



Phytochemical Screening and Toxicity Testing of Red Turmeric (*Curcuma zedoaria*) and White Turmeric (*Curcuma mangga*) Extracts in White Wistar Rats (*Rattus norvegicus*)

Rita Kirana^{1*}, Agus Rachmadi¹, Nurlailah¹

¹Ministry of Health Polytechnic of Health Banjarmasin, Banjarmasin, Indonesia.

Received: December 17, 2025

Revised: January 02, 2026

Accepted: February 25, 2026

Published: February 28, 2026

Corresponding Author:

Rita Kirana

kiranaritaari@gmail.com

DOI: [10.29303/jppipa.v12i2.13497](https://doi.org/10.29303/jppipa.v12i2.13497)

 Open Access

© 2026 The Authors. This article is distributed under a (CC-BY License)



Abstract: This study aimed to conduct phytochemical analysis and toxicity testing of Red Turmeric (*Curcuma zedoaria*) and White Turmeric (*Curcuma mangga*) extracts in male Wistar rats (*Rattus norvegicus*). This study employs an experimental design conducted at the Poltekkes Kemenkes Banjarmasin laboratory. Phytochemical screening was undertaken to detect bioactive compounds utilizing spectrophotometry for quantitative analysis, with each compound evaluated in triplicate. The experimental subjects were male Wistar rats, divided into two treatment groups (300 mg/kgBW and 2000 mg/kgBW), with observations recorded at multiple intervals (30 minutes to 14 days) post-administration. Toxicity indicators included physical symptoms such as skin conditions, lethargy, and survival status. Data were analyzed descriptively, calculating the mean and standard deviation for phytochemical content and employing frequency tables to highlight clinical symptom patterns. Results showed that both types of turmeric contain these compounds, with White Turmeric having higher phenolic (23.41 mg/g) and flavonoid (17.21 mg/g) contents than Red Turmeric (21.72 mg/g and 15.50 mg/g, respectively). These findings indicate a higher antioxidant potential in White Turmeric. In the toxicity test, two doses (300 mg/kgBW and 2000 mg/kgBW) were tested through observations of physical conditions, including skin and fur, as well as clinical symptoms such as lethargy, seizures, tremors, diarrhea, and survival status.

Keywords: Bioactive compounds; *Curcuma mangga*; *Curcuma zedoaria*; Phytochemical screening; Toxicity testing; Wistar rats

Introduction

Extracts from some *Curcuma* species, such as *C. zedoaria* and *C. mangga*, have been demonstrated in earlier research to contain important phytochemical components, such as flavonoids, saponins, tannins, and alkaloids, which are thought to contribute to their health benefits (Sasanti et al., 2025; Wardhani et al., 2023). In a health context, it is also important to understand the toxicity profile of the extract before it is used in medical applications, especially considering that some components can potentially have dangerous side effects at certain doses (Wardhani et al., 2023; Zega et al., 2023).

While *Curcuma zedoaria* has been shown not to cause significant toxic effects in animal models (Zega et al., 2023), this research needs to be expanded to ensure its safety for larger-scale use. Other studies have also shown that *C. zedoaria* can act as an anti-carcinogenic agent (Nicholas et al., 2022; Saragih et al., 2021). Likewise, research on *C. mangga* shows strong potential in traditional medicine (Sasanti et al., 2025).

Compounds having medicinal properties can be found with the use of successful phytochemical screening, which will also offer empirical proof of the extract's safety. For instance, studies have demonstrated that the toxicity of *C. longa* might change based on the

How to Cite:

Kirana, R., Rachmadi, A., & Nurlailah. (2026). Phytochemical Screening and Toxicity Testing of Red Turmeric (*Curcuma zedoaria*) and White Turmeric (*Curcuma mangga*) Extracts in White Wistar Rats (*Rattus norvegicus*). *Jurnal Penelitian Pendidikan IPA*, 12(2), 454-461. <https://doi.org/10.29303/jppipa.v12i2.13497>

extract's form and dosage (Lubis et al., 2023; Vera et al., 2021). Therefore, it is important to conduct detailed toxicity testing for both types of turmeric in this study by assessing the morphology and histopathology of vital organs such as the liver and kidneys (John et al., 2024; Nkempu et al., 2021). There are many benefits to using white Wistar rats as animal models in biomedical research, especially when it comes to toxicity studies. Since these rats are the most commonly utilized organisms, more accurate and trustworthy data may be gathered (Nirvanashetty et al., 2022). In the context of plant extract research, such as *Curcuma zedoaria* (white turmeric), toxicity testing involving the determination of the LD50 is essential. Research shows that white turmeric extract has an LD50 of more than 2000 mg/kg body weight, indicating that this extract is non-toxic and safe for use (Gani et al., 2022; Gozali et al., 2022).

The aim of this study was to conduct phytochemical screening of red turmeric (*Curcuma species*) and white turmeric (*Curcuma zedoaria*). The first step involved identifying and determining the levels of phenolic compounds, flavonoids, tannins, and other bioactive compounds present in both types of turmeric. These compounds are crucial for evaluating the therapeutic and nutritional potential of each type of turmeric. Furthermore, the study will examine the acute toxicity of a mixture of red and white turmeric extracts. This toxicity testing aims to determine the safe limits for the use of the extract mixture in pharmaceutical and culinary preparations. The results of this study are expected to contribute to our understanding of the health benefits and safety of consuming these two types of turmeric.

Method

Research Design

This research method was designed as an experimental study consisting of several stages: phytochemical screening, determination of chemical compound levels, and toxicity testing. The study was conducted at the Banjarmasin Ministry of Health Polytechnic Laboratory in Banjarmasin City, South Kalimantan Province. Screening was conducted to detect active compounds found in red and white turmeric, including phenolics, flavonoids, tannins, alkaloids, saponins, terpenoids, and steroids. Qualitative analysis was performed using proven methods. Quantitative determination was performed using spectrophotometry. Each compound was tested three times to ensure the accuracy of the data obtained.

Tools and Materials

This study used two types of turmeric, namely Red Turmeric (*Curcuma zedoaria*) and White Turmeric

(*Curcuma mangga*), which were obtained from trusted sources to ensure their quality and purity. The required chemical reagents included ethanol, water, and dye solutions, which were used in phytochemical testing to identify phenolic compounds, flavonoids, tannins, alkaloids, saponins, terpenoids, and steroids. In addition, standard solutions were also prepared to determine the levels of phenolic and flavonoid compounds. The tools used in this study included an analytical balance for precise measurements, a laboratory hot plate for the extraction process, and a UV-Vis spectrophotometer for quantitative analysis. Wire pipettes, test tubes, graduated cylinders, pipettes, and other standard laboratory equipment were also provided to support the research process.

Research Sample

The samples used were male white Wistar rats (*Rattus norvegicus*) aged 8-12 weeks and of uniform body weight. Twenty-four rats were divided into two treatment groups: 300 mg/kgBW and 2000 mg/kgBW, with 12 rats in each group. A mixture of red and white turmeric extracts was administered orally using a probe. Toxicity was observed at 30 minutes, 4 hours, 24 hours, 7 days, and 14 days after administration. Observed parameters included skin and fur conditions, lethargy, seizures, tremors, diarrhea, and the life/death status of the rats. The data obtained were analyzed descriptively to assess the toxicity of the tested extracts.

Red and white turmeric samples were obtained from locations with guaranteed cultivation authenticity. The turmeric used was declared to have met established quality standards. The turmeric was dried and ground into powder before extraction. Screening was performed to detect active compounds found in red and white turmeric, including phenolics, flavonoids, tannins, alkaloids, saponins, terpenoids, and steroids. Qualitative analysis was performed using proven methods. Quantitative determination was performed using spectrophotometry. Each compound was tested in three replicates to ensure the accuracy of the data obtained.

Phytochemical Screening

The phytochemical screening process for red and white turmeric begins with extraction, where the rhizomes are dried and ground into powder. The dried powder is then extracted using ethanol at a ratio of 1:10 (w/v) for 24 hours in the dark to maintain the stability of the light-sensitive compounds. After the extraction process, the mixture is filtered using a clean cloth, and the solvent present in the extract is removed through evaporation. This step is crucial for obtaining a pure extract for further analysis.

Following the extraction stage, phytochemical testing was performed using standard methods to identify various bioactive compounds. Phenolic compounds were tested using the Folin-Ciocalteu method, where reagents were added and the staining intensity was measured using a spectrophotometer. Flavonoids were tested by adding an AlCl₃ solution, while tannins were tested by precipitation reactions using the green and red methods. Other compounds, such as alkaloids, saponins, terpenoids, and steroids, were tested using dissolution and precipitation procedures, consistent with existing literature. This process provided a comprehensive overview of the phytochemical content of both types of turmeric.

Content Analysis

The next step is analyzing the levels of each compound present in the extract. In this procedure, a standard curve is prepared using reference compounds to control for variability in the measurements. Compound quantification is performed using a spectrophotometric method, which utilizes a linear calibration approach to ensure data validity. Each extract is tested in triplicate to obtain average data, thus increasing the accuracy and consistency of the analysis results.

Toxicity Testing

Toxicity testing is designed using control and treatment groups. This grouping aims to compare the reactions of animals exposed to the test substance with those not exposed. Experimental animals, such as rats, will be divided into two groups: one group as a control that receives no treatment, and another group that receives the test treatment.

Next, toxicity testing was conducted by recording the reactions of the experimental animals at several time intervals: 30 minutes, 4 hours, 24 hours, 7 days, and 14 days after exposure. Observed parameters included skin and fur conditions, lethargy, seizures, tremors, diarrhea, and survival rate (live/dead). This observation process will allow researchers to evaluate the short- and long-term effects of toxicant exposure and aid in understanding the mechanisms of toxicity.

Data Analysis

Data generated from phytochemical screening and compound assay were analyzed descriptively. This method involves calculating the mean and standard deviation for each detected compound, providing a comprehensive overview of the variability and trends in the data. Toxicity testing results will be compared between the two study groups. A frequency table analysis approach will be applied to describe the clinical symptoms that appear in response to treatment. This

table will include the frequency of symptom occurrence, which can help identify patterns and significant differences between groups. This descriptive analysis is essential for providing a deeper understanding of the potential and risks associated with the tested compounds.

Research Method for Turmeric Extract Analysis

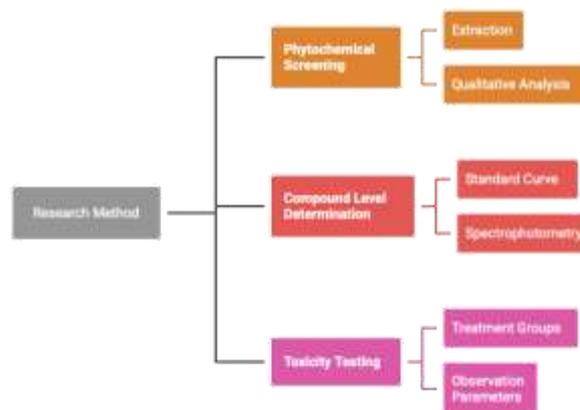


Figure 1. Research method flow

Result and Discussion

Table 1 shows the results of phytochemical screening of two types of turmeric: red turmeric and white turmeric. Each compound tested showed positive results in both types. The phenolic compounds, flavonoids, tannins, alkaloids, saponins, terpenoids, and steroids detected in both turmeric species indicate potential biological activities, including antioxidant, anti-inflammatory, and anticancer properties.

Table 1. Phytochemical screening results of red turmeric and white turmeric

Compound Groups	Red Turmeric	White Turmeric
Phenolic	Positive	Positive
Flavonoid	Positive	Positive
Tannin	Positive	Positive
Alkaloid	Positive	Positive
Saponin	Positive	Positive
Terpenoid	Positive	Positive
Steroid	Positive	Positive

Table 2 shows that the average total phenolic content in red turmeric is 21.72 mg/g, while white turmeric shows a higher level, namely 23.41 mg/g. This indicates that white turmeric has better antioxidant potential compared to red turmeric based on phenolic content. In the total flavonoid category, red turmeric has an average level of 15.50 mg/g, while white turmeric is slightly higher at 17.21 mg/g. Similarly, for

total tannin levels, red turmeric recorded an average of 2.49 mg/g, while white turmeric recorded 3.61 mg/g. Overall, the results indicate that white turmeric has higher levels of bioactive compounds than red turmeric, which may have implications for biological activity and health. These results can be the basis for further research into the health benefits of both types of turmeric.

Table 2. Results of determination of marker levels of red turmeric and white turmeric

Level	Replication	Red Turmeric	White Turmeric
Phenolic	1	21.71	23.42
	2	21.93	23.63
	3	21.52	23.19
	Average	21.72	23.41
Flavonoids	1	15.45	17.11
	2	15.31	17.05
	3	15.74	17.46
	Average	15.50	17.21
Tannin	1	2.47	3.52
	2	2.62	3.61
	3	2.38	3.72
	Average	2.49	3.61

Table 3 presents the results of acute toxicity testing of a mixture of red turmeric and white turmeric extracts on white Wistar rats, which were observed at various times after dose administration, namely 300 mg/KgBW and 2000 mg/KgBW. Observations included skin and fur conditions, the occurrence of lethargy, seizures, tremors, diarrhea, and the status of life/death of the rats. From the observation results, both at doses of 300 mg/KgBW and 2000 mg/KgBW, all parameters showed normal conditions without any symptoms of toxicity,

such as lethargy, seizures, tremors, or diarrhea, during the recorded time periods (30 minutes, 4 hours, 24 hours, 7 days, and 14 days). The rats' life status was also maintained, indicating that the turmeric extract mixture did not cause significant toxic effects at the tested doses.

It is well known that the phenolic and flavonoid chemicals included in both turmeric types have strong antioxidant qualities. *Curcuma zedoaria* has strong antioxidant activity, according to research, which may help prevent cell damage brought on by free radicals (Sumarheni et al., 2019; Yurasbe et al., 2023). In addition, these compounds can also contribute to the apoptosis process of cancer cells, as shown in studies on the compatibility between turmeric extract and chemotherapy agents in enhancing anticancer effects. From a toxicity perspective, studies conducted on white Wistar rats (*Rattus norvegicus*) have shown promising results. For example, acute toxicity tests on white turmeric extract showed no deaths or toxicity symptoms at low to high doses, indicating that the extract is non-toxic with an LD50 of more than 2000 mg/kg BW (Wardhani et al., 2023). This is strong evidence that both types of turmeric, especially white turmeric, can be used as a safe natural ingredient for medicinal purposes. The active potential of both types of turmeric in reducing inflammation and improving liver function has also been identified. Red turmeric extract is known to function as a hepatoprotective agent, with the ability to protect liver cells from damage caused by harmful substances, such as cigarette smoke (Amin et al., 2019). This suggests that the active compounds in turmeric are not only beneficial for addressing specific health issues but also exhibit protective effects on vital organs.

Table 3. Results of acute toxicity testing of a mixture of red turmeric and white turmeric extracts on white winstar mice

Observation	Dose	30 minutes	4 hours	24 hours	7 days	14 days
Skin and Fur	300 mg/KgBW	Normal	Normal	Normal	Normal	Normal
	2000 mg/KgBW	Normal	Normal	Normal	Normal	Normal
Sluggish	300 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
	2000 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
Seizures	300 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
	2000 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
Shiver	300 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
	2000 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
Diarrhea	300 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
	2000 mg/KgBW	No Happen	No Happen	No Happen	No Happen	No Happen
Life and death	300 mg/KgBW	Life	Life	Life	Life	Life
	2000 mg/KgBW	Life	Life	Life	Life	Life

The active compounds in turmeric, particularly curcumin, have shown significant hepatoprotective properties, contributing to liver function and inflammation reduction. Curcumin has been observed

to mitigate oxidative stress and inflammatory pathways in hepatic cells, thereby preventing liver damage from various stressors, including environmental pollutants (Tong et al., 2021; Wu et al., 2024). Specifically,

curcumin demonstrates its efficacy by downregulating critical inflammatory mediators such as COX-2 and TNF- α , which are essential in the inflammatory response (Clayton et al., 2023; Ismail & Mazuki, 2021). Its antioxidant properties also offer protective effects on cellular structures, enhancing liver health (Nosrati-Oskouie et al., 2022). This underscores the potential of turmeric's bioactive components, suggesting that their inclusion in dietary regimens could aid in ameliorating liver diseases and inflammatory conditions (Yang et al., 2022; Zhou et al., 2020).

In evaluating the phytochemical screening and toxicity testing of Red Turmeric (*Curcuma zedoaria*) and White Turmeric (*Curcuma mangga*) extracts in White Wistar rats (*Rattus norvegicus*), it is crucial to review the bioactive compound content and associated health implications these extracts offer. The findings indicate that both turmeric varieties contain essential antioxidants in the form of total phenolics, flavonoids, and tannins, which play significant roles in promoting health through their biological activities (Akinola et al., 2014; Lobo et al., 2009; Mozartha et al., 2022; Rahayu et al., 2020).

White turmeric has a higher average total phenolic content (23.41 mg/g) than red turmeric (21.72 mg/g), which may indicate that it has a greater potential for antioxidant activity. Phenolic chemicals are widely known for their ability to neutralize free radicals, reducing oxidative stress and possibly lowering the risk of a number of illnesses (Ibukun & Oluwadare, 2021; Rahayu et al., 2020). The increased levels of these compounds could correlate with enhanced antioxidant defense mechanisms, which implies that the higher content in white turmeric may lead to more favorable health outcomes (Mateş et al., 2024). This finding aligns with research indicating that curcumin and other phenolic compounds present in *Curcuma* species exhibit notable antioxidant activity, beneficial for cancer prevention and other chronic diseases (Rahayu et al., 2020). Moreover, the flavonoid content, with white turmeric at 17.21 mg/g versus red turmeric's 15.50 mg/g, also supports this antioxidant potential (Mozartha et al., 2022). Flavonoids are pivotal in various biological activities, including anti-inflammatory and anticancer effects, which can enhance the overall health benefits of consuming these turmeric varieties (Mateş et al., 2024; Wardhani et al., 2023). The tannin levels, showing white turmeric with 3.61 mg/g compared to 2.49 mg/g in red turmeric, imply that both extracts can be beneficial in nutritional and therapeutic applications. Tannins are recognized for their antimicrobial properties and their capacity to aid in managing blood glucose levels, pertinent particularly in the context of metabolic diseases (Lubis et al., 2023).

In terms of toxicity testing, the acute toxicity assessments conducted on white turmeric extracts revealed an LD50 of greater than 2000 mg/kg body weight, categorizing it as non-toxic. This outcome indicates the safety of white turmeric for consumption at this dosage level (Tania et al., 2021; Wardhani et al., 2023). The lack of significant toxicity supports the traditional use of this herb in various medicinal formulations and reinforces the notion that it can be further researched for health supplements (Tinrat, 2022). Additionally, *Curcuma zedoaria*'s historical applications in traditional medicine point to its potential in alleviating a range of health issues, reinforcing its status as a valuable medicinal plant (Yurasbe et al., 2023).

The acute toxicity testing of red turmeric (*Curcuma zedoaria*) and white turmeric (*Curcuma mangga*) extracts conducted on Wistar rats revealed outcomes related to safety and physiological impact. The experiments involved administering two doses, 300 mg/Kg body weight (BW) and 2000 mg/Kg BW, followed by a series of observations at various time intervals: 30 minutes, 4 hours, 24 hours, 7 days, and 14 days. Across all dosages and observation periods, the rats exhibited no signs of toxicity, such as skin and fur abnormalities, lethargy, seizures, tremors, diarrhea, or mortality (Gozali et al., 2022; Yuandani & Suwarso, 2016). This consistent observation suggests that these extracts could be considered safe for consumption within the given dosage parameters.

Phytochemical research on *Curcuma* species, such as *Curcuma zedoaria* and *Curcuma mangga*, has shown that they are known to contain bioactive substances like curcumin, which have anti-inflammatory, antioxidant, and perhaps anticancer qualities (Fahmy et al., 2023). In particular, compounds such as flavonoids and phenolic acids, found in these turmeric varieties, are associated with protective effects against certain diseases, which might contribute to their low toxicity profile (Astuti et al., 2024). Moreover, other studies corroborate the findings of low toxicity levels associated with turmeric extracts. For instance, a study on the acute toxicity of white turmeric found similar results, indicating no adverse effects and affirming that the extracts present no significant risk at tested doses (Lubis et al., 2023; Saragih et al., 2021). The non-toxic nature of turmeric compounds aligns well with other pharmacological evaluations that report minimal side effects even at higher dosages (Fahmy et al., 2023; Lubis et al., 2023). Another aspect that warrants attention is the potential for varying toxicity depending on the specific compound or extraction method used. For example, extracts high in specific curcuminoids might demonstrate beneficial effects without the risks associated with synthetic compounds or other natural

products with a more complex toxicity profile (Liang et al., 2023). This highlights the necessity of rigorous toxicity assessments, especially when considering the therapeutic applications of herbal extracts (Jain et al., 2021; Saragih et al., 2021).

Conclusion

White turmeric showed higher levels of total phenolic (23.41 mg/g) and flavonoid (17.21 mg/g) content than Red turmeric (21.72 mg/g and 15.50 mg/g, respectively). Both turmeric varieties demonstrated positive results for a variety of phytochemicals, including phenolics, flavonoids, and tannins. These results point to White Turmeric's increased antioxidant capability, which probably contributes to its noted health advantages. Both extracts were shown to be non-toxic by acute toxicity testing, which was supported by an LD50 of more than 2000 mg/kg for White Turmeric and the lack of side effects at dosages of 300 mg/kg and 2000 mg/kg body weight. This evidence bolsters the traditional medicinal use of these plants, advocating for further exploration of their pharmacological applications in health and wellness. Future research should continue to investigate the therapeutic potential and safety of these curcuma species to optimize their benefits in culinary and medicinal practices.

Acknowledgments

We would like to thank Poltekkes Kemenkes Banjarmasin for providing laboratory facilities for this research, as well as to all members of the research team who have worked hard throughout the experimental process. We also express our gratitude to the supervisors and parties involved in data collection and analysis. Without the support and collaboration of all parties, the results of this research would not have been possible. We hope that these findings can provide benefits in the development of the use of turmeric as a safe and effective medicinal ingredient.

Author Contributions

For the conceptualization of the study, R.K. led the development of the overarching framework while A.R. and N. contributed foundational ideas and insights. In terms of methodology and software utilized; R.K., A.R., and N. collaboratively engaged in the design and execution of the analytical approaches employed throughout the study. Validation and formal analysis were primarily conducted by A.R., with contributions from R.K. and N. ensuring robustness and reliability of findings. The writing of the original draft was facilitated by R.K., with A.R. and N. providing critical feedback and revisions. Project administration duties were coordinated by N., while R.K. and A.R. assisted in organization and oversight of the project timeline. Finally, the funding acquisition efforts were spearheaded by R.K., with A.R. participating in grant applications, and N. providing supportive documentation.

Funding

No Funding.

Conflicts of Interest

The authors declare no conflict of interest.

References

- Akinola, A. O., Ahmad, S., & Mahmood, M. (2014). Total Anti-Oxidant Capacity, Flavonoid, Phenolic Acid and Polyphenol Content in Ten Selected Species of Rhizomes. *African Journal of Traditional Complementary and Alternative Medicines*, 11(3), 7. <https://doi.org/10.4314/ajtcam.v11i3.2>
- Amin, F., Yanti, N. I., Sartini, S., & Sumarheni, S. (2019). Efek Pemberian Ekstrak Etanol Rimpang Temu Putih (*Curcuma zedoaria* (Berg.) Roscoe) Terhadap Perubahan Kadar Protein Total dan Alkali Fosfatase pada Tikus (*Rattus norvegicus*) yang Dipaparkan Asap Rokok. *Majalah Farmasi dan Farmakologi*, 22(3), 99–103. <https://doi.org/10.20956/mff.v22i3.5861>
- Astuti, A. C., Syamswisna, S., & Fajri, H. (2024). Ethnobotany of Women's Health Plants in Trimulya Village Sanggau Regency. *Bioscientist Jurnal Ilmiah Biologi*, 12(1), 1215. <https://doi.org/10.33394/bioscientist.v12i1.11263>
- Clayton, D. J., Burbeary, R., Hennis, P. J., James, R. M., Saward, C., Colledge, A., Scott, R., Gilpin, S., McMahan, R., & Varley, I. (2023). Turmeric Supplementation Improves Markers of Recovery in Elite Male Footballers: A Pilot Study. *Frontiers in Nutrition*, 10. <https://doi.org/10.3389/fnut.2023.1175622>
- Fahmy, H. M., Aboalasaad, F. A., Mohamed, A. S., Elhusseiny, F. A., Khadrawy, Y. A., & Elmekawy, A. (2023). Evaluation of the Therapeutic Effect of Curcumin-Conjugated Zinc Oxide Nanoparticles on Reserpine-Induced Depression in Wistar Rats. *Biological Trace Element Research*, 202(6), 2630–2644. <https://doi.org/10.1007/s12011-023-03849-z>
- Gani, J. O., Wardhani, F. M., & Tandanu, E. (2022). Uji Toksisitas Akut Ekstrak Kunyit Putih (*Curcuma zedoaria*) pada Ginjal Tikus Wistar Jantan. *Majalah Kesehatan*, 8(4), 192–198. <https://doi.org/10.21776/ub.majalahkesehatan.2021.008.04.2>
- Gozali, K., Erny, T., Fiska, W. M., & Rico, S. A. (2022). Acute Toxicity of Extract of White Turmeric Rhizome (*Curcuma zedoaria*) Review of Ld50 and Blood Cell Components. *Jambura Journal of Health Sciences and Research*, 4(3), 648–655. <https://doi.org/10.35971/jjhsr.v4i3.13309>
- Ibukun, O., & Oluwadare, E. E. (2021). In Vitro Antioxidant Property and Acute Toxicity Study of Methanol Extract of Leaves of *Zingiber Officinale*

- and Curcuma Longa. *Free Radicals and Antioxidants*, 11(2), 42–45. <https://doi.org/10.5530/fra.2021.2.10>
- Ismail, Z., & Mazuki, N. A. N. (2021). An Overview of Golden Spice's (Turmeric) Medicinal Properties for Future Development Potential. *Malaysian Journal of Science Health & Technology*, 6. <https://doi.org/10.33102/mjosht.v6io.127>
- Jain, A., Madu, C. O., & Lü, Y. (2021). Phytochemicals in Chemoprevention: A Cost-Effective Complementary Approach. *Journal of Cancer*, 12(12), 3686–3700. <https://doi.org/10.7150/jca.57776>
- John, O. C., Kalu, A. N., Christopher, O. O., & Amarachi, O. C. (2024). Phytochemical Composition and Toxicological Profiling of Curcuma longa (Turmeric) Root Extract in Rats. *International Journal of Biochemistry Research & Review*, 33(1), 1–12. <https://doi.org/10.9734/ijbcrr/2024/v33i1847>
- Liang, Q., Chen, T., Luo, L., Ma, Y., Wen, C., & Huang, X. (2023). Pharmacokinetics and Bioavailability of Curdione in Mice By UPLC-MS/MS. *Acta Chromatographica*, 35(2), 144–148. <https://doi.org/10.1556/1326.2022.01020>
- Lobo, R., Prabhu, K. S., Shirwaikar, A., & Shirwaikar, A. (2009). Curcuma zedoaria Rosc. (White Turmeric): A Review of Its Chemical, Pharmacological and Ethnomedicinal Properties. *Journal of Pharmacy and Pharmacology*, 61(1), 13–21. <https://doi.org/10.1211/jpp.61.01.0003>
- Lubis, A., Wardhani, F. M., Lubis, A. T., & Tandanu, E. (2023). Cerebral Histopathology in Acute Toxicity Test of Curcuma zedoria. *Jurnal Penelitian Pendidikan IPA*, 9(10), 8368–8375. <https://doi.org/10.29303/jppipa.v9i10.5482>
- Mateş, L., Banc, R., Zaharie, F. A., Rusu, M. E., & Popa, D. (2024). Mechanistic Insights into the Biological Effects and Antioxidant Activity of Walnut (*Juglans regia* L.) Ellagitannins: A Systematic Review. *Antioxidants*, 13(8), 974. <https://doi.org/10.3390/antiox13080974>
- Mozartha, M., Hudiayati, M., & Anastasia, D. (2022). The Effect of Extracts of Curcuma zedoaria on The Expression of The Proinflammatory Cytokine Tnf-A. *International Journal of Islamic and Complementary Medicine*, 3(1), 1–8. <https://doi.org/10.55116/ijicm.v3i1.31>
- Nicholas, N., Wardhani, F. M., Tandanu, E., & Alexander, R. (2022). Acute Toxicity Test of White Turmeric (*Curcuma zedoaria*) Extract on Histopathological Analysis of the Heart Muscle. *Jambura Journal of Health Sciences and Research*, 4(3), 642–647. <https://doi.org/10.35971/jjhsr.v4i3.12374>
- Nirvanashetty, S., Panda, S. K., & Jackson-Michel, S. (2022). Safety Evaluation of Oleoresin-Based Turmeric Formulation: Assessment of Genotoxicity and Acute and Subchronic Oral Toxicity. *Biomed Research International*, 2022(1). <https://doi.org/10.1155/2022/5281660>
- Nkempu, A. F., Fokunang, T. E., Narcisse, B. H., Berinyuy, E. B., Omgba, T. Y., Nono, N. B., Ngameni, B., & Ntungwen, F. C. (2021). Evaluation of the Systemic Serum Exposure and Acute Toxicity of the Aqueous Extract of Curcuma longa (Zingiberaceae) Rhizomes in Wistar Rats. *Journal of Pharmaceutical Research International*, 242–252. <https://doi.org/10.9734/jpri/2021/v33i38b32120>
- Nosrati-Oskouie, M., Aghili-Moghaddam, N. S., Tavakoli-Rouzbehani, O. M., Jamialahmadi, T., Johnston, T. P., & Sahebkar, A. (2022). Curcumin: A Dietary Phytochemical for Boosting Exercise Performance and Recovery. *Food Science & Nutrition*, 10(11), 3531–3543. <https://doi.org/10.1002/fsn3.2983>
- Rahayu, D. U. C., Setyani, D. W. I. A., Dianhar, H., & Sugita, P. (2020). Phenolic Compounds from Indonesian White Turmeric (*Curcuma zedoaria*) Rhizomes. *Asian Journal of Pharmaceutical and Clinical Research*, 13(7), 194–198. <https://doi.org/10.22159/ajpcr.2020.v13i7.38249>
- Saragih, A. R. B., Wardhani, F. M., Tandanu, E., & Alexander, R. (2021). Acute Toxicity Testing of White Turmeric Extract (*Curcuma zedoaria*) on Histopathological Imaging of the Lungs. *Archives of The Medicine and Case Reports*, 2(4), 195–200. <https://doi.org/10.37275/amcr.v2i4.125>
- Sasanti, A. D., Widanarni, W., Sukenda, S., Wahjuningrum, D., Yuhana, M., & Setiawati, M. (2025). Phytochemical Screening and Antibacterial Activity Test of Curcuma zedoaria, *C. aeruginosa*, and *C. mangga* Extracts Against *Aeromonas Hydrophila*. *Biodiversitas Journal of Biological Diversity*, 26(4). <https://doi.org/10.13057/biodiv/d260409>
- Sumarheni, S., Nursyamsi, N., Agustina, R., Fitriyani, F., Amin, F., Faisal, R., & Sartini, S. (2019). The Effect of Curcuma Zedoaria (Berg.) Roscoe Extract on Liver Function Tests of Rattus norvegicus Exposure By Cigarette Smoke. *Proceedings of the 3rd International Conference on Environmental Risks and Public Health, ICER-PH 2018*, 26-27, October 2018, Makassar, Indonesia. <https://doi.org/10.4108/eai.26-10-2018.2288699>
- Tania, P. O. A., Misuari, P. A., Yudhayana, S., & Prayoga, K. A. E. (2021). Liver Histopathological Change and Malondialdehyde Level of Rattus norvegicus on Administration of Curcuma zedoaria and Paracetamol Toxic Dose. *Indonesian Journal of Medical Laboratory Science and Technology*, 3(1), 38–46. <https://doi.org/10.33086/ijmlst.v3i1.1927>
- Tinrat, S. (2022). Preliminary Phytochemical Analysis, Antibacterial and Anti-Biofilm Activities of

- Curcuma zedoaria (Christm.) Roscoe Extracts. *Malaysian Journal of Microbiology*. <https://doi.org/10.21161/mjm.221398>
- Tong, C., Wu, H., Gu, D., Li, Y., Fan, Y., Zeng, J., & Ding, W. (2021). Effect of Curcumin on the Non-Alcoholic Steatohepatitis Via Inhibiting The M1 Polarization of Macrophages. *Human & Experimental Toxicology*, 40(12_Suppl), S310-S317. <https://doi.org/10.1177/096032712111038741>
- Vera, J., Rivadeneira, A. A. D., Rodríguez-Díaz, J. M., & Radice, M. (2021). Phytochemical Characterization of the Ethanolic Extract, Antioxidant Activity, Phenolic Content and Toxicity of the Essential Oil of Curcuma longa L. *Revista De La Facultad De Agronomía Universidad Del Zulia*, 39(1), E223906. [https://doi.org/10.47280/revfacagron\(luz\).v39.n1.06](https://doi.org/10.47280/revfacagron(luz).v39.n1.06)
- Wardhani, F. M., Florenza, A. G., Mustafa, E. T., & Azizoglu, A. (2023). Acute Toxicity Test of White Turmeric Extract (Curcuma zedoaria) on Female Wistar Rat Endometrium. *Journal La Medihealthico*, 4(3), 123-128. <https://doi.org/10.37899/journallamedihealthico.v4i3.895>
- Wu, Y., Guo, F., Ma, Y., Chai, W., Li, J., Shi, W., & Liu, J. (2024). Curcumin's Protective Role in Heatstroke-Induced Acute Liver Injury: Targeting Pyroptosis and Enhancing Sirt1 Expression. *Global Challenges*, 8(12). <https://doi.org/10.1002/gch2.202400178>
- Yang, Y., Liu, Y., Wang, Y., Chao, Y., Zhang, J., Jia, Y., Tie, J., & Hu, D. (2022). Regulation of Sirt1 and Its Roles in Inflammation. *Frontiers in Immunology*, 13. <https://doi.org/10.3389/fimmu.2022.831168>
- Yuandani, Y., & Suwarso, E. (2016). Acute Toxicity Evaluation of Ethanol Extract of Curcuma Mangga Rhizome. *Asian Journal of Pharmaceutical and Clinical Research*, 10(1), 383. <https://doi.org/10.22159/ajpcr.2017.v10i1.16196>
- Yurasbe, N. U. R. Q., Din, N. A., Palaniveloo, K., Manikam, S., & Nagappan, T. (2023). Phytochemical Diversity and Biological Activities of Curcuma Species from the East Coast of Peninsular Malaysia. *Biodiversitas Journal of Biological Diversity*, 24(8). <https://doi.org/10.13057/biodiv/d240805>
- Zega, A. M., Tandanu, E., & Wardhani, F. M. (2023). Toxicity Test of White Turmeric (Curcuma zedoaria) on Liver Organs in White Male Rats. *Jurnal Kedokteran Raflesia*, 7(1). <https://doi.org/10.33369/juke.v7i1.19102>
- Zhou, W., Liu, Q., Zang, X., Hu, M., Yue, Y., Wang, Y., Lv, C., & Du, Z. (2020). Combination Use of Tolfenamic Acid with Curcumin Improves Anti-Inflammatory Activity and Reduces Toxicity in Mice. *Journal of Food Biochemistry*, 44(6). <https://doi.org/10.1111/jfbc.13240>