

Bioactivity of Purple Sweet Potato (*Ipomea batatas*) as Anti Inflammatory Agent: Review

Sheila Carlina Tasya ¹, Paula Mariana Kustiawan ^{2*}

¹ Undergraduate Program of Pharmacy, Faculty of Pharmacy, Universitas Muhammadiyah Kalimantan Timur, Jl. Juanda No. 15 Samarinda 75124, Indonesia

² Faculty of Pharmacy, Universitas Muhammadiyah Kalimantan Timur, Jl. Juanda No. 15 Samarinda 75124, Indonesia

* Corresponding author. Email: pmk195@umkt.ac.id

ABSTRACT

This Inflammation is a defensive response to tissue damage that occurs locally. NSAID (Non Steroid Anti-Inflammatory Drugs) and AIS (Antiinflammatory Steroids) have been used in Indonesia to treat inflammation but have side effects on the body. Purple sweet potato leaf (*Ipomoea batatas*) is one of the herbal medicines used by the community to treat inflammation. This research is a literature review by collecting information from Google Scholar, PubMed, Scopus, and Garuda. The results showed that the active anti-inflammatory compounds in purple sweet potato leaves were flavonoids. Flavonoids can work as anti-inflammatory compounds by passing through several pathways such as inhibition of cyclooxygenase (COX) and lipoxygenase enzyme activities, inhibition of neutrophil degranulation, inhibition of histamine increase, and inhibition of leukocyte accumulation. Purple sweet potato (*Ipomoea batatas*) leaves are scientifically proven to have anti-inflammatory activity as evidenced by the presence of compounds that have anti-inflammatory effects and can be developed into products for inflammation.

Copyright © 2023 Jsscr. All rights reserved.

Keywords:

Anti-inflammatory; Purple sweet potato leaves; Flavanoid; *Ipomoea batatas*

Received:

2022 -05-14

Accepted:

2023-01-14

Online:

2023 -01-30

1. Introduction

Indonesia has a national prevalence of Dermatitis of 6.8%, this disease includes diseases that have an inflammatory reaction [1]. Nonsteroidal anti-inflammatory drugs (NSAIDs) are primarily used for symptoms associated with arthritis. Arthritis is inflammation of one or more joints accompanied by pain, swelling, stiffness, and limitation of movement. Other indications include myofascial pain syndrome, gout, fever, dysmenorrhea, migraine, perioperative pain, prophylaxis of stroke and myocardial infarction [2]. Corticosteroids are anti-inflammatory drugs that are often used as therapy. The use of high doses and long periods of time has an effect on changes in carbohydrate, protein and fat metabolism, changes in fluid and electrolyte balance, cardiovascular function and system, body resistance, skeletal muscles, kidneys, nervous system and endocrine system as well as the nervous system. The use of corticosteroids must consider the level of safety and indications as well as contraindications and side effects that occur [3].

Purple sweet potato (*Ipomoea batatas*) is a plant that is well known among the public because it can be found in various regions throughout Indonesia. Purple sweet

potato is an alternative food ingredient besides rice, which is a source of vitamins and minerals that are very beneficial for health. Purple sweet potato is a local food commodity that has high productivity and is increasing from year to year. Based on the projected results of sweet potato production in Indonesia in 2019 of 2,628,807 tons with a productivity of 196.12 quintals/hectare, this number is expected to increase in 2020 with production of 2,715,825 and productivity of 206.46 quintals/hectare [4].



Figure 1. *Ipomea batatas* leaves

Therefore, this study was conducted to determine whether purple sweet potato (*Ipomea batatas*) (Figure 1.) have potential as anti-inflammatory as well as the mechanism of active compounds and their effects on the inflammatory process. Empirically the sweet potato leaves have the property of curing swelling, but the information about this pontency still limeted. Based on that, its important to study about bioactivity of sweet potatoes as an anti-inflammatory agent.

2. Method

The method used in this study is a narrative review by searching for related journals. The data sources used are Google Scholar, Scopus, and Elsevier. Data collection using several keywords, such as anti-inflammatory, purple sweet potato leaves, bioactivity. This narrative literature review was conducted to provide the latest information regarding the potential of purple sweet potato as an anti-inflammatory agent.

3. Result and Discussion

Anti-inflammatory Mechanism

The decrease in inflammation is thought to be due to the presence of flavonoid compounds that have been extracted in sweet potato. Because flavonoids generally have the ability to inhibit cyclooxygenase and lipoxygenase enzymes. This process causes inflammation to decrease [5]. The active compounds that have anti-inflammatory activity are flavonoids. The mechanism of anti-inflammatory activity of flavonoids can be through several pathways, namely by inhibiting the activity of COX and lipoxygenase enzymes, inhibiting leukocyte accumulation, inhibiting neutrophil degranulation, and inhibiting histamine release. The anti-inflammatory activity of flavonoids by inhibiting COX and lipoxygenase inhibits the synthesis of leukotrienes and prostaglandins which can cause inhibition of mucus secretion which functions to protect the stomach wall [6], [7]. Inhibition of leukocytes during the inflammatory process will cause a decrease in the body's response to inflammation, this inhibition of leukocyte accumulation is caused by inhibition of COX (cyclooxygenase) so that thromboxane will be inhibited where this thromboxane will cause leukocyte modulation. Inhibition of neutrophil degranulation

will reduce the release of arachidonic acid by neutrophils. Inhibition of histamine release occurs because flavonoids can inhibit the release of histamine from mast cells [8].

Potential Activity of Purple Sweet Potato as Antiinflammatory

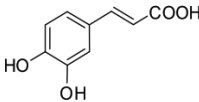
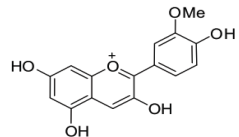
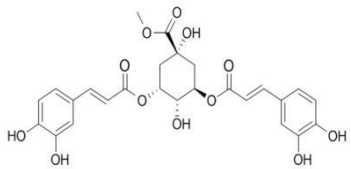
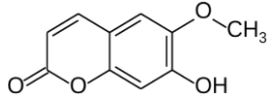
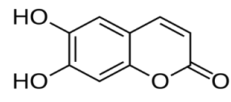
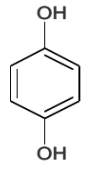
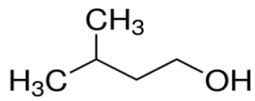
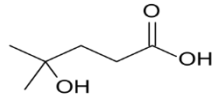
Purple sweet potato commonly use as dietary food. The part of this plant such as leaves and bulb have a several bioactivities. Such as anti-inflammatory activity [9], anticancer activity [10] and immunomodulatory [11]. This plant contains of flavonoids and anthocyanin, more than another sweet potato [12]. This plant has several advantages because it is inexpensive, can be grown all year round, and is easier to cultivate compared to some other foods rich in anthocyanins [13]. The potential compound from purple sweet potato decribed on Table 1.

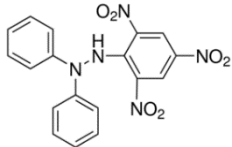
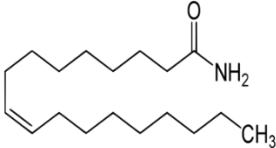
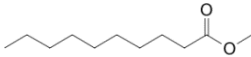
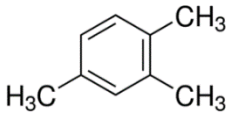
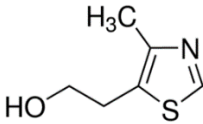
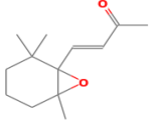
Table 1. The potential bioactivity of compounds in purple sweet potato

Part of plant	Extract	Compounds	Bioactivity	References
Leaves	Ethanol	1,4-Benzenedio	Antiinflammatory	[14]
Leaves	Ethanol	3-methyl-1-butanol	Antimicrobial	[15]
Leaves	Ethanol	4-hydroxy	Antiinflammatory	[16]
Leaves	Ethanol	1,-diphenyl-2-picrylhydrazil	Antioxidant	[17]
Leaves	Ethanol	(Z)-9-Octadecenamide (Oleamide) phytol	Antiinflammatory, Antimicrobial, Antioxidant	[18]
Bulbs	Metanol	1 and 3 n-decanoic acid methyl ester	Antioxidant	[19]
Bulbs	Ethanol	1,2,4-Trimethyl benzene	Antioxidant	[20]
Bulbs	Ethanol	4-methyl-5-thiazoleethanol	Antiinflammatory	[21]
Bulbs	Ethanol	5,6-epoxy- β -ionone	Antioxidant	[22]

The content of purple sweet potato leaves is a component of secondary metabolites of the tannin and flavonoid group and has a higher antioxidant activity than alpha tocopherol which is a popular antioxidant compound [23]. Anthocyanins have a conjugated double bond system that can make anthocyanins as antioxidants with a radical scavenging mechanism. The leaves contain higher antioxidants and phytochemical components than the tubers [24]. The active compounds inside purple sweet potato also founded on another plant sources (Table 2.). This also showed that purple sweet potato not only have benefit as functional food, but also as medicinal sources.

Table 2. Active compounds in purple sweet

Active compound in purple sweet potato	Activities	Sources	References
 <i>Caffeic Acid</i>	Antioxidant	<i>Curcuma longa</i> Linn.	[25], [26]
 <i>Peonidin</i>	Antioxidant, Antiinflammatory	<i>Phaseolus vulgaris</i> L.	[25], [27]
 <i>Isochlorogenic Acid</i>	Hypoglycemic, Antioxidant	<i>Solanum tuberosum</i>	[25], [28]
 <i>Scopoletin</i>	Antioxidant, Hepatoprotective	<i>Morinda citrifolia</i>	[25], [29]
 <i>Esculetin</i>	Antioxidant, Anticoagulant	<i>Solanum melongena</i>	[25], [30]
 <i>Benzenedio</i>	Antiinflammatory	<i>Hylocereus polyrhizus</i>	[14], [31]
 <i>Methyl Butanol</i>	Antimicrobial	<i>Centella asiatica</i>	[15], [31]
 <i>Hydroxy Acid</i>	Antiinflammatory	<i>Cinnamomum verum</i>	[16], [32]

 <p>Picrylhydrazil</p>	Antioxidant	<i>Moringa oleifera</i>	[17], [33]
 <p>Octadecenamide</p>	Antinflammatory, Antimicrobial, Antioxidant	<i>Reullia tuberosa</i> L.	[18], [34]
 <p>Methyl Ester</p>	Antioxidant	<i>Cocos nucifera</i>	[19], [35]
 <p>Trimethyl benzene</p>	Antioxidant	<i>Phyllanthus urinaria</i>	[20], [36]
 <p>Thiazoleethanol</p>	Antinflammatory	<i>Glycine max</i>	[21], [37]
 <p>Beta Ionone</p>	Antioxidant	<i>Ipomoea batatas</i> leaves	[22], [38]

Functional Product From Purple Sweet Potato

Active compounds are compounds that are beneficial to human health because they have the ability to heal or prevent when the body is in bad condition. Active compounds can be referred to as substances that are able to provide physiological effects on other organisms and are usually active compounds found in animals and plants. In the medical world, the use of active compounds is intended to cure or prevent patient disease [39]. The purple sweet potato can be modified to be functional product to increase their specific function (Table 3).

Table 3. Potential of purple sweet potato as a functional product

Country	Products	Mechanisms	References
Indonesia	Losio	Bacteria can be inhibited from purple sweet potato leaves because they are influenced by the presence of flavonoid compounds which are useful as antibacterial by binding to bacterial proteins so that they inhibit enzyme activity which ultimately interferes with bacterial metabolic processes.	[40]
Indonesia	Cream	Flavonoids are useful as antibacterial by binding to bacterial proteins so that they can inhibit enzyme activity which ultimately interferes with the mechanism of the bacteria.	[41]
Indonesia	Herbs	Flavonoids work as anti-inflammatory by inhibiting the bacterial activity of lipooxygenase and cyclooxygenase (COX) enzymes, as well as inhibiting leukocyte accumulation, inhibiting histamine release.	[42]
Indonesia	Sunscreen	Antioxidants as an oxidizer to the skin against sunlight.	[43]
Philippines	Flour	Antioxidants can inhibit oxidation through reactions with free radicals and the decomposition of lipid hydroperoxide, which form free radicals.	[44]

Antioxidants are compounds that function in overcoming oxidative damage caused by free radicals in the body. The active compounds contained in medicinal plants have various therapeutic properties. Various therapeutic effects are attributed to medicinal plants including anti-inflammatory, antiviral, antimalarial, antitumor, and analgesic properties. Antioxidants are beneficial for the body because they can delay, slow down and prevent the oxidation process [45]. Anthocyanin is a type of flavonoid derived from plants that can work as an antioxidant. Purple sweet potato leaf is one type of medicinal plant that contains anthocyanins. Purple sweet potato leaves contain secondary metabolites of flavonoids and tannins which have higher antioxidant activity than tocopherols or vitamin E [46], [47].

4. Conclusion

Purple sweet potato (*Ipomoea batatas* (L.) are scientifically proven to have anti-inflammatory activity as evidenced by the presence of compounds, dominantly flavonoid compounds that have anti-inflammatory effects.

References

- [1] F. M. Menoh, Y. R., Mulyantini, N. G. A., & Telupere, "Pengaruh penggunaan pelet daun ubi jalar ungu (*Ipomoea batatas* var. ayamurasaki) terfermentasi larutan effective microorganism 4 (EM-4) dalam ransum terhadap performa ayam broiler," 2018.

- [2] W. Soleha, M., Isnawati, A., Fitri, N., Adelina, R., Soblia, H. T., & Winarsih, "Profil penggunaan obat antiinflamasi nonstereoid di Indonesia," *J. Kefarmasian Indones.*, pp. 109-117, 2018.
- [3] M. C. N. Setiawati, "Drug Use Evaluation Of Corticosteroids in Systemic Lupus Erythematosus Outpatients," *J. Farm. J. Pharm.*, vol. 1, no. 1, pp. 11-15, 2018.
- [4] Central Bureau of Statistics, "Produktivitas Ubi Jalar Menurut Provinsi, tahun 1993-2015," Jakarta, 2015.
- [5] M. Lončarić, M., Strelec, I., Moslavac, T., Šubarić, D., Pavić, V., & Molnar, "Lipoxygenase inhibition by plant extracts," *Biomolecules*, vol. 11, no. 2, p. 152, 2021.
- [6] J. C. Giménez-Bastida, J. A., González-Sarriás, A., Laparra-Llopis, J. M., Schneider, C., & Espín, "Targeting mammalian 5-lipoxygenase by dietary phenolics as an anti-inflammatory mechanism: A systematic review," *Int. J. Mol. S.*, 2021.
- [7] B. Kaur and P. Singh, "Inflammation: Biochemistry, cellular targets, anti-inflammatory agents and challenges with special emphasis on cyclooxygenase-2," *Bioorganic Chem.*, p. 105663, 2022.
- [8] T. Yang, C. Li, W. Xue, L. Huang, and Z. Wang, "Natural immunomodulating substances used for alleviating food allergy," *Crit. Rev. Food Sci. Nutr.*, pp. 1-19, 2021.
- [9] W. Sun, J., Liu, J., Ren, G., Chen, X., Cai, H., Hong, J., ... & Zhang, "Impact of purple sweet potato (*Ipomoea batatas* L.) polysaccharides on the fecal metabolome in a murine colitis model," *RSC Adv.*, vol. 12, no. 18, pp. 11376-11390, 2022.
- [10] Y. C. Lin, H. H., Lin, K. H., Wu, K. F., & Chen, "Identification of *Ipomoea batatas* anti-cancer peptide (IbACP)-responsive genes in sweet potato leaves," *Plant Sci.*, vol. 305, p. 110849, 2021.
- [11] C. Tang *et al.*, "Immune-enhancing effects of polysaccharides from purple sweet potato," *Int. J. Biol. Macromol.*, vol. 123, pp. 923-930, 2019.
- [12] F. Wang, S., Nie, S., & Zhu, "Chemical constituents and health effects of sweet potato," *Food Res. Int.*, vol. 89, pp. 90-116, 2016.
- [13] A. A. Escobar-Puentes *et al.*, "Sweet Potato (*Ipomoea batatas* L.) Phenotypes: From Agroindustry to Health Effects," *Foods*, vol. 11, no. 7, p. 1058, 2022.
- [14] S. Kurniasih and D. D. Saputri, "PHYTOCHEMICAL SCREENING AND GASS CROMATOGRAPHY - MASS SPECTROMETER (GC-MS) ANALYSIS ETHANOL EXTRACT OF PURPLE SWEET POTATO (*Ipomoea batatas* L.)," *J. Sci. Innovare*, vol. 2, no. 2, 2019, doi: 10.33751/jsi.v2i2.1527.
- [15] X. Li *et al.*, "Identification of rhizospheric actinomycete *streptomyces lavendulae* sps-33 and the inhibitory effect of its volatile organic compounds against *ceratocystis fimbriata* in postharvest sweet potato (*Ipomoea batatas* (L.) Lam.)," *Microorganisms*, vol. 8, no. 3, 2020, doi: 10.3390/microorganisms8030319.
- [16] E. Waluyo, D. B. Pambudi, Wirasti, and Slamet, "UJI AKTIVITAS ANTIINFLAMASI EKSTRAK ETANOL, FRAKSI METANOL DAN FRAKSI N-HEKSAN DAUN UBI JALAR UNGU (*Ipomoea batatas* (L.) Lam.) DENGAN METODE STABILISASI MEMBRAN SEL DARAH MERAH SECARA IN VITRO," Pekalongan, 2019.
- [17] H. Irawan, S. Syera, N. Ekawati, and D. Tisnadjaja, "PENGARUH PROSES MASERASI DENGAN VARIASI KONSENTRASI PELARUT ETANOL TERHADAP KANDUNGAN SENYAWA EKSTRAK DAUN PEPAYA (*Carica papaya* L.) DAN DAUN UBI JALAR UNGU (*Ipomoea batatas* L. Lam)," *J. Ilm. Manuntung*, vol. 6, no. 2, 2020, doi: 10.51352/jim.v6i2.372.

- [18] U. Aameamsri, T. Tanee, A. Chaveerach, S. Peigneur, J. Tytgat, and R. Sudmoon, "Anti-inflammatory and detoxification activities of some Ipomoea species determined by ion channel inhibition and their phytochemical constituents," *ScienceAsia*, vol. 47, no. 3, 2021, doi: 10.2306/SCIENCEASIA1513-1874.2021.042.
- [19] Y. Q. Yin, X. F. Huang, L. Y. Kong, and M. Niwa, "Three new pentasaccharide resin glycosides from the roots of sweet potato (*Ipomoea batatas*)," *Chem. Pharm. Bull. (Tokyo)*, vol. 56, no. 12, 2008, doi: 10.1248/cpb.56.1670.
- [20] Y. Wang and S. J. Kays, "Contribution of volatile compounds to the characteristic aroma of baked 'Jewel' sweetpotatoes," *J. Am. Soc. Hortic. Sci.*, vol. 125, no. 5, 2000, doi: 10.21273/jashs.125.5.638.
- [21] Y. J. Tsai, L. Y. Lin, K. M. Yang, Y. C. Chiang, M. H. Chen, and P. Y. Chiang, "Effects of roasting sweet potato (*Ipomoea batatas* L. lam.): Quality, volatile compound composition, and sensory evaluation," *Foods*, vol. 10, no. 11, 2021, doi: 10.3390/foods10112602.
- [22] D. Agarwal, L. Mui, E. Aldridge, J. McKinney, L. Hewson, and I. D. Fisk, "The progression of lipid oxidation, β -carotenes degradation and sensory perception of batch-fried sliced sweet potato crisps during storage," *Food Funct.*, vol. 12, no. 10, 2021, doi: 10.1039/d0fo03100c.
- [23] H. Ahmad, A. Mustarin, and R. Fadilah, "Analisis Kualitas Mie Basah dengan Penambahan Daun Ubi Jalar Ungu (*Ipomoea batatas*)," *J. Pendidik. Teknol. Pertan.*, vol. 6, no. 1, pp. 87–100, 2020.
- [24] D. S. Kabore *et al.*, "Radical-Scavenging activities of total extracts and identification of four anthocyanin isomers from two purple-fleshed varieties of *Ipomoea batatas* L. produced in Burkina Faso, by hplc-ms/ms," *Int J Biol Chem Sci*, vol. 16, no. 1, pp. 464–480, 2022.
- [25] M. Meira, E. Pereira Da Silva, J. M. David, and J. P. David, "Review of the genus *Ipomoea*: traditional uses, chemistry and biological activities," *Rev. Bras. Farmacogn. Braz. J. Pharmacogn.*, vol. 22, no. 3, pp. 682–713, 2012, doi: 10.1590/S0102.
- [26] S. Paramita, K. Kosala, D. Dzulkifli, D. I. Saputri, and E. Wijayanti, "Anti-inflammatory activities of ethnomedicinal plants from dayak abai in North Kalimantan, Indonesia," *Biodiversitas*, vol. 18, no. 4, pp. 1556–1561, Oct. 2017, doi: 10.13057/biodiv/d180434.
- [27] L. Banda *et al.*, "Analysis of β -amylase gene (*Amy β*) variation reveals allele association with low enzyme activity and increased firmness in cooked sweetpotato (*Ipomoea batatas*) from East Africa," *J. Agric. Food Res.*, vol. 4, no. February, p. 100121, 2021, doi: 10.1016/j.jafr.2021.100121.
- [28] N. J. S. Dusuki, M. F. Abu Bakar, F. I. Abu Bakar, N. A. Ismail, and M. I. Azman, "Proximate composition and antioxidant potential of selected tubers peel," *Food Res.*, vol. 4, no. 1, 2020, doi: 10.26656/fr.2017.4(1).178.
- [29] V. Panda, M. Sonkamble, V. Sanjeev Panda, and P. K. M. Kundnani, "Anti-ulcer activity of *Ipomoea batatas* tubers (sweet potato)," 2012.
- [30] S. V Stankov, "Definition of Inflammation, Causes of Inflammation and Possible Anti-inflammatory Strategies," 2012.
- [31] N. M. Motsa, A. T. Modi, and T. Mabhaudhi, "Sweet potato (*Ipomoea batatas* L.) as a drought tolerant and food security crop," *South Afr. J. Sci.*, vol. Volume 111, no. Number 11/12, pp. 1–8, 2015, doi: 10.17159/sajs.2015/20140252.
- [32] T. Nurtamin, I. P. Sudayasa, and Tien, "In Vitro Anti-Inflammatory Activities of Ethanolic Extract *Elephantopus Scaber* Leaves," *J. Kedokt. Dan Kesehat. Indones.*, vol. 9, no. 1, pp. 46–52, Apr. 2018, doi: 10.20885/jkki.vol9.iss1.art9.

- [33] N. S. Aminah, C. Isma, and A. N. Kristanti, "SKOPOLETIN SUATU SENYAWA FENILPROPANOID DARI EKSTRAK ETIL ASETAT UMBI UBI JALAR (*Ipomoea batatas* L.)," *J. Kim. Ris.*, vol. 3, no. 2, 2019, doi: 10.20473/jkr.v3i2.12061.
- [34] E. Kusumastuti, J. Handajani, dan Heni Susilowati, F. Kedokteran Gigi Institut Ilmu Kesehatan Bhakti Wiyata Kediri, F. K. Kedokteran Gigi Universitas Gadjah Mada Jl Wachid Hasyim No, and J. Timur, "Ekspresi COX-2 dan Jumlah Neutrofil Fase Inflamasi pada Proses Penyembuhan Luka Setelah Pemberian Sistemik Ekstrak Etanolik Rosela (*Hibiscus sabdariffa*) (studi in vivo pada Tikus Wistar)."
- [35] A. Ghasemzadeh *et al.*, "Plant-growth regulators alter phytochemical constituents and pharmaceutical quality in Sweet potato (*Ipomoea batatas* L.)," *BMC Complement. Altern. Med.*, vol. 16, no. 1, 2016, doi: 10.1186/s12906-016-1113-1.
- [36] E. Waluyo, D. B. Pambudi, Wirasti, and Slamet, "Naskah Publikasi Sarjana Farmasi UJI AKTIVITAS ANTIINFLAMASI EKSTRAK ETANOL, FRAKSI METANOL DAN FRAKSI N-HEKSAN DAUN UBI JALAR UNGU (*Ipomoea batatas* (L.) Lam.) DENGAN METODE STABILISASI MEMBRAN SEL DARAH MERAH SECARA IN VITRO ANTI-INFLAMATORY ACTIVITY TES," 2019.
- [37] H. Kang, Y. G. Kwak, and S. Koppula, "Protective effect of purple sweet potato (*ipomoea batatas* Linn, Convolvulaceae) on neuroinflammatory responses in lipopolysaccharide-stimulated microglial cells," *Trop. J. Pharm. Res.*, vol. 13, no. 8, pp. 1257-1263, 2014, doi: 10.4314/tjpr.v13i8.9.
- [38] M. Gao, S. F. Soriano, Q. Cao, X. Yang, and G. Lu, "Hexaploid sweetpotato (*Ipomoea batatas* (L.) Lam.) may not be a true type to either auto- or allopolyploid," *PLoS ONE*, vol. 15, no. 3, 2020, doi: 10.1371/journal.pone.0229624.
- [39] D. Juárez-López and A. Schcolnik-Cabrera, "Drug repurposing: considerations to surpass while re-directing old compounds for new treatments," *Arch. Med. Res.*, vol. 52, no. 3, pp. 243-251, 2021.
- [40] A. Rangotwat, P. YamLean, and W. A. Lolo, "FORMULASI DAN UJI ANTIBAKTERI SEDIAAN LOSIO EKSTRAK METANOL DAUN UBI JALAR UNGU (IPOMOEA BATATAS POIR) TERHADAP BAKTERI STAPHYLOCOCCUS AUREUS," *PHARMACON*, vol. 5, no. 4, 2016, doi: 10.35799/pha.5.2016.13978.
- [41] M. Sindang and P. Astuti, "AKTIVITAS SEDIAAN KRIM EKSTRAK DAUN UBI JALAR UNGU (*Ipomoea batatas* Poir) SEBAGAI ANTIBAKTERI TERHADAP BAKTERI *Staphylococcus aureus*," *Pharmacan*, 2018.
- [42] S. N. Khotimah and M. Ahmad, "Riview Artikel: Beberapa Tumbuhan Yang Mengandung Senyawa Aktif Antiinflamasi," *FarmakaFakultas Farm. Univ. Padjadjaran*, vol. 14, no. 2, 2017.
- [43] D. Dipahayu and D. Arifiyana, "Pengaruh Metode Pengeringan Simplisia Daun Ubi Jalar Ungu (*Ipomoea batatas* (L.) Lamk) Varietas Antin 3 Terhadap Kadar Abu Ekstrak," *J. Pharm. Sci.*, vol. 4, no. 1, 2019, doi: 10.53342/pharmasci.v4i1.123.
- [44] Q. A. L. Curayag, E. I. Dizon, and W. A. Hurtada, "Antioxidant activity, chemical and nutritional properties of raw and processed purple-fleshed sweet potato (*Ipomoea batatas* Lam.)," *Cogent Food Agric.*, vol. 5, no. 1, 2019, doi: 10.1080/23311932.2019.1662930.
- [45] A. Moskalev *et al.*, "Targeting aging mechanisms: pharmacological perspectives," *Trends Endocrinol. Metab.*, vol. 33, no. 4, pp. 266-280, 2022, doi: <https://doi.org/10.1016/j.tem.2022.01.007>.

- [46] Q. Qi *et al.*, "Anthocyanins and Proanthocyanidins: Chemical Structures, Food Sources, Bioactivities, and Product Development," *Food Rev. Int.*, pp. 1-29, 2022, doi: <https://doi.org/10.1080/87559129.2022.2029479>.
- [47] L. Bassolino *et al.*, "Does Plant Breeding for Antioxidant-Rich Foods Have an Impact on Human Health?," *Antioxidants*, vol. 11, no. 4, p. 794, 2022, doi: <https://doi.org/10.3390/antiox11040794>.