



Inflammation, Oxidative Stress, and Medicinal Plants in Health Therapy

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Abstract

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Inflammation and oxidative stress are key biological mechanisms involved in the development of various diseases. An imbalance between the inflammatory response and the antioxidant system can lead to cellular damage and worsen health conditions. As the side effects of synthetic drugs become increasingly recognized, interest in the use of natural substances, particularly medicinal plants, is growing as an alternative therapy. This study aims to examine the role of inflammation and oxidative stress, as well as the potential and safety of using natural substances in the context of health. The method employed is a qualitative approach through a literature review of various scientific sources published over the past five years. The results of the review indicate that medicinal plants contain bioactive compounds such as flavonoids and polyphenols that possess antioxidant and anti-inflammatory activities. Additionally, most plant extracts demonstrate good safety profiles at specific doses based on toxicity tests. However, the use of non-standardized extracts still carries the potential for side effects. Therefore, further research and standardization are necessary to ensure the efficacy and safety of using natural substances as health therapies.



1. Introduction

The development of health science in recent decades shows that various diseases, both acute and chronic, are inseparable from the role of inflammatory processes as the body's biological response to various harmful stimuli. Inflammation is a natural defense mechanism that involves the immune system in responding to infection, cell damage, and exposure to toxic compounds. However, an uncontrolled inflammatory response can contribute to the occurrence of various health disorders, including skin diseases, degenerative diseases, and other chronic conditions (Fioranelli et al., 2021). In addition, factors such as oxidative stress caused by an imbalance between free radical production and the body's antioxidant capacity also play an important role in aggravating inflammatory conditions (Liguori et al., 2018).

In the context of global health, the increasing prevalence of inflammatory related diseases is driving the need for more effective and safe therapeutic approaches. The use of synthetic drugs has indeed made a great contribution to the treatment of various diseases, but it is not uncommon to cause side effects that can reduce patient comfort and adherence to treatment (Peyravian et al., 2022). This is one of the reasons for the growing interest in the use of drugs based on natural ingredients, especially medicinal plants, as an alternative therapy that is considered safer and has relatively lower side effects.

Natural products, especially those of plant origin, have long been used in traditional medicine and continue to be an important resource in the development of modern medicine. Studies show that most of the drugs in circulation today have links to bioactive compounds from natural sources, including plants (Calixto, 2019).

In addition, modern approaches in drug discovery also increasingly integrate the use of plant bioactive compounds that have the potential to be therapeutic agents (Najmi et al., 2022). The World Health Organization also reports that the use of traditional medicine is still the main choice for a large part of the world's population in meeting basic health needs, especially in developing countries (WHO, 2019).

Nonetheless, the use of herbal remedies is not completely risk-free. Various studies show that in addition to having pharmacological benefits, bioactive compounds in plants also have the potential to cause side effects, including allergic reactions, irritation, and toxic effects if not used appropriately (Zhang et al., 2019). Therefore, the safety aspect is one of the important factors that must be considered in the development and use of natural ingredients-based drugs. This safety evaluation is generally conducted through a variety of toxicity tests, including acute toxicity tests that aim to identify potential adverse effects within a short period of time after exposure to a substance.

A number of studies have been conducted to evaluate the safety of various plant extracts through toxicity tests, both *in vitro* and *in vivo*. The results showed that most plant extracts had a fairly good level of safety, with no significant toxic effects found at certain doses (Ng'uni et al., 2018; Reduan et al., 2020). However, variations in research methods, extract types, and testing conditions lead to the need for a more comprehensive study to ensure the safety of the widespread use of these natural ingredients.

Based on this description, it can be concluded that although medicinal plants have great potential as an effective and relatively safe therapeutic alternative, further

studies are still needed regarding their safety aspects. Therefore, this study aims to examine the role and safety of the use of natural ingredients in the context of health, especially through a scientific approach that integrates the results of the latest research. It is hoped that the results of this study can contribute to the development of natural ingredient-based therapies that are not only effective but also safe for long-term use.

2. Literature Review

2.1 Inflammation, Oxidative Stress, and Their Role in Health

Inflammation is a complex biological response that functions as the body's defense mechanism against various harmful stimuli, such as infection, tissue damage, and exposure to toxic substances. This process involves the activation of various immune cells as well as the release of chemical mediators, such as cytokines and chemokines, which play a role in regulating the immune response (Fioranelli et al., 2021). Although inflammation has a protective role, excessive or prolonged activation can lead to tissue damage and contribute to the development of various chronic diseases, including skin disorders and degenerative diseases.

In addition to inflammation, oxidative stress is also an important factor in the pathogenesis of various diseases. Oxidative stress occurs due to an imbalance between the production of free radicals and the ability of the antioxidant system to neutralize them. This condition can lead to cellular damage, including lipids, proteins, and DNA, which ultimately triggers various health disorders (Liguori et al.,

2018). The relationship between inflammation and oxidative stress is reciprocal, where both reinforce each other and worsen the pathological conditions that occur.

In recent years, research has shown that external factors such as lifestyle, exposure to pollution, as well as an unhealthy diet can increase the production of free radicals and worsen the inflammatory response (Martemucci et al., 2022). This makes inflammation and oxidative stress the main target in the development of prevention and therapy strategies for various diseases.

Therefore, a deep understanding of the mechanisms of inflammation and oxidative stress is essential in the development of effective therapies. An approach that is able to control both processes is expected to provide benefits in reducing the risk of disease and improving overall quality of life.

2.2 Potential of Medicinal Plants and Their Safety Aspects

The use of medicinal plants as an alternative to therapy has seen a significant increase in recent decades. This is driven by increasing public awareness of the side effects of synthetic drugs and the need for more natural and sustainable therapies. Medicinal plants are known to contain various bioactive compounds, such as flavonoids, alkaloids, and polyphenols, which have pharmacological activity, including as antioxidants and anti-inflammatories (Calixto, 2019). In addition, modern approaches in drug discovery are also increasingly utilizing natural compounds as prime candidates in the development of new therapies (Najmi et al., 2022).

The World Health Organization reports that most of the world's population still relies on traditional plant-based medicine to meet their basic health needs

(WHO, 2019). This shows that medicinal plants have an important role in the global health system, especially in developing countries. Various studies have also shown that plant extracts have the potential to address a variety of health conditions, including diseases related to inflammation and oxidative stress.

Nevertheless, the use of medicinal plants is not completely risk-free. Some studies report that bioactive compounds in plants can cause certain side effects, especially if used without proper dosage and standards (Zhang et al., 2019). Therefore, safety evaluation is an important aspect in the development of drugs based on natural ingredients.

Research on plant toxicity, including acute toxicity tests, suggests that most plant extracts are relatively safe at certain doses, although further testing is still needed to ensure long-term safety (Ng'uni et al., 2018). Thus, the integration between therapeutic potential and safety aspects is key in the development of effective and safe herbal medicines.

3. Methods

This study uses a qualitative approach with a literature study method that aims to in-depth examine various scientific information related to the role of inflammation, oxidative stress, and the potential and safety of the use of natural ingredients in the health sector. The qualitative approach was chosen because it allows researchers to comprehensively understand the phenomenon through the analysis of various relevant data sources without conducting direct experiments in the laboratory. The data used in this study is secondary data obtained from various

scientific sources available online, such as international journals, scientific articles, reports of health organizations, and other academic publications.

The data collection process is carried out by searching scientific databases through academic search engines such as Google Scholar, ResearchGate, Elsevier, and others. Keywords used in searches include terms related to inflammation, oxidative stress, medicinal plants, antioxidants, and toxicity of natural ingredients. The inclusion criteria used in the selection of literature sources include articles published in the last five years, available in full text, and relevant to the research topic. In addition, the selected sources are prioritized from journals that have high credibility and have gone through a peer-review process. Meanwhile, exclusion criteria include articles that do not have a direct connection to the topic, publications that do not have methodological clarity, and sources that are not fully accessible.

After the data collection process, the next stage is the selection and evaluation of the literature to ensure the quality and relevance of the information obtained. The selected articles were then analyzed descriptively by identifying the main concepts, important findings, and relationships between variables discussed in each study. The analysis process is carried out by comparing the results of various studies to find patterns, similarities, and differences that can enrich the understanding of the topic being studied. In addition, data synthesis is also carried out to integrate various findings into a systematic and structured conclusion.

The validity of the data in this study is maintained through the source triangulation technique, which is by comparing information from various different references to ensure the consistency and validity of the data. By using this approach,

it is hoped that the results of the study can provide a comprehensive and objective picture of the role of inflammation, oxidative stress, as well as the potential and safety of using natural ingredients in the context of health. This method also allows researchers to identify gaps in research that still exist as well as provide a solid basis for further research development.

4. Results and Discussion

Based on the results of the literature review that has been conducted, it is known that inflammation and oxidative stress are two biological mechanisms that are interrelated and have an important role in the development of various diseases. Inflammation serves as the body's protective response to various harmful stimuli, but under certain conditions it can develop into chronic and cause tissue damage (Fioranelli et al., 2021). This process involves a variety of inflammatory mediators that can trigger a systemic response if not properly controlled. On the other hand, oxidative stress characterized by increased production of free radicals also contributes to cell damage and worsens inflammatory conditions (Liguori et al., 2018).

The relationship between inflammation and oxidative stress is complex and interdependent. Excessive free radicals can activate inflammatory pathways, while the inflammatory response can also increase the production of reactive oxygen species in the body (Martemucci et al., 2022). This condition creates a cycle that has the potential to aggravate various diseases, including skin disorders such as acne and

other chronic diseases. Therefore, therapeutic strategies that are able to control these two mechanisms are very important in disease prevention and treatment efforts.

In recent years, attention to the use of natural ingredients as an alternative to therapy has increased. Medicinal plants are known to contain various bioactive compounds that have antioxidant and anti-inflammatory activities. Compounds such as flavonoids and polyphenols are able to neutralize free radicals and inhibit inflammatory pathways, thus potentially reducing cell and tissue damage (Calixto, 2019). In addition, modern approaches in drug development are also increasingly leading to the exploration of natural compounds as a source of new drug candidates (Najmi et al., 2022).

The use of medicinal plants is not only supported by scientific evidence, but also by traditional practices that have been going on for centuries. The World Health Organization reports that a large portion of the world's population still relies on traditional medicine as part of their health system (WHO, 2019). This shows that natural ingredients have an important role to play in providing affordable and accessible health solutions. In addition, several studies have shown that plant extracts have effectiveness in addressing inflammatory skin conditions, including acne, through the mechanism of inhibiting the growth of microorganisms as well as modulating the immune response (Peyravian et al., 2022).

Despite having great therapeutic potential, the use of natural ingredients still requires special attention regarding its safety aspects. Some studies show that bioactive compounds in plants can cause side effects when used inappropriately, such as allergic reactions or irritation (Zhang et al., 2019). Therefore, safety

evaluation is an important aspect in the development of plant-based medicines. One commonly used method is acute toxicity testing, which aims to identify potential harmful effects within a short period of time after exposure to a substance.

The results of studies have shown that most plant extracts have a good level of safety at certain doses. A study conducted by Ng'uni et al. (2018) showed that plant extracts did not cause symptoms of toxicity or mortality in test animals in high doses. Similar findings were also reported by Reduan et al. (2020), who stated that the plant extracts tested showed no significant toxic effects on biological systems. This suggests that the natural ingredient has the potential to be developed as a relatively safe therapy.

However, there are variations in the results of the study that are influenced by various factors, such as the type of plant, extraction method, and testing conditions. Other studies show that the biological activity of an extract is highly dependent on the content of active compounds in it, which can vary depending on environmental conditions and processing processes (Najmi et al., 2022). Therefore, standardization in the production and testing process is important to ensure consistency of product quality and safety.

In addition, some studies have also highlighted the importance of dosage in determining the safety of an ingredient. Although a plant extract is considered safe at certain doses, excessive use can increase the risk of side effects. This is in line with the principle of toxicology which states that any substance has the potential to be toxic depending on the dose used. Therefore, determining the right dosage is one of

the important aspects in the development of drugs based on natural ingredients (Ng'uni et al., 2018).

In the context of modern therapeutic development, the integration between traditional knowledge and scientific approaches is key in maximizing the potential of natural ingredients. Research conducted by Taddese et al. (2021) shows that plant extracts not only have wound-healing activity, but also show a good safety profile through toxicity tests. These findings are supported by other studies that show that plants like *Brassica carinata* have significant antioxidant activity and do not cause toxic effects in certain tests (Alemu et al., 2020).

In addition to therapeutic benefits, the use of natural ingredients also provides economic and sustainability benefits. Medicinal plants are generally easier to obtain and have lower production costs compared to synthetic drugs. This makes natural ingredients an attractive alternative in healthcare systems, especially in countries with limited resources. Nevertheless, the development of herbal medicines still requires strict regulations to ensure their safety and effectiveness.

Further, the importance of toxicity evaluation is not only limited to acute effects, but also includes long-term effects that may arise from repeated use. Although most studies show safe results in the short term, further research is still needed to evaluate the chronic effects of using natural ingredients. This is important to ensure that long-term use does not have a negative impact on health.

Based on all the results of this study, natural ingredients have great potential as an effective and relatively safe therapeutic alternative. However, its development and use must be supported by strong scientific evidence, especially regarding safety

aspects and proper dosage. The integration between scientific research and traditional practice is expected to result in therapies that are not only effective, but also safe and sustainable.

5. Conclusion

Based on the results of the study, it can be concluded that inflammation and oxidative stress are two key mechanisms involved in the development of various diseases, both acute and chronic. The two are closely linked and exacerbate pathological conditions if not properly controlled. Therefore, a therapeutic approach is needed that is not only effective but also capable of suppressing both mechanisms simultaneously. The use of natural ingredients, particularly medicinal plants, shows great potential as a therapeutic alternative.

Bioactive compounds such as flavonoids and polyphenols have been shown to possess antioxidant and anti-inflammatory activities that can help reduce cellular damage and enhance the healing process. Additionally, natural ingredients offer advantages in terms of availability and relatively lower costs compared to synthetic drugs. Nevertheless, safety remains a critical factor that must be considered. Study results indicate that most plant extracts are relatively safe at specific doses; however, improper use may potentially cause side effects. Therefore, further research and standardization are required in the development and use of natural materials to ensure they can be optimally utilized as effective, safe, and sustainable therapies.

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