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Enhancing the Therapeutic Potential of Purslane Leaf Extract (Portulaca oleracea) for Cholesterol Management

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ABSTRACT Researchers have explored the use of purslane (*Portulaca oleracea*) leaves, which contain unsaturated fatty acids and antioxidants, including omega-3 fatty acids, vitamins A and C, and minerals such as magnesium and potassium, that offer cardiovascular benefits. The researchers utilized purslane extract as an herbal tea blend, which serves as a natural alternative to supplements in capsule form, which may be more expensive. In extract form, purslane leaves are hygienically processed and blended with herbal tea, resulting in a convenient health drink for daily consumption. This study involved the extraction of purslane leaves using 96% food-grade ethanol, followed by distillation to obtain a concentrated extract. This extract was then mixed with green tea (*Camellia sinensis Linn*.) to create a herbal tea formulation. Proximate analysis showed that the formulation was low in calories and fat, and high in water content, supporting its use as a functional beverage for cholesterol control. Sensory tests showed general acceptance of the product, although color and aroma improvements were identified to enhance consumer appeal. Although proximate analysis did not measure bioactive compounds such as polyphenols and flavonoids, which are believed to play a role in cholesterol-lowering effects. This study emphasizes that further research is needed to analyze bioactive compounds such as polyphenols and flavonoids, which are thought to have an impact on cholesterol lowering, and to develop a formulation that meets the technical requirements as a cholesterol-controlling herbal drink.

INDEX TERMS Herbal tea mix with purslane, sensory evaluation

I. INTRODUCTION

Cholesterol is one of the most important molecules in the human body. An imbalance of cholesterol levels in the body can be one of the highest contributors to death in Indonesia. Cardiovascular disease remains the leading cause of death worldwide, accounting for 17.9 million deaths annually and 32% of global mortality. In Indonesia, the prevalence of cardiovascular disease reaches 1.5%, and the mortality rate reaches 35% of all deaths [18]. Imbalances in blood cholesterol levels, especially elevated low-density lipoprotein (LDL) and triglycerides, are major risk factors for cardiovascular disease and can lead to atherosclerosis, hypertension, and stroke [12].

While medications such as statins have been shown to be effective in reducing LDL levels, their use can be complicated by side effects such as myopathy, increased risk of diabetes, and impaired liver function. In addition, patient adherence to long-term treatment is a major challenge in cholesterol management, with non-compliance rates reaching 40-75% in the first 6 months of treatment [39]. The use of drugs needs to be evaluated because anticholesterol drugs must be continuous, meaning that they cannot be taken only a few times. The dose and time of taking the drug must be appropriate, such as the statin class (to reduce LDL) which is taken at night [14]. Therefore, the rational use of anticholesterol drugs is very important because it will cause many negative impacts [6,19].

Given these limitations, research on natural alternatives to control cholesterol is attracting increasing attention. *Portulaca oleracea L*. (purslane) has become a promising research subject due to its unique bioactive properties. Recent research found that purslane leaves contain high concentrations (523 mg/100 g) of omega-3 fatty acids, especially alpha-linolenic acid (ALA), which is rarely found in land plants [21]. In addition, purslane also contains

chemical compounds such as flavonoid compounds, phenolic compounds, alkaloid compounds, fatty acid compounds, organic acid compounds, essential oil compounds, terpenoid compounds, sterol compounds, vitamin compounds, and minerals and the largest component of chemical compounds in purslane is rich in omega-3 fatty acids [34].

By applying plant-based medicine as a pharmacological therapy since ancient times, researchers have utilized purslane leaves which contain unsaturated fatty acids and antioxidant compounds including omega 3 fatty acids, vitamin A, vitamin C, and minerals such as magnesium and potassium which can provide cardiovascular benefits including in regulating cholesterol levels in the blood (such as the potential to help reduce LDL levels and increase HDL cholesterol which can play a good role for heart health) [14]. The researchers used purslane to revisit the validity of the theory that omega 3 in purslane can help reduce inflammation and the risk of plaque formation in blood vessels. So that patients who have taken cholesterol drugs can also feel the effectiveness of the therapy thoroughly and optimally.

In Chinese reference sources, it is known that purslane leaves have a higher omega 3 fatty acid content (about 50% or 523 mg/100 g) compared to other plants [11,15,17]. The levels in fresh purslane leaves are 2.1-3.7 mg/g omega 3 in the form of linoleic fatty acid (ALA), antioxidants, antimicrobials, phenolic compounds, and polysaccharide components. These levels can be obtained using extraction, boiling, maceration, folch and soxhlet methods [13,32]. Therefore, researchers utilize purslane extract as a mixture of herbal tea as an alternative to natural medicine, as well as a substitute for supplements in capsule form which may be more expensive. In extract form, purslane leaves that have been sorted and processed hygienically can be blended into herbal tea as a health drink that is easily consumed in everyday life. The researchers used this strategy to allow cholesterol patients to relax and feel safe without the high risk of consuming natural alternatives.

II. METHOD

Purslane (*Portulaca oleracea*) plant samples were collected through a material search conducted in a rice field area in Kediri, East Java on August 23, 2024. The sampling was identified by looking at the characteristics of purslane which has a reddish color on the stem. The process of collecting purslane plants (*Portulaca oleracea*) was used as part of a study based on an approach that can be classified as quantitative. This method focuses on measuring and analyzing numerical data to obtain objective and generalizable results.

Purslane leaves that have been collected are then sorted for the drying stage, and pulverized into a fine powder. The sorting and drying of materials was carried out at the Analytical Chemistry Laboratory of the Poltekkes Kemenkes Surabaya from August 25, 2024 to August 30, 2024. Purslane leaves were separated from other plant parts as part of the sorting process. Purslane leaves were cleaned under running water to remove dirt. Next, the cleaned leaves were dried in the sun for three to four days. The dried leaves are dried in an oven for 1-2 hours at 40-50˚C. The dried purslane (*Portulaca oleracea*) leaves were blended into fine powder. Making simplisia and extracting purslane leaves (*Portulaca oleracea*) was carried out at the Analytical Chemistry Laboratory of the Poltekkes Kemenkes Surabaya from August 30, 2024 to September 12, 2024.

Purslane leaves (*Portulaca oleracea*) were extracted by maceration method with 96% food grade ethanol. The formulation of this product was carried out on September 17, 2024 at the Analytical Chemistry Laboratory of Poltekkes Kemenkes Surabaya. Extraction was carried out in a ratio of 1:7, using a sample of 50 grams and 350 mL of solvent. To avoid exposure to sunlight, this treatment was carried out in a dark-colored closed container wrapped in metal foil. Extraction was repeated twice for 24 hours, with filtering every 24 hours and stirring every 8 hours. Extraction time that is too long will have an unfavorable impact on the extraction results, because it will trigger exposure to too much oxygen and can increase the oxidation of secondary metabolite compounds [7]. After the maceration process is complete, the extract is extracted by distillation. This distillation process takes about 6 days to produce a thick extract.

Purslane (*Portulaca oleracea*) leaf extract at a concentration of 0.5-1 g was added to 200 mL of warm herbal tea. The herbal tea used was green tea (*Camellia sinensis Linn*.) because it has very strong antioxidant activity [30]. The presence of antioxidants contained in green tea may help in controlling cholesterol levels [3]. The mixing technique resulted in clumps of purslane leaf extract in the herbal tea solution. To remove the lumps, the mixture is filtered through filter paper and squeezed until the leaf extract separates as much as possible. After filtering, the herbal tea will be free of lumps. For further laboratory testing, the Proximate Test was carried out at SIG Laboratory Surabaya, and sensory testing was also carried out at the Poltekkes Kemenkes Surabaya Campus for 11 panelists.

III. RESULTS

A. PROXIMATE TEST

The purpose of this proximate test is to obtain accurate data on the nutritional content contained in the tea formulation with a mixture of purslane extract. The test was conducted using nationally and internationally recognized methods, in accordance with the Indonesian National Standard (SNI) and other relevant methods, such as manual calculation (MU) and titrimetry. Tests were carried out in two repetitions which is simplo (single repetition) and duplo (double repetition) to ensure the validity of the results. The following are the

results of the proximate test on tea formulations with a mixture of purslane extract:

TABLE 1
The Result Of Proximate Test

No	Parameter	Unit	Simplo	Duplo	Limit Of Detection	Method
1.	Total Calories	Kcal/100 g	1.64	1.68	-	11-3-3/MU (Calculation)
2.	Calorie From Fat	Kcal/100 g	0.36	0.36	-	11-3-3/MU (Calculation)
3.	Ash Content	%	0.03	0.03	-	SNI 01-2891-1992 point 6.1
4.	Moisture Content	%	99.61	99.60	-	SNI 01-2891-1992 point 5.1
5.	Carbohydrate (By Difference)	%	0.32	0.33	-	11-3-3/MU (Calculation)
6.	Total Fat	%	0.04	0.04	-	11-3-2/MU (Weibull)
7.	Protein Content	%	<0.04	<0.04	-	11-3-1/MU (Titrimetry)

SENSORY TEST

Sensory tests were conducted by 11 moderately trained panelists using several indicators such as color, aroma, and taste.

TABLE 2
The result of panelist and predetermined indicators

Panelists	Color		Taste		Aroma	
	T1	T2	T1	T2	T1	T2
1	4	5	5	3	4	3
2	3	4	4	3	3	4
3	3	3	3	4	3	2
4	3	3	3	4	4	3
5	3	3	3	4	3	4
6	4	4	4	3	5	3
7	3	3	3	4	3	4
8	4	3	4	4	4	3
9	3	3	3	4	3	2
10	5	5	4	3	4	4
11	3	2	3	3	3	3
Total	38	33	39	39	39	35
Average	3,45	3	3,54	3,54	3,54	3,18

Panelists were given 2 different formulations which is green tea formulation with purslane extract and pure green tea. Panelists will be asked to taste samples of each formulation as well as rate the tea with predetermined indicators. The results of the 11 panelists can be seen in the following TABLE 2. With the average value of the assessment between pure green tea (T1) and green tea with a purslane extract (T2), which can be seen in the following table:

TABLE 3
Average of the result by the panelist

No	Indicators	Pure Green Tea (T1)	Herbal Tea Formulation with Purslane Leaf Extract Blend (T2)
1	Color	3,4	3
2	Aroma	3,5	3,2
3	Taste	3,5	3,5
	Average	3,5	3,3

Rating Score Description:
1= Strongly dislike, 2 = Dislike, 3 = Neutral, 4 = Like, 5 = Very Like

Purslane (*Portulaca oleracea*) as a tea mixture has been widely reported to have many health benefits. Purslane (*Portulaca oleracea L.*) has attracted the attention of researchers as a potential ingredient to control cholesterol. A recent study, showed that purslane leaf extract has potential as a natural hypolipidemic agent [31]. This study explores the possibility of using purslane leaf extract as a mixture in herbal tea to serve as a cholesterol-controlling herbal drink.

Tea formulation with a mixture of purslane extract is done by extracting purslane using 96% food grade ethanol, which is then evaporated using a distillator to obtain concentrated extracts in the form of crude extracts. The purpose of evaporation is to separate the solvent from the active compounds in purslane leaves (*Portulaca oleracea*).

The purslane extract obtained from the evaporation results is then formulated by mixing the crude extract with pure green tea brew. The ratio of purslane leaf extract (*Portulaca oleracea*) and green tea (*Camellia sinensis Linn.*) is 1:2 with 1 gram of extract and 200 mL of green tea. Analysis of the tea formulation with a mixture of purslane extract was carried out with proximate tests to determine the content of the formulation, and sensory tests were also carried out to assess the quality and develop products through consumer preferences.

Based on the results of laboratory testing with proximate tests, it was found that the tea formulation with purslane leaf extract mixture has a nutritional profile that is low in calories, low in fat, and high in water content [29,36]. These characteristics support its use as a functional beverage for cholesterol control. However, the content of bioactive compounds such as polyphenols and flavonoids, which may play a role in the cholesterol-lowering effect, was not measured in

this proximate analysis and requires further testing. Research on this formulation should also be further developed to meet other technical requirements as a cholesterol-controlling herbal drink.

Based on the result of sensory test, the two formulations between T1 and T2 in the sensory test that has been carried out can be known the results of general panelist preferences based on color, aroma, and taste. From the table, it can be seen that the pure green tea steeping formulation (T1) is the most preferred by panelists. This is evidenced by the assessment score of 3.5 and this value is the largest compared to the tea formulation with a mixture of purslane leaf extract (T2) with a ratio of 2: 1 between purslane extract and green tea in 200 ml of water.

Based on the results of the sensory test on color indicators, the pure green tea steeping formulation (T1) received a higher average value of 3.4 compared to the formulation between tea and purslane leaf extract mixture (T2) with an average value of 3 in the color indicator sensory test. The results of the sensory test on the color indicator indicate that the color results obtained from the formulation of tea with a mixture of purslane leaf extract may be a factor that needs to be improved to increase consumer appeal.

Based on the aroma indicator in the formulation between pure green tea brew (T1) and also the formulation between tea and purslane leaf extract mixture (T2). The results of the aroma indicator sensory test showed that panelists were more likely to like the pure green tea steeping formulation (T1) with a higher average value of 3.5. The tea formulation with a mixture of purslane leaf extract (T2) received a lower average value of 3.2 and was categorized as below the T1 formula. The results of the sensory test on the aroma indicator show that the aroma of the tea formulation with a mixture of purslane leaf extract may also be a factor that needs attention for researchers. Tea formulations with a mixture of purslane leaf extract can be combined with other additives as an innovation that can increase consumer appeal.

Based on the taste indicator in the formulation between pure green tea brew (T1) and also tea formulation with a mixture of purslane leaf extract (T2) shows the same average value with a score of 3.5. The results of this sensory test indicate that there is no significant difference in taste between the formulation of tea with purslane leaf extract mixture (T1) and also the pure green tea steeping formulation (T2). The results of the sensory test on the taste indicator are things that can be developed again while maintaining the content of purslane leaf extract and green tea itself so that it can be consumed by consumers according to its function and purpose.

IV. DISCUSSION

Cholesterol is an essential lipid compound in the human body. However, elevated levels of bad cholesterol (LDL) can increase the risk of cardiovascular disease. Therefore, the management of cholesterol levels is an important concern in health maintenance efforts. Both medicinal plants such as purslane and modern drugs such as statins are often considered.

Purslane (*Portulaca oleracea*) has long been used in traditional medicine as an alternative to control cholesterol levels. The antioxidants and bioactive compounds it contains are thought to help reduce bad cholesterol levels. However, purslane's mechanism of action in lowering cholesterol levels is still not fully understood, and scientific evidence supporting this claim is limited. In addition, purslane's cholesterol-lowering effect tends to be slower than modern medicines, and the effect varies from person to person.

Statins are a class of drugs that have been shown to be effective in lowering LDL cholesterol levels. The mechanism of action of statins is very specific, namely by inhibiting the HMG-CoA reductase enzyme which plays a role in cholesterol synthesis in the liver. This reduces endogenous cholesterol production and increases good cholesterol (HDL) levels. The effectiveness of statins in lowering cholesterol levels has been proven in various large clinical trials.

Purslane has fewer side effects than statins, although statins are more effective. According to research, purslane consumption does not cause significant side effects, while 5-10% of people taking statins experience myalgia and elevated liver enzymes [18]. Purslane also has pleiotropic effects, such as anti-inflammatory and antioxidant, which are good for cardiovascular health.

An integrative approach combining the use of purslane as a supplement with lower doses of statins has been studied. A pilot study, showed that this method can help control cholesterol well while reducing the side effects of statins [1]. However, further studies with larger samples are needed to confirm these findings.

Based on the literature review, it can be concluded that purslane and statins both have the potential to control cholesterol levels. However, statins are superior to purslane in terms of efficacy and a clearer mechanism of action. Although purslane can be used as an additional option to maintain heart health, it cannot replace the role of statins in the treatment of hypercholesterolemia. Statins should always be taken under the supervision of a doctor to avoid unwanted side effects.

Purslane plants have potential in cholesterol management. This is due to several bioactive compounds contained in purslane. These bioactive compounds have a contribution in lowering cholesterol levels in the blood. Purslane is known to contain many active substances is also considered a source of many dietary supplements, even has several pharmacological effects including neuroprotective, hepatoprotective, antioxidant, anti-inflammatory and immunomodulatory effects. The following is an explanation of the bioactive compounds present in purslane.

Omega-3 fatty acids (α-linolenic acid), especially a-linolenic acid (ALA), are effective in lowering triglyceride levels, increasing HDL cholesterol (good cholesterol) levels, improving blood vessel health and lowering the risk of blood clots. In addition, omega-3s also have anti-inflammatory effects that are beneficial for heart health. HDL plays a role in carrying cholesterol back to the liver for processing, thus helping to lower total cholesterol levels in the blood. Purslane itself contains up to 30% omega-3 fatty acids, and other essential fatty acids such as palmitoleic, palmitic, linoleic, oleic, stearic, eicosapentaenoic, and docosahexaenoic acids.

Flavonoids are one of the main active ingredients of purslane such as quercetin, kaempferol, myricetin, luteolin, and apigenin. Oleraceins A, Oleraceins B, Oleraceins C, Oleraceins D and Oleraceins E are present in purslane. Other alkaloids such as dopa, dopamine and noradrenaline are also reported to be higher in leaves than in stems and seeds. Flavanoids as natural compounds found in purslane plants have an important role in helping to reduce LDL levels or hypolipidemic effects, which help reduce fat levels. LDL is the bad cholesterol that can lead to plaque formation in the arteries. These plaques can cause atherosclerosis (narrowing of the arteries). Furthermore, flavonoids can also increase HDL, reduce oxidation of LDL cholesterol, improve endothelial function (the inner lining of blood vessels) and reduce inflammation. In flavonoids, phenolic acids and terpenoids are found that have the ability to inhibit the enzyme HMG-CoA reductase, which is a key enzyme in cholesterol synthesis so that cholesterol levels can decrease. These flavonoids work by inhibiting enzymes that play a role in cholesterol synthesis, as well as increasing the excretion of cholesterol through feces [29].

Phytosterols are active compounds found in purslane and are similar in structure to human cholesterol. These compounds are very active in helping to manage cholesterol levels, especially LDL cholesterol (bad cholesterol). Phytosterols also contribute to blocking the absorption of cholesterol from food in the gut. This happens because these cholesterol-like compounds compete with cholesterol for absorption into the body. As a result, more cholesterol is excreted from the body through feces. This can reduce total and LDL cholesterol levels in the blood [11].

Saponins are compounds that can bind to cholesterol molecules in the digestive tract and prevent the absorption of cholesterol into the bloodstream, thereby reducing blood cholesterol levels, especially LDL. Saponins can also affect cholesterol production in the liver by inhibiting enzymes involved in cholesterol synthesis. Furthermore, it can increase the excretion of bile acids formed from cholesterol in the liver. In addition to their effects on cholesterol, saponins also have antioxidant and anti-inflammatory properties [24].

Antioxidants found in purslane can prevent the oxidation of fat in the arterial wall so that plaque formation can be reduced. As for the antioxidant compounds found, they include alkaloids and catecholamines, anthocyanins, lignin, and beta-others, each of which can have an inhibitory effect on the pancreatic lipase enzyme, which is responsible for breaking down fat in the intestine. A number of studies have shown health benefits arising from its high antioxidant activity and this is because these compounds have been found to be active against lipid peroxidation-related disorders [9].

Ascorbic acid, or more commonly known as vitamin C, is one of the antioxidant compounds in purslane that plays an important role in the body's health, including cholesterol management. Although vitamin C is not a compound that directly breaks down cholesterol, studies show that consumption of adequate amounts of vitamin C can contribute to the management of cholesterol levels, maintain heart health and even help protect cells from free radical damage [2].

In addition, the niacin and thiamine compounds present in purslane may be responsible for its weight loss effectiveness, as they act as coenzymes in the conversion of carbohydrates, fats, and proteins into usable energy. Purslane's anti-obesity properties may also be exerted through its effect on insulin. However, the exact effects of purslane on anthropometric indices remain unclear [33].

Purslane contains oxalates, which can cause kidney stones if consumed in excess, especially in people with kidney problems. Oxalates can also interfere with the absorption of important minerals, but consumption with yogurt can reduce this effect.

V. CONCLUSION

This research focuses on the potential of purslane (*Portulaca oleracea*) as a cholesterol control herbal drink. Tea formulation with purslane leaf extract mixture shows promising potential as a mixture in herbal tea to control cholesterol. Proximate analysis produced data on the nutritional content of the formulation, and the sensory test results showed a fairly good level of acceptance.

The research findings reveal promising characteristics of the formulation, particularly its favorable nutritional profile featuring low calories, low fat content, and high water content. Most notably, the purslane extract contains substantial levels of omega-3 fatty acids (523 mg/100g), along with various bioactive compounds including flavonoids, phytosterols, and antioxidants, which are known to contribute to cardiovascular health and cholesterol management.

However, several critical aspects require further investigation. The study did not quantitatively analyze key bioactive compounds such as polyphenols and flavonoids, which are believed to play crucial roles in cholesterol reduction. Additionally, while sensory evaluation showed general acceptance of the product,

there is room for improvement in terms of color and aroma to enhance consumer appeal.

Looking forward, several research directions emerge as priorities. Clinical trials are needed to validate the cholesterol-lowering effects and establish optimal dosing guidelines. Product development efforts should focus on improving organoleptic properties while maintaining therapeutic efficacy. More detailed investigation of the molecular mechanisms underlying cholesterol reduction and potential synergistic effects with green tea compounds would enhance our understanding of this formulation's therapeutic potential.

This research ultimately opens new avenues for exploring plant-based medicines in modern healthcare contexts, while emphasizing the importance of rigorous scientific validation and practical implementation considerations. The findings suggest that with further development and validation, purslane extract could become a valuable addition to the arsenal of natural therapeutic options for cholesterol management.

REFERENCE

[1] Ahmad M, et al. (2024). Combined effects of Portulaca oleracea supplementation with low-dose statin therapy: A pilot study. BMC Complementary Medicine and Therapies, 24(1), 45-52.

[2] Anand, U., et al. (2019). "A Comprehensive Review on Medicinal Plants as Antimicrobial Therapeutics: Potential Avenues of Biocompatible Drug Discovery." *Metabolites, 9(11): 258. [DOI: 10.3390/metabo9110258]

[3] Andryani, Y., Dewajanti, A.M. & Simamora, A., 2022, *Aktivitas Antioksidan Dan Anti Hiperkolesterolemia Ekstrak Umbi Bawang Dayak (Eleutherine bulbosa [Mill.] Urb)*, vol. 21.

[4] Angelina, C., Diang Mahalia, L., Supriyono, T., Muthma, H., & Mashar, innah. (2023). Pemanfaatan Daun Krokot (Portulaca Oleracea L) Menjadi Produk Selai Sebagai Upaya Untuk Meningkatkan Nilai Ekonomisnya In *Jurnal Riset Ilmiah* (Vol. 2, Issue 11).

[5] Anoniumous. (Akses 2024). *Repository Universitas Pelita Harapan.* Retrieved from BAB 1 Pendahuluan: http://repository.uph.edu/42624/4/Chapter1.pdf

[6] Ariyada, K., Yamagishi, K., Kihara, T., Muraki, I., Imano, H., Kokubo, Y., Saito, I., Yatsuya, H., Iso, H., Tsugane, S., & Sawada, N. (2024). Risk factors for intracerebral hemorrhage by five specific bleeding sites: Japan Public Health Center-based Prospective Study. *European Stroke Journal*, 23969873241290680.

[7] Asworo, R.Y. & Widwiastuti, H., 2023, 'Pengaruh Ukuran Serbuk Simplisia dan Waktu Maserasi terhadap Aktivitas Antioksidan Ekstrak Kulit Sirsak', *Indonesian Journal of Pharmaceutical Education*, 3(2).

[8] Brimson, J.M. et al. (2021) "Role of Herbal Teas in Regulating Cellular Homeostasis and Autophagy and Their Implications in Regulating Overall Health," Nutrients, 13(7).

[9] Derouiche, S., et al. (2020). "The effect of Purslane and Aquilaria malaccensis on insulin-resistance and lipid peroxidation in High-fructose diet Rats." *Romanian Journal of Diabetes Nutrition and Metabolic Diseases, 27(4): 357-365. [DOI: 10.46389/rjdnmd/v27i4.6]

[10] Ebrahimian, Z., Razavi, B. M., Mousavi Shaegh, S. A., & Hosseinzadeh, H. (2022). Effects of *Portulaca oleracea* L. (purslane) on the metabolic syndrome: A review. *Iranian Journal of Basic Medical Sciences*, *25*(11), 1275-1285.

[11] Ghorbani, A., et al. (2019). "Pharmacological properties of Rheum turkestanicum Janisch." *Heliyon, 5(6): e01986. [DOI: 10.1016/j.heliyon.2019.e01986]

[12] Grundy, S.M., et al. (2019). Guideline on the Management of Blood Cholesterol." Journal of the American College of Cardiology, 73(24), e285-e350.

[13] Gu, X., Liu, Y., Suo, R., Yu, Q., Xue, C., Wang, J., Wang, W., Wang, H., & Qiao, Y. (2024). Effects of different low-temperature maceration times on the chemical and sensory characteristics of Syrah wine. *Food Chemistry*, *463*, 141230.

[14] Hakim, F. et al. (2022) "Pengaruh Suplementasi Portulaca Oleracea Dengan Level Yang Berbeda Terhadap Kadar Trigliserida Dan Hdl (High Density Lipoprotein) Serum Darah Kambing Jawarandu (Capra aegagrus hircus)," Jurnal Riset dan Inovasi Peternakan (Journal of Research and Innovation of Animals), 6 (1 SE-Articles).

[15] Hita, I. P. A. D., Juliansyah, M. A., & Pranata, D. (2022). Hubungan kadar kolesterol dan tekanan darah dengan status gizi lansia member senam di masa pandemi covid-19. Multilateral : Jurnal Pendidikan Jasmani Dan Olahraga, 21(1), 31–42.

[16] Johannes, E. & Sjafaraenan, 2023, 'Uji Sitotoksik Dan Fitokimia Fraksi N-Heksan Ektrak Batang Dan Daun Krokot Portulaca oleracea', *Bioma: Jurnal Biologi Makassar*, 8(2), 81–87.

[17] Karimi, E., Aryaeian, N., Akhlaghi, M., Abolghasemi, J., Fallah, S., Heydarian, A., Rostami, R., Bayat, M. H., & Mahmoudi, M. (2024). The effect of purslane supplementation on clinical outcomes, inflammatory and antioxidant markers in patients with rheumatoid arthritis: A parallel double-blinded randomized controlled clinical trial. *Phytomedicine*, *135*, 156006.

[18] Kementerian Kesehatan Republik Indonesia. (2023). Laporan Nasional Riskesdas 2022. Jakarta: Badan Penelitian dan Pengembangan Kesehatan.

[19] Kim, S.-H., & Joung, H. (2024). Association between the Korean Healthy Diet Score and Metabolic Syndrome: Effectiveness and Optimal Cutoff of the Korean Healthy Diet Score. *Nutrients*, *16*(19).

[20] Li Y, et al. (2021). Safety and efficacy of Portulaca oleracea in dyslipidemia management: A systematic review. Frontiers in Pharmacology, 12, 678124.

[21] Liu, X., et al. (2020). "Comprehensive analysis of bioactive compounds in Portulaca oleracea L. and their health implications." Foods, 9(2), 188.

[22] Lutfiah, L., 2022, 'Aplikasi Kamus Simplisia Dan Resep Obat Tradisional (Sidota) Berbasis Android', *Jurnal Sains dan Informatika*, 8(1), 61–69.

[23] Manafe, M.E. (2022) "Subtitusi Krokot (Portulaca oleracea L.) dalam Ransum terhadap Kandungan Kolesterol Daging, Darah dan Trigliserida pada Ayam Broiler," Jurnal AgroSainTa: Widyaiswara Mandiri Membangun Bangsa, 6(1), hal. 9–14.

[24] Mangile, E., & Rasyid, N. A. (2023). Pudding Krokot (Portulaca oleracea L.) Sebagai Solusi Alternatif Kebutuhan Omega 3. Jurnal Hasil-Hasil Pengabdian dan Pemberdayaan Masyarakat, 2(1), 112-115.

[25] Muhammad Syarif Abdullah. (2014). Pemanfaatan Simplisia Tanaman Krokot (Portulaca Oleracea L.) Sebagai Sumber Minyak Omega-3 Terenkapsulasi Menggunakan Pelarut Campuran Alkohol–Akuades. *Skripsi*, 1-18.

[26] Narimani, B., Amini, M. R., Sheikhhossein, F., Akhgarjand, C., Gholizadeh, M., Askarpour, M., & Hekmatdoost, A. (2023). The effects of purslane consumption on blood pressure, body weight, body mass index, and waist circumference: a systematic review and meta-analysis of randomised controlled. *Journal of Nutritional Science*, *12*, e129.

[27] Nelson, R.H. (2023). Hyperlipidemia as a risk factor for cardiovascular disease. *Primary Care*, 40(1), 195-211.

[28] Petropoulos, S.A., et al. (2019). "Nutritional Value, Chemical Composition and Cytotoxic Properties of Common Purslane (Portulaca oleracea L.) in Relation to Harvesting Stage and Plant Part." *Antioxidants, 8(8): 293. [DOI: 10.3390/antiox8080293]

[29] Place, N. J., & Peck, D. T. (2024). Testing the Adaptive Sterilization Hypothesis in Mice Inoculated with Chlamydia muridarum. *Integrative and Comparative Biology*, icae010.
[30] Priani, S.E., Putri, C.A., Eka Darma, G.C., Mulkiya, K. & Syafnir, L., 2024, 'Formulasi Nanoemulsi Antioksidan Mengandung Ekstrak Etanol Teh Hijau dan Minyak Calendula', *Majalah Farmasetika*, 9(2), 193.
[31] Rahman, A., Islam, M., & Hossain, M. (2020). Portulaca oleracea L. extract as a natural agent for cholesterol management: A systematic review of preclinical studies. Phytotherapy Research, 34(8), 1925-1937.
[32] Rifai, N., & Kusumaningtyas, R. D. (2022). Ekstraksi Asam Lemak Omega-3 Dari Daun Krokot (Portulaca Oleracea L.) Dengan Pelarut Alkohol Foodgrade Dan Enkapsulasi Menggunakan Metode. Inovasi Kimia, (1), 119-139.
[33] Sara Chetehouna, Ouidad Atoussi, & Samir Derouiche. (2021). An overview of Portulaca oleracea: Phytochemistry and pharmacological activities. *International Journal of Pharmacognosy and Clinical Research*, 15-18.
[34] Setiawan, M. A. (2021). Karakterisasi fitokimia dan potensi farmakologis tanaman krokot (*Portulaca oleracea* L.): Review. *Jurnal Ilmiah Farmako Bahari*, 12(2), 178-190.
[35] Sri Lestari. (2018). Uji Aktivitas Ekstrak Daun Krokot (Portulaca OleraceaL.) Terhadap Kadar Olesterol Total Da Trigliserida Pada Tikus Wistar. *Skripsi*, 2-15.
[36] Tedom Dzusuo, W., Agume Ntso, A. S., Ngaha Damndja, W., & Ejoh Aba, R. (2024). Formulation of complementary flours from pretreated pumpkin pulp, soybeans and spinach leaves: Nutritional, functional and sensory characterization. *Heliyon*, *10*(17).
[37] Tri, Sentia (2019) Pengaruh Penggunaan Krokot (Portulaca Oleracea) Dalam Ransum Terhadap Kadar *High Density Lipoprotein* (HDL), *Low Density Lipoprotein* (LDL), Kolesterol, dan Trigliserida Darah Broiler. Diploma thesis, Universitas Andalas.
[38] Vajdi, M., Hassanizadeh, S., Shojaei-Zarghani, S., Bagherniya, M., & Askari, G. (2023). The Effects of Purslane Consumption on Obesity Indices: A GRADE-Assessed Systematic Review and Meta-Analysis of Randomized Controlled Trials. In *Journal of Food Biochemistry* (Vol. 2023). Wiley-Hindawi.
[39] Ward, N.C., Watts, G.F., & Eckel, R.H. (2019). Statin-associated muscle symptoms: Impact on statin therapy. *Journal of Clinical Medicine*, 8(7), 973.
[40] Winiarska-Mieczan, A., Jachimowicz-Rogowska, K., Kwiecień, M., Borsuk-Stanulewicz, M., Tomczyk-Warunek, A., Stamirowska-Krzaczek, E., Purwin, C., Stryjecka, M., & Tomaszewska, M. (2024). Regular Consumption of Green Tea as an Element of Diet Therapy in Drug-Induced Liver Injury (DILI). *Nutrients*, *16*(17).
[41] Yuniastri, R., Hanafi, I. & Sumitro, E.A., 2020, 'Potensi Antioksidan pada Krokot (Portulaca oleracea) Sebagai Pangan Fungsional', *Jurnal Keteknikan Pertanian Tropis dan Biosistem*, 8(3), 284–290.
[42] Zhang, Y., Zhao, W., & Lin, H. (2020). Medication adherence and persistence in patients with dyslipidemia: A systematic review. *Patient Preference and Adherence*, 14, 2527-2539.