cytokines such as TNF-α and IL-6. Research by Soemarie (2016) tested the effects of quercetin from shallot peels on male white mice induced by inflammation. The results showed dose-responsive anti-inflammatory activity, with a dose of 200 mg/kg body weight producing the highest inflammation-inhibiting effectiveness with an AUC of 73.75%. This significant reduction in inflammation supports the role of shallot peels as a natural anti-inflammatory agent. (Soemarie, 2016).

Antimicrobial Activity

Shallot skin contains secondary metabolites such as flavonoids, alkaloids, saponins, and tannins, which are known to have antibacterial and antifungal properties. Research

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conducted by Sofihidayati et al. (2018) demonstrated that the 70% ethanol extract of shallot skin can inhibit the growth of Staphylococcus aureus with an inhibition zone of 18–22 mm. Furthermore, based on GC-MS results, shallot skin extract processed with ethyl acetate and n-hexane solvents contains active compounds with potential antibacterial activity against Escherichia coli, Salmonella typhi, and the fungus Trichophyton mentagrophytes (Sari Pertala et al., 2022). Tannins and triterpenoids damage bacterial cell walls and inhibit microbial protein synthesis. (Sari Pertala et al., 2022).

Antidiabetic Activity

Shallot peel has potential as an antidiabetic agent because it contains flavonoids and polyphenols that can inhibit blood glucose-regulating enzymes such as α-glucosidase and α-amylase. Based on in silico and in vitro studies, quercetin from shallot peel has shown potential as an α-glucosidase inhibitor comparable to acarbose (a synthetic antidiabetic drug), with a low IC_{50} value. Furthermore, polyphenols in shallot peel can improve insulin sensitivity and reduce oxidative stress that contributes to insulin resistance. Although research on the specific antidiabetic activity of shallot peel extract is still limited, its compounds have been shown to have similar effects in various studies of identical plants. (Narsa et al., 2022).

Anticancer Activity

Quercetin and other flavonoids in shallot skin also contribute to its anticancer effects through apoptosis, cancer cell proliferation inhibition, and tumor angiogenesis suppression. Previous research has shown that flavonoids from shallots can inhibit the growth of breast, colon, and prostate cancer cells by regulating the MAPK and PI3K/Akt signaling pathways. Although few in vivo studies of shallot skin extract directly exist, data from its molecular activity and phytochemical content strongly support its potential role as a natural anticancer agent. Further research is needed to test the cytotoxic effects and selectivity of the extract against normal and cancer cells directly. (Narsa et al., 2022).

Compound Content

Shallot skin (Allium cepa L.) contains a variety of secondary metabolites with varying polarity characteristics. Therefore, the type of solvent used in the extraction process significantly influences the compounds that can be isolated. Polar compounds, such as flavonoids, polyphenols, tannins, and saponins, have hydroxyl or sugar groups that dissolve well in polar solvents like water, ethanol, or methanol. Key flavonoids, such as quercetin, are known to be highly soluble in ethanol and have high biological activity as antioxidants and anti-inflammatory agents. Tannins and saponins are also considered polar due to their ability to form hydrogen bonds with water. (Badriyah et al., 2022)
On the other hand, compounds such as alkaloids and terpenoids are generally classified as semi-polar, depending on their specific structure and the number of polar functional groups they contain. These compounds are usually extracted using semi-polar solvents such as ethyl acetate or chloroform. Meanwhile, non-polar compounds

found in onion skins, such as steroids, triterpenoids, and essential oils, tend to be insoluble in polar solvents, but are effectively isolated using non-polar solvents such as n-hexane or dichloromethane. (Sari Pertala et al., 2022)

Thus, shallot skin contains compounds with a broad spectrum of polarity—from polar to non-polar. Therefore, a multistep extraction process (fractionation) using solvents from non-polar to polar (n-hexane → ethyl acetate → ethanol → water) is often used to recover all types of active compounds efficiently. Understanding this polarity is essential in determining the optimal extraction method for developing pharmaceutical raw materials from shallot skin. (Narsa et al., 2022).

CONCLUSION

Shallot skin (Allium cepa L.) has been shown to contain various secondary metabolite compounds such as flavonoids, tannins, saponins, terpenoids, and alkaloids that have potential as antioxidants and antibacterials. Based on the literature review results, specific pharmacognosy parameters such as organoleptic, microscopic, and thin layer chromatography (TLC) show distinctive characteristics that can be used as markers of the identity of shallot skin simplex. Meanwhile, according to the Indonesian Herbal Pharmacopeia, non-specific parameters such as water content, total ash content, and acid-insoluble ash are still within the permissible limits. These results support the use of shallot skin as a raw material for traditional medicine that meets quality and safety standards.

SUGGESTION

Further experimental laboratory research is needed to test the pharmacological activity of shallot peels both in vitro and in vivo. Furthermore, comprehensive standardization of quality parameters, including microbial and heavy metal contamination testing, is also necessary. With proper processing and standardization, shallot peels have great potential for development as an active ingredient in phytopharmaceutical preparations, thereby increasing the economic value of agricultural waste and supporting the development of natural-based traditional medicines.

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TABLE AND FIGURE

Table 1. Results of the review of the pharmacological activity of shallots

No	Journal Title	Pharmacological Activity Result
1	Extraction and Identification of Flavonoid Compounds from Red Onion Skin Waste as Natural Antioxidants (Rahayu et al., 2015)	Antioxidant
2	Analysis of shallot skin (Allium cepa L.) extraction using the maceration method (Badriyah et al, 2022)	Antibacterial
3	Anti-inflammatory Activity Test of Red Onion (Allium Cepa L.) Skin Quercetin on Male White Mice (Mus musculus) (Soemarie, 2016)	Anti-inflammatory Dose I: 100 mg/kgBB → 57,13% Dose II: 150 mg/kgBB →

		59,08% Dose III: 200 mg/kgBB → 73,75%
4	Identification of Secondary Metabolite Compounds Using GC-MS Instrument on Red Onion (Allium Cepa L.) Peel Extract Using Ethyl Acetate and N-Hexane Solvents (Sari Pertala et al., 2022)	Antioxidant, antimicrobial, antidiabetic, and anti-inflammatory
5	Identification of Secondary Metabolites and Pharmacognosy Profile of Shallot Peels (Allium cepa L.) as a Renewable Pharmaceutical Raw Material (Narsa et al., 2022)	Antioxidant, anticancer, antimicrobial, anti-inflammatory, antidiabetic
6	Antioxidant, anticancer, antimicrobial, anti-inflammatory, antidiabetic Determination of Flavonoid Content of 70% Ethanol Extract of Shallot Peels (Allium cepa L.) Using Maceration and Microwave-Assisted Extraction (MAE) Methods (Lusi et al., 2017)	Antioxidant and Anti-inflammatory Maceration Dose: 14.92% flavonoids MAE: 17.18% flavonoids
7	Antioxidant and Anti-inflammatory Maceration Dose: 14.92% flavonoids MAE: 17.18% flavonoids Bioactive Compound Content and Antioxidant Activity of Nganjuk Shallots (Allium cepa L.) (Hikmah & Anggarani, 2021)	Antioxidant Dose IC_{50} Ethanol extract: 384.03 ppm (weak) Ethyl acetate extract: 5336.78 ppm (very weak) Dichloromethane: 884.27 ppm (weak)

Table 2. Results of the Review of the Characteristics of Shallots

No	Extraction / Fraction Parameters	
1	Water fraction, ethyl acetate, n-hexane (Rahayu et al., 2015)	Water fraction: flavonoids, polyphenols, saponins, terpenoids, alkaloids. Ethyl acetate fraction: flavonoids (flavonols), polyphenols, alkaloids. N-hexane fraction: saponins, steroids, terpenoids. All fractions contain alkaloids, flavonoids, saponins..
2	Maceration with 96% ethanol solvent, water, ethanol-water mixture (Badrivah et al., 2022)	All fractions contain alkaloids, flavonoids, and saponins. The highest yield was in mixed solvents (13.27%).
3	Quercetin extract from red onion skin (Soemarie, 2016)	The main ingredient is quercetin (a type of flavonoid). It exhibits dose-dependent anti-inflammatory activity.
4	Ethyl acetate and n-hexane fractions (Sari Pertala et al. 2022)	Ethyl acetate: flavonoids, saponins, tannins, alkaloids, polyphenols, steroids, N-hexane saponins, steroids/triterpenoids.

5	Extract ethanol 96% (maserase) (Narsa et al., 2022)	Flavonoids, tannins, terpenoids, saponins, and alkaloids. water: 4.01%, ash content: 7.60%.
6	Maceration vs MAE (Microwave Assisted Extraction) using 70% ethanol (Lusi et al., 2017)	Maceration: flavonoids 14.92%. MAE: flavonoids 17.18%. Standard compound: quercetin..
7	Ethyl acetate, ethanol extract, dichloromethane (Hikmah & Anggrani 2021)	Flavonoids, phenolics, saponins, triterpenoids, quinones. Weak antioxidant activity (IC50 > 200 ppm).