



BIBLIOGRAPHY

- Augusti, R., Fulgêncio, A.C.C., Nogueira, H.M., Gomes, J.C.L., dos Santos, L.B., de Macedo, A.N., Porto, B.L.S., Sena, M.M., Almeida, M.R., 2024. Enhancing food authentication screening through the integration of chemometrics and ambient ionization mass spectrometry: A comprehensive review. *Trends Food Sci. Technol.* 147, 104480. <https://doi.org/10.1016/j.tifs.2024.104480>
- Babu, S., Jayaraman, S., 2020. An update on β -sitosterol: A potential herbal nutraceutical for diabetic management. *Biomed. Pharmacother.* 131, 110702. <https://doi.org/10.1016/j.biopha.2020.110702>
- Bucci, R., Magrì, A.D., Magrì, A.L., Marini, F., 2003. Comparison of three spectrophotometric methods for the determination of gamma-oryzanol in rice bran oil. *Anal. Bioanal. Chem.* 375, 1254–1259. <https://doi.org/10.1007/s00216-002-1700-5>
- Chaudhari, P.R., Tamrakar, N., Singh, L., Tandon, A., Sharma, D., 2018. Rice nutritional and medicinal properties: A review article. *J. Pharmacogn. Phytochem.* 7, 150–156.
- Chinvongamorn, C., Sansanya, S., 2020. The γ -oryzanol Content of Thai Rice Cultivars and the Effects of Gamma Irradiation on the γ -oryzanol Content of Germinated Thai Market Rice. | Oriental Journal of Chemistry | EBSCOhost [WWW Document]. <https://doi.org/10.13005/ojc/360503>
- Cho, J.-Y., Lee, H.J., Kim, G.A., Kim, G.D., Lee, Y.S., Shin, S.C., Park, K.-H., Moon, J.-H., 2012. Quantitative analyses of individual γ -Oryzanol (Steryl Ferulates) in conventional and organic brown rice (*Oryza sativa* L.). *J. Cereal Sci.* 55, 337–343. <https://doi.org/10.1016/j.jcs.2012.01.005>
- Chutipaijit, S., Sutjaritvorakul, T., 2018. Comparative study of total phenolic compounds, flavonoids and antioxidant capacities in pigmented and non-pigmented rice of indica rice varieties. *J. Food Meas. Charact.* 12, 781–788. <https://doi.org/10.1007/s11694-017-9692-1>
- Devi, L., Badwaik, L., 2022. Variety difference in physico-chemical, cooking, textural, pasting and phytochemical properties of pigmented rice. *Food Chem. Adv.* 1, 100059. <https://doi.org/10.1016/j.focha.2022.100059>
- Dong-Jin Lee, Y.-H.C., Seon-Young Lim, A.R., Muhammad Farooq, 2019. Characterization and quantification of γ -oryzanol in Korean rice landraces. *J. Cereal Sci.* 88, 150–156. <https://doi.org/10.1016/j.jcs.2019.05.019>
- Faber, N.M., Rajkó, R., 2007. How to avoid over-fitting in multivariate calibration—The conventional validation approach and an alternative.



Anal. Chim. Acta, Papers presented at the 10th International Conference on Chemometrics in Analytical Chemistry 595, 98–106.
<https://doi.org/10.1016/j.aca.2007.05.030>

Ferrari, P.F., Pettinato, M., Casazza, A.A., De Negri Atanasio, G., Palombo, D., Perego, P., 2021. Polyphenols from Nerone Gold 26/6, a new pigmented rice, via non-conventional extractions: antioxidant properties and biological validation. J. Chem. Technol. Biotechnol. 96, 1691–1699.
<https://doi.org/10.1002/jctb.6694>

Granato, D., Santos, J.S., Escher, G.B., Ferreira, B.L., Maggio, R.M., 2018. Use of principal component analysis (PCA) and hierarchical cluster analysis (HCA) for multivariate association between bioactive compounds and functional properties in foods: A critical perspective. Trends Food Sci. Technol. 72, 83–90. <https://doi.org/10.1016/j.tifs.2017.12.006>

Granite, n.d. Beer Lambert Law | Transmittance & Absorbance [WWW Document]. Edinb. Instrum. URL <https://www.edinst.com/blog/the-beer-lambert-law/> (accessed 3.30.23).

Hosoda, K., Sasahara, H., Matsushita, K., Tamura, Y., Miyaji, M., Matsuyama, H., 2018. Anthocyanin and proanthocyanidin contents, antioxidant activity, and in situ degradability of black and red rice grains. Asian-Australas. J. Anim. Sci. 31, 1213–1220.
<https://doi.org/10.5713/ajas.17.0655>

Huang, S.-H., Ng, L.-T., 2011. Quantification of Tocopherols, Tocotrienols, and γ -Oryzanol Contents and Their Distribution in Some Commercial Rice Varieties in Taiwan [WWW Document]. ACS Publ.
<https://doi.org/10.1021/jf202884p>

Islam, M.S., Yoshida, H., Matsuki, N., Ono, K., Nagasaka, R., Ushio, H., Guo, Y., Hiramatsu, T., Hosoya, T., Murata, T., Hori, M., Ozaki, H., 2009. Antioxidant, free radical-scavenging, and NF- κ B-inhibitory activities of phytosteryl ferulates: structure-activity studies. J. Pharmacol. Sci. 111, 328–337. <https://doi.org/10.1254/jphs.09146fp>

Ito, J., Sawada, K., Ogura, Y., Xinyi, F., Rahmania, H., Mohri, T., Kohyama, N., Kwon, E., Eitsuka, T., Hashimoto, H., Kuwahara, S., Miyazawa, T., Nakagawa, K., 2019. Definitive evidence of the presence of 24-methylenecycloartanyl ferulate and 24-methylenecycloartanyl caffeoate in barley. Sci. Rep. 9, 12572. <https://doi.org/10.1038/s41598-019-48985-6>

Juan, S., Hui, Z., Li, W., Haifeng, Q., Xiguang, Q.I., 2016. Method for rapid discrimination of varieties rice by using Raman spectroscopy. Food Mach. 32, 41–45. <https://doi.org/10.13652/j.issn.1003-5788.2016.01.010>



- Kaewsorn, K., Sirisomboon, P., 2014. Study on evaluation of gamma oryzanol of germinated brown rice by near infrared spectroscopy. *J. Innov. Opt. Health Sci.* 07, 1450002. <https://doi.org/10.1142/S1793545814500023>
- Khuwijitjaru, P., Taengtieng, N., Changprasit, S., 2004. Degradation of gamma-oryzanol in rice bran oil during heating: An analysis using derivative UV-spectrophotometry. *Silpakorn Univ. Int. J.* 4, 154–165.
- Kim, H.W., Kim, J.B., Shanmugavelan, P., Kim, S.N., Cho, Y.S., Kim, H.R., Lee, J.-T., Jeon, W.-T., Lee, D.J., 2013. Evaluation of γ -oryzanol content and composition from the grains of pigmented rice-germplasms by LC-DAD-ESI/MS. *BMC Res. Notes* 6, 149. <https://doi.org/10.1186/1756-0500-6-149>
- Kim, H.-W., Lee, S.-H., Lee, Y.-M., Jang, H.-H., Hwang, K.-A., Cho, H.-S., Lee, J.-T., Jeon, W.-T., Kim, J.-B., 2014. Variation of γ -Oryzanol by Incorporation of Green Manure Crops in Korean Rice Cultivars. *Korean J. Soil Sci. Fertil.* 47, 275–283. <https://doi.org/10.7745/KJSSF.2014.47.4.275>
- Le Truong, G., Tran-Lam, T.-T., 2020. Rapid classification of rice in Northern Vietnam by using FTIR spectroscopy combined with chemometrics methods. *Vietnam J. Chem.* 58. <https://doi.org/10.1002/vjch.202000001>
- Lemus, C., Angelis, A., Halabalaki, M., Skaltsounis, A.L., 2014. Chapter 32 - γ -Oryzanol: An Attractive Bioactive Component from Rice Bran, in: Watson, R.R., Preedy, V.R., Zibadi, S. (Eds.), *Wheat and Rice in Disease Prevention and Health*. Academic Press, San Diego, pp. 409–430. <https://doi.org/10.1016/B978-0-12-401716-0.00032-5>
- Lesma, G., Luraghi, A., Bavarro, T., Bortolozzi, R., Rainoldi, G., Roda, G., Viola, G., Ubiali, D., Silvani, A., 2018. Phytosterol and γ -Oryzanol Conjugates: Synthesis and Evaluation of their Antioxidant, Antiproliferative, and Anticholesterol Activities. *J. Nat. Prod.* 81, 2212–2221. <https://doi.org/10.1021/acs.jnatprod.8b00465>
- Limtrakul (Dejkriengkraikul), P., Semmarath, W., Mapoung, S., Limtrakul (Dejkriengkraikul), P., Semmarath, W., Mapoung, S., 2019. Anthocyanins and Proanthocyanidins in Natural Pigmented Rice and Their Bioactivities, Phytochemicals in Human Health. IntechOpen. <https://doi.org/10.5772/intechopen.86962>
- Liu, Ruru, Xu, Y., Chang, M., Tang, L., Lu, M., Liu, Ruijie, Jin, Q., Wang, X., 2021. Antioxidant interaction of α -tocopherol, γ -oryzanol and phytosterol in rice bran oil. *Food Chem.* 343, 128431. <https://doi.org/10.1016/j.foodchem.2020.128431>
- Lu, W., Niu, Y., Yang, H., Sheng, Y., Shi, H., Yu, L.L., 2014. Simultaneous HPLC quantification of five major triterpene alcohol and sterol ferulates in



rice bran oil using a single reference standard. *Food Chem.* 148, 329–334. <https://doi.org/10.1016/j.foodchem.2013.10.027>

Lv, L., Zhang, L., Gao, M., Ma, F., 2023. Simultaneous Determination of γ -Oryzanol in Agriproducts by Solid-Phase Extraction Coupled with UHPLC–MS/MS. *Agriculture* 13, 531. <https://doi.org/10.3390/agriculture13030531>

Mattei, L., Francisqueti-Ferron, F.V., Garcia, J.L., Ferron, A.J.T., Silva, C.C.V. de A., Gregolin, C.S., Nakandakare-Maia, E.T., Silva, J. das C.P., Moreto, F., Minatel, I.O., Corrêa, C.R., 2021. Antioxidant and anti-inflammatory properties of gamma- oryzanol attenuates insulin resistance by increasing GLUT- 4 expression in skeletal muscle of obese animals. *Mol. Cell. Endocrinol.* 537, 111423. <https://doi.org/10.1016/j.mce.2021.111423>

Miao, X., Miao, Y., Tao, S., Liu, D., Chen, Z., Wang, J., Huang, W., Yu, Y., 2021. Classification of rice based on storage time by using near infrared spectroscopy and chemometric methods. *Microchem. J.* 171, 106841. <https://doi.org/10.1016/j.microc.2021.106841>

Miller, A., Engel, K.-H., 2006. Content of γ -Oryzanol and Composition of Steryl Ferulates in Brown Rice (*Oryza sativa* L.) of European Origin. *J. Agric. Food Chem.* 54, 8127–8133. <https://doi.org/10.1021/jf061688n>

Minatel, I.O., Francisqueti, F.V., Corrêa, C.R., Lima, G.P.P., 2016. Antioxidant Activity of γ -Oryzanol: A Complex Network of Interactions. *Int. J. Mol. Sci.* 17, 1107. <https://doi.org/10.3390/ijms17081107>

Nakano, H., Yoshida, H., Yabe, S., Fushimi, E., Tanaka, R., Yamasaki, M., Nakagawa, H., 2022. γ -Oryzanol concentrations in various rice genotypes ripened under different air temperatures. *Cereal Chem.* 99. <https://doi.org/10.1002/cche.10597>

Nurmi, T., Lampi, A.-M., Nyström, L., Turunen, M., Piironen, V., 2010. Effects of Genotype and Environment on Steryl Ferulates in Wheat and Rye in the HEALTHGRAIN Diversity Screen. *J. Agric. Food Chem.* 58, 9332–9340. <https://doi.org/10.1021/jf100170s>

Perez-Ternero, C., Alvarez de Sotomayor, M., Herrera, M.D., 2017. Contribution of ferulic acid, γ -oryzanol and tocotrienols to the cardiometabolic protective effects of rice bran. *J. Funct. Foods* 32, 58–71. <https://doi.org/10.1016/j.jff.2017.02.014>

Pokkanta, P., Sookwong, P., Tanang, M., Setchaiyan, S., Boontakham, P., Mahatheeranont, S., 2019. Simultaneous determination of tocots, γ -oryzanol, phytosterols, squalene, cholecalciferol and phylloquinone in rice bran and vegetable oil samples. *Food Chem.* 271, 630–638. <https://doi.org/10.1016/j.foodchem.2018.07.225>



Pungseeklao, T., 2016. Development of a method for quantitative determination of γ -oryzanol using near infrared spectroscopy.

Pungseeklao, T., Opanasopit, P., Khuwijitjaru, P., 2016. Development of a method for quantitative determination of γ -oryzanol using near infrared spectroscopy. *Food Appl. Biosci. J.* 4, 107–115. <https://doi.org/10.14456/fabj.2016.10>

Rogowska, A., Szakiel, A., 2020. The role of sterols in plant response to abiotic stress. *Phytochem. Rev.* 19. <https://doi.org/10.1007/s11101-020-09708-2>

Rohman, A., Irnawati, Riswanto, F.D.O., 2023. Analisis Farmasi dengan Spektroskopi UV-Vis dan Kemometrika. UGM PRESS.

Sabir, A., Rafi, M., Darusman, L.K., 2017. Discrimination of red and white rice bran from Indonesia using HPLC fingerprint analysis combined with chemometrics. *Food Chem.* 221, 1717–1722. <https://doi.org/10.1016/j.foodchem.2016.10.114>

Sakunpak, A., Suksaeree, J., Monton, C., Pathompak, P., Kraisintu, K., 2014. Quantitative analysis of γ -oryzanol content in cold pressed rice bran oil by TLC-image analysis method. *Asian Pac. J. Trop. Biomed.* 4, 119–123. [https://doi.org/10.1016/S2221-1691\(14\)60219-7](https://doi.org/10.1016/S2221-1691(14)60219-7)

Santoso, U., Setyaningsih, W., Ningrum, A., Ardhi, A., Sudarmanto, 2021. Analisis Pangan. UGM PRESS.

Savitha, Y., Singh, V., 2011. Status of dietary fiber contents in pigmented and non-pigmented rice varieties before and after parboiling. *Lwt - Food Sci. Technol.* 44, 2180–2184. <https://doi.org/10.1016/j.lwt.2011.06.004>

Setyaningsih, W., Hidayah, N., Saputro, I.E., Lovillo, M.P., Barroso, C.G., 2014. Melatonin Profile during Rice (*Oryza Sativa*) Production. *J. Adv. Agric. Technol.* 1, 60–64. <https://doi.org/10.12720/joaat.1.1.60-64>

Setyaningsih, W., Saputro, I.E., Carrera, C.A., Palma, M., García-Barroso, C., 2019. Fast Determination of Phenolic Compounds in Rice Grains by Ultraperformance Liquid Chromatography Coupled to Photodiode Array Detection: Method Development and Validation. *J. Agric. Food Chem.* 67, 3018–3027. <https://doi.org/10.1021/acs.jafc.8b05430>

Subramanian, J., Simon, R., 2013. Overfitting in prediction models – Is it a problem only in high dimensions? *Contemp. Clin. Trials* 36, 636–641. <https://doi.org/10.1016/j.cct.2013.06.011>

Tian, W., Chen, G., Gui, Y., Zhang, G., Li, Y., 2021. Rapid quantification of total phenolics and ferulic acid in whole wheat using UV-Vis spectrophotometry. *Food Control* 123, 107691. <https://doi.org/10.1016/j.foodcont.2020.107691>



- Tistaert, C., Dejaegher, B., Heyden, Y.V., 2011. Chromatographic separation techniques and data handling methods for herbal fingerprints: A review. *Anal. Chim. Acta* 690, 148–161. <https://doi.org/10.1016/j.aca.2011.02.023>
- Tsuzuki, W., Komba, S., Kotake-Nara, E., 2019. Diversity in γ -oryzanol profiles of Japanese black-purple rice varieties. *J. Food Sci. Technol.* 56, 2778–2786. <https://doi.org/10.1007/s13197-019-03767-w>
- U. S. Government Accountability, O., 2018. Food Safety: Federal Efforts to Manage the Risk of Arsenic in Rice | U.S. GAO [WWW Document]. URL <https://www.gao.gov/products/gao-18-199> (accessed 3.29.23).
- Vardhani, A., Perdanastuti, H., Kadar, P., Oryzanol, G., Etanol, D., Beras, B., 2024. Determination of Gamma Oryzanol from Ethanolic Extract of Indonesian Rice Bran (*Oryza sativa*) 11, 87–91. <https://doi.org/10.24198/ijpst.v11i1.46297>
- Verma, D.K., Srivastav, P.P., 2020. Bioactive compounds of rice (*Oryza sativa* L.): Review on paradigm and its potential benefit in human health. *Trends Food Sci. Technol.* 97, 355–365. <https://doi.org/10.1016/j.tifs.2020.01.007>
- Verma, D.K., Srivastav, P.P., 2017. Proximate Composition, Mineral Content and Fatty Acids Analyses of Aromatic and Non-Aromatic Indian Rice. *Rice Sci.* 24, 21–31. <https://doi.org/10.1016/j.rsci.2016.05.005>
- Wang, O., Liu, J., Cheng, Q., Guo, X., Wang, Y., Zhao, L., Zhou, F., Ji, B., 2015. Effects of ferulic acid and γ -oryzanol on high-fat and high-fructose diet-induced metabolic syndrome in rats. *PloS One* 10, e0118135. <https://doi.org/10.1371/journal.pone.0118135>
- Wirdatun, N., Patera, N.A., Aditya, N., Isti, S.A., Sapta, N.D., Philia, J., Iqbal, K.M., Wirdatul, A., Tresnadiana, H.V., Ahmad, N.T.N.E. binti T., 2023. Benefit of Asian pigmented rice bioactive compound and its implication in breast cancer: a systematic review. *F1000Research* 12. <https://doi.org/10.12688/f1000research.130329.1>
- Xu, Z., Hua, N., Godber, J.S., 2001. Antioxidant activity of tocopherols, tocotrienols, and gamma-oryzanol components from rice bran against cholesterol oxidation accelerated by 2,2'-azobis(2-methylpropionamidine) dihydrochloride. *J. Agric. Food Chem.* 49, 2077–2081. <https://doi.org/10.1021/jf0012852>
- Yasuda, S., Sowa, Y., Hashimoto, H., Nakagami, T., Tsuno, T., Sakai, T., 2019. Cycloartenyl Ferulate and β -Sitosteryl Ferulate - Steryl Ferulates of γ -Oryzanol - Suppress Intracellular Reactive Oxygen Species in Cell-based System. *J. Oleo Sci.* 68, 765–768. <https://doi.org/10.5650/jos.ess19054>
- Yudthavorasit, S., Wongravee, K., Leepipatpiboon, N., 2014. Characteristic fingerprint based on gingerol derivative analysis for discrimination of



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Development of UV-Vis Spectroscopy Combined with Chemometrics for Simultaneous

Multi-Component

Analysis of Gamma Oryzanol in Different Parts of Rice (*Oryza Sativa*) Grain

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ginger (*Zingiber officinale*) according to geographical origin using HPLC-DAD combined with chemometrics. *Food Chem.* 158, 101–111.
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