



Effectiveness of Flavonoid (*Moringa oleifera*) as an Anti-inflammatory

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Abstrak

Latar belakang: Inflamasi merupakan respon tubuh terhadap cedera karena infeksi pada antigen atau kerusakan sel, sehingga menandakan adanya sesuatu yang berbahaya atau sakit di dalam tubuh. Inflamasi juga merupakan respon protektif terhadap kerusakan sel atau infeksi. Saat ini perkembangan pengobatan tradisional di Indonesia sedang marak dibicarakan. Dimana perkembangan teknologi semakin pesat, banyak masyarakat yang terkena berbagai macam penyakit seperti inflamasi, dan lain sebagainya. Daun kelor berpotensi sebagai antiinflamasi. Flavonoid berpotensi sebagai antioksidan untuk menghambat perkembangan radikal bebas. **Tujuan:** Tujuan penelitian ini adalah melakukan kajian pustaka untuk mengumpulkan informasi umum tentang penggunaan *Moringa oleifera* Lamk dan peran flavonoid terhadap inflamasi. **Metode:** Tinjauan artikel ini disusun menggunakan metode perbandingan dan penelusuran dari berbagai sumber seperti (Google, Google Scholar, NCBI, PubMed) pada periode 2020-2025. **Hasil:** Berdasarkan tinjauan pustaka artikel yang dilakukan dapat disimpulkan bahwa penggunaan daun kelor (*Moringa oleifera*) secara signifikan berpengaruh terhadap inflamasi. Hal ini dikarenakan adanya kandungan flavonoid yang memiliki sifat antiinflamasi pada daun kelor. **Kesimpulan:** Daun kelor memiliki banyak manfaat sehingga dianjurkan untuk memperbanyak konsumsi daun kelor ini.

Kata Kunci: Peradangan, Flavonoid, *Moringa oleifera* Lamk, Anti-Peradangan

Abstract

Background: Inflammation is the body's response to injury due to infection by antigens or cell damage, indicating that something harmful or painful is present in the body. Inflammation is also a protective response to cell damage or infection. Currently, the development of traditional medicine in Indonesia is a hot topic of discussion. With the rapid advancement of technology, many people are affected by various diseases such as inflammation, and so on. Moringa leaves have anti-inflammatory properties. Flavonoids have antioxidant properties that inhibit the development of free radicals. **Objective:** The objective of this study is to conduct a literature review to gather general information about the use of *Moringa oleifera* Lamk and the role of flavonoids in inflammation. **Method:** This article review was compiled using a comparative and search method from various sources such as (Google, Google Scholar, NCBI, PubMed) in the period 2020-2025. Results: Based on the literature review, it can be concluded that the use of moringa leaves (*Moringa oleifera*) has a significant effect on inflammation. This is due to the flavonoid content in moringa leaves, which has anti-inflammatory properties. **Conclusion:** Moringa leaves have many benefits, so it is recommended to increase consumption of these leaves.

Keywords: Inflammation, Flavonoid, *Moringa oleifera* Lamk, Anti-Inflammatory.



Introductions

Inflammation is the body's response to injury, infection/contamination, antigens or cell damage, thus indicating that there is something dangerous or diseased in the body. Inflammation is also a protective response to cell damage or infection. Inflammation occurs through a complex process and involves inflammatory cells which will essentially identify the tissue involved, then recruit leukocytes to the tissue, eliminate the cause of inflammation and restore damaged cell parts.¹ This inflammation is triggered by several factors such as infections that cannot be treated properly and even exposure to pollutants such as chemicals and air pollution. Furthermore, autoimmune disorders are also a trigger for inflammation in the body.

Inflammation can also occur due to allergies or body sensitivity to something. This inflammation will easily affect someone who is stressed and lacks sleep, someone who is obese, and someone who smokes. This inflammation can be treated using drug medical. One of them is NSAID drugs, NSAID drugs are common drugs that are widely used because characteristic anti-inflammatory, analgesic and antipyretic. However, treatment with the consumption of these drugs will last for a long time and has the potential to have high side effects. As a result, there is a possibility that an increase in the hypersensitivity reaction of a drug will also increase a person's sensitivity to the drug.² In addition to treatment with medical drugs, inflammation can also be treated with traditional medicine using herbal plants or medicinal plants.

Currently, the development of traditional medicine in Indonesia is being widely discussed. Where the development of technology is increasing, many people are affected by various diseases such as inflammation, etc. If this disease is treated using synthetic drugs, it will have side effects on sufferers. So that the treatment is carried out by utilizing herbal plants or medicinal plants that have the potential to cure the disease. Indonesia is known as a country with plant resources that abundant. In forest tropical Indonesia found around 30,000 varieties of plants. Regarding the whole, it is predicted that there are around 9,600 types of plants that have the potential to be used as medicine, 200 of which play an important role in the traditional medicine industry because they are processed as raw materials (Sudaryati *et al.* 2025).

Moringa leaves (*Moringa oleifera* Lam) is known to have medicinal potential. In addition to being used as a vegetable, moringa leaves also have various benefits and have been proven effective in treating various types of diseases, including diabetes, hepatitis, heart disease, and high cholesterol. According to previous scientific research, moringa leaves contain the most complete nutrients of all types of plants.⁴ Chemical compounds in moringa leaves, such as alkaloids, flavonoids, phenolics, tannins, triterpenoids, or steroids, have anticancer and anti-bacterial properties. In pharmaceutical formulations, moringa leaves are often modified to be used as medicines. Moringa leaves can be used in the cosmetics industry as raw materials, medicines, and probiotic supplements for health, or as a fortifying agent (nutrient) in food to control nutrition (Dewi *et al.*, 2025).

Moringa leaves also have the potential as anti-inflammatory. Based on the phytochemical analysis that has been carried out, it has been proven that the content of flavonoid compounds, saponins and polyphenol compounds in moringa leaf extract is known to have anti-inflammatory activity.⁶ Based on research by obtained results that in vitro experiments with moringa leaf extract containing flavonoids showed that there was activity that could prevent liposaccharide-induced implantation of PgE2 (prostaglandin E2) and COX-2 (cyclooxygenase 2).⁷ If uncontrolled inflammation occurs, it will cause disruption to the body's homeostasis balance and develop into chronic inflammation and damage tissue. Therefore, a literature review was conducted on the use of moringa leaves for inflammation with the aim of providing information about the benefits of moringa leaves (*Moringa oleifera*) which has the potential for inflammation so that it can be used as a parameter for further researchers and the general public. Inflammation is a disease that is of concern and often occurs in everyone in certain areas of the human body which is characterized by swelling, pain, redness, and a feeling of heat. This happens because there is an immune response from the body working on tissue that has experienced physical stimulation, exposed to harmful substances or microbiological substances.

Inflammation is called the ability of the human body to eliminate invisible organisms or harmful substances that attack, eliminate irritation then the body will carry out the tissue repair stage.⁸ The main goal of treating inflammation is to reduce pain which is the initial process of tissue

destruction and slow down (localize) the process of tissue destruction to defend against infection. Treatment of inflammation generally uses synthetic drugs that are often used to treat inflammation, for example NSAIDs (*Non-Steroidal Anti-Inflammatory Drugs*) and steroids which generally cause many side effects, including nausea, digestive problems, ulcers, melena, and increased blood pressure.⁹ Therefore, further research should further analyze alternative medicines for inflammation with fewer side effects by creating the potential of efficacious compounds from plants derived from nature. The parts of the plant that are utilized include leaves, bark, rhizomes, fruits, and flowers (Juliasih and Adnyana, 2023).

Moringa plant is one of the plants that has the ability as a therapeutic plant where there are many compounds in it. In traditional medicine in Africa and India, Moringa is known to have 539 compounds that have been used in the prevention of more than 300 diseases. The medicinal properties produced by Moringa leaves are as anti-inflammatory, antioxidant, antiulcer, antihypertensive, antidiabetic, antibacterial, lowering cholesterol, smoothing blood circulation, heart stimulant, and diuretic. In Moringa plants, compounds with medicinal properties are found, namely flavonoids. The anti-inflammatory activity of flavonoids has a mechanism in inhibiting the lipooxygenase pathway, cyclooxygenase, and accumulating histamine and leukocytes. Flavonoids are also able to limit the secretion of lysosomal enzymes and arachidonic acid.¹¹ In previous research, anti-inflammatory effectiveness tests were carried out on 3 organs of the Moringa plant (leaves, seeds, roots) through various methods, namely, phytochemical analysis using HPLC-UV/ESI-MS/MS and the effect on production nitric oxide.

In the phytochemical analysis, 5 derivatives of compounds were identified that showed flavonoids, namely rutin, quercetin 3-O- glucoside, quercetin-acetyl-glycoside, kaempferol 3-O- glucoside, and kaempferol-acetylglycoside. Anti-inflammatory activity was evaluated by determining NO production, Moringa leaves showed lower production than positive control, in contrast to other organs. showed higher NO production compared to positive controls, so that moringa leaf extract has greater anti-inflammatory potential. The results of the study concluded that there is a flavonoid content that reveals a positive correlation between the three different parts of the moringa plant, moringa leaves have a more potential anti-inflammatory source than other parts of the plant so that moringa leaves are very promising to be developed as a food supplement or natural medicinal ingredient in the near future.¹² This study aims to determine the ability of ethanol extract of Moringa leaves on male Wistar rats that have been injected with 1% carrageenan. This study can be used as a source of perspective in the utilization of natural plants that have anti-inflammatory activity

Materials and Methods

The method used in this study is a literature review or article review obtained through Google Scholar, PubMed, Scopus, dan Web of Science from 2020 to 2025 (Wiguna et al. 2024). Furthermore, the sources obtained were collected, identified, and evaluated. This study uses appropriate inclusion criteria in the form of articles and journals, which are then used to analyze the use of Moringa leaves in the treatment of inflammation. Inclusion criteria include the content of the article according to the problem that will be discussed research studied (describe the research problem studied) and meanwhile, the exclusion criteria include topics not related to the discussion of research problems. The articles cited come from various sources, such as national journals, original research articles, and non- literature review forms written in Indonesian between 2020 and 2025. The articles in this study use the keyword moringa leaves (*Moringa oleifera*), inflammation and anti-inflammatory. The search was conducted in March 2023 and used Google Scholar as a database source and a search using the Google search engine. The data taken included articles published in 2021 to 2025 using the following keywords: Moringa leaves, Inflammation.

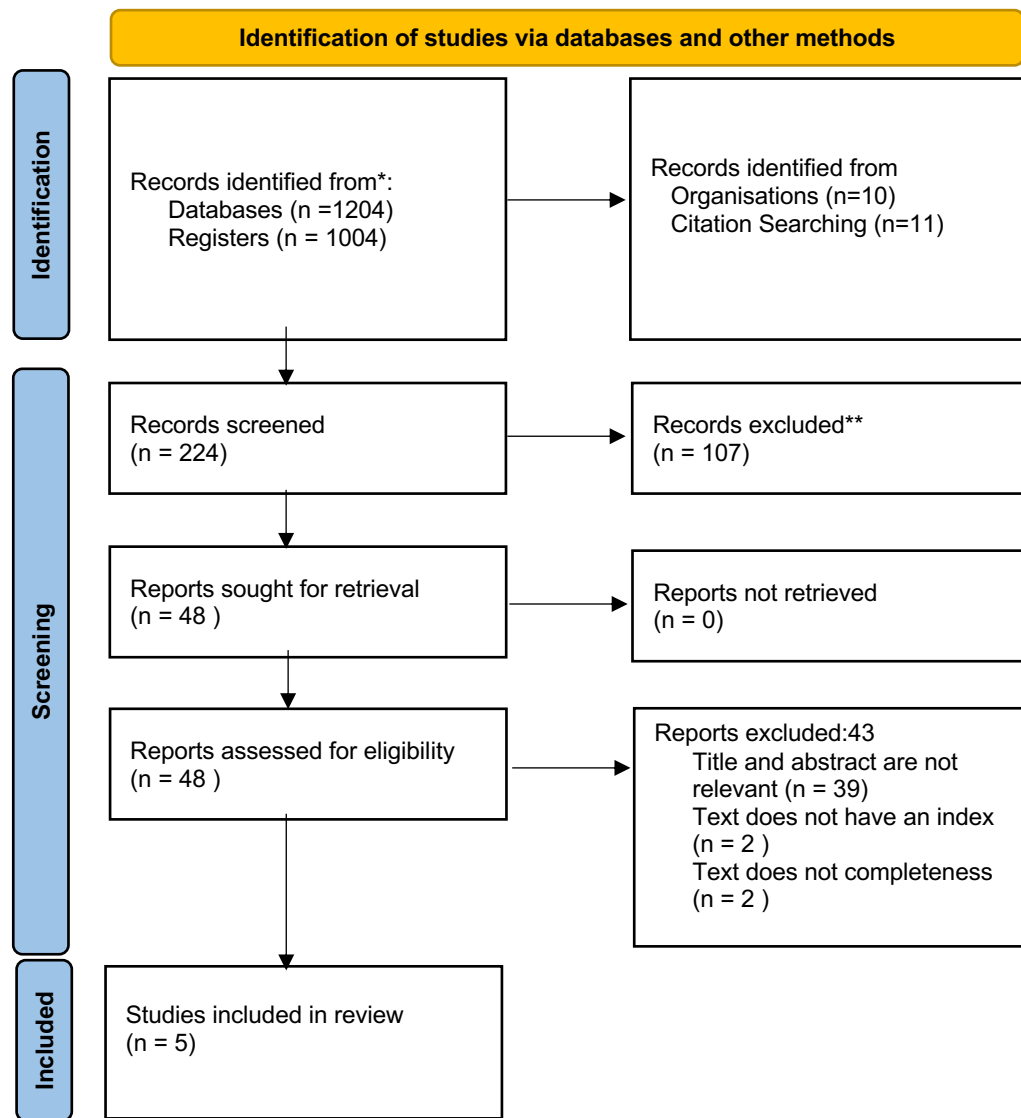


Figure 1. PRISMA Flowcart

Results

According to literature research article which fulfil criteria inclusion/eligibility with systematic review during 2020 to 2025, which is the last 5 years of research. The results of the literature review indicate that moringa leaves can be used for inflammation botulism. Where the content of moringa leaves acts as an anti- inflammatory. A summary description of the research material is presented in the following table.

Table 1. Summary of research results

Title	Author	Method	Result
Uji Efektivitas Antiinflamasi Ekstrak Etanol Daun Kelor (<i>Moringa Oleifera</i> L.) Pada Tikus Jantan Galur Wistar	(Norhikami & Fadhilah, 2024)	In vitro method performed on the soles rat feet with Na-CMC negative control and Na Diklofenak positive control	From this study it can be concluded that the etanol extract of moringa leaves (<i>Moringa Oleifera</i> L.) has anti-infammaty effectiveness in reducing

Title	Author	Method	Result
Pengaruh Variasi Konsentrasi Ekstrak Daun Kelor (<i>Moringa Oleifera</i> Lamk) Terhadap Efek Antiinflamasi Emulgel	(Robby et al., 2022)	In vivo method with analysis statistic use test Anova	or inhibiting inflammation. Study that variety concentration composition emulsifier moringa leaves extract reduce inflammation and have anti-inflammatory effect which strong.
Uji Aktivitas Inflamasi Ekstrak Etanol daun Kelor (<i>Moringa Oleifera</i> L.) Terhadap Tikus Putih Jantan (Galur Wistar)	(Gultom & M, 2021)	Eksperimental Method using mice white male	Result study prove that for lower volume of edema in the feet of mice, ethanol extract of <i>Moringa</i> leaves (<i>Moringa Oleifera</i>) 200 mg/kg bw is the most as anti-inflammatory. The flavonoid that ability for prevent secretion sour arachidonate and enzym lysosom from endothelial. Flavonoid also can prevent proliferation accretion of the inflammatory process.
Formulasi Gel Ekstrak Daun Kelor (<i>Moringa Oleifera</i> Lamk) Sebagai Sediaan Antiinflamasi	(Sugihartini et al., 2020)	Method in vitro use rabbit as experimental animals and the data were studied one – way Anova.	The <i>Moringa</i> Leaves extract have activity anti-inflammatory and can concluded that leaf moringa significant influential to inflammation of the skin
Uji Aktivitas Antibakteri Sediaan Peef Of Mask Ekstrak Etanol Daun Kelor	(Ishak et al., 2022)	Method Quasi Experimental. By obtaining makes peel preparation that mask the etanol contain extract with different concentration.	Based on study result the ethanol extract of moringa leaves have antibacterial and anti-inflammatory

Discussions

Inflamation can overcome with Herbal medicine that can be obtained from nature, one of which is *Moringa* leaves (*Moringa oleifera* Lamk). Based on the literature review article, the results showed that *Moringa* leaves can be used as an anti-inflammatory. *Moringa* leaves can be used to reduce inflammation, both in edema/swelling, endometriosis and skin inflammation. Swelling/edema is a condition that indicates that there is excessive fluid in the body's tissues. This edema occurs when small blood vessels in the body (capillaries) release fluid. This will cause inflammation in the body. One of the plants that can overcome inflammation is *Moringa* leaves. *Moringa* has many

pharmacological properties, including as an antimicrobial, antifungal, antihypertensive, antihyperglycemic, antitumor, anticancer, and pro-implantation. *Moringa oleifera* is another name for moringa leaf extract which contains flavonoids, tannins, terpenoids, alkaloids, and saponins.

These compounds are recognized as being able to be used as herbal medicine substances/materials for health. Flavonoids, alkaloids, and saponins are also components of moringa leaf extract that can function as anti-inflammatory. Flavonoids in moringa leaves have anti-inflammatory, antimutagenic, anti-carcinogenic properties, and have the power to change the function of primary connecting enzymes. In addition, alkaloids can reduce inflammation/inflammation and colon damage in some types of colitis, and saponins can function as anticholesterolemia, anti-inflammatory, anti-parasitic, anti-bacterial, and anti-viral. Moringa Leaves has anti-inflammatory, antibacterial, and immunomodulatory properties. So it can be used as a treatment for skin inflammation. Inflammation also often occurs on the skin, one example is acne. Acne is included in the disease chronic inflammation of the skin and acne caused by bacterial infections such as *Propionibacterium acnes* and *Staphylococcus epidermis*.

In addition, it can reduce dsDNA levels and manage histopathological conditions related to lupus nephritis. The content of quercetin, kaempferol glucoside, and malate flavonoids are flavonoids that show anti-inflammatory activity through stimulation of NO production in macrophage LPS. In line with previous research, specifically research conducted in Malang, the results showed that *Moringa oleifera* can be relevant reduce activity related disease in a mouse lupus model. These results are not much different from the anti-inflammatory properties *Moringa olivine* which was previously observed in a number of studies. The use of Moringa leaves as an anti-inflammatory and anti-oxidant is also effective in reducing leukosis and oxidative stress caused by free radial cells. Such as the results obtained showed that compared to the iron (Fe) tablet group, moringa leaf tea reduced leukocyte levels both before and after the intervention.

This shows that moringa leaf tea is more effective in reducing leukocytes in pregnant women. Because moringa leaves have various macronutrients needed by pregnant women, including, thiamine, riboflavin, niacin, beta-carotene, calcium, iron, phosphorus, magnesium, selenium, vitamin C, anti-oxidants, and anti-inflammatories. One of the chronic inflammatory conditions known as endometriosis occurs in endometrial tissue that grows outside the uterine cavity. Endometrial tissue found in the outer uterine cavity will cause infertility, pelvic inflammation, and long-term pain. In addition to being used as an anti-inflammatory, Flavonoids are also antioxidants that can with stand the oxidation activity of ROS (*Reactive Oxygen Stress*). Flavonoids bind free radicals, resulting in decreased oxidative stress. Decreased oxidative reactions then insulin resistance blocks the development of dysfunction and damage to pancreatic β cells will also decrease.

Flavonoids are also known as compounds that can suppress hyperglycemia by preventing active glucose transport in the intestine and inhibiting sodium-dependent glucose transporters (SGLT1), and increasing transport by inhibiting GLUT2, thereby reducing glucose absorption, thereby lowering blood sugar. ⁶The provision of moringa leaf juice (*Moringa oleifera*) had no significant impact on fasting blood glucose levels in adults at risk for type 2 diabetes. Flavonoid compounds have the potential as antioxidants because there is a series of hypothetical affinities between flavonoids and amino acid residues, most of which provide significant applications regarding the prediction of interactions between flavonoids and proteins in order to understand the biological activity of flavonoids. ¹⁵ In the study it was stated that the activity of flavonoids as antioxidants is characterized by the presence of an ortho-dihydroxy structure in the B- ring causing a double bond at C2-3 conjugated with an oxo-functional group at C4, and there is a hydroxyl group

at C3 on the ring determining the carbon group and hydroxyl at C5 on ring A. The presence of a combination of C3 -hydroxyl group and C5 hydroxyl with a double bond of carbonyl C4 and C2-3 optimizes the ability to capture ROS.

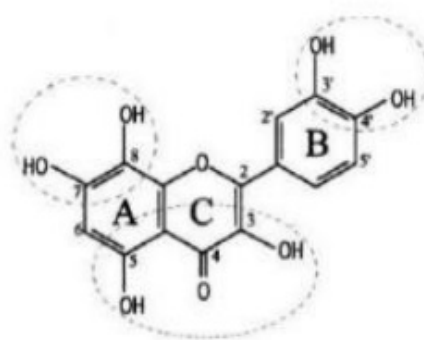


Figure 2. (Munthe et al., 2023)

According to in preventing free radicals, flavonoids are able to stabilize ROS by eliminating oxidizing species of compounds xenobiotic. In the ROS inhibition process, flavonoids will activate the signal route from endogenous enzymes, for example, Cat, SOD, and GPx so that hydrogen peroxide (H₂O₂) and hydroxyl radical (OH) is not formed. Flavonoids can neutralize free radicals directly by donating H atoms. Free radicals become inactive through the response shown in Figure:

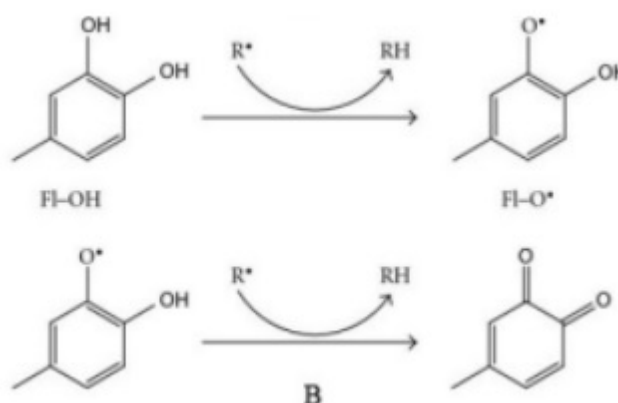


Figure 3. (Munthe et al., 2023)

Where (R) represents free radicals while (Fl-O) is a phenoxyl radical. The antioxidant activity of flavonoids depends on how the functional group arrangement of the core structure is arranged where the arrangement and total number of OH groups in a significant context are able to stimulate the mechanism of flavonoids as antioxidants (Cahyaningrum et al., 2025). The hydroxyl arrangement of ring B is the most dominant in regulating free radical scavenging, while the exchange of rings A and C has a smaller effect on scavenging superoxide anion radicals. The rich content of flavonoid compounds is also shown in the ethanol extract of bidara leaves with the Latin name (*Ziziphus spina Christi* L.). Ethanol extract from bidara leaves (*Ziziphus spina christi* L.) has a total flavonoid content of 1.5312%. In this study, ethanol solvent with a concentration of 70% was used. This is because variations in ethanol concentration can affect the solubility of flavonoid compounds stated that the greater the concentration of ethanol, the lower the polarity of the solvent. So that the use of ethanol with a concentration of > 70% will reduce the total content of flavonoids. The antioxidant activity of bidara leaf extract containing flavonoid compounds was tested using the DPPH method

which obtained the IC value 5090.9584 ppm which is categorized as having very strong antioxidant activity. This is in line with the theory which states that the lower the IC value, the better 50 then the antioxidant activity produced will be greater (Wolde et al. 2024). Who in his research used kaca piring leaf extract (*Gardenia jasminoides* Ellis).

In this study, ethanol solvent with a concentration of 70% was also used so that the total flavonoid content was obtained, namely 5.984 mg QE/g with an IC value of 508.48 ppm which is classified as having very strong antioxidant activity, also conducted research related to the total flavonoid content which has the potential as an antioxidant using different leaf extract samples, namely papasan leaves (*Coccinia grandis* L.) and makadamai (*Macadamia integrifolia*). Determination of antioxidant activity was also carried out using the DPPH method showing the IC value 5039.80 ppm and 24.99 ppm, indicating very strong antioxidant activity. Referring to the study conducted by regarding the effectiveness of leaves *Juniperus phoenicea* It is known that flavonoid compounds with a concentration of 11.33 mg QE/g contained in the leaf extract have been proven to be able to reduce MDA levels in the dermal layer of the feet of mice that have been induced by carrageenan. This is due to the increased activity of antioxidant enzymes produced by flavonoid compounds.

The activity of flavonoid compounds as antioxidants is further strengthened, in which the results showed that flavonoid compounds contained in lemon peel are able to protect the skin from exposure to UVB rays. This is because the flavonoids contained in lemon peel are able to increase Nrf2/HO-1 and antioxidant enzymes such as, Superoxide dismutase (SOD) and encourages a decrease in serum MDA and 8-iso-PGF2a levels. Superoxide dismutase (SOD) is one of the free radical scavenging which is responsible for defending the body from the impact of increased oxidative stress. ¹⁵Research conducted by also stated that lemon peel extract containing flavonoid compounds has very strong antioxidant activity.

Conclusions

Based on the results of studies from several literatures above, it can be concluded that flavonoids are included in the group of secondary plant metabolite compounds that have the potential as antioxidants to inhibit the development of free radicals. Overall, flavonoids from various sources show strong potential as antioxidant agents that can be seen both through in vitro and in vivo tests. This potential is also influenced by the basic structure and the most important structure of the flavonoid compound. Flavonoids are also components of moringa leaf extract that can function as anti- inflammatories. Flavonoids in moringa leaves have the power to change the function of primary connecting enzymes. The use of Moringa leaves as an anti- inflammatory and anti-oxidant is also effective in reducing leukosis and oxidative stress caused by free radial cells. On the literature review of the articles conducted, it can be concluded that the use of Moringa leaves (*Moringa oleifera*) significantly affects inflammation. This is due to the content of flavonoids, have anti-inflammatory properties in moringa leaves. Moringa leaves have many benefits so it is recommended that the consumption of these moringa leaves be increased.

Conflict of Interest

The authors declare that there are no conflicts of interest with any party.

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