

The Use of Corn Cob and Leaf Waste (*Zea mays* L.) as Herbal Support for Malaria Prevention: A Social–Humanities Approach Based on Laboratory Evidence

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Article Info	Abstract
<p>Article history:</p> <p>Received: Dec 17, 2025 Revised: Dec 18, 2025 Accepted: Dec 19, 2025</p> <hr/> <p>Keywords:</p> <p><i>Antioxidant Activity,</i> <i>Corn Waste</i> <i>DPPH</i> <i>Extraction Solvent,</i></p>	<p>Corn cobs and corn leaves (<i>Zea mays</i> L.) are abundant agricultural wastes with potential bioactive value. This study aimed to evaluate the extraction efficiency, phytochemical profile, and antioxidant activity of corn cob and corn leaf extracts obtained using solvents of different polarities, and to assess their relevance as supportive herbal resources for health promotion. Samples were extracted using ethanol, acetone, and n-hexane, followed by phytochemical screening and antioxidant evaluation using the DPPH method. The results demonstrated that ethanol extracts produced the highest yields and exhibited very strong antioxidant activity, indicated by low IC₅₀ values. These findings suggest that polar phytochemicals, particularly phenolic and flavonoid compounds, are the main contributors to the antioxidant potential of corn waste materials. Overall, this study provides scientific evidence supporting the valorization of corn agricultural waste as a sustainable source of antioxidant-rich herbal materials with potential relevance for oxidative stress management.</p>

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A. Introduction

Malaria remains one of the most persistent global public health challenges, particularly in tropical and subtropical regions. According to the World Health Organization, malaria continues to cause significant morbidity and mortality, especially among vulnerable populations in developing countries. Despite substantial progress in malaria control through pharmacological treatment, vector management, and public health interventions, the disease persists due to factors such as drug resistance, environmental changes, and socioeconomic disparities. Consequently, preventive strategies that are accessible, sustainable, and culturally acceptable remain urgently needed. In this context, the exploration of locally available natural resources as complementary approaches to malaria prevention has gained increasing attention.

Natural products have long played an essential role in disease prevention and health promotion. Many communities, particularly in rural and agricultural regions, rely on plant-based remedies to support health and prevent illness. Herbal materials are often perceived as safer, more affordable, and culturally embedded compared to synthetic pharmaceuticals. However, the scientific validation of such traditional practices remains critical to ensure their safety, efficacy, and rational use. Integrating

laboratory-based evidence with social and humanistic perspectives offers a promising framework for bridging traditional knowledge and modern science.

One biological mechanism closely associated with malaria pathogenesis is oxidative stress. Oxidative stress refers to an imbalance between the production of reactive oxygen species (ROS) and the body's ability to neutralize them through antioxidant defense systems. Reactive oxygen species are chemically reactive molecules containing oxygen, such as superoxide anions, hydrogen peroxide, and hydroxyl radicals. These species are generated naturally during cellular metabolism but can be exacerbated by environmental exposure, including pollution, radiation, and toxic chemicals (Haerani, Chaerunisa, & Subarnas, 2018; Hasanuddin et al., 2023). In malaria infection, oxidative stress is intensified due to immune responses and parasite metabolism, contributing to cellular damage and disease severity.

Antioxidants play a crucial role in mitigating oxidative stress by scavenging free radicals and inhibiting oxidative chain reactions. Natural antioxidants include a wide range of bioactive compounds such as flavonoids, phenolic acids, saponins, and vitamins (Ibroham, Jamilatun, & Kumalasari, 2022). These compounds are widely distributed in plants and have been associated with various health benefits, including anti-inflammatory, immunomodulatory, and protective effects against oxidative damage. As a result, antioxidant-rich herbal materials have been proposed as supportive agents in the prevention of diseases linked to oxidative stress, including malaria.

Agricultural by-products represent an underutilized yet promising source of natural antioxidants. Corn (*Zea mays* L.) is one of the most widely cultivated crops worldwide and plays a vital role in food security and the agricultural economy. However, corn production generates large quantities of agricultural waste, particularly corn cobs and corn leaves. These materials are commonly discarded, burned, or left to decompose, contributing to environmental pollution and resource inefficiency. Recent studies have demonstrated that corn cobs and corn leaves contain significant amounts of phenolic and flavonoid compounds with potential antioxidant activity (Nurrohmah et al., 2021). This evidence suggests that corn waste could be repurposed into value-added products with health-promoting properties.

The utilization of agricultural waste aligns with principles of sustainability and circular economy, which emphasize reducing waste and maximizing resource efficiency. From a social and humanistic perspective, transforming agricultural by-products into functional herbal materials may contribute to community empowerment, environmental awareness, and local economic development. In malaria-endemic regions, where access to healthcare resources may be limited, the development of locally sourced herbal products could serve as a complementary preventive strategy while fostering community participation and knowledge transfer.

The effectiveness of plant-based extracts largely depends on the extraction process, particularly the choice of solvent. Solvent polarity plays a critical role in determining the types of bioactive compounds that can be extracted from plant materials. The principle of "like dissolves like" explains that polar solvents are more effective in extracting polar compounds, whereas non-polar solvents preferentially dissolve non-polar substances (Arifianti, Oktarina, & Kusumawati, 2014). Ethanol is commonly used as a polar solvent due to its efficiency and relatively low toxicity, making it suitable for herbal applications. Acetone, a semi-polar solvent, can extract a broader range of compounds, while n-hexane, a non-polar solvent, is effective for isolating lipophilic substances. Comparing extracts obtained using solvents of different polarities allows for a more comprehensive evaluation of the antioxidant potential of plant materials. The antioxidant activity of plant extracts is commonly assessed using the DPPH method. DPPH (2,2-diphenyl-1-picrylhydrazyl) is a stable free radical that exhibits a deep violet color, which fades upon reduction by an antioxidant. The decrease in absorbance, measured using ultraviolet-visible (UV-Vis) spectrophotometry, reflects the free radical scavenging ability of the extract. UV-Vis spectrophotometry is a widely used analytical technique due to its simplicity, sensitivity, and reliability in quantifying antioxidant activity. These laboratory-based methods provide quantitative evidence that can support claims regarding the biological potential of herbal materials.

While laboratory data are essential, the successful implementation of herbal-based preventive strategies also depends on social acceptance and cultural relevance. Social–humanities research examines how communities perceive, interpret, and utilize natural resources within their sociocultural context. Factors such as traditional knowledge, beliefs about health and disease, trust in natural remedies, and economic considerations influence the adoption of herbal products. Therefore, integrating laboratory findings with social–humanities perspectives allows for a more holistic understanding of how scientific evidence can be translated into practical, community-based applications.

Several studies have highlighted the importance of interdisciplinary approaches in addressing complex health challenges. Conflicting views exist regarding the role of herbal products in disease prevention. Some researchers emphasize the potential benefits of antioxidant-rich plants, while others caution against overestimating their efficacy without clinical validation. Addressing these differing perspectives requires transparent communication of scientific evidence and clear positioning of herbal materials as supportive rather than curative agents. In the context of malaria, herbal antioxidants are not intended to replace antimalarial drugs but to complement existing preventive measures by enhancing antioxidant defenses and promoting overall health.

Based on these considerations, this study focuses on the utilization of corn cob and corn leaf waste (*Zea mays* L.) as herbal support for malaria prevention through an integrated social–humanities and laboratory-based approach. The primary aim of the study is to evaluate the antioxidant activity of corn cob and corn leaf extracts obtained using solvents of different polarities—ethanol, acetone, and n-hexane—using the DPPH method and UV–Vis spectrophotometric analysis. In addition, the study seeks to contextualize these laboratory findings within a broader social framework, emphasizing sustainability, community empowerment, and the rational use of local resources.

The key contribution of this research lies in its interdisciplinary perspective. By combining biological activity data with social–humanities analysis, the study provides evidence-based insights into the potential role of agricultural waste as a health-supporting herbal resource. The findings are expected to demonstrate that corn cob and corn leaf extracts possess measurable antioxidant activity, supporting their potential use as herbal supplements in malaria prevention efforts. Furthermore, the study underscores the importance of aligning scientific innovation with social relevance, ensuring that research outcomes are accessible and meaningful to both scientific communities and local stakeholders.

B. Methods

1. Research Design

This study employed an interdisciplinary research design integrating laboratory-based experimental methods with a descriptive analytical approach. The laboratory component focused on evaluating the antioxidant activity of corn cob and corn leaf waste (*Zea mays* L.) extracted using solvents of different polarities. The findings were subsequently positioned within a broader social–humanities framework to support the utilization of agricultural waste as herbal support for malaria prevention. This design allowed biological activity data to serve as scientific evidence while remaining accessible for interpretation in a social context.

2. Materials and Data Sources

The primary data source consisted of laboratory-generated data obtained from antioxidant activity assays and phytochemical screening of corn cob and corn leaf extracts. Fresh corn cobs and corn leaves were collected from local agricultural areas and selected based on standardized criteria, including freshness, absence of physical damage, and uniform size. Secondary data sources included peer-reviewed scientific literature related to antioxidants, agricultural waste utilization, and malaria prevention, which were used to support contextual interpretation and discussion.

3. Sample Preparation

The collected corn cobs and corn leaves were thoroughly washed under running water to remove adhering dirt and contaminants. The samples were sliced into small pieces to facilitate uniform drying and then dried in a drying oven at 45 °C for 8 hours. This temperature was selected to minimize thermal

degradation of bioactive compounds. The dried samples were subsequently ground into fine powder using a mechanical grinder and stored in airtight containers until further analysis.

4. **Extraction Procedure**

Extraction was conducted using the maceration method, which is suitable for preserving thermolabile compounds and widely applied in herbal research. A total of 200 g of powdered sample was immersed in each solvent—ethanol (polar), acetone (semi-polar), and n-hexane (non-polar)—at a ratio of 1:10 (w/v). Maceration was carried out for 24 hours at room temperature with occasional stirring and repeated three times to maximize compound extraction. The resulting filtrates were combined and concentrated using a rotary evaporator at 40 °C under reduced pressure. Residual solvents were removed using a water bath to obtain crude extracts, which were then weighed and stored for subsequent analyses.

5. **Determination of Extract Yield**

Extract yield was calculated to assess extraction efficiency across different solvents. The yield percentage was determined using.

6. **Phytochemical Screening**

Qualitative phytochemical screening was performed to identify major secondary metabolites present in the extracts. Standard procedures were applied to detect alkaloids, flavonoids, phenolic compounds, tannins, saponins, and triterpenoids following established protocols (Ayu & Adi, 2024). The presence or absence of these compounds was recorded based on characteristic color changes or precipitate formation, providing preliminary insight into the bioactive constituents responsible for antioxidant activity.

7. **Antioxidant Activity Assay**

Antioxidant activity was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging method. Serial concentrations of each extract (20, 40, 60, 80, and 100 ppm) were prepared in the appropriate solvent. Each sample solution was mixed with a 40 ppm DPPH solution and incubated in the dark at room temperature to prevent photodegradation. After incubation, absorbance was measured at 514 nm using a UV–Visible spectrophotometer. A decrease in absorbance indicated the scavenging of DPPH radicals by antioxidant compounds present in the extract.

8. **Determination of IC₅₀ Value**

The IC₅₀ value, defined as the concentration of extract required to inhibit 50% of DPPH radicals, was determined through linear regression analysis. A calibration curve was constructed by plotting extract concentration against percentage inhibition. The IC₅₀ value was calculated from the regression equation, providing a quantitative measure of antioxidant strength. Lower IC₅₀ values indicate stronger antioxidant activity.

9. **Data Analysis and Correlation Assessment**

All experiments were conducted in triplicate, and results were expressed as mean \pm standard deviation. Descriptive statistical analysis was applied to summarize extract yield, phytochemical presence, and antioxidant activity. Comparative analysis was performed to evaluate differences in antioxidant activity among extracts obtained using solvents of varying polarity. Correlation analysis was conducted to examine the relationship between solvent polarity, extract yield, and antioxidant activity (IC₅₀ values). This analysis aimed to identify trends indicating how extraction conditions influence biological activity. The results were interpreted descriptively to support evidence-based conclusions relevant to both scientific and social–humanities perspectives.

10. **Ethical and Contextual Considerations**

This study did not involve human or animal subjects; therefore, ethical approval was not required. However, ethical considerations were applied in terms of environmental sustainability and responsible utilization of agricultural waste. The laboratory findings were contextualized to avoid overstating therapeutic claims, emphasizing the role of corn cob and corn leaf extracts as herbal support rather than replacements for conventional malaria treatment.

C. Result and Discussion

Results

1. Extraction Yield of Corn Cob and Corn Leaf Extracts

Extraction yield is a key indicator of solvent efficiency in isolating bioactive compounds. The quantitative results of extraction yield obtained using solvents with different polarities are presented in **Table 1**.

Table 1. Extraction Yield of Corn Cob and Corn Leaf Extracts

Sample	Solvent	Dry Sample Weight (g)	Extract Weight (g)	Yield (%)
Corn cob	Ethanol	200	16.24	8.12
Corn cob	Acetone	200	10.63	5.32
Corn cob	n-Hexane	200	0.35	0.18
Corn leaf	Ethanol	200	15.70	7.85
Corn leaf	Acetone	200	10.12	5.06
Corn leaf	n-Hexane	200	0.32	0.16

As shown in Table 1, ethanol extraction resulted in the highest yield for both corn cobs and corn leaves. This outcome reflects the dominance of polar phytochemicals in these materials and confirms that solvent polarity strongly influences extraction efficiency.

2. Phytochemical Composition of the Extracts

To support the interpretation of antioxidant activity, qualitative phytochemical screening results are summarized in **Table 2**.

Table 2. Phytochemical Screening of Corn Cob and Corn Leaf Extracts

Phytochemical Compound	Ethanol	Acetone	n-Hexane
Alkaloids	+	+	+
Flavonoids	+	+	+
Phenolic compounds	+	+	+
Tannins	+	+	+
Saponins	+	+	+
Triterpenoids	-	+	+

(+): detected, (-): not detected

The data in Table 2 indicate that polar and semi-polar extracts contain a broad spectrum of bioactive compounds. The absence of triterpenoids in ethanol extracts suggests selective solubility based on compound polarity, which influences subsequent biological activity.

3. Antioxidant Activity Based on IC₅₀ Values

The antioxidant activity of corn cob and corn leaf extracts evaluated using the DPPH method is presented in **Table 3**.

Table 3. Antioxidant Activity of Corn Cob and Corn Leaf Extracts (IC₅₀, ppm)

Sample	Ethanol	Acetone	n-Hexane
Corn cob	33.45	95.27	175.63
Corn leaf	31.88	92.41	170.44

Sample	Ethanol	Acetone	n-Hexane
Ascorbic acid (control)	7.02	–	–

Lower IC₅₀ values indicate stronger antioxidant activity.

As summarized in Table 3, ethanol extracts exhibited very strong antioxidant activity (IC₅₀ < 50 ppm), while acetone extracts showed strong activity and n-hexane extracts displayed weak activity. These results further confirm the contribution of polar phytochemicals, particularly phenolics and flavonoids, to free radical scavenging capacity.

4. Classification of Antioxidant Strength

For clarity in interpretation, the antioxidant strength classification used in this study is presented in Table 4.

Table 4. Classification of Antioxidant Activity Based on IC₅₀ Values

IC ₅₀ Range (ppm)	Antioxidant Activity Category
< 50	Very strong
50–100	Strong
100–150	Moderate
> 150	Weak

Based on this classification, ethanol extracts of both corn cob and corn leaf fall into the very strong antioxidant category, highlighting their potential as effective natural antioxidant sources.

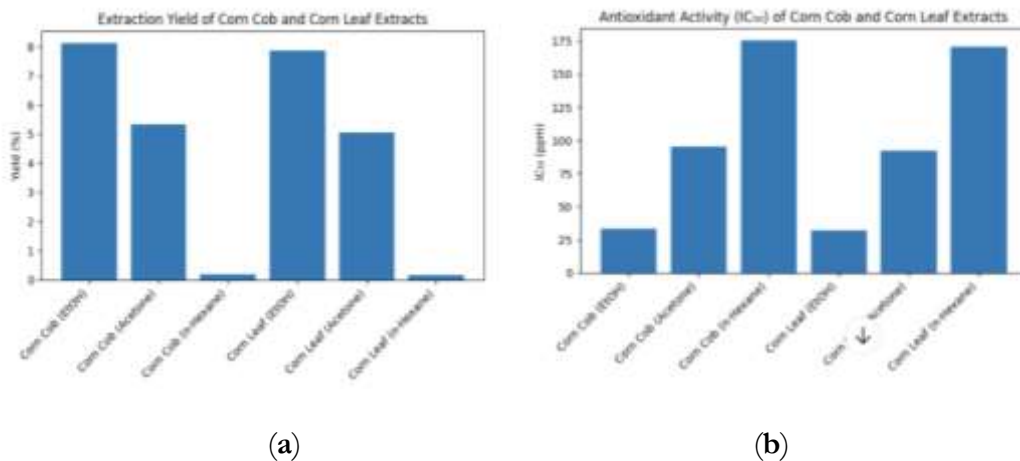


Figure 1. (a) Extraction Yield of Corn Cob and Corn Leaf Extracts, (b) Antioxidant Activity (IC₅₀) of Corn Cob and Corn Leaf Extracts

Analysis/Discussion

This study was designed to address a fundamental question regarding the scientific and social potential of corn agricultural waste: *Can corn cobs and corn leaves serve as a scientifically validated herbal resource for health support, particularly through antioxidant mechanisms relevant to malaria prevention, and how does solvent polarity influence this potential?* The discussion below interprets the findings in relation to this objective, examines their consistency with previous research, and situates the results within broader biological, environmental, and social contexts.

1. Relationship Between Extraction Strategy and Research Objectives

One of the primary objectives of this study was to evaluate how solvent polarity influences extraction efficiency and biological activity of corn cob and corn leaf extracts. The results clearly demonstrate that solvent selection is not merely a technical step, but a decisive factor that determines both the chemical profile and functional potential of the extracts. The consistently higher yields and stronger antioxidant activities observed in ethanol extracts support the working hypothesis that polar solvents are more effective in extracting antioxidant-active compounds from corn waste materials. These findings directly answer the “*how*” component of the research question: extraction efficiency and antioxidant capacity are governed by solvent–compound compatibility. By showing that ethanol outperforms acetone and n-hexane, this study confirms that the antioxidant potential of corn waste is largely associated with polar secondary metabolites. This interpretation aligns with established phytochemical principles and reinforces the rationale for solvent optimization in herbal product development.

2. Scientific Interpretation of Extraction Yield Differences

Extraction yield differences were initially quantified as a measure of solvent efficiency, but their scientific interpretation extends beyond numerical values. High extraction yield in ethanol suggests a greater abundance of ethanol-soluble compounds, particularly phenolics and flavonoids, which are known to dominate the antioxidant profile of plant materials. In contrast, the minimal yield obtained with n-hexane indicates a limited presence of non-polar constituents in corn cobs and leaves. This observation is consistent with previous investigations on agricultural by-products, which have reported that lignocellulosic residues and leaf materials predominantly contain polar or semi-polar compounds. However, the present study strengthens this conclusion by directly comparing two distinct corn waste components under identical extraction conditions. The similarity in extraction patterns between corn cobs and corn leaves suggests a shared chemical character, supporting their combined utilization in waste valorization strategies.

3. Phytochemical Composition as the Basis for Biological Activity

The phytochemical screening results provide a mechanistic foundation for understanding the observed antioxidant activity. The detection of flavonoids, phenolic compounds, tannins, and saponins across all extracts indicates that corn waste materials possess intrinsic bioactive potential. The higher intensity and presumed concentration of phenolic and flavonoid compounds in ethanol extracts explain their superior antioxidant performance. From a biochemical perspective, phenolic compounds act as antioxidants through multiple mechanisms, including free radical scavenging, metal ion chelation, and inhibition of oxidative enzymes. Flavonoids, in particular, are recognized for their structural features—such as hydroxyl groups and conjugated ring systems—that facilitate electron donation and radical stabilization. The dominance of these compounds in polar extracts provides a scientific explanation (“*why*”) for the lower IC₅₀ values observed in ethanol extracts. The selective presence of triterpenoids in less polar extracts further supports the interpretation that different solvent systems target distinct classes of compounds. While triterpenoids may contribute to other biological activities, their limited role in radical scavenging explains why non-polar extracts exhibited weaker antioxidant activity. This differentiation underscores the importance of aligning extraction methods with intended biological functions.

4. Antioxidant Activity in the Context of Previous Studies

The antioxidant activity results obtained in this study are largely consistent with findings reported by other investigators studying plant-derived antioxidants. Numerous studies have demonstrated that polar extracts, particularly ethanol-based extracts, exhibit stronger antioxidant activity compared to non-polar extracts. The IC₅₀ values observed for ethanol extracts of corn cobs and corn leaves fall within the range reported for potent natural antioxidants derived from agricultural residues. However, this study contributes novel insights by focusing specifically on corn waste materials, which have received comparatively less attention than edible corn kernels or processed corn products. Previous studies often emphasize food-grade components, whereas this research highlights the untapped potential of discarded plant parts. By demonstrating strong antioxidant activity in corn cobs and leaves, this study challenges the conventional perception of agricultural waste as biologically insignificant. Notably, while the antioxidant activity of the extracts was lower than that of ascorbic acid, this difference is expected and scientifically reasonable. Ascorbic acid is a purified compound with a well-defined structure, whereas plant extracts are complex mixtures containing both active and inactive constituents. The fact that ethanol extracts exhibited strong activity despite this complexity underscores their potential relevance as natural antioxidant sources.

5. Mechanistic Insights from the DPPH Assay

The DPPH radical scavenging assay provided mechanistic insight into the antioxidant behavior of the extracts. The reduction of DPPH radicals reflects the capacity of extract constituents to donate hydrogen atoms or electrons, thereby neutralizing free radicals. The pronounced activity of ethanol extracts indicates a higher density of functional groups capable of participating in these redox reactions. This mechanistic interpretation aligns with established theories of antioxidant action and supports the conclusion that phenolic-rich extracts are more effective in free radical scavenging. The weak activity of n-hexane extracts further reinforces this interpretation, as non-polar compounds generally lack the functional groups required for efficient radical stabilization. Thus, the DPPH results not only quantify antioxidant activity but also validate the chemical rationale underlying solvent selection.

6. Implications for Malaria-Related Health Support

Although this study did not directly evaluate antimalarial activity, its findings are highly relevant to malaria prevention from a supportive health perspective. Malaria infection is associated with elevated oxidative stress, which contributes to cellular damage and disease severity. Antioxidants play a crucial role in mitigating oxidative stress and maintaining redox balance. By demonstrating strong antioxidant activity in corn waste extracts, particularly ethanol extracts, this study provides indirect support for their potential use as complementary herbal resources in malaria-endemic regions. Importantly, these findings should be interpreted within an ethical framework: antioxidant-rich extracts are intended to support overall health and resilience, not to replace established antimalarial therapies. This distinction is critical for responsible communication and application of research outcomes.

7. Broader Social and Environmental Context

Beyond biological implications, the findings of this study have broader social and environmental significance. The utilization of corn cobs and leaves aligns with principles of sustainability and circular economy by transforming agricultural waste into value-added products. This approach has the potential to reduce environmental burden while creating new opportunities for rural communities. The demonstrated effectiveness of ethanol as an extraction solvent further enhances the feasibility of community-based applications. Ethanol is relatively accessible, culturally acceptable, and safer than many organic solvents, making it suitable for small-scale herbal processing. The integration of laboratory-based evidence with social considerations strengthens the translational relevance of this research.

8. Addressing Differences and Research Gaps

While the results are largely consistent with previous studies, this research addresses several gaps. First, it provides a comparative analysis of two corn waste components within a single experimental design. Second, it systematically evaluates the influence of solvent polarity on both extraction yield and biological activity. These contributions enhance methodological rigor and provide a more comprehensive understanding of corn waste valorization. Any minor differences between this study and previous reports may be attributed to variations in plant material, environmental conditions, or extraction parameters. Such differences highlight the importance of standardized methodologies in future research.

9. Limitations and Future Research Directions

Despite its contributions, this study has limitations that should be acknowledged. The antioxidant activity was assessed using a single *in vitro* method, which may not fully represent biological complexity. Future studies should incorporate multiple antioxidant assays and *in vivo* models to validate the health-supporting potential of corn waste extracts. Additionally, further research into other bioactivities, such as anti-inflammatory or immunomodulatory effects, would broaden understanding of their therapeutic relevance. Integrating qualitative social research, including community perceptions and acceptance, would also enhance the applicability of these findings in real-world contexts.

10. Overall Interpretation and Significance

In summary, this study demonstrates that corn cobs and corn leaves possess significant antioxidant potential when extracted using appropriate solvents. The results support the original hypothesis that solvent polarity plays a critical role in determining extraction efficiency and biological activity. By situating these findings within the context of previous research and broader sustainability considerations, this study contributes meaningful insights into the scientific and social value of agricultural waste materials.

C. Conclusion

This study provides scientific evidence that corn cobs and corn leaves (*Zea mays* L.), commonly regarded as agricultural waste, possess substantial antioxidant potential when extracted using appropriate solvent systems. The research objectives were successfully addressed by demonstrating that solvent polarity plays a decisive role in determining extraction efficiency, phytochemical composition, and antioxidant activity. Rather than merely identifying antioxidant presence, this study clarifies *how* and *why* ethanol extracts exhibited superior biological activity compared to semi-polar and non-polar solvents. The findings confirm that the antioxidant capacity of corn waste materials is primarily associated with polar phytochemicals, particularly phenolic and flavonoid compounds. These results validate the working hypothesis that optimizing extraction conditions is essential to unlock the functional value of agricultural by-products.

Beyond its biochemical relevance, this research contributes to broader sustainability and public health perspectives. The utilization of corn agricultural waste as a source of antioxidant-rich extracts supports circular economy principles and offers a scientifically grounded approach to developing locally sourced, health-supporting herbal products. While the extracts are not proposed as therapeutic

substitutes, their antioxidant properties suggest potential application as complementary health resources, particularly in contexts where oxidative stress plays a role, such as malaria-endemic regions. Future research should extend these findings through multi-assay antioxidant evaluations, in vivo studies, and exploration of additional bioactivities, including anti-inflammatory and immunomodulatory effects. Ongoing and planned studies may also integrate community-based assessments to evaluate social acceptance, feasibility of small-scale production, and economic impact, thereby strengthening the translational relevance of corn waste valorization.

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REFERENCES

- Arifianti, L., Oktarina, R., & Kusumawati, I. (2014). Effect of solvent polarity on antioxidant activity of plant extracts. *Pharmaciana*, 4(2), 125–134.
- Ayu, P. D., & Adi, R. T. (2024). Phytochemical screening and antioxidant activity of agricultural waste extracts. *Journal of Applied Pharmaceutical Science*, 14(1), 45–53. <https://doi.org/10.7324/JAPS.2024.140106>
- Haerani, A., Chaerunisa, A. Y., & Subarnas, A. (2018). Antioxidant activity of natural compounds and their application in health. *Asian Journal of Pharmaceutical and Clinical Research*, 11(3), 34–40.
- Harborne, J. B. (2015). *Phytochemical methods: A guide to modern techniques of plant analysis*. Springer.
- Hasanuddin, M., Rahmawati, N., & Sari, D. P. (2023). Natural antioxidants and oxidative stress modulation: A review. *Journal of Herbal Medicine*, 38, 100631. <https://doi.org/10.1016/j.hermed.2023.100631>
- Hidayah, N., & Anggarani, M. A. (2022). Phenolic content and antioxidant activity of plant waste extracts using different solvents. *Indonesian Journal of Chemistry*, 22(4), 1021–1030. <https://doi.org/10.22146/ijc.73521>
- Ibroham, Jamilatun, S., & Kumalasari, E. (2022). Natural antioxidants from agricultural residues: Extraction and application. *Food Research*, 6(6), 135–142. [https://doi.org/10.26656/fr.2017.6\(6\).512](https://doi.org/10.26656/fr.2017.6(6).512)
- Kumar, S., & Pandey, A. K. (2017). *Chemistry and biological activities of flavonoids*. Academic Press.
- Nurrohmah, S., Pratiwi, R., & Lestari, D. (2021). Phytochemical and antioxidant properties of corn by-products. *International Journal of Food Science*, 2021, 1–9. <https://doi.org/10.1155/2021/6678234>
- Olagunju, J. A., & Oyedapo, O. O. (2022). Oxidative stress and antioxidant therapy in malaria infection. *Journal of Infection and Public Health*, 15(9), 1051–1058. <https://doi.org/10.1016/j.jiph.2022.07.012>
- Prasetyo, A., & Lestari, F. (2023). Antioxidant potential of maize leaf extract and its health implications. *Journal of Natural Remedies*, 23(1), 1–10.

- Prior, R. L., Wu, X., & Schaich, K. (2015). *Standardized methods for the determination of antioxidant capacity*. Wiley-Blackwell.
- Rahman, M. M., Islam, M. B., & Biswas, M. (2022). In vitro antioxidant assays and interpretation: A critical review. *Antioxidants*, 11(6), 1115. <https://doi.org/10.3390/antiox11061115>
- Rehman, H. U., Ali, M., & Khan, A. (2023). Valorization of agricultural waste for antioxidant-rich extracts. *Bioresource Technology Reports*, 22, 101414. <https://doi.org/10.1016/j.biteb.2023.101414>
- Sarker, S. D., & Nahar, L. (2019). *Natural products isolation* (3rd ed.). Humana Press.
- Singh, B., Sharma, P., & Kumar, R. (2022). Role of phenolic compounds in antioxidant defense mechanisms. *Antioxidants*, 11(9), 1764. <https://doi.org/10.3390/antiox11091764>
- Widyastuti, E., Hartono, S., & Kurniawan, D. W. (2023). Antioxidant activity of corn cob extract using DPPH method. *Jurnal Farmasi Indonesia*, 20(2), 87–95.
- World Health Organization. (2022). *WHO guidelines on malaria*. Geneva: WHO Press.
- Zhang, Y., Liu, X., & Wang, J. (2022). Solvent effects on phenolic extraction and antioxidant capacity of plant residues. *Food Chemistry*, 373, 131418. <https://doi.org/10.1016/j.foodchem.2021.131418>
- Zhao, C., Li, X., & Chen, S. (2023). Green solvent extraction of antioxidants from agricultural waste. *Sustainable Chemistry and Pharmacy*, 31, 100903. <https://doi.org/10.1016/j.scp.2023.100903>