

BAB 5

KESIMPULAN DAN SARAN

5.1 Kesimpulan

Berdasarkan data dari 19 kajian literatur berupa artikel ilmiah terkait hubungan metode ekstraksi terhadap kadar dan kandungan senyawa flavonoid dan aktivitasnya dalam menghambat enzim α -glukosidase dapat disimpulkan bahwa:

1. Metode ekstraksi ultrasonik daun tanaman *M. oleifera* dengan pelarut etanol 50%, rasio pelarut terhadap bahan 52 ml/g, waktu ekstraksi 43 menit dan suhu 76 °C memberikan kadar total kandungan flavonoid sebesar 61,09 mg/g ekuivalen kuersetin dan terdapat beberapa kandungan senyawa flavonoid yaitu, rutin, kaempferol asetil glikosida, kuersetin-3-glukosida, kuersetin-3-asetil-glukosida, dan kaempferol-3-O-glukosida.
2. Ekstrak daun tanaman *M. oleifera* menggunakan metode maserasi memberikan daya hambat enzim α -glukosidase sebesar 75,65% dan 83,14%, yang mana ketika dianalisis terdapat masing-masing senyawa yaitu rutin dan flavon sebagai flavonoid.

5.2 Saran

Berdasarkan data dari 19 kajian literatur berupa artikel ilmiah terkait pengaruh metode ekstraksi terhadap kadar dan kandungan senyawa flavonoid dan aktivitasnya dalam menghambat enzim α -glukosidase dapat diberikan saran bahwa:

1. Perlu dilaksanakan penelitian kajian literatur lebih lanjut mengenai ukuran partikel yang optimum dari daun tanaman *Moringa oleifera*. Ukuran partikel merupakan salah satu variabel penting dalam

optimasi ekstraksi, yang mana semakin kecil ukuran partikel maka efisiensi ekstraksi dapat ditingkatkan.

DAFTAR PUSTAKA

- Abalaka, M.E., Daniyan, S. Y., Oyelekel, S.B., and Adeyemo, S.O., 2012, The Antibacterial Evaluation of *Moringa oleifera* Leaf Extracts on Selected Bacterial Phatogens, *Journal of Microbiology Research*, **2(2)**: 1-4.
- Abano, E.E., Amoah, R., and Mbabazi, C., 2020, Microwave and steam blanching as pre-treatments before air drying of *Moringa oleifera* leaves, *Journal of Agricultural Engineering*, **51(4)**: 200-208.
- Abdulkadir, A.R., Zawawi, D.D., and Jahan, M.S., 2015, DPPH antioxidant activity, total phenolic and total flavonoid content of different part of Drumstic tree (*Moringa oleifera* Lam.), *Journal of Chemical and Pharmaceutical Research*, **7(4)**: 1423-1428.
- Abubakar, A.R., and Haque, M., 2020, Preparation of Medicinal Plants: Basic Extraction and Fractionation Procedures for Experimental Purposes, *Journal of Pharmacy and Bioallied Sciences*, **12(1)**: 1-10.
- Acuram, L.K., and Hernandez, C.L.C., 2019, Anti-hypertensive effect of *Moringa oleifera* Lam, *Cogent Biology*, **5**:1-10.
- Adejoh, I.P., Chiadikaobi, O.S., Barnabas, A.O., Ifeoluwa, A.O., and Muhammed, H.S., 2016, In Vivo and In Vitro Comparative Evaluation of the Anti-diabetic Potentials of the Parts of *Moringa oleifera* Tree, *European Journal of Biotechnology and Bioscience*, **4(1)**: 14-22.
- Ademiluyi, A.O., Aladeselu, O.H., Oboh, G., and Boligon, A.A., 2018, Drying alters the phenolic constituents, antioxidant properties, α -amylase, and α -glucosidase inhibitory properties of *Moringa (Moringa oleifera)* leaf, *Food Science and Nutrition*, **6**: 2123-2133.
- Adisakwattana, S., and Canathong, B., 2011, α -glucosidase inhibitory activity and lipid-lowering mechanisms of *Moringa oleifera* leaf extract, *European Review for Medical and Pharmacological Sciences*, **15**: 803-808.
- Alfaridz, F., dan Amalia, R., 2018, Review Jurnal: Klasifikasi dan Aktivitas Farmakologi dari Senyawa Aktif Flavonoid, *Farmaka*, **16(3)**: 1-9.

- Amaglo, N.K., Bennett. R.N., Curto. R.B.L., Rosa. E.A.S., Turco. V.L., Giuffrida. A., Curto, A.L., Crea, F., and Timpo, G.M., 2010, Profiling Selected Phytochemicals and Nutrients in Different Tissues of the Multipurpose Tree *Moringa oleifera* L. Grown in Ghana, *Food Chemistry*, **122(4)**:1047-1054.
- Arifin, B., 2018, Struktur, Bioaktivitas dan Antioksidan Flavonoid, *Jurnal Zarah*, **6(1)**:21-29.
- Arora, D.S., Onsare, J.G., and Kaur, H., 2013, Bioprospecting of Moringa (Moringaceae): Microbiological Perspective. *Journal of Pharmacognosy and Phytochemistry*, **1(6)**:193-215.
- Azwanida, N.N., 2015, A Review on the Extraction Methods Use in Medicinal Plants, Principle, Strength and Limitation, *Medicinal and Aromatic Plants*, **4(3)**:1-6.
- Baldisserotto, A., Buso, P., Radice, M., Dissette, V., Lampronti, I., Gambari, R., Manfredi, S., and Vertuani, S., 2018, *Moringa oleifera* Leaf Extracts as Multifunctional Ingredients for “Natural and Organic” Sunscreens and Photoprotective Preparations, *Molecules*, **23(3)**: 1-16.
- Bennour, N., Mighri, H., Eljani, H., Zammouri, T., and Akrouf, A., 2020, Effect of solvent evaporation method on phenolic compounds and the antioxidant activity of *Moringa oleifera* cultivated in Southern Tunisia, *South African Journal of Botany*, **129**: 181-190.
- Blanco, A., and Blanco, G., 2017, *Medical Biochemistry*, Academic Press, United States of America.
- Brilhante, R.S.N., Sales, J.A., Pereira, V.S., Castelo-Branco, D.D.S.C.M., Cordeiro, R.D.A., Sampaio, C.M.D.S., Paiva, M.D.A.N., Santos, J.B.F.D., Sidrim, J.J.C., Rocha, M.F.G., 2017, Research advances on the multiple uses of *Moringa oleifera*: a sustainable alternative for socially neglected population, *Asian Pacific Journal of Tropical Medicine*, **10(7)**: 621-630.
- Brodowska, K.M., 2017, Natural Flavonoids: Classification, Potential Role, and Application of Flavonoid Analogues, *European Journal Biological Research*, **7**:108–123.
- Chávez-González, M.L., Sepúlveda, L., Verma, D.K., Luna-García, H.A., Rodríguez-Durán, L.V., Iliina, A., and Aguilar, C.N., 2020,

Conventional and Emerging Extraction Processes of Flavonoids, *Processes*, **8**: 1-29.

- Choudhury, H., Pandey, M., Hua, C.K., Mun, C.S., Jing, J.K., Kong, L., Ern, L.Y., Ashraf, N.A., Kit, S.W., Yee, T.S., Pichika, M.R., Gorain, B., and Kesharwani, P., 2018, An update on natural compounds in the remedy of diabetes mellitus: A systematic review, *Journal of Traditional and Complementary Medicine*, **8(3)**: 361-376.
- Coppin, J.P, Xu, Y., Chen, H., Pan, M.H., Ho, C.T., Juliani, R., Simon, J., and Wu, Q., 2019, Determination of flavonoids by LC/MS and anti-inflammatory activity in *Moringa oleifera*, *Journal of Functional Foods*, **5**:1892-1899.
- De melo, E.B., Gomes, A.D.S., and Carvalho, I., 2006, α - and β -Glucosidase Inhibitors: Chemical Structure and Biological Activity, *Tetrahedron*, **62**:10277-10302.
- Direktorat Jenderal Pengawasan Obat dan Makanan, 2000, *Parameter Standar Umum Ekstraksi Tumbuhan Obat* Cetakan Pertama, Jakarta: Departemen Kesehatan RI.
- Djande, C.Y.H., Piater, L.A., Steenkamp, P.A., Madala, L.E., and Dubery, I.A., 2018, Differential extraction of phytochemicals from the multipurpose tree, *Moringa oleifera*, using green extraction solvents, *South African Journal of Botany*, **115**: 81-89.
- Djemoui, D., Saidi, M., Rahmani, Z., and Djemoui, A., 2019, Influence of phenolic compounds on antioxidant capacity of leaves extracts of *Moringa oleifera* from tamanrasset region, *Journal of Fundamental and Applied Sciences*, **11(1)**: 280-293.
- El-Hadary, A.E., and Ramadan, M.F., 2018, Antioxidant traits and protective impact of *Moringa oleifera* leaf extract against diclofenac sodium-induced liver toxicity in rats, *Journal of Food Biochemistry*, **43(2)**: 1-9.
- Fahey J.W., 2005, *Moringa oleifera*: A Review of The Medical Evidence for Its Nutritional, Therapeutic, and Prophylatic Properties Part 1, *Trees for Life Journal*. <http://www.tfljournal.org/article.php/20051201124931586>.
- Fakurazi, S., Sharifudin, S.A., and Arulselvan, P., 2012, *Moringa oleifera* Hydroethanolic Extracts Effectively Alleviate Acetaminophen-

- Induced Hepatotoxicity in Experimental Rats through Their Antioxidant Nature, *Molecules*, **17**(7): 8334-8350.
- Febrinda, A.E., Astawan, M., Wresdiyati, T., dan Yuliana, N.D., 2013, Kapasitas Antioksidan dan Inhibitor Alfa Glukosidase Ekstrak Umbi Bawang Dayak, *Jurnal Teknologi dan Industri Pangan*, **24**(2):161-167.
- Feng, J., Yang, X.W., and Wang, R.F., 2011, Bio-assay Guided Isolation and Identification of A α -Glucosidase Inhibitors From The Leaves of *Aquilaria sinensis*, *Phytochemistry*, **72**: 242-247.
- Fuglie L.J. (eds). 1999, *The Miracle Tree: Moringa oleifera: Natural nutrition of the tropics*, Church World Service, New York.
- Gara, A.B., Kolsi, R.B.A., Jardak, N., Chaaben, R., Feki, A.E., Fki, L., Belghith, H., and Belghith, K., 2016, Inhibitory Activities of *Cystoseira Crinita* Sulfated Polysaccharide on Key Enzymes Related to Diabetes and Hypertension: In Vitro and Animal Study, *Journal of Metabolic Diseases*, **123**:31-42.
- Goyal, N., 2014, 'Screening of Novel Drugs Against Alpha Glucosidase, A Key Enzyme in Diabetes', *Thesis*, Magister, Institute of Technology, Rourkela.
- Hamed, Y.S., Abdin, M., Akhtar, H.M.S., Chen, D., Wan, P., Chen, G., and Zheng, X., 2019, Extraction, purification by macrospores resin and in vitro antioxidant activity of flavonoids from *Moringa oleifera* leaves, *South African Journal of Botany*, **124**: 270-279.
- Hedrington, M.S., and Davis, S.N., 2019, Considerations When Using Alpha-glucosidase Inhibitors in The Treatment of Type 2 Diabetes, *Expert on Opinion Pharmacotherapy*, **20**:2229-2235.
- Hirondart, M., Rombaut, N., Tixier, A.S.F., Bilyy, A., and Chemat, F., 2020, Comparison between Pressurized Liquid Extraction and Conventional Soxhlet Extraction for Rosemary Antioxidants, Yield, Composition, and Environmental Footprint, *Foods*, **9**: 1-14.
- Hoda, M.E., and Pierre, S.H., 2017, The Antidiabetic Potential of Quercetin: Underlying Mechanisms, *Current Medicinal Chemistry*, **4**(24):355-364.
- Hollander, P., Pi-Sunyer, X., and Coniff, R.F., 1997, Acarbose in The Treatment of Type 1 Diabetes, *Diabetes Care*, **20**(3): 248-253.

- Jadhav, D., Rekha, B.N., Gogate, P.R., and Rathod, V.K., 2009, Extraction of Vanilla Pods: A Comparison Study of Conventional Soxhlet and Ultrasound Assisted Extraction, *Journal of Food Engineering*, **93**: 421-426.
- Jaiswal, D., Rai, P.K., Mehta, S., Chatterji, S., Shukla, S., Rai, D.K., Sharma, G., Sharma, B., Khair, S., and Watal, G., 2013, Role of *Moringa oleifera* in regulation of diabetes-induced oxidative stress, *Asian Pacific Journal of Tropical Medicine*, **6(6)**: 426-432.
- Jimoh, T.O., 2018, Enzymes inhibitory and radical scavenging potentials of two selected tropical vegetable (*Moringa oleifera* and *Telfairia occidentalis*) leaves relevant to type 2 diabetes mellitus, *Brazilian Journal of Pharmacognosy*, **28**:73-79.
- Kajaria, D., Tiwari, S., Tripathi, J., and Tripathi, Y., 2013, Ranjana In-vitro α -Amylase and Glycosidase Inhibitory Effect of Ethanolic Extract of Antiasthmatic Drug-Shirishadi, *Journal of Advanced Pharmaceutical Technology and Research*, **4**:206–209.
- Karageorgou, I., Grigorakis, S., Lalas, S., and Makris, D.P., 2017, Enhanced extraction of antioxidant polyphenols from *Moringa oleifera* Lam. leaves using a biomolecule-based low-transition temperature mixture, *European Food Research and Technology*, **243(10)**: 1-10.
- Karageorgou, I., Grigorakis, S., Lalas, S., and Makris, D.P., 2018, The effect of 2-hydroxypropyl β -cyclodextrin on the stability of polyphenolic compounds from *Moringa oleifera* Lam. leaf extracts in a natural low-transition temperature mixture, *Nova Biotechnologia et Chimica*, **17(1)**: 29-37.
- Khan, W., Parveen, R., Chester, K., Parveen, S., and Ahmad, S., 2017, Hypoglycemic Potential of Aqueous Extract of *Moringa oleifera* leaf and *In Vivo* GC-MS Metabolomics, *Frontiers in Pharmacology*, **8**:1-16.
- Khatri, D.K., and Juvekar, A.R., 2014, α -Glucosidase and α -Amylase Inhibitory Activity of *Indigofera cordifolia* Seeds and Leaves Extract, *International Journal of Pharmacy and Pharmaceutical Sciences*, **6(11)**:152-155.
- Khor, K.Z., Lim, V., Moses, E.J., and Samad, N.A., 2018, The In Vitro and In Vivo Anticancer Properties of *Moringa oleifera*, *Evidence-Based Complementary and Alternative Medicine*, **18**: 1-14.

- Khoza, B.S., Chimuka, L., Mukwevho, E., Steenkamp, P.A., and Madala, N.E., 2014, The Effect of Temperature on Pressurised Hot Water Extraction of Pharmacologically Important Metabolites as Analysed by UPLC-Qtof-MS and PCA, *Evidence-Based Complementary and Alternative Medicine*, **14**: 1-9.
- Krisnadi, A.D., 2015, *Kelor Super Nutrisi*, Morindo, Blora.
- Kumar, S., and Pandey, A.K., 2013, Chemistry and Biological Activities of Flavonoids: An Overview, *The Scientific World Journal*, **13**: 1-16.
- Kumari, D.J., 2010, Hypoglycemic Effect of *Moringa oleifera* and *Azadirachta indica* in Type-2 Diabetes, *Bioscan*, **5(2)**: 211-214.
- Lee, S.S., Lin, H.C., and Chen, C.K., 2008, Acylated Flavonol Monorhamnosides, α -Glucosidase Inhibitor, from *Machilus phillippinensis*, *Phytochemistry*, **69**:2347-2353.
- Leone, A., Bertoli, S., Lello, S.D., Bassoli, A., Ravasenghi, S., Borgonovo, G., Forlani, F., and Battezzati, A., 2018, Effect of *Moringa oleifera* Leaf Powder on Postprandial Blood Glucose Response: In Vivo Study on Saharawi People Living in Refugee Camps, *Nutrients*, **10(10)**: 1-14.
- Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J., and Bertoli, S., 2015, Cultivation, Genetic, Ethnopharmacology, Phytochemistry and Pharmacology of *Moringa oleifera* Leaves: An Overview, *International Journal of Molecular Sciences*, **16(6)**: 12791-12835.
- Leroux-Stewart, J., Rabasa-Lhoret, R., and Chiasson, J.L., 2015, ' α -Glucosidase Inhibitors', In Defronzo, R.A., Ferrannini, E., Keen, H., and Zimmet, P. *International Textbook of Diabetes Mellitus*, 3rd ed, John Wiley and Sons, Montréal, pp 673-685.
- Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gotzsche, P.C., Loannidis, J.P.A., Clarke, M., Devereaux., P.J., Kleijnen, J., and Moher, D., 2009, The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration, *Plos Medicine*, **6**: 1-28.
- Lin, M., Zhang, J., and Chen, X., 2018, Bioactive flavonoids in *Moringa oleifera* and their health-promoting properties, *Journal of Functional Foods*, **47**: 469-479.

- Luqman, S., Srivastava, S., Kumar, R., Maurya, A.K., and Chanda, D., 2012, Experimental Assessment of *Moringa oleifera* Leaf and Fruit for Its Antistress, Antioxidant, and Scavenging Potential Using In Vitro and In Vivo Assays, *Evidence-Based Complementary and Alternative Medicine*, **12**: 1-12.
- Mabberley, D.I., 1987, *The Plant Book*, Columbia University Press, Cambridge.
- Mabrouki, L., Rjeibi, I., Taleb, J., and Zourgui, L., 2020, Cardiac Ameliorative Effect of *Moringa oleifera* Extract in High-Fat Diet-Induced Obesity in Rat Model, *BioMed Research International*, **20**: 1-10.
- Magaji, U.F., Sacan, O., and Yanardag, R., 2020, Alpha amylase, alpha glucosidase and glycation inhibitory activity of *Moringa oleifera* extracts, *South African Journal of Botany*, **128**: 225-230.
- Makita, C., Chimuka, L., Steenkamp, P., Cukrowska, E., and Madala, E., 2016, Comparative analyses of flavonoid content in *Moringa oleifera* and *Moringa ovalifolia* with the aid of UHPLC-qTOF-MS fingerprinting, *South African Journal of Botany*, **105**: 116-122.
- Marzali, A., 2016, Menulis Kajian Literatur, *Jurnal Etnosia*, **1(2)**: 27-36.
- Meena, S.N., Kumar, U., Naik, M.M., Ghadi, S.C., and Tilve, S.G., 2019, α -Glucosidase Inhibition Activity and In Silico Study of 2-(benzo[d][1,3]dioxol-5-yl)-4H-chromen-4-one, A Synthetic Derivative of Flavone, *Bioorganic and Medicinal Chemistry*, **27(12)**: 2340-2344.
- Moyo, B., Oyedemi, S., Masika, P.J., and Muchenje, V., 2012, Polyphenolic content and antioxidant properties of *Moringa oleifera* leaf extracts and enzymatic activity of liver from goats supplemented with *Moringa oleifera* leaves/sunflower seed cake, *Meat Science*, **91**: 441-447.
- Muhammad, H.I., Asmawi, M.Z., and Khan, N.A.K., 2016, A review on promising phytochemical, nutritional and glycemic control studies on *Moringa oleifera* Lam. in tropical and subtropical regions, *Asian Pacific Journal of Tropical Biomedicine*, **6(10)**: 896-902.
- Mukhriani., 2014, Ekstraksi, Pemisahan Senyawa, dan Identifikasi Senyawa Aktif, *Jurnal Kesehatan*, **7(2)**: 361-367.
- Munn, Z., Peters, M.D.J., Stern, C., Tufanaru, C., Mcarthur, A., and Aromataris, E., 2018, Systematic Review or Scoping Review?

Guidance for Authors When Choosing Between A Systematic or Scoping Review Approach, *BMC Medical Research and Methodology*, **18(143)**:1-7.

- Mutiara, T., Harijono., Estiasih, T., and Sriwahyuni, E., 2012, Nutrient Content of Kelor (*Moringa Oleifera* Lam) Leaves Powder under Different Blanching Methods, *Food and Public Health*, **2(6)**: 296-300.
- Murray., Robert, K., Daryl K.G., and Victor W.R., 2009. *Biokimia Harper*, edisi 27, Diterjemahan dari Bahasa Inggris oleh Brahm U. Pendit, Penerbit Buku Kedokteran EGC, Jakarta.
- Mwamatope, B., Tembo, D., Chikowe, I., Kampira, E., and Nyirenda, C., 2020, Total phenolic contents and antioxidant activity of *Senna singuena*, *Melia azedarach*, *Moringa oleifera*, and *Lannea discolor* herbal plants, *Scientific African*, **9**: 1-7.
- Naviglio, D., Scarano, P., Ciaravalo, M., and Gallo, M., 2019, Rapid Solid-Liquid Dynamic Extraction (RSLDE): A Powerful and Greener Alternative to the Latest Solid-Liquid Extraction Techniques, *Foods*, **8(245)**: 1-22.
- Nobossé, P., Fombang, E.N., and Mbofung, C.M.F., 2018, Effect of age and extraction solvent on phytochemical content and antioxidant activity of fresh *Moringa oleifera* L. leaves, *Food Science and Nutrition*, **6(8)**: 2188-2198.
- Nweze, N.O., and Nwafor, F.I., 2014, Phytochemical, Proximate and Mineral Composition of Leaf Extracts of *Moringa oleifera* Lam. from Nsukka, South-Eastern Nigeria, *Journal of Pharmacy and Biological Sciences*, **9(1)**: 99-103.
- Oak, M.H., Bedoui, J.E., Madeira, S.V.F., Chalupsky, K., and Schini-Kerth, V.B., 2006, Delphinidin and Cyanidin Inhibit PDGF(AB)-induced VEGF Release in Vascular Smooth Muscle Cells by Preventing Activation of p38 MAPK and JNK, *British Journal of Pharmacology*, **149**:283–290.
- Okumu, M.O., Mbaria, J.M., Kanja, L.W., Gakuya, D.W., Kiama, S.G., and Ochola, F.O., 2016, Phytochemical profile and antioxidant capacity of leaves of *Moringa oleifera* Lam. extracted using using different solvent systems, *Journal of Pharmacognosy and Phytochemistry*, **5(4)**: 302-308.

- Olson, M.E., 2002, Combining Data from DNA Sequences and Morphology for a Phylogeny of Moringaceae (Brassicales), *Systematic Botany*, **27(1)**:55-73.
- Omodanisi, E.I., Aboua, Y.G., and Oguntibeju, O.O., 2017, Assessment of the Anti-Hyperglycaemic, Anti-Inflammatory and Antioxidant Activities of the Methanol Extract of *Moringa oleifera* in Diabetes-Induced Nephrotoxic Male Wistar Rats, *Molecules*, **22(4)**: 1-16.
- Pae, C.U., 2015, Why Systematic Review Rather than Narrative Review? *Psychiatry Investigation*, **12(3)**: 417 – 419.
- Pakade, V., Cukrowska, E., and Chimuka, L., 2013, Metal and flavonol contents of *Moringa oleifera* grown in South Africa, *South African Journal of Science*, **109(3)**: 1-7.
- Pakade, V., Cukrowska, E., Lindahl, S., Turner, C., and Chimuka, L., 2013, Molecular imprinted polymer for solid-phase extraction of flavonol aglycones from *Moringa oleifera* extracts, *Journal of Separation Science*, **36**: 548-555.
- Panche, A.N., Diwan, A.D., and Chandra, S.R., 2016, Flavonoids: An Overview, *Journal of Nutritional Science*, **5**: 1-15.
- Peng, X., Zhang, G., Liao, Y., and Gong, D., 2016, Inhibitory kinetics and mechanism of kaempferol on α -glucosidase, *Food Chemistry*, **190**: 207–215.
- PFAF, 2010, *Moringa oleifera*-Lam , Plant for a Future, Diakses pada tanggal 19 Oktober 2020, <https://pfaf.org/user/Plant.aspx?LatinName=Moringa+oleifera>.
- Phan, M.A.T., Jin, W., Jingyi, T., Yan, Z.L., and Ken, N., 2013, Evaluation of Alpha-glucosidase Inhibition Potential of Some Flavonoids from *Epimedium brevicornu*, *Food Science and Technology*, **53**:492-498.
- Plaza, M., and Turner, C., 2015, Pressurized hot water extraction of bioactives, *Trends in Analytical Chemistry*, **71**: 39-54.
- Pollini, L., Tringaniello, C., Lanni, F., Blasi, F., Manes, J., and Cossignani, L., 2020, Impact of Ultrasound Extraction Parameters on the Antioxidant Properties of *Moringa Oleifera* Leaves, *Antioxidants*, **9(277)**: 1-14.

- Pubchem, 2020, Acarbose (CID: 445421), National Institute of Health, Diakses pada tanggal 19 Oktober 2020, <https://pubchem.ncbi.nlm.nih.gov/compound/445421>.
- Pubchem, 2020, Miglitol (CID: 441314), National Institute of Health, Diakses pada tanggal 19 Oktober 2020, <https://pubchem.ncbi.nlm.nih.gov/compound/441314>.
- Pubchem, 2020, Voglibose (CID: 444020), National Institute of Health, Diakses pada tanggal 19 Oktober 2020, <https://pubchem.ncbi.nlm.nih.gov/compound/444020>.
- Rani, N.Z.A., Kumolosasi, E., Jasamai, M., Jamal, J.A., Lam, K.W., and Husain, K., 2019, In vitro anti-allergic activity of *Moringa oleifera* Lam. extracts and their isolated compounds, *BMC Complementary and Alternative Medicine*, **19(361)**: 1-16.
- Robinson, PK., 2015, Enzymes: Principles and Biotechnological Applications, *Essays Biochem*, **59**: 1-41.
- Rompas, R.A., Edy, H.J., dan Yudistira, A., 2012, Isolasi dan Identifikasi Flavonoid dalam Daun Lamun (*Syngodium isoetifolium*), *Pharmacon*, **1(2)**:59-62.
- Sadek, K.M., Abouzed, T.K., Abouelkhair, R., and Nasr, S., 2017, The chemo-prophylactic efficacy of an ethanol *Moringa oleifera* leaf extract against hepatocellular carcinoma in rats, *Pharmaceutical Biology*, **55(1)**: 1458-1466.
- Salam, A. M., Lyles, J. T., and Quave, C. L. 2019. 'Methods in the Extraction and Chemical Analysis of Medicinal Plants' in: *Methods and Techniques in Ethnobiology and Ethnoecology*. Humana Press, New York.
- Sankhalkar, S., and Vernekar, V., 2016, Quantitative and qualitative analysis of phenolic and flavonoid content in *Moringa oleifera* Lam. and *Ocimum tenuiflorum* L., *Pharmacognosy Research*, **8(1)**: 16-21.
- Santoso., 2010, *Biokimia Kedokteran I*, Penerbit Buku Kedokteran EGC, Jakarta.
- Sarker, S.D., Latif, Z., and Gray, A.I. (eds), 2005, *Natural Products Isolation*, Humana Press, New Jersey, USA.

- Shahidi, F., and Ambigaipalan, P., 2015, Phenolics and polyphenolics in foods, beverages and spices: Antioxidant activity and health effects-A review, *Journal of Functional Foods*, **18**: 820-897.
- Shahriar, M., Hossain, M.I., Bahar, A.N.M., Akhter, S., Haque, M.A., and Bhuiyan, M.A., 2012, Preliminary Phytochemical Screening, In-Vitro Antioxidant and Cytotoxic Activity of Five Different Extracts of *Moringa Oleifera* Leaf, *Journal of Applied Pharmaceutical Science*, **2(5)**: 65-68.
- Shervington, L.A., Li, B.S., Shervington, A.A., Alpan, N., Patel, R., Muttakin, U., and Mulla, E., 2018, A Comparative HPLC Analysis of Myricetin, Quercetin, and Kaempferol Flavonoids Isolated from Gambian and Indian *Moringa oleifera* leaves, *International Journal of Chemistry*, **10(4)**: 28-37.
- Shibano, M., Kakutani, K., Taniguchi, M., Yasuda, M., and Baba, K., 2008, Antioxidant Constituents in the Dayflower (*Commelina communis* L.) and Their Alpha-Glucosidase-Inhibitory Activity, *Journal of Natural Medicines*, **62(3)**: 349-353.
- Shim, Y.J., Doo, H.K., Ahn, S.Y., Kim, Y.S., Seong, J.K., Park, I.S., and Min, B.H., 2003, Inhibitory Effect of Aqueous Extract from The Gall of *Rhus chinensis* on Alpha-glucosidase Activity and Postprandial Blood Glucose, *Journal of Ethnopharmacology*, **85**:283-287.
- Shinde, J., Taldone, T., Barletta, M., Kunaparaju, N., Hu, B., Kumar, S., Placido, J., and Zito, S.W., 2008, Alpha-Glucosidase Inhibitory Activity of *Syzygium cumini* (Linn) Skeels Seed Kernel In Vitro and In Goto-Kakizaki (GK) Rats, *Carbohydrate Research*, **343(7)**: 1278-1281.
- Siswanto, 2010, Systematic Review sebagai Metode Penelitian Untuk Mensintesis Hasil – Hasil Penelitian, *Buletin Penelitian Sistem Kesehatan*, **13(4)**: 326 – 333.
- Shousha, W.G., Aboulthana, W.M., Salama, A.H., Saleh, M.H., and Essawy, E.A., 2019, Evaluation of the biological activity of *Moringa oleifera* leaves extract after incorporating silver nanoparticles, in vitro study, *Bulletin of the National Research Centre*, **43(212)**: 1-13.
- Şöhretoğlu, D., and Sari, S., 2020, Flavonoids as Alpha-glucosidase Inhibitors: Mechanistic Approaches Merged with Enzyme

Kinetics and Molecular Modelling, *Phytochemistry Reviews*, **19**: 1081-1092.

- Sosa-Gutiérrez, J.A., Valdéz-Solana, M.A., Forbes-Hernández, T.Y., Avitia-Domínguez, C.I., García-Vargas, G.G., Salas-Pacheco, J.M., Flores-Herrera, O., Téllez-Valencia, A., Battino, M., and Sierra-Campos, E., 2018, Effects of *Moringa oleifera* Leaves Extract on High Glucose-Induced Metabolic Changes in HepG2 Cells, *Biology*, **7(3)**: 1-19.
- Sugihartini, N., Bachri, M.S., Sari, D.E.M., and Yuliani, S., 2019, The amount of β -carotene, Total Phenolic and Total Flavonoid of Ethanol Extract of Leaf *Moringa oleifera* with Variation Concentration of Solvent, *Advances in Health Sciences Research*, **18**: 110-114.
- Sulistiyaní., Safithri, M., and Sari, Y.M., 2016, Inhibition of α -Glucosidase Activity by Ethanol Extract of *Melia azedarach* L. leaves, *Journal of Earth and Environmental Sciences*, **31**:1-5.
- Sultana, B., and Anwar, F., 2007, Flavonols (Kaempferol, Quercetin, Myricetin) Contents of Selected Fruits, Vegetables and Medicinal Plants, *Food Chemistry*, **108**:879-884.
- Sultana, B., Anwar, F., and Adhraf, M., 2009, Effect of extraction solvent / technique on the antioxidant activity of selected medicinal plant extracts, *Molecules*, **14(6)**: 2167-2180.
- Swamy, G.M., and Meriga, B., 2020, Therapeutic effect of *Moringa oleifera* leaf extracts on oxidative stress and key metabolic enzymes related to obesity, *International Journal of Pharmaceutical Sciences and Research*, **1(4)**: 1949-1957.
- Tadera, K., Minami, Y., Takamatsu, K., and Matsuoka, T., 2006, Inhibition of α -Glucosidase and α -Amylase by Flavonoids, *Journal of Nutritional Science and Vitaminology*, **52**:149-153.
- Thilakarathna, S.H., and Rupasinghe, H.P.V., 2013, Flavonoid Bioavailability and Attempts for Bioavailability Enhancement, *Nutrients*, **5(9)**: 3367-3387.
- Tomasik, P., and Horton, D., 2012, *Advances in Carbohydrate Chemistry and Biochemistry*, Elsevier, Columbus.
- Tonthubthimthong, P., Chuaprasert, S., Douglas, P., and Luewisutthichat., 2001, Supercritical CO₂ Extraction of Nimbin from Neem Seeds

- An Experimental Study, *Journal of Food Engineering*, **47**: 289-293.
- Unuigbo, C.A., Okeri, H.A., Erharuyi, O., Oghenero, E., and Obamedo, D., 2014, Phytochemical and antioxidant evaluation of *Moringa oleifera* (Moringaceae) leaf and seed, *Journal of Pharmacy and Bioresources*, **11**(2): 51-57.
- Urias-Orona, V., Gutiérrez-Soto, G., Ruiz-Bautista, J., Flores-Alonso, R., Montiel-Ramos, I., Martínez-Ávila, G.C.G., Aranda-Ruiz, J., and Niño-Medina, G., 2017, Influence of extraction solvent on phenolic content and antioxidant capacity level of a commercial food supplement from *Moringa oleifera* leaves, *Archivos Latinoamericanos De Nutrición*, **67**(3): 211-217.
- Vargas-Sánchez, K., Garay-Jaramillo, E., and González-Reyes, R.E., 2019, Effects of *Moringa oleifera* on Glycaemia and Insulin Levels: A Review of Animal and Human Studies, *Nutrients*, **11**(12): 1-19.
- Vongsak, B., Sithisarn, P., and Gritsanapan, W., 2014, Simultaneous HPLC Quantitative Analysis of Active Compounds in Leaves of *Moringa oleifera* Lam., *Journal of Chromatographic Science*, **52**(7): 641-645.
- Vongsak, B., Sithisarn, P., Mangmool, S., Thongpraditchote, S., Wongkrajang, Y., and Gritsanapan, W., 2013, Maximizing Total Phenolic, Total Flavonoids Contents and Antioxidant Activity of *Moringa oleifera* Leaf Extract by The Appropriate Extraction Method, *Industrial Crops and Products*, **44**: 566-571.
- Wahono, R.S., 2015, A Systematic Literature Review of Software Defect Prediction: Research Trends, Datasets, Methods, and Frameworks, *Journal of Software Technology*, **1**(1): 1-16.
- Wahono, R.S., 2016, 'Literatur Review: Pengantar dan Metode', *Research Methodology*. Diakses pada 24 November 2020, <https://romisatriawahono.net/lectures/>.
- Wang, H., Du, Y.J., and Song, H.C., 2010, α -Glucosidase and α -Amylase Inhibitory Activities of Guava Leaves, *Food Chemistry*, **123**:6-13.
- Wang, T.Y., Li, Q., and Bi, K.S., 2018, Bioactive Flavonoid and Medical Plants: Structure, Activity, and Biological Fate, *Asian Journal of Pharmaceutical Sciences*, **13**:12-23.

- Wang, Y., Gao, Y., Ding, H., Liu, S., Han, X., Gui, J., and Liu, D., 2017, Subcritical ethanol extraction of flavonoid from *Moringa oleifera* leaf and evaluation of antioxidant activity, *Food Chemistry*, **218**: 152-158.
- Wangcharoen, W., and Gomolmanee, S., 2013, Antioxidant activity changes during hot-air drying of *Moringa oleifera* leaves, *Maejo International Journal of Science and Technology*, **7(3)**: 353-363.
- Waterman, C., Cheng, D.M., Rojas-Silva, P., Poulev, A., Dreifus, J., Lila, M.A., and Raskin, I., 2014, Stable, water extractable isothiocyanates from *Moringa oleifera* leaves attenuate inflammation in vitro, *Phytochemistry*, **103**: 114-122.
- Winarno, F.G., 2018, *Tanaman Kelor (Moringa oleifera) Nilai Gizi, Manfaat, dan Potensi Usaha*, Gramedia Pustaka Utama, Jakarta.
- Wu, L., Li, L., Chen, S., Wang, L., and Lin, X., 2020, Deep eutectic solvent-based ultrasonic-assisted extraction of phenolic compounds from *Moringa oleifera* L. leaves: Optimization, comparison and antioxidant activity, *Separation and Purification Technology*, **247**:1-11.
- Zainab, B., Ayaz, Z., Alwahibi, M.S., Khan, S., Rizwana, H., Soliman, D.W., Alawaad, A., and Abbasi, A.M., 2020, In-silico elucidation of *Moringa oleifera* phytochemicals against diabetes mellitus, *Saudi Journal of Biological Sciences*, **27(9)**: 2299-2307.
- Zhang, M., Hettiarachchy, N.S., Horax, R., Kannan, A., Praisoody, A.M.D., Muhundan, A., and Mallangi, C.R., 2011, Phytochemicals, antioxidant and antimicrobial activity of *Hibiscus sabdariffa*, *Centella asiatica*, *Moringa oleifera* and *Murraya koenigii* leaves, *Journal of Medicinal Plants Research*, **5(30)**: 6672-6680.
- Zhang, Y., Peng, L., Li, W., Dai, T., Nie, L., Xie, J., Ai, Y., Li, L., Tian, Y., and Sheng, J., 2020, Polyphenol Extract of *Moringa Oleifera* Leaves Alleviates Colonic Inflammation in Dextran Sulfate Sodium-Treated Mice, *Evidence-Based Complementary and Alternative Medicine*, **20**: 1-9.
- Zhang, Q.W., Lin, L.G., and Ye, W.C., 2018, Techniques for Extraction and Isolation of Natural Products: A Comprehensive Review, *Chinese Medicine*, **13(20)**:1-26.

- Zhao, B., Deng, J., Li, H., He, Y., Lan, T., Wu, D., Gong, H., Zhang, Y., and Chen, Z., 2019, Optimization of phenolic compound extraction from Chinese *Moringa oleifera* leaves and antioxidant activities, *Journal of Food Quality*, **19**:1-13.
- Zheng, Y., Wu, B., Deng, J., and Jiang, S., 2016, Extraction Process Optimization of Total Flavones from *Moriga Oleifera* Leaves Based on Computeraided Response Surface Method, *Iberian Journal of Information Systems and Technologies*, **5**: 287-298.
- Zhu, Y., Yin, Q., and Yang, Y., 2020, Comprehensive Investigation of *Moringa oleifera* from Different Regions by Simultaneous Determination of 11 Polyphenols Using UPLCESI-MS/MS, *Molecules*, **25**(3): 1-15.