MEDIA PENELITIAN DAN
PENGEMBANGAN KESEHATAN
Vol 35 No 1, Maret 2025

e-ISSN: 2338-3445
p-ISSN: 0853-9987

EFFECTIVITY OF STENOCHLAENA PALUSTRIS (BURM.) BEDD EXTRACT AS ANTIOXIDANT FROM CENTRAL KALIMANTAN: SCOPING REVIEW

Efektivitas Ekstrak Stenochlaena Palustris (Burm.) Bedd Sebagai Antioksidan Asal Kalimantan Tengah: Scoping Review

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ABSTRAK

Tumbuhan kelakai banyak ditemukan di Kalimantan dan biasanya dikonsumsi dengan cara di tumis dan direbus. Kelakai mengandung bioaktif yang bermanfaat bagi kesehatan dan dapat meningkatkan sistem imun tubuh Secara teoritis, artikel ini memberikan informasi bahwa kelakai memiliki manfaat kesehatan seperti antihiperlipidemia, penurunan kadar glukosa darah, dan pencegahan kanker payudara. Secara praktis, artikel ini membuka peluang penggunaan kelakai dalam penatalaksanaan diabetes, antihiperlipidemia, dan pencegahan kanker payudara pada manusia. Penelitian ini bertujuan memberikan informasi komprehensif tentang kelakai yang memiliki aktivitas antioksidan dan mengeksplorasi zat bioaktif yang terkandung dalam kelakai yang dapat dimanfaatkan untuk penelitian lebih lanjut secara in vivo seperti diabetes, bisa digunakan untuk mengeksplorasi aplikasi klinis seperti senyawa atau zat bioaktif yang terkandung dalam kelakai dapat dimanfaatkan untuk penelitian lebih lanjut secara in vivo seperti diabetes, antikanker. Scoping review yang dimulai dengan Pedoman Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Informasi diperoleh melalui basis data elektronik PubMed, Google Scholar, dan Science Direct dari tahun 2019 - 2024. Hasil penelitian ini adalah sintesis unsur deskriptif dan naratif dari 13 artikel didapatkan tujuh artikel yang memenuhi kriteria inklusi. Informasi dari berbagai artikel menunjukkan bahwa perlunya antioksidan eksternal untuk tubuh, yang dapat berasal dari tanaman atau vitamin. Salah satu tanaman yang memiliki aktivitas antioksidan adalah kelakai (Stenochlaena palustris (Burm.) Bedd). Kelakai mengandung flavonoid, alkaloid, dan tanin yang memiliki aktivitas antioksidan dalam menghambat radikal bebas. Kajian scoping ini mengonfirmasi adanya aktivitas antioksidan pada tanaman kelakai.

Kata kunci: antioksidan, oksidan, oksidatif, Stenochlaena palustris (burm.) bedd

ABSTRACT

The kelakai plant is found in abundance in Kalimantan and is usually consumed by stir-frying and boiling it. Kelakai contains bioactives that are beneficial for health and can improve the body's immune system. Theoretically, this article provides information that kelakai has health benefits such as antihyperlipidemia, lowering blood glucose levels, and preventing breast cancer. Practically, this article opens up opportunities for the use of kelakai in the management of diabetes, antihyperlipidemia, and preventing breast cancer in humans. This study aimed to provide comprehensive information about kelakai, which has antioxidant activity, and explore the bioactive substances contained in kelakai, which can be used for further research in vivo, such as on diabetes. can be used to

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

explore clinical applications such as compounds or bioactive substances contained in kelakai can be used for further in vivo research such as diabetes, anticancer and others. Carried out using a scoping review starting with the PRISMA guidelines. Information was obtained through the electronic databases PubMed, Google Scholar, and Science Direct from 2019 to 2024. The results of this study are a synthesis of descriptive and narrative elements from 13 articles, seven articles were obtained that met the inclusion criteria. Information from various articles shows the need for external antioxidants for the body, which can come from plants or vitamins. One of the plants that has antioxidant activity is kelakai. Kelakai contains flavonoids, alkaloids, and tannins that have antioxidant activity in inhibiting free radicals. This scoping study confirms the presence of antioxidant activity in the kelakai plant.

Keywords: antioxidant, oxidant, oxidative, *Stenochlaena palustris* (burm.) bedd

INTRODUCTION

The human body's cells have low antioxidant potential and produce more reactive oxygen species. Plant-derived antioxidants protect living tissues by scavenging reactive oxygen species through various reaction mechanisms. Although oxygen is essential for life, some oxygen in the body can become a reactive oxygen species (ROS). Antioxidants are compounds that can delay, inhibit, or prevent the oxidation of substances by capturing free radicals. Oxidative stress occurs when the level of ROS becomes too high, disrupting the balance of the body's antioxidant system. This plays a role in the development of diseases; therefore, antioxidants need to be included in the diet. [1]. Excessive reactive oxygen species (ROS) can cause lipid peroxidation, protein glycation/oxidation/nitration, enzyme inactivation, and DNA damage. The search for effective antioxidants and anti-inflammatory agents from natural resources in plants serves as an alternative with fewer side effects compared to synthetic chemicals [2].

Free radicals can cause oxidative reactions and lead to damage to the normal cell membranes surrounding the membrane and result in damage to DNA components, which can cause mutations. Mutations or damage to DNA components can lead to several diseases caused by inflammation or other degenerative diseases [3]. Metabolic and chronic diseases such as cardiovascular disorders, diabetes, cancer, cataracts, muscle degeneration, and neurological diseases such as Parkinson's and Alzheimer's diseases are related to the imbalance between oxidative stress formation and antioxidant defense mechanisms [4].

There has been no effective drug/therapy for diabetes; therefore, natural ingredients that have antioxidants are needed. Many studies have used plants that have antioxidants for various diseases by making extracts, including using Tacazzea apiculata plant extract in diabetic model mice [5]. Kelakai plants (*Stenochlaena palustris* (Burm.) Bedd) originating from Central Kalimantan grow in peat soil and are beneficial for health [6]. Kelakai plants (Stenochlaena palustris (Burm.) Bedd) are widely used as medicinal plants for conditions such as hyperlipidemia [7] wound healing, infections, and diabetes [8]. Fresh Kelakai plant extracts (*Stenochlaena palustris* (Burm.) Bedd) show various antioxidant and anti-inflammatory potentials [9]. The main bioactive compounds found in Kelakai plants (Stenochlaena palustris (Burm.) Bedd) consist of flavonoids, alkaloids, and tannins [10].

Diseases caused by oxidative stress are increasingly prevalent. There is an inverse relationship between the prevalence of diseases and the consumption of antioxidant-rich foods [3]. Therefore, for future research design for the development of Kelakai plants (*Stenochlaena palustris* (Burm.) Bedd) as a potential source of antioxidant and anti-inflammatory supplements, scientific evidence is needed to support the claimed therapeutic effects of these plants. Ideally, the mechanisms of action should also be understood. The potential use of Kelakai plants (*Stenochlaena palustris* (Burm.) Bedd)

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

as phyto-medicines with antioxidant properties has been well-documented in several articles, but we could not identify specific reviews focusing on the antioxidant and anti-inflammatory effects of Kelakai plants (*Stenochlaena palustris* (Burm.) Bedd). This review aimed to obtain overall information about the kelakai plant originating from Kalimantan, which has antioxidant activity and can be used to explore clinical applications such as compounds or bioactive substances contained in kelakai and can be used for further in vivo research such as diabetes, anticancer, and others.

This article is expected to be useful as a reference for learning materials and enriching knowledge and insight into kelakai (*Stenochlaena palustris* (burm.) bedd). There are four main elements of the pathogenesis of diabetes mellitus, namely oxidative stress, inflammation, mitochondrial dysfunction, and autophagic dysfunction [11]. Oxidative stress occurs due to an imbalance between free radicals produced with antioxidants in the body, resulting in cell membrane damage characterized by an increase in *malondialdehyde* (MDA) levels as an indicator of lipid peroxidation [12]. Antioxidants are compounds that can help reduce oxidative stress, which consists of *superoxide dismutase* (SOD) produced by body cells that function as inhibitors of superoxide radical reactions [13]. Therefore, it is necessary to increase SOD by consuming food ingredients that contain antioxidants.

METHODS

This review used a scoping review approach to identify literature obtained from journals and official websites on the topic of on kelakai plants originating from Kalimantan which have antioxidant activity, then the questions were grouped, and conclude. The stages carried out in the *scoping review* are as follows: the 5-step Arksey and O'Malley framework was used for validation, and the results were published following PRISMA ScR (priority reporting item for systematic review and a meta-analysis extension for scoping reviews)[14]. The quality of the literatures was determined by referring [15].

This study was conducted by searching for research articles that had been previously conducted, and the selection process for their results has also been completed. The process of searching and selecting articles began from 2019 to 2024.
The stages of this study are as follows:

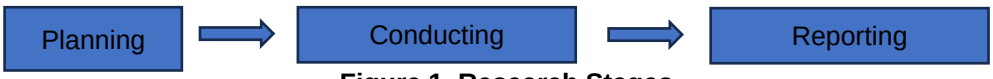

Figure 1. Research Stages

The study stages above consist of the planning stage, which is the initial stage in conducting systematic literature review research, followed by the implementation stage, which is the stage of conducting a scoping review, and finally, the reporting stage, which is the stage of writing a systematic literature review into a report. The descriptions and stages above are explained as follows:

Preparing Research Questions

The formulation of research questions serves as a reference in determining the articles to be included. The relevant research question for this study is "What are the antioxidant effects of the Kelakai plant, Stenochlaena palustris (Burm.) Bedd, native to Central Kalimantan?"

The search for research articles utilized the eligibility criteria by adopting PICO (Population, Intervention, Comparison, Outcome) as follows: Population: Kelakai plants *Stenochlaena palustris* (Burm.) Bedd originating from Central Kalimantan; Intervention: Kelakai extracts and Kelakai infusions; Comparison: -; Outcome: antioxidant content of Kelakai plants Stenochlaena palustris (Burm.) Bedd originating from Central Kalimantan; Study Design: laboratory experiments and qualitative and quantitative analysis approaches.

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

Data Search Strategy

Information was obtained through comprehensive literature searches using the electronic databases PubMed, Google Scholar, and Science Direct from 2019 to 2024. The keyword combinations used in PubMed are as follows: "Kelakai plant," "Stenochlaena palustris (Burm.) Bedd," "antioxidant."

The data collection involved narrowing down 174 articles to 7 by applying specific selection criteria set by the authors of each journal. The chosen articles were filtered according to the following inclusion criteria: complete articles published within the last five years (2019-2024), using Indonesian or English, the research subject is the kelakai plant *Stenochlaena palustris* (Burm.) Bedd from Central Kalimantan, the interventions carried out are kelakai extract and kelakai infusa. The result of this study is the antioxidant content of the kelakai plant *Stenochlaena palustris* (Burm.) Bedd. Exclusion criteria are: the article is a scoping review, systematic review, meta analysis, literature review, as well as reviews or comments, or articles that cannot be fully accessed.

Literature Selection

The literature selection stage was selecting literature according to the keywords that had been determined. The inclusion categories of the literature were articles that were suitable for the research problems as the main review. Therefore, further screening was performed on 174 articles to obtain full-text articles written in Indonesian or English. The screening was followed with reading the abstract and full text articles, then critical assessment was conducted to assess the feasibility of the articles, especially the suitability with the research objectives. Based on the above criteria, five articles were selected for further analysis. The author designed a flow diagram showing the process of literature search, screening, and final results of literature to be reviewed (Figure 2).

Compilation and Reporting of Literature Analysis Results

At this stage, the authors analyzed, summarized, and compiled the selected references, then reported them in the results and discussion.
PRISMA Diagram as follows: SPAR 4 SLR[16].

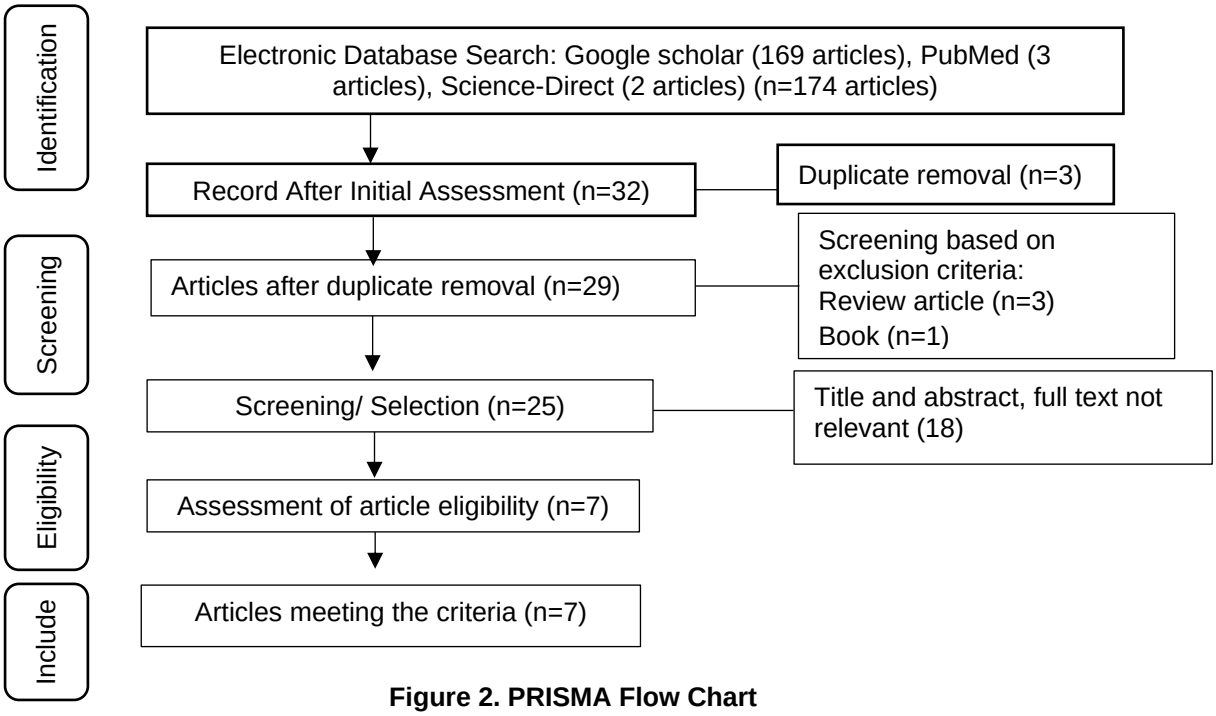

Figure 2. PRISMA Flow Chart

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

Identification of Relevant Reference Sources

Relevant reference sources were obtained by searching literature in PUBMED, Science Direct, and Google Scholar databases published from 2019 to 2024. The author used the question format of population, exposure, and outcome (PEO) to determine the keywords used in the literature search, aiming to help find literatures published with qualitative and quantitative research methods [12]. There were 174 articles obtained, consisting of 3 articles from PUBMED, 2 articles from Science Direct, and 169 articles from Google Scholar. The keyword combinations used in PubMed are as follows: "Kelakai plant," "Stenochlaena palustris (Burm.) Bedd," "antioxidant." Written in Indonesian or English language.The research subject is the Kelakai plant Stenochlaena palustris (Burm.) Bedd originating from Central Kalimantan.The intervention performed is Kelakai extracts and Kelakai infusions.The outcome of this research is the antioxidant content of the Kelakai plant Stenochlaena palustris (Burm.) Bedd.

The study, published between 2019 and 2024, provided relevant data to address the objectives and review questions. The data extraction process involved mapping the study results to give readers a clear and logical summary. The article was sourced based on several key details, including the author's name, publication year, study location, objectives, study population, methodology, type of intervention, and results.

To overcome/minimize potential bias in this study, the researchers set inclusion and exclusion criteria, select the population, and determine the specific intervention. The basic strategy to minimize bias is to explicitly state the hypothesis to be tested and by conducting a methodological approach that will be used before conducting research.

Searching Research Articles

Articles that meet the relevant criteria for the research topic, whether already published or unpublished but meeting the inclusion criteria, will be examined. Articles, both published and unpublished, that met the inclusion criteria and were relevant to the research topic were identified and reviewed

Assessing the Quality of Research Articles

The quality assessment of research articles was conducted by experts in the field, and the subsequent process followed the Checklist for Critical Appraisal according to the research design. The literature review results of each article have been identified and assessed for eligibility, research quality, and reporting of results. The findings from the literature review of each article were examined and evaluated based on the research's feasibility, quality, and the clarity of the reported outcomes in each study.

Data extraction and synthesis of gathered research evidence.

This stage involves summarizing data from selected research articles into a simple table. The summary includes the title, author's name, publication, design, and relevant findings.

Preparing the systematic literature review report

The authors analyze, summarize, and organize relevant references to be reported in the form of results and discussion.

RESULTS

The results of the content analysis of the seven references that can be seen in table 1 and table 2 found that 5 articles stated that kelakai extract contains phytochemical compounds, astragalin is a flavonoid with kaempferol-3-O- β -D-glucoside [17]. Meanwhile, 1 article stated that kelakai extract contains other nutrients such as hemoglobin and hematocrit. 1 article states that kelakai extract has strong antioxidants with an IC50 value of 19.06 ppm.

Antioxidant activity is Inhibition concentration (IC50), which is the concentration of sample solution required to inhibit 50% of DPPH free radicals. Categories of antioxidant

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

compound strength are <50 very strong, 50 - 100 strong, 100 - 250 moderate, 250 - 500 weak, and >500 inactive. The smaller the IC50 value, the higher the antioxidant activity Molyneux [18] Research Savitri *et al.*, (2021). Natural antioxidants found in plants function to increase immunity, regulate blood pressure, lower blood glucose levels, and lower cholesterol. Chemical antioxidants are chemical levels that can inhibit damage due to the oxidation process. Therefore, to reduce the side effects of chemical antioxidants, many researchers use natural antioxidants found in plants, grains, and others[6].

Kalakai is a plant that thrives in peat soil and is also found growing well in sandy soil. In terms of physical and chemical characteristics, there are significant differences between peat soil and sandy soil. The results of the antioxidant activity test on the ethanol extract of kalakai roots grown in sandy soil and peat soil show very strong antioxidant activity. This is indicated by the IC50 value of the ethanol extract of kalakai roots in peat soil of 19.06 ppm and the ethanol extract of kalakai roots in sandy soil of 24.40 ppm [19].

Bioactive compounds, such as flavonoids, are potent antioxidants found in plants. They act as antioxidants by neutralizing free radicals. Both in vitro and in vivo research suggests that flavonoids hold potential for development in the pharmaceutical and food industries, particularly for their ability to combat free radicals. In the food industry, flavonoids are used in applications like preservatives, antioxidants, and pigments, while they also have roles in cosmetics and pharmaceuticals [20]. Alkaloids are amino acids that are widely found in plants, many researchers have found that alkaloids as new therapeutic agents to deal with diseases associated with multidrug resistance, in cancer cells and drug-resistant microorganisms, and to treat neglected diseases, the author discusses the need for a new international strategy in the discovery and development of natural products, emphasizing the importance of broad collaboration as the key to the success of drug discovery programs [21]. Saponins made by extracts from plants such as seeds, stems, roots, and stems leaves have biological activities including anti-inflammatory and immunomodulatory effects. Saponins found in plants can increase immune activity [22].

Antioxidants not only possess antioxidant properties but also serve effectively as anti-inflammatory agents. Bioactive compounds in plant extracts can inhibit key signaling pathways, such as NF-κB and mitogen-activated protein kinase (MAPK). For instance, various parts of the Moringa plant (Moringa oleifera), including its leaves, roots, pods, seeds, fruits, and flowers, exhibit significant anti-inflammatory effects[23]. Medicinal plants for diabetes, namely Mahkota Dewa (Phaleria macrocarpa) ethyl acetate extract from its young stem has the highest ability of 40.86% in inhibiting alpha glucosidase at a concentration of 50 ppm. This plant also contains alkaloid, flavonoid, and polyphenol compounds[24]. The literature analyzed has the same population or sample, namely kelakai from Kalimantan, and aims to find out comprehensive information about kelakai plants from Central Kalimantan that have antioxidant activity. A summary of data extraction and synthesis of research evidence collected from library articles relevant to the research topic is presented in tables 1 and 2 as follows:

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
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Table 1. Data Extraction and Synthesis of Research Articles Collected

No	Title, Authors, Year	Research Objective	Method	Relevant Findings
1.	Potensi Tumbuhan Kelakai (Stenochlaena Palustris (Burm.F.) Bedd.) Asal Kalimantan Tengah Sebagai Afrodisiaka Fahruni *et al.*, 2018	This research was aimed to determine the content of the active compound on the Kelakai roots that efficacious as an aphrodisiac and to determine the profile of Thin Layer Chromatography (TLC) of active compound contained in Kelakai roots	Sample: Kelakai roots Design study: Experimental laboratory	The result showed that Kelakai Roots contain active compounds potentially aphrodisiac namely alkaloids and saponin. While the TLC profile obtained is the presence of stains on the appearance of a non-polar eluent (Chloroform: Ethyl Acetate) with a ratio of 7: 3, 8: 2, 9: 4 with each Rf value is 0.70 cm (7: 3), 0.94 cm (8: 2) and 0.94 cm (9: 4). This research reported for the first time the potential of Kelakai roots as aphrodisiac. Thus, further work will focus on the study of the pharmacological effects of Kelakai roots.
2.	Antioxidant Activity of Ethanol Extracts of Kelakai (*Stenochlaena Palustris* Bedd) Roots from Central Kalimantan Adawiyah and Rizki, 2018	Analyzing the botanical composition and potential of Kelakai plants growing in Central Kalimantan peatlands as medicinal plants	Sample: Kelakai roots Design study: *True experimental, post-test only control group design* Kelakai roots from sandy soil.	Antioxidant testing of Kelakai (*Stenochlaena Palustris* (Burm.F) Bedd) roots in peat soil obtained an IC50 capability of 19.06 ppm. This result is classified as very strong as IC50 is below 50 ppm. Antioxidant testing of Kelakai (*Stenochlaena Palustris* (Burm.F) Bedd) roots in sandy soil obtained an IC50 capability of 24.40 ppm. This result is classified as very strong as IC50 is below 50 ppm
3.	Effectiveness of the Addition of Kelakai (Stenochlaena palustris) Extracts in Commercial Pellet as an Immunostimulant for Snakehead (Channa striata) Fitriliani and Bijaksana, 2020	This study was aimed at determining the best performance of the addition of Kelakai (Stenochlaena palustris) in commercial pellets as an immunostimulant to increase the Snakehead's immune system	Sample: Kelakai extract Design study: Experimental laboratory	This study is the first reference for assessing the effect of Kelakai extracts to the immune- triggering response in Snakehead. The outcome of the research could be useful for aquaculture management systems and the pellet industry.

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

No	Title, Authors, Year	Research Objective	Method	Relevant Findings
4.	Antioxidant Activity of Infusions of Kelakai (*Stenochlaena Palustris* (Burm.F) Bedd) Savitri *et al.*, 2021	Determining the antioxidant activity of Kelakai infusions *Stenochlaena Palustris* (Burm.) Bedd	Sample: Kelakai leaves Design study: *True experimental, post-test only control group design*	Antioxidant testing of Kelakai (*Stenochlaena Palustris* (Burm.F) Bedd) infusions obtained an IC50 capability of 6.4035 ppm. This result is classified as very strong as IC50 is below 50 ppm.
5.	Post-harvest and Extraction Conditions for the Optimum Alpha Glucosidase Inhibitory Activity of Stenochlaena palustris Puteri *et al.*, 2021	aimed to evaluate the impact of post-harvest and extraction conditions on the AGI activity of S. palustris and isolate the AGI bioactive principal component	Sample: extract Stenochlaena palustris Design study: laboratory	Impact of Harvesting Technique and Extraction Solvent AGI: S. palustris can remain fresh up to 2 days after harvesting before it wilts. This study also identified astragalin as the active compound responsible for the AGI activity in S. palustris
6.	Analysis of Botanical Composition and Potential of Kelakai Leaves (*Stenochlaena palustris*) of Peat Swamp Plants in Central Kalimantan as Medicinal Plants Puspitasari *et al*, 2022	Analyzing the botanical composition and potential of Kelakai plants growing in Central Kalimantan peatlands as medicinal plants	Sample: extract Stenochlaena palustris Design study: laboratory .	Testing shows that Kelakai leaf extract gel proves potential and can be recommended as an effective wound healing medicine at a concentration level of 35%, with the optimal concentration in wound healing at the level of 40%.
7.	Effect of Giving The Ointment of Kelakai Leaf And Stem Extract (Stenochlaena Palustris (Burm. F) Bedd) on Wound Healing of The Mice's Skin Jamilah *et al.*, 2022	This study aimed to determine the effect of giving the ointment of kelakai leaf and stem extract (Stenochlaena palustris (Burm. F) Bedd). On wound healing of the mice's skin	Sample: extract kelakai leaf and stem extract (Stenochlaena palustris (Burm. F) Bedd) Design study: laboratory	Analysis of the data using the nonparametric test Mann-Whitney stated the significance of $p<0.05$. The results of this study indicated that the ointment of the leaves and stems of kelakai extract can heal wound on mice's skin

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

Table 2. Health Benefits.

No	Solvent	Method of Antioxidant Testing	Antioxidant Power, Bioactive Substance	Health Benefits
1.	Ethanol	KLT	The TLC profile obtained is Chloroform: Ethyl Acetate. This research reported for the first time the potential of Kelakai roots as aphrodisiac Bioactive Substance: Alkaloid, saponin ,tanin	Saponin has aglycone properties and has its toxic effects so that it can act as a chemotherapy agent. Biological activities such as anticancer, antioxidant activity. Treatment of various diseases including obesity, diabetes mellitus, osteoporosis, cancer [28].
2.	Ethanol	DPPH	IC50 19.06 ppm Bioactive Substance: not tested	IC50 is used to determine the antioxidant level, strong 50-100 and very strong <50, so it can fight free radicals as in research [29]
3.	Water with a ratio of 1:5 and then mixed with pellet flour		- Bioactive Substance: hemoglobin, hematocrit blood plasma	Hemoglobin is a protein found in red blood cells. the concentration of men is 13g/dL and women 12g/dL. This plant can increase hemoglobin levels, especially in pregnant women who usually found with iron deficiency anemia [30].
4	Infusion (water)	DPPH	IC50 6.4035 ppm Bioactive Substance: flavonoid	Flavonoids are bioactive substances that are usually found in plants and have good effects on human health. Among them are anti-inflammatory, anti-viral, antioxidant [31]
5.	Methanol		- Bioactive Substance: astragalin	Astragalin has therapeutic effects on anti-inflammatory, antidiabetic, cardioprotective, allergy, atherosclerosis [17].
6.	Ethanol	KLT	Spots distance (-) RI Value of ethanol extract (-) Bioactive Substance: alkaloid, saponin	Alkaloids come from amino acids which have effects on health such as antihypertensive, anti-diabetic, antioxidant and also have an effect on DNA ((Deoxy Ribonucleic acid), RNA (Ribonucleic acid), membrane permeability and protein [32].
7.	Ethanol	Fitokimia With method kromatografi	- Bioactive Substance: alkaloid, flavonoid, saponin, tanin, tripenoid	Tannins are useful for protein energy deficiency problems [33].

DISCUSSION

Kelakai commonly consumed by the people of Central Kalimantan, contains antioxidants that can protect our body and prevent the formation of oxidants and lipid peroxidation. According to Nurkhasanah *et al* (2023), antioxidants consist of two types: the first endogenous antioxidants, which are naturally present in the body (enzymes such as superoxide dismutase, glutathione peroxidase, and catalase), and the second

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

exogenous antioxidants derived from outside the body in the form of vitamins and minerals (consumed through food or supplements). Vitamins and minerals known to have antioxidant activity include beta-carotene, flavonoids, vitamin C, selenium, manganese, vitamin E, and zinc [34].

The antioxidant testing methods used are frequently and readily available to researchers. This is consistent with study Satriyani (2021) which states that antioxidants can be tested for their activity using methods such as DPPH (1,1-diphenyl-2-picrylhydrazyl), CUPRAC, and FRAP. The DPPH method is commonly used because it is the simplest, easiest to use, and provides accurate results [35].

The antioxidant activity of Kelakai or *Stenochlaena palustris* (Burm.) Bedd from Central Kalimantan is expressed as the percentage of inhibition against the DPPH radical. The magnitude of antioxidant activity is indicated by IC50, which is the concentration of the sample solution needed to inhibit 50% of the DPPH free radicals. Test results show that Kelakai or *Stenochlaena palustris* (Burm.) Bedd from Central Kalimantan has strong antioxidant activity because it has a low IC50 value. A substance is considered to have antioxidant properties if the IC50 value is less than 100 ppm according to Chow *et al* [36].

The bioactive compounds of Kelakai or *Stenochlaena palustris* (Burm.) Bedd from Central Kalimantan consist of flavonoids, alkaloids, and saponins, which were qualitatively tested with descriptive observations. Alkaloids are indicated by yellowish precipitate; saponins are indicated by the absence of sediment; flavonoids are indicated by the presence of red-orange color. This is consistent with the research of Adawiyah *et al* (2023) which states that Kelakai or *Stenochlaena palustris* (Burm.) Bedd from Central Kalimantan contains flavonoids, alkaloids, and saponins [38].

The studies reviewed had limitations related to antioxidant testing methods. For example, article (1) used KLT profiles to analyze the bioactive compounds in kelakai [25] , article (2) assessed antioxidant activity through IC50 measurements [19], and article (4) also utilized IC50 [6]. Meanwhile, articles (3) [39], (5) [26], (6) [27], and (7)[10] relied on KLT profiles to determine the bioactive content in kelakai. These limitations present challenges for the authors in identifying alternative approaches to reduce bias, ensuring that the generalization of the study's findings is not compromised. Including the strengths and weaknesses of each testing method in the articles ensures that limitations do not undermine the overall results.

Practical application materials from the health benefits of Stenochlaena palustris include: (1) nutraceuticals offer potential benefits for enhancing overall well-being, preventing chronic illnesses, slowing the aging process, and ultimately extending life expectancy. These products are recognized as a natural means to help prevent serious health conditions, including diabetes, kidney and gastrointestinal diseases, and various infections, while also supporting the proper function and integrity of the body [40]. (2) Education and Training on making herbal supplements (*stenochlaena palustris*) for the Immune System [41]. Pharmacy: herbal agency, which is an alternative medicine that uses plants, both native ingredients and their preparations (concoctions) as an alternative medicine ingredient[42]

The limitation of this study is that more complete research is needed, such as antioxidants in the stems and leaves of kelakai, because kelakai is a type of vegetable that is usually consumed by stir-frying or boiling. So the nutritional content of the stems and leaves of kelakai is beneficial for health. Theoretical implications: This article can provide information that kelakai plants are antioxidants and have bioactive substances such as flavonoids, alacoloids, and phenols. In practical terms, this article highlights potential opportunities for developing Stenochlaena palustris into a commercially viable antioxidant product.

https://doi.org/10.34011/jmp2k.v35i1.2291

e-ISSN: 2338-3445
p-ISSN: 0853-9987

CONCLUSION

The Kelakai plant from Kalimantan has antioxidant activity, and can be used to explore clinical applications such as compounds or bioactive substances contained in Kelakai, which can be used for further research in vivo such as diabetes, anticancer, and others. Proven from seven articles showing that Kelakai has antioxidant activity from compounds such as flavonoids, alkaloids, and saponins, which are found in the roots and leaves of Kelakai or Stenochlaena palustris (Burm.) Bedd. Further research was needed on the dosage of steno as an antioxidant supplement in the long term.

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