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Bioactive compounds in anacardium occidentale and their role in antimalarial activity: A phytochemical perspective

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Abstract

Anacardium occidentale, commonly known as cashew, is a tropical plant with a long history of use in traditional medicine for treating various ailments, including malaria. The plant's bioactive compounds, such as flavonoids, alkaloids, and phenolic acids, have been shown to exhibit significant pharmacological activities, including anti-inflammatory, antioxidant, and antimalarial effects. This study aimed to investigate the phytochemical composition of Anacardium occidentale, particularly focusing on its potential role in malaria treatment. Using advanced High-Performance Liquid Chromatography (HPLC) techniques, bioactive compounds such as quercetin, kaempferol, rutin, and ferulic acid were identified and quantified from the plant extracts. The results showed that the plant contains high concentrations of quercetin and kaempferol, which have been extensively studied for their antimalarial properties, inhibiting the growth of the malaria parasite, Plasmodium falciparum. Other compounds such as rutin, hesperidin, and phenolic acids like P-hydroxybenzoic acid also contributed to the plant's therapeutic potential. These findings suggest that Anacardium occidentale is a valuable source of bioactive compounds that could enhance the development of novel antimalarial treatments. The study highlights the importance of integrating traditional plant-based remedies with modern scientific techniques, such as phytochemical profiling, to discover effective alternatives to synthetic drugs. Further research is necessary to explore the synergistic effects of these compounds and their potential in clinical applications for malaria therapy.

Keywords: Bioactive compounds; Antimalarial; ; Anacardium occidentale; Malaria; Phytochemicals

1. Introduction

Malaria remains a critical public health concern globally, with Africa shouldering the highest disease burden (Dao *et al.*, 2021; WHO, 2019). Nigeria, in particular, reports approximately 27% of global malaria cases, reflecting the severity of the challenge (WHO, 2019). Synthetic drugs, such as artemisinin-based combination therapies (ACTs), have traditionally been the cornerstone of malaria treatment. However, issues like limited accessibility, high costs, and the emergence of drug-resistant Plasmodium strains highlight the need for alternative interventions (Mogha, 2022; Omara *et al.*, 2020).

In this context, plant-based remedies, particularly those rooted in traditional medicine, offer promising alternatives. Bioactive compounds derived from plants are accessible, affordable, and culturally accepted in many malaria-endemic regions (Addis *et al.*, 2021; Sileshi *et al.*, 2023). These compounds are found in various plant parts, such as leaves, roots, bark, and seeds, and exhibit significant antimalarial properties (Tiko *et al.*, 2020). Traditional healers leverage extensive

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indigenous knowledge to select and prepare plant-based treatments effectively, underscoring the therapeutic potential of botanical remedies (Oyeyemi *et al.*, 2019).

Among the notable antimalarial botanicals is *Anacardium occidentale*, commonly known as the cashew tree. Native to Brazil but widely cultivated in tropical regions like Nigeria, this versatile tree is renowned for its economic and medicinal significance (Barbosa-Filho *et al.*, 2014; Ihegboroa *et al.*, 2020). The bark, leaves, and other parts of *A. occidentale* have been used in traditional medicine to address various ailments, including malaria and hypertension (Ihegboroa *et al.*, 2020). Its bioactive compounds, including flavonoids, tannins, and alkaloids, have shown potential in inhibiting malaria-causing parasites (Barbosa-Filho *et al.*, 2014).

Phytochemicals are bioactive compounds naturally occurring in plants, which contribute to their color, flavor, and disease resistance (Mbinile et al., 2020). These compounds include alkaloids, flavonoids, terpenoids, phenols, and glycosides, among others. Phytochemicals are recognized for their potential health benefits, including antioxidant, anti-inflammatory, antimicrobial, and anticancer properties (Sileshi et al., 2023). These compounds have been used traditionally in herbal medicine and are increasingly being studied for their therapeutic potential in modern medicine.

Phytochemical profiling is the process of identifying and quantifying the phytochemicals present in plant extracts (Phillipson and Wright, 2019). This involves advanced techniques such as High-Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GC-MS), and Thin Layer Chromatography (TLC), which allow for the detailed analysis of plant components (Mbinile et al., 2020). The aim is to create a comprehensive profile of the bioactive compounds that may contribute to the plant's medicinal properties.

The therapeutic potential of A. occidentale lies in its diverse array of phytochemicals, including alkaloids, flavonoids, phenolic acids, tannins, and saponins. Phytochemical analyses have consistently identified these compounds in significant quantities, suggesting their role as bioactive agents (Eze et al., 2021). Among these, flavonoids and phenolic acids are of particular interest due to their strong antioxidant activities. These compounds play a critical role in mitigating oxidative stress, a hallmark of malaria pathology caused by the host's immune response to Plasmodium infection (Adeoye et al., 2022). Furthermore, anacardic acid derivatives, a unique group of alkyl phenols found in A. occidentale, have demonstrated potent antimicrobial and antiparasitic activities, making them promising candidates for antimalarial drug development (Julius et al., 2020).

Comparative studies have further validated the antimalarial potential of A. occidentale. Bello et al. (2023) conducted a study comparing the efficacy of A. occidentale extracts with Azadirachta indica (neem), a well-established antimalarial plant. The findings revealed that A. occidentale exhibited superior inhibitory effects on Plasmodium growth, attributed to its higher flavonoid and anacardic acid content. This comparative advantage underscores the plant's unique phytochemical profile and its potential as a lead source for novel antimalarial compounds.

This article explores the phytochemical composition of *A. occidentale* and its role in antimalarial activity, emphasizing the importance of plant-based solutions in combating malaria. By examining the bioactive compounds present in *A. occidentale*, this study aims to provide a scientific basis for its use in traditional medicine while advocating for further research to harness its full therapeutic potential. This phytochemical perspective aligns with the broader goal of integrating traditional knowledge and modern science to address pressing global health challenges.

1.1. Statement of the Problem

The rising prevalence of drug-resistant strains of Plasmodium and the limitations of synthetic antimalarial drugs in terms of accessibility and affordability pose significant challenges to malaria control, particularly in endemic regions like Nigeria. Despite the potential of plant-based remedies, there is insufficient scientific validation of their efficacy and bioactive components. This gap necessitates a focused exploration of botanicals such as *Anacardium occidentale*, widely used in traditional medicine, to identify and validate their antimalarial properties.

Aim and Objectives

To investigate the phytochemical composition and antimalarial activity of bioactive compounds in *Anacardium occidentale*.

The specific objectives are to

- Identify the bioactive compounds present in various parts of *Anacardium occidentale*.
- Evaluate the antimalarial potential of these compounds through phytochemical screening and related assays.

- Assess the significance of *A. occidentale* as a plant-based alternative for malaria treatment.
- Contribute to the scientific validation of traditional medicinal practices for malaria management.

2. Materials and Methodology

The methodology employed in this study focuses on the phytochemical profiling of *Anacardium occidentale* using High-Performance Liquid Chromatography (HPLC). The sample collection process involved gathering plant materials from the field, followed by identification to ensure accuracy. The plant materials were air-dried and then blended into fine powder to facilitate the extraction of bioactive compounds.

2.1. Materials

The key materials required for the HPLC analysis include the HPLC system, HPLC-grade solvents (e.g., methanol, acetonitrile, water), analytical standards for phytochemical compounds, and sample preparation equipment such as a sonicator. An HPLC column suitable for the separation of plant extracts, a UV-visible detector for the identification and quantification of compounds, and filtration equipment are also essential. The mobile phase components are selected based on the nature of the compounds being analyzed.

2.2. Procedure

The first step involves the preparation of sample extract. The dried, powdered plant material of *Anacardium occidentale*, is extracted using appropriate solvents, primarily methanol, through sonication or Soxhlet extraction. After extraction, the samples are filtered to remove particulate matter, and the supernatants are collected for HPLC analysis.

HPLC analysis is performed by injecting the extracts into the HPLC system, where chromatographic separation occurs under optimized conditions. Analytical standards are initially injected to generate calibration curves and determine retention times for each compound. UV-visible detection is then used to identify and quantify the bioactive compounds based on their retention times and absorbance spectra. The screening for specific bioactive compounds, such as alkaloids, glycosides, phenols, tannins, proteins, and oils, follows the protocols described by Alhaithloul (2023) and Gustavo *et al.* (2019).

2.3. Data Analysis of Phytochemicals

The analysis of phytochemicals involved quantifying the concentrations of identified compounds using High-Performance Liquid Chromatography (HPLC). The results were tabulated, showing the specific compounds, their retention times, and concentrations (mol/L). Key compounds such as quercetin, luteolin, mangiferin, isomangiferin, and mangostin exhibited varying concentrations, with quercetin being the highest. A line chart was employed to visualize the concentration trends, highlighting the dominance of quercetin, Kaempferol and Rutin. This graphical representation provides a clear comparison of the bioactive compounds, emphasizing their potential significance in antimalarial applications. The data underscore the therapeutic potential of Anarcadium occidentale phytochemical profile.

3. Results

Table 1 presents the phytochemical Composition of Anarcadium occidentale leaves, while Figure 1 shows the line chart of fve result. According to the results quercetin has the highest area concentration with 9718.6550 mol/L, Kaempferol has the second highest with 3930.4055 mol/L, Rutin has 3396.8960 mol/L, with Hesperidin having the lowest with 74.8670 mol/L. The total area concentration of the phytochemical Composition of Mangifera indica identified is 23863.6855 mol/L.

Table 1 Phytochemical Composition of *Anacardium occidentale* leaves

PYTOCHEMICALS	AREA (mol/L)	CONCENTRATION (mol/L)	PERCENTAGE COMPOSITION	(%)
Xanthophyll	1150.4510	0.0492	4.92	
P-Hydroxybenzoic Acid	2752.5920	0.1178	11.78	
Beta-Carotene	913.4615	0.0390	3.90	
Alpha-Carotene	453.8890	0.0194	1.94	
P-Coumaric Acid	162.5760	0.0069	0.69	
Naringin	122.8975	0.0052	0.52	
Hesperidin	74.8670	0.0032	0.32	
Alpha-Tocopherol	137.6285	0.0058	0.58	
Quercetin	9718.6550	0.4159	41.59	
Kaempferol	3930.4055	0.1682	16.82	
Rutin	3396.8960	0.1453	14.53	
Apigenin	84.1820	0.0036	0.36	
Lutein	302.6820	0.0129	1.29	
Ferulic Acid	86.1615	0.0036	0.36	
Procyanidin B2	75.6200	0.0032	0.32	
Total	23,362.9645	100	1	

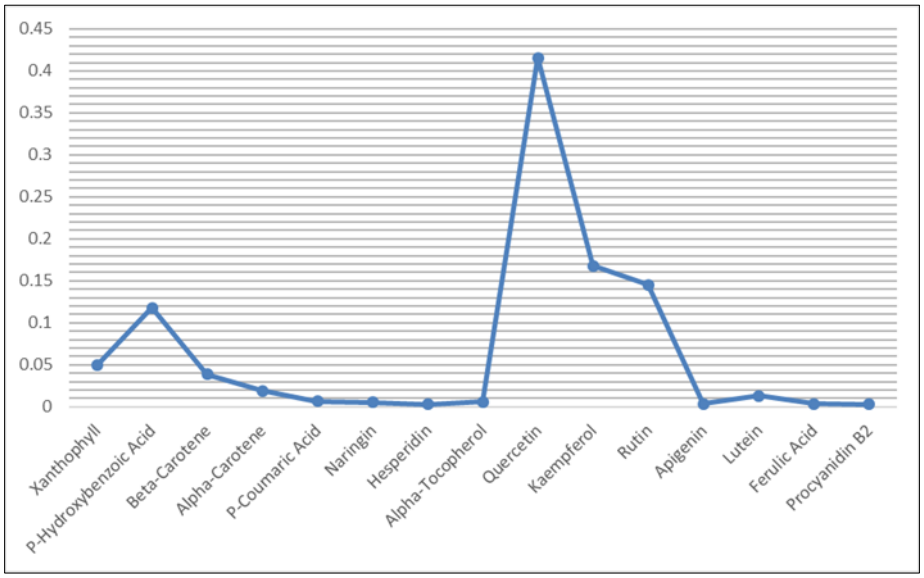

Figure 1 Line Chart of the Phytochemical Composition of *Anacardium occidentale* leaves

4. Discussion

The bioactive compounds identified in *Anacardium occidentale* reveal a promising array of compounds with potential antimalarial properties. Among the most notable compounds are Rutin, Kaempferol, Quercetin, and Hesperidin, which collectively contribute to the plant's potential in treating malaria. Rutin was identified as the third most abundant compound in *Anacardium occidentale*, with a concentration of 3396.8960 mol/L. Rutin is a flavonoid glycoside that has

garnered attention for its cardiovascular and anti-inflammatory benefits. Recent research has explored Rutin's antimalarial activity, particularly its ability to inhibit the growth of Plasmodium parasites. Studies by Alebie *et al.* (2017) suggest that Rutin may hinder the parasite's ability to proliferate, making it a potential therapeutic agent in malaria treatment. The anti-inflammatory effects of Rutin could also contribute to reducing the inflammation associated with malaria, further enhancing its value as a medicinal compound.

Hesperidin, although present in lower concentrations, also exhibits significant antioxidant and anti-inflammatory properties, both of which are essential in malaria therapy. Its potential to modulate immune responses may provide support in combating malaria, as inflammatory responses are often heightened in malaria infections (Muthaura *et al.*, 2015). By mitigating the effects of oxidative stress and inflammation, Hesperidin could complement other compounds in *Anacardium occidentale* to enhance overall antimalarial efficacy.

Kaempferol was found in both *Anacardium occidentale* (3930.4055 mol/L) and Psidium guajava (3733.6645 mol/L), highlighting its widespread occurrence in plants with medicinal properties. Kaempferol is a flavonoid that has demonstrated antimalarial activity by inhibiting the growth of Plasmodium parasites. According to Rasmussen *et al.* (2022), Kaempferol enhances immune response and directly interferes with the parasite's life cycle. Its relatively high concentrations in *Anacardium occidentale* suggest that this plant may serve as a valuable source of Kaempferol, offering a dual mechanism of action direct parasiticidal effects combined with immune enhancement.

Quercetin, found in the highest concentration (9718.6550 mol/L) in *Anacardium occidentale*, is one of the most studied flavonoids for its antimalarial properties. Quercetin has been extensively researched for its ability to inhibit *Plasmodium falciparum*, the parasite responsible for the most severe form of malaria (Rasmussen *et al.*, 2022). It disrupts the parasite's lifecycle and reduces inflammation, as outlined by Azam-Ali *et al.* (2012). The high levels of Quercetin in *Anacardium occidentale* support the potential of this plant as a potent source of antimalarial compounds. The antioxidant activity of Quercetin further complements its antimalarial effects by reducing the oxidative damage that typically accompanies malaria infections.

In addition to these flavonoids, the presence of various acids such as P-hydroxybenzoic acid, P-coumaric acid, and Ferulic acid in *Anacardium occidentale* may also play a role in its therapeutic properties. Ferulic acid, a phenolic compound found in various plants, has shown promising therapeutic potential in malaria control due to its antioxidant and anti-inflammatory properties. By scavenging free radicals, it helps reduce oxidative stress, which plays a significant role in malaria pathogenesis. Malaria infection leads to the generation of reactive oxygen species (ROS), which damage red blood cells and tissues. Ferulic acid can mitigate this damage by neutralizing ROS, thus protecting erythrocytes and other cellular structures. Additionally, its anti-inflammatory effects may help regulate the immune response during malaria infection, preventing excessive inflammation and tissue damage. Studies suggest that ferulic acid may also enhance the activity of other antimalarial compounds, improving their efficacy (Thu *et al.*, 2017). Overall, ferulic acid's ability to reduce oxidative stress and modulate immune responses positions it as a potential adjunct in malaria treatment strategies.

These compounds have been linked to antioxidant activity, which can reduce oxidative stress in malaria infections and contribute to overall health benefits (Shukla *et al.*, 2018). The synergistic interaction between these compounds in *Anacardium occidentale* strengthens their individual effects, potentially enhancing the plant's ability to combat malaria. The diversity of compounds identified, particularly those with known antimalarial activities, positions *Anacardium occidentale* as a promising candidate for future research and development in malaria treatment. Together, these bioactive compounds may not only inhibit the growth of Plasmodium parasites but also support the body's immune response, reduce inflammation, and alleviate the oxidative stress associated with the disease. Thus, *Anacardium occidentale* presents a potential natural source of antimalarial agents that could complement existing therapies.

5. Conclusion

In conclusion, Anacardium occidentale presents a promising natural source of bioactive compounds with significant antimalarial properties. The identification of flavonoids like quercetin, kaempferol, and rutin, alongside phenolic acids such as ferulic acid, supports the plant's therapeutic potential in treating malaria. Phytochemical profiling using HPLC revealed high concentrations of these compounds, confirming their importance in inhibiting Plasmodium falciparum growth. The findings emphasize the potential of combining traditional plant-based knowledge with modern scientific methods to develop alternative therapies to synthetic drugs. As the global fight against malaria continues, this research paves the way for further exploration of Anacardium occidentale as a viable candidate for antimalarial drug development. Future studies focusing on clinical trials and the synergistic effects of these compounds will be crucial in establishing their efficacy and safety for widespread use.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Statement of ethical approval

This study did not involve human participants, animals, or biological materials requiring ethical clearance. All plant materials were collected with due permission from local authorities and in accordance with relevant institutional and national guidelines.

Statement of informed consent

Not applicable. This study did not involve human participants or personal data.

References

[1] Addis, T., Mekonnen, Y., Ayenew, Z., Fentaw, S., and Biazin, H. (2021). Bacterial uropathogens and burden of antimicrobial resistance pattern in urine specimens referred to Ethiopian Public Health Institute. PLOS One, 16(11), e0259602.

[2] Alebie G, Urga B, Worku A. 2017. Systematic review on traditional medicinal plants used for the treatment of malaria in Ethiopia: trends and perspectives. Malar J. 16(1):307

[3] Barbosa-Filho VM, Waczuk EP, Kamdem JP, Abolaji AO, Lacerda SR, Da Costa JGM, et al. Phytochemical constituents, antioxidant activity, cytotoxicity and osmotic fragility effects of Caju (Anacardium microcarpum). Indus Crops Prod. (2014) 55:280–8. 10.1016/j.indcrop.2014.02.021

[4] Dao, F., Djonor, S. K., and Ayin, C. T. M., et al.,(2021). Burden of malaria in children under five and caregivers' health-seeking behaviour for malaria-related symptoms in artisanal mining communities in Ghana. Parasites and Vectors, 14, 418.

[5] Mbinile SD, Munishi LK, Ngondya IB, Ndakidemi PA. 2020. Spatial distribution and anthropogenic threats facing medicinal plant Zanthoxylum chalybeum in Simanjiro area, Northern Tanzania. Sci Afr. 10:e00562

[6] Mogha NG, Kalokora OJ, Amir HM, Kacholi DS. 2022. Ethnomedicinal plants used for treatment of snakebites in Tanzania – a systematic review. Pharm Biol. 60(1):1925–1934. doi: 10.1080/13880209.2022.2123942

[7] Muthaura CN, Keriko JM, Mutai C, Yenesew A, Gathirwa JW, Irungu BN, Nyangacha R, Mungai GM, Derese S. 2015. Antiplasmodial potential of traditional antimalarial phytotherapy remedies used by the Kwale community of the Kenyan Coast. J Ethnopharmacol. 170:148–157. doi: 10.1016/j.jep.2015.05.024.

[8] Omara T, Kagoya S, Openy A, Omute T, Ssebulime S, Kiplagat KM, Bongomin O. 2020. Antivenin plants used for treatment of snakebites in Uganda: ethnobotanical reports and pharmacological evidences. Trop Med Health. 48(1):6. doi: 10.1186/s41182-019-0187-0.

[9] Oyeyemi, I. T., Akinseye, K. M., Adebayo, S. S., and Oyetunji, M. T., Oyeyemi, O. T. (2019). Ethnobotanical survey of the plants used for the management of malaria in Ondo State, Nigeria. South African Journal of Botany, 124, 391-401.

[10] Phillipson JD, Wright CW. 1991. Can ethnopharmacology contribute to the development of antimalarial agents? J Ethnopharmacol. 32(1–3):155–165

[11] Rasmussen C, Alonso P, Ringwald P. 2022. Current and emerging strategies to combat antimalarial resistance. Expert Rev Anti Infect Ther. 20(3):353–372.

[12] Shukla G, Bhatt JA, Chakravarty S. 2018. Folk therapeutic uses of ethnomedicinal plants to cure gynecological disorders: a meta-analysis of West Bengal State in India. Ethnobot Res Appl. 24:1–19.

[13] Sileshi D., Dereje K., Ahmed Z., Negera A., and Sultan S. (2023). Phytochemical Screening and Antimicrobial Activity Evaluation of Selected Medicinal Plants in Ethiopia. J Exp Pharmacol. 2023; 15: 51–62. doi: 10.2147/JEP.S379805

[14] Tabuti JRS, Obakiro SB, Nabatanzi A, Anywar G, Nambejja C, Mutyaba MR, Omara T, Waako P. 2023. Medicinal plants used for treatment of malaria by indigenous communities of Tororo District, Eastern Uganda. Trop Med Health. 51(1):34. doi: 10.1186/s41182-023-00526-8.

[15] Thu AM, Phyo AP, Landier J, Parker DM, Nosten FH. 2017. Combating multidrug-resistant Plasmodium falciparum malaria. FEBS J. 284(16):2569–2578. doi: 10.1111/febs.14127.

[16] Tiko, G. H., Adamou, R., Amoussa, A. M. O., Medjigbodo, A. A., Sanni, A., Djogbénou, L. S., and Lagnika, L. (2020). Antiplasmodial, antioxidant, hemolytic activities and acute toxicity of Costus afer Ker Gawl (Costaceae) used in malaria healing in Benin. Research Journal of Medicinal Plants, 14(1), 24–34.

[17] WHO (2019) World malaria report: World Health Organization. licence (CC BY-NC-SA 3.0 IGO; https://creativecommons.org/ licenses/by-nc-sa/3.0/igo).