DEVELOPMENT OF AN AFRICAN MEDICINAL PLANTS HEALTHCARE INFORMATION SYSTEM: A DATA MINING APPROACH

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Abstract: Nigerian medicinal plants have over the time been identified to be a good alternative to orthodox medicines in managing health-related problems especially among those living below the poverty line. The limited ethno-botanical knowledge of indigenous medicinal plants of our richly endowed green vegetation, has created a challenging gap that needs to be filled. In this study, we identified in their indigenous names, a total of one hundred and fourteen (114) medicinal plants of fifty eight (58) different botanical family species. The study area covers the three senatorial zones of Kogi State, Nigeria. In order to present the knowledge of identifying sets of plants that can cure a particular disease/ailment, thereby improving on the efficacy of herbs; this research adapted the use of Apriori algorithm to identify the hidden patterns among the different medicinal plants in the compiled repository. The compiled repository is an indigenous database that is peculiar to the three major languages that exists in Kogi State of Nigeria. The developed model was used to implement the classification of diseases and links them with corresponding medicinal plant(s) that can cure them. The model was further deployed into a web based application (KAMPHIS-Kogi African Medicinal Plants Healthcare Information System) built using these tools; Python programming language (Laravel) for the frontend design and MySQL for the backend. The web application is expected to assist individuals in natural self-healthcare, supplements for medical practitioners and industrial use, such as pharmaceutical companies for the production of drugs and herbs that will have higher level efficacy.

Keywords: Medicinal plants, frequent diseases, Apriori algorithm, Data Mining, KAMPHIS.

Introduction

The increasing reliance on medicinal plants as an alternative or supplement to conventional healthcare solutions has become more prominent in recent times. Despite Nigeria's rich biodiversity and potential to produce and market herbal supplements, the country continues to import herbs and spices from nations like India and China. This reliance is partly due to the limited ethnobotanical knowledge of indigenous medicinal plants, despite the wealth of green vegetation in Nigeria. This knowledge gap is a significant challenge that needs addressing to fully harness the potential of traditional medicine.

The World Health Organization (WHO) has identified the strategic gathering, analysis, and synthesis of data on Traditional and Complementary Medicine (T&CM) as a key priority for Member States, emphasizing the development of national research agendas to support this initiative (World Health Organization, 2021). The recent economic downturn in Nigeria has exacerbated the inaccessibility of conventional orthodox medicine, pushing a significant portion of the population - 47.7% living below the poverty line - to seek alternatives for managing health conditions (Aigbokhan, 2017; Asif & Tabrej, 2020; Abubakar, 2022).

Despite Nigeria's rich vegetation, which supports the growth of various medicinal plants, the limited knowledge of their ethnomedical properties has led to an increased reliance on foreign remedies, particularly in light of the rising prevalence of antimicrobial resistance to conventional medications (Murray et al., 2022). The global healthcare systems are currently facing a surge in chronic illnesses and escalating healthcare costs, leading to a growing demand for healthcare services that emphasize individualized, patient-centered care (Roberti et al., 2021). This situation underscores the need to explore affordable alternatives, such as herbal medicine, to mitigate the high cost of medical care. Orthodox medicine often argues, albeit erroneously, that traditional herbal practices lack adequate research and documentation. Contrary to this belief, there is a substantial body of well-documented literature, alongside a vast amount of untapped and undocumented information that needs to be collected, analyzed, and published. This would serve as a crucial reference for individuals, researchers, traditional medical practitioners, and their orthodox counterparts. To ensure accessible healthcare for all, especially in rural areas, it is essential to revive the traditional medical practices used by our ancestors, particularly for common ailments prevalent in various local environments.

Given the inadequacy, unaffordability, and sometimes complete absence of modern healthcare facilities in many Nigerian and African rural communities, the demand for medicinal plants is on the rise in both developing and developed countries. This surge is driven by factors such as population growth, inadequate drug supply, a scarcity of medical practitioners, and the high cost of treatments (Awodi *et al*., 2020; Emmanuel *et al*., 2018).

Herbal (Traditional) medicine is often underestimated in healthcare services, despite its long history of use in health maintenance, disease prevention, and treatment, particularly for chronic diseases. When used correctly, many herbs are considered safer than conventional medications. However, issues such as mislabeling and incorrect identification of plants pose significant challenges, especially when sourcing

this information locally. To promote the use of traditional medicine, a solid foundation in identifying medicinal plants and their components is crucial. This foundational knowledge is essential for the effective practice of traditional medicine (World Health Organization, 2023).

To address these challenges, a user-friendly, robust, indigenous African Medicinal Plants Healthcare Information System (KAMPHIS) was developed. This web application/software is designed for public use and will be accessible online. It enables users to identify medicinal plants by their botanical names, available in the three major local languages in Kogi State, the parts of the plants used, and the diseases/ailments they can cure. More importantly, it provides information on combinations of medicinal plants that can cure the same type of ailment or disease, ensuring better efficacy. This system is particularly beneficial to the people of Kogi State, comprising three senatorial zones (West, East, and Central), as it allows them to identify and understand the use of medicinal plants readily available in their environment.

Existing research has primarily focused on identifying medicinal plants, including their names, images, parts used, and medicinal uses. However, comparisons with other medicinal plant databases reveal that the hidden patterns within these databases have not been fully explored (Odugbemi, 2013; Yemi-Peters et al., 2018). The medicinal plants used in these preparations are often named in vernacular, depending on the locality and environment. Botanists have conducted extensive research to identify these plants individually, classifying them according to their family and species, and assigning them botanical names. After identifying the medicinal plants by their local names, it is crucial to determine what ailments a particular plant can cure. Additionally, users should have access to information on all possible medicinal plants that can treat a specific ailment or disease within the repository database.

Yemi-Peters et al. (2017; 2018a) utilized the Apriori algorithm to demonstrate that valuable information can be extracted from medicinal plant databases, aiding healthcare professionals, individuals, and researchers in making better decisions. Odugbemi (2013) created a Nigerian website for traditional medicinal plants, but it was observed that his work primarily focused on one of the Nigerian languages (Yoruba). Aigbokhan (2014) covered the names of traditional medicinal plants in the three major Nigerian languages in his book, but public accessibility is limited since it has not been automated and made available online. This has created a gap, as a sound knowledge of medicinal plants is the foundation and basis for traditional and herbal medicine. Furthermore, the works of Ogirima (2017), Ogirima et al. (2012; 2014), and Omotosho (2014) also highlight the need for users to have basic knowledge of properly identifying the raw materials used in producing herbal mixtures.

Indigenous research conducted in various parts of Nigeria and other African countries has demonstrated the uses and importance of medicinal plants to African communities (Linfongo et al., 2022; Nithya & Brindha, 2019; Elufioye et al., 2021). The integration of Health Information Systems into this framework offers a transformative approach to documenting, disseminating, and utilizing this wealth of traditional knowledge, ultimately contributing to a more holistic and accessible healthcare system in Nigeria and beyond.

Materials and Methods

Data Collection

The Data for this research was gathered through the primary data (interviews with a few traditional herbal medicine practitioners and academics/researchers specialized in the area of medicinal plants) and secondary data (compiled and documented research on medicinal plants as well as reviews of related works). A total of 114 medicinal plants species belonging to 58 plant families were compiled and authenticated by a Plant Biologist for this research work.

The corresponding names of the plants in the three major local languages of Kogi State, Nigeria (Okun, Igala and Ebira), their common names, parts of the plants used for medicinal purposes, and their medicinal uses were compiled in a repository database.

The use of an association rule mining algorithm (Apriori algorithm) was applied and implemented on the collated repository database. The model was then used to implement the classification of diseases/ailments that can frequently occur together and subsequently links them with the corresponding plant(s) that can cure them.

The web based application (KAMPHIS-Kogi African Medicinal Plants Healthcare Information System) was built using Python programming language (Laravel) for the frontend design and MySQL for the backend.

The steps for the implementation of Apriori algorithm is shown below:

Algorithm: Mathematical Representation of the Classification Model

Given a set where A = {a_1 ,a_2 , ..., a_R} are all set of ailments/diseases that can be presented over transaction T = {t_1 , t_2 , ..., t_k} represents a set of ailments/diseases. Each ailment/disease set {t_1 , t_2 , ...t_k}is a subset of A, then

Rule 1 $t_n \subseteq A \forall \quad n = 1 \dots k$

Let P be a set of medicinal w *plants, P = {P_1, P_2, …, P_k}.*

Rule 2 $P \mid \forall P_n \in P \ni t_n$ *where n = 1...k*

The frequent occurrence of an ailment/disease is defined as:

Rule 3 $\sum(a_m) = \sum_{n=1}^{k} a_m \subseteq t_n \ \forall \ t_n \in T$

Where m = 1...R

Support S is the threshold for determining the frequency of an itemset (ailment/disease). Given ailments/diseases X and Y.

Rule 4 $Support\{X\} \rightarrow \{Y\} = \frac{\sum(X \cup Y)}{|T|} = P(X \cup Y)$

An ailment/disease is considered frequent if

Rule 5 $\sum(a_m) \geq Support$ where *Support = 2*

Results and Discussion

System Implementation and Deployment

With the aid of standard development tools, the implementation and deployment of an indigenous healthcare information Web based Application called Kogi-African Medicinal Plants Healthcare Information System (KAMPHIS) is achieved. Using a classic algorithm of association rule to determine all the common itemset

(ailments/diseases) that a medicinal plant can cure, a repository database for KAMPHIS is developed. A user can access information on all the possible medicinal plants that can cure an ailment/disease that exists in the database repository, using the local languages in Kogi State for searching. The model gotten from the algorithm provides the best mixture of medicinal plants for higher and better efficacy of herbal medicines.

Currently, the URL for accessing the web base application (KAMPHIS) is: https://ulven-d7b7a2fabea1.herokuapp.com/ However, this is a temporary URL since the web base application (KAMPHIS) will be linked to the website for Federal University Lokoja, Kogi State, Nigeria.

The figures below shows the interface screenshot of Kogi-African Medicinal Plants Healthcare Information System (KAMPHIS).

Figure (1) shows the home page of the KAMPHIS, where a user is privileged to search and access the information about a medicinal plant and all the ailments/diseases it can cure or for each ailment all the medicinal plants that can be used as curative. Figure (2) shows plant search result interface displaying information about the names of medicinal plants. Figure (3) displays search result about information on medicinal use of plant for treatment of ailments/diseases. Figure (4) presents disease search result using ailments/disease to search for information about medicinal plants used to cure ailments/diseases, subject to its existence in the repository. Figure (5) presents how the model classified all the medicinal plants associated with treatment of a particular ailment/disease.

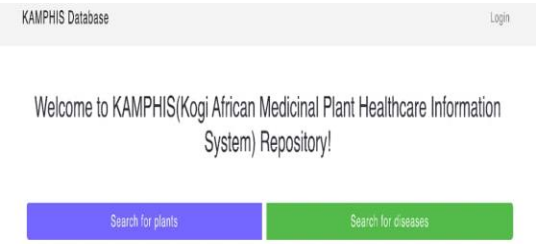

Figure 1: Home page of the KAMPHIS

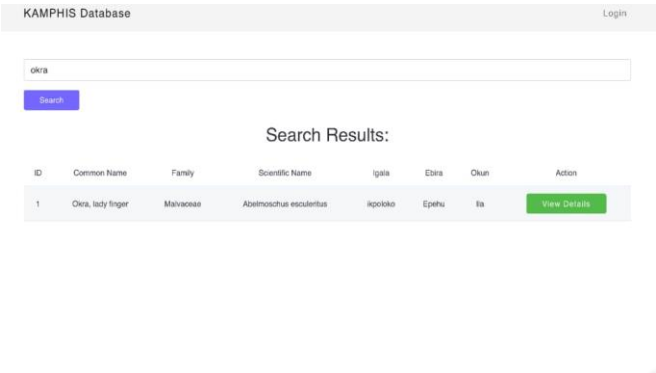

Figure 2: Search result interface showing local plant names

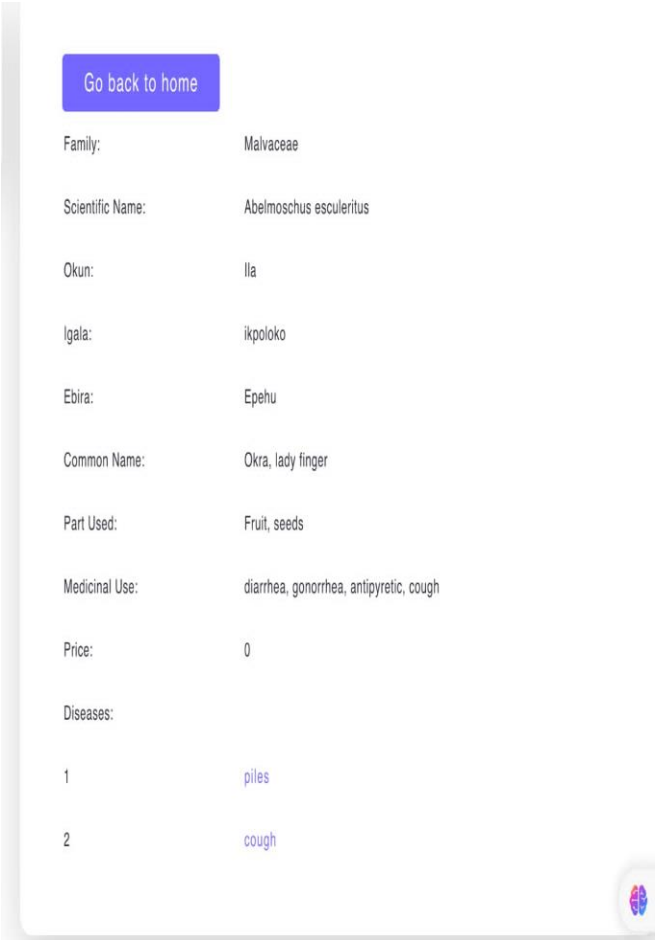

Figure 3: Search result interface showing medicinal use of plants

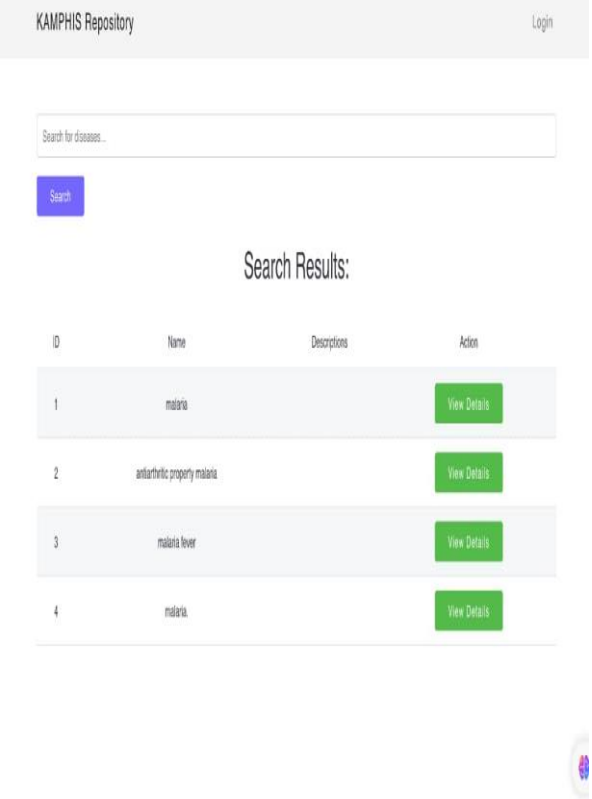

Figure 4: Search result interface using ailments/disease to search for medicinal plants to cure them

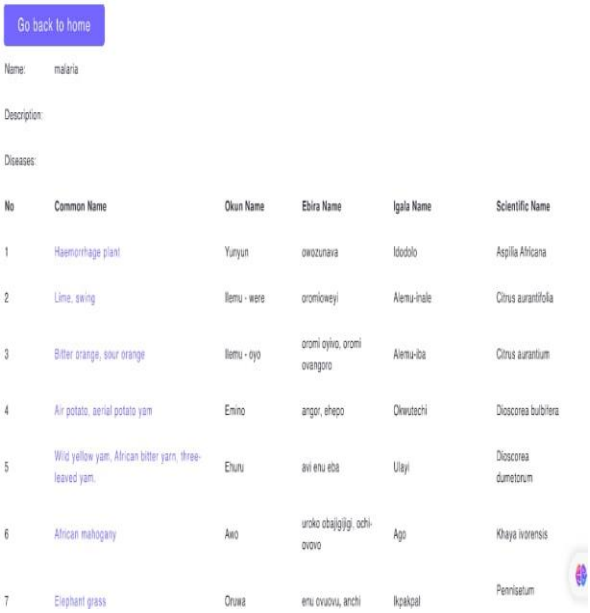

Figure 5: Interface showing information about all medicinal plants that can cure a particular ailment/disease (e.g. Malaria)

System Testing

During testing, the Kogi-African Medicinal Plants Healthcare Information System (KAMPHIS) was executed with set of test data as contained in the repository database; the output was evaluated to determine if the system is working as specified; and producing desired result.

Conclusion

The building of a web application was implemented to create more awareness of the importance of the usage of medicinal plants in African nations to alleviate the problems in the primary healthcare delivery system as well as improve the economy of the nations. A user is privileged to view and access information on all the possible medicinal plants that can cure a particular ailment/disease that exists in the compiled repository comprising of a hundred and fourteen (114) medicinal plants, their botanical names, family specie, common name, local names (Okun, Igala and Egbira), using the local medicinal plant name or ailment to query the database. Information on the part of plants used for medicinal purpose, and the ailment(s) they can cure are also made available. The results showed that more valuable information can be extracted from the medicinal plants' database for better decision-making by healthcare professionals, individuals, and researchers using the indigenous names of the plants for the production of indigenous drugs and herbs that has better and higher efficacy.

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Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

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