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A Phytochemical Evaluation of Sierra Leonean *Cassia siamea*: A Source of Bioactive Compounds

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Abstract: This study investigates the phytochemical profile of the leaves and stem bark of *Cassia siamea*, a leguminous plant with recognized ethnomedicinal importance, collected from tropical Sierra Leone. The global health crisis posed by antibiotic resistance and the increased interest in natural product-based therapeutics have spurred the re-evaluation of traditional medicinal plants as reservoirs of novel bioactive compounds. In this context, *Cassia siamea*, widely used in African and Asian traditional medicine, was selected for in-depth phytochemical assessment. The plant materials were extracted using both methanol and aqueous solvents through cold maceration, and the resulting crude extracts were subjected to qualitative phytochemical screening following standard procedures.

The investigation revealed the presence of several classes of secondary metabolites, including flavonoids, glycosides, tannins, steroids, saponins, and phenolic compounds. Notably, phenols were exclusive to the leaf extract, while saponins and glycosides were more abundant in the stem bark. Neither alkaloids nor anthraquinones were detected in either plant part, indicating potential chemotypic differences from other regional variants. These findings underscore the importance of geographic influence on phytochemical composition, a factor often overlooked in cross-regional herbal pharmacognosy.

The presence of flavonoids and tannins in both plant parts suggests strong antioxidant and antimicrobial potential, aligning with the traditional use of *Cassia siamea* for infections, inflammation, and gastrointestinal disorders. Furthermore, the high concentration of glycosides and saponins in the stem bark suggests additional therapeutic applications, particularly as expectorants, immune boosters, and anti-inflammatory agents. These results validate the plant's long-standing role in traditional medicine and highlight its relevance in contemporary drug discovery efforts.

This study not only contributes to the growing body of literature on African medicinal flora but also provides foundational data for future pharmacological and biochemical studies. The confirmation of bioactive compounds supports the ethnobotanical applications of *Cassia siamea* and opens pathways for further isolation, structural characterization, and pharmacodynamic evaluation of its constituents. In the broader context of global health, particularly in regions where access to modern pharmaceuticals is limited, the development of safe and effective phytotherapeutics from *Cassia siamea* may represent a sustainable solution to address antibiotic resistance and support primary healthcare systems.

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I. INTRODUCTION

Medicinal plants have served as the cornerstone of traditional health systems for millennia, offering a wide array of therapeutic agents long before the advent of modern pharmaceuticals. In recent decades, their relevance has re-emerged in global health discussions due to the mounting challenges associated with antimicrobial resistance, side effects of synthetic drugs, and the prohibitive costs of conventional treatments. Approximately 80% of the world's population, particularly in developing nations, relies on plant-based remedies for primary healthcare, underscoring the critical need for scientific validation of traditional medicinal knowledge.

Among these plants, *Cassia siamea* (syn. *Senna siamea*), belonging to the family Fabaceae, stands out as a species of considerable pharmacological interest. Native to Southeast

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Asia and now naturalized in many parts of Africa, including Sierra Leone, this fast-growing tree is valued not only for its ecological contributions (such as soil fertility improvement and erosion control) but also for its extensive ethnomedicinal applications. Various parts of the plant including the leaves, stem bark, roots, flowers, and seeds are traditionally used to treat ailments such as malaria, fever, constipation, insomnia, microbial infections, liver disorders, and inflammation.

The therapeutic potential of *Cassia siamea* is attributed to its diverse phytoconstituents, which include flavonoids, saponins, alkaloids, anthraquinones, glycosides, tannins, phenols, and triterpenoids. Several of these compounds are known to possess antimicrobial, antioxidant, anti-inflammatory, and antimalarial properties, which collectively contribute to the plant's medicinal utility. However, phytochemical composition is not universally consistent across geographic regions. Factors such as soil composition, altitude, rainfall, temperature, and plant age significantly influence the concentration and presence of secondary metabolites. This variability underscores the necessity of region-specific phytochemical investigations to accurately determine a plant's therapeutic value and potential.

Despite the widespread traditional use of *Cassia siamea* in Sierra Leone, there is a marked paucity of empirical data supporting its phytochemical profile in this locale. This gap in knowledge limits the potential for local pharmaceutical development and the formal recognition of Sierra Leonean traditional medicine within the broader scientific community. Consequently, systematic studies are essential not only for substantiating traditional claims but also for identifying novel compounds that may serve as lead candidates in drug development pipelines.

The present study seeks to address this research deficit by evaluating the phytochemical constituents of the leaves and stem bark of *Cassia siamea* harvested from Sierra Leone. The choice to focus on these plant parts stems from their prevalent use in herbal preparations across African traditional medicine systems. Using both methanol and aqueous solvents to mimic traditional extraction techniques and modern analytical practices, this study aims to compare the distribution of bioactive compounds and discuss their potential therapeutic applications. Ultimately, the findings from this study will contribute to a deeper understanding of the pharmacognostic attributes of *Cassia siamea* and support its integration into evidence-based phytomedicine.

II. MATERIALS AND METHODS

- *Plant Material Collection and Preparation*

Leaves and stem bark were collected in April 2020 from mature *Cassia siamea* trees in Makotha Village, Marampa Chiefdom, Port Loko District, Sierra Leone. The plant specimens were authenticated at the Department of Botany, Fourah Bay College, University of Sierra Leone. The collected materials were washed thoroughly under running water, shade-dried at room temperature for five days to preserve thermolabile compounds, and subsequently pulverized using a mechanical grinder.

- *Extraction Procedure*

The powdered samples (100 g each) were separately soaked in 1 L of methanol and distilled water for 72 hours with intermittent shaking. The mixtures were filtered using Whatman No.1 filter paper, and the filtrates were concentrated using a rotary evaporator under reduced pressure at 40°C. The aqueous extracts were freeze-dried to obtain a concentrated crude extract for further analysis.

- *Phytochemical Screening*

Standard qualitative phytochemical screening procedures were performed to detect the presence of flavonoids, alkaloids, tannins, saponins, steroids, glycosides, phenols, anthraquinones, and terpenoids. These methods were based on protocols by Trease and Evans (2002) and Sofowora (1993). Colorimetric and precipitation-based reactions were used to infer the presence of respective compounds.

III. RESULTS

The phytochemical screening of *Cassia siamea* revealed the presence of various secondary metabolites in both the leaves and stem bark, extracted using methanol and water as solvents. These secondary metabolites are associated with diverse biological activities, including antimicrobial, anti-inflammatory, antioxidant, and cytotoxic effects, thus supporting the plant's ethnomedicinal relevance. The qualitative analysis focused on identifying major phytochemical groups such as alkaloids, flavonoids, glycosides, tannins, saponins, steroids, phenols, terpenoids, and anthraquinones.

The findings showed that flavonoids were present in both leaf and stem bark extracts, signifying their widespread occurrence in the plant and potential for radical scavenging and anti-inflammatory activities. Glycosides were strongly present in the leaf extract (++), but only moderately in the stem bark (+), indicating a higher concentration or more active glycosidic linkage in the foliage. Conversely, saponins exhibited an inverse pattern, showing higher concentration in the stem bark (++), aligning with the bark's traditional use in decoctions for bronchial and expectorant purposes.

Tannins, known for their antimicrobial and astringent effects, were strongly present (++) in both the leaf and stem bark extracts. Steroids, another important class of bioactive compounds involved in membrane stabilization and inflammation control, were detected in moderate levels (+) across both plant parts. Phenolic compounds, significant for their antioxidant properties, were found only in the leaf

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extracts (+), highlighting a potential differential role in stress protection mechanisms localized in the foliage.

Alkaloids, anthraquinones, and terpenoids were not detected in either part of the plant. The absence of these groups, often considered highly bioactive, suggests that the chemotype of *Cassia siamea* growing in Sierra Leone may differ from that in other regions where these metabolites have been previously reported. This supports the hypothesis that local environmental conditions and soil chemistry significantly influence the biosynthesis of secondary metabolites in medicinal plants.

Table 1: Phytochemical Constituents of *Cassia siamea* Leaf and Stem Bark Extracts

Compound	Leaf	Stem Bark
Alkaloids	–	–
Anthraquinones	–	–
Flavonoids	+	+
Glycosides	++	+
Saponins	+	++
Tannins	++	++
Steroids	+	+
Terpenoids	–	–
Phenols	+	–

Legend: "+" = Present, "++" = Strongly Present, "–" = Absent

Fig 1: Plant Parts Used in the Study

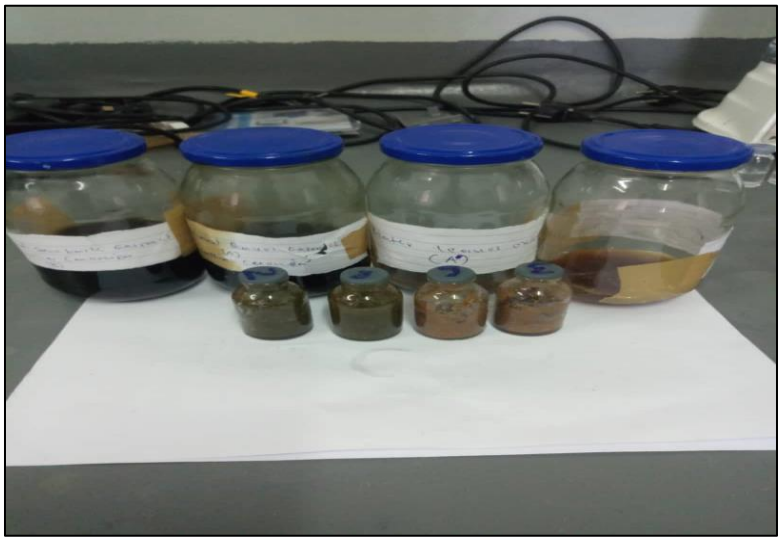

Fig 2: Crude Extracts of Leaf and Stem Bark in Petri Dishes

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The results indicate a consistent presence of compounds such as flavonoids, tannins, and steroids in both parts of the plant, thereby reinforcing the plant's utility in diverse therapeutic applications. The differential distribution of other compounds like glycosides, saponins, and phenols suggests potential variations in the pharmacological activity between the plant parts. These findings are crucial in determining which parts of the plant should be prioritized for specific medicinal purposes, and they pave the way for further quantitative and bioassay-guided studies to isolate and characterize the active constituents.

IV. DISCUSSION

The results of this study provide compelling evidence for the phytochemical richness of *Cassia siamea* leaves and stem bark, confirming the presence of several biologically significant secondary metabolites, including flavonoids, glycosides, saponins, tannins, steroids, and phenolic compounds. The phytochemical diversity observed in this Sierra Leonean variant underscores its considerable therapeutic potential and supports the continuation of ethnopharmacological studies in the region.

The detection of flavonoids in both leaf and stem bark extracts is particularly noteworthy. Flavonoids are polyphenolic compounds known for their wide range of bioactivities, including antioxidant, anti-inflammatory, antimicrobial, antiviral, and anticarcinogenic effects. Their consistent presence across both plant parts suggests a systemic distribution within *Cassia siamea* and reinforces their role in the plant's defense mechanisms. This supports traditional applications of *C. siamea* in the treatment of infectious and inflammatory diseases such as wounds, skin infections, and febrile conditions.

Tannins were also strongly present in both parts of the plant. These compounds are well-documented for their protein-precipitating properties, which make them effective in managing diarrhea, reducing inflammation, and promoting wound healing. Their astringent nature contributes to mucosal protection and bacterial inhibition, offering a biochemical rationale for the use of *C. siamea* in gastrointestinal therapies and oral care.

Saponins and glycosides were particularly concentrated in the stem bark, suggesting its potential superiority for certain therapeutic applications. Saponins are known for their ability to enhance immune responses, reduce cholesterol levels, and exert expectorant effects. Their surfactant properties allow for interaction with cell membranes, which can enhance drug absorption and bioavailability. Glycosides, especially cardiac and phenolic glycosides, have long been studied for their antimicrobial, anti-inflammatory, and sometimes cardiotonic effects. Their predominance in the stem bark aligns with reports of bark decoctions being used traditionally for chest and respiratory infections, indicating a pharmacological synergy worthy of further exploration.

Interestingly, phenolic compounds were detected exclusively in the leaf extracts. Phenols are potent antioxidants capable of scavenging free radicals, chelating metal ions, and modulating oxidative stress pathways. Their presence exclusively in the leaves suggests that this plant part may be better suited for therapeutic interventions targeting oxidative stress-related disorders such as neurodegenerative diseases, cardiovascular conditions, and cancer prevention. The distinct distribution of phenols and saponins between leaves and stem bark highlights the need for targeted harvesting practices in herbal medicine and natural product research.

The absence of alkaloids, terpenoids, and anthraquinones in both plant parts is somewhat surprising given their presence in *C. siamea* specimens from other geographic regions, such as India, Thailand, and Nigeria. Alkaloids, in particular, are widely regarded as potent pharmacophores with a broad spectrum of biological activities, including antimalarial, analgesic, and antimicrobial effects. Their absence in the Sierra Leonean samples may indicate a chemotypic variation influenced by local environmental conditions such as soil mineral composition, altitude, seasonal variation, and ecological stressors. This supports the assertion that the phytochemical profile of a plant species cannot be universally generalized without regional analysis.

These results are consistent with earlier reports from West Africa and Southeast Asia, but also diverge in meaningful ways, particularly concerning the absence of certain expected compounds. This emphasizes the importance of continued regional phytochemical assessments and cautions against over-reliance on generalized phytochemical databases that may not account for intraspecific variability.

Moreover, these findings provide a critical scientific foundation for the documented ethnomedicinal uses of *Cassia siamea* in Sierra Leone, many of which have been passed down orally without experimental validation. By confirming the presence of key bioactive compounds, this study enhances the credibility of traditional healing practices and offers a bridge between indigenous knowledge and modern pharmacological science. It also underscores the potential of *Cassia siamea* as a source of novel phytotherapeutic agents that may contribute to the development of cost-effective and locally-sourced alternatives to synthetic drugs, particularly in the face of growing antibiotic resistance and limited access to healthcare infrastructure in sub-Saharan Africa.

Future studies should pursue quantitative phytochemical analyses, bioassay-guided fractionation, and pharmacodynamic investigations to isolate and characterize individual constituents. In addition, toxicity studies and clinical evaluations will be essential for translating these

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findings into safe and effective medicinal products. The regional uniqueness of *Cassia siamea* chemotypes further calls for conservation efforts and sustainable harvesting practices to protect biodiversity while ensuring the continued availability of this valuable medicinal resource.

V. CONCLUSION

This study provides critical insights into the phytochemical landscape of *Cassia siamea* collected from Sierra Leone, affirming its status as a rich source of bioactive secondary metabolites. The identification of key phytochemicals namely flavonoids, tannins, saponins, steroids, glycosides, and phenols in both the leaf and stem bark supports its extensive use in traditional medicine for treating a variety of health conditions including infections, inflammation, and gastrointestinal disorders. The selective presence of phenols in the leaves and the stronger abundance of saponins and glycosides in the stem bark underscore the plant's pharmacological versatility and suggest that different parts of the plant may be optimized for specific therapeutic targets.

These findings not only validate longstanding ethnomedicinal practices in Sierra Leone but also contribute valuable data toward the global pharmacognostic profile of *Cassia siamea*. In an era marked by the alarming rise of antimicrobial resistance and the urgent need for safer, more accessible therapeutic alternatives, plants such as *C. siamea* offer a promising solution. Its documented antimicrobial and antioxidant properties, alongside the observed phytochemical richness, position it as a viable candidate for natural drug discovery and development.

Importantly, the study also highlights the potential chemotypic variability of *C. siamea*, reinforcing the need for regional phytochemical mapping to accurately assess medicinal efficacy. The absence of alkaloids and anthraquinones in this Sierra Leonean variant calls attention to the environmental and ecological factors that influence phytoconstituent expression.

Moving forward, further research is warranted to quantify the concentrations of the identified phytochemicals through chromatographic and spectrometric techniques. In addition, bioassay-guided isolation and structural elucidation of individual compounds are essential for identifying the specific agents responsible for observed therapeutic effects. Toxicological assessments and clinical trials will also be vital to establishing the safety, dosage, and efficacy of *C. siamea*-derived formulations.

In conclusion, *Cassia siamea* holds considerable promise as a phytotherapeutic resource with both local and global implications. Its integration into evidence-based medicine, supported by rigorous scientific validation, could greatly enhance healthcare outcomes in resource-limited settings while contributing to the growing demand for plant-based interventions in modern pharmacology.

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