

## **PREPARING TOMORROW'S HEALTHCARE LEADERS FOR CONTEMPORARY PRACTICE: AN EXPLORATION OF FINAL YEAR MEDICAL AND PHARMACY STUDENTS' AWARENESS AND KNOWLEDGE OF MEDICINAL PLANTS AND HERBAL PRODUCTS**

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**Abstract: Background:** Medicinal plants and herbal remedies are the most widely used forms of traditional medicine globally. These age-old interventions form the basis for many orthodox therapeutic innovations and are often the first-line treatment in many communities. Thus, it is essential for healthcare professionals to have adequate knowledge of these herbal remedies. This study assessed the awareness and knowledge of final-year medical and pharmacy students in Nigeria regarding medicinal plants and herbal products within the context of modern integrative healthcare.

**Methods:** A cross-sectional survey was conducted using a structured questionnaire among 362 final-year students from selected Nigerian universities. Univariate analysis yielded descriptive statistics, and inferential statistics (multivariate binary logistic regression and Chi-square test) were employed to determine associations between knowledge levels and demographic, institutional, and experiential factors.

**Results:** A higher proportion of the students recognized commonly used medicinal plants, such as ginger and garlic, but were unaware of clinically relevant indigenous products, such as Niclovix® and Ciklavit®. While 84.0% of students reported prior use of herbal medicines, only 31.5% demonstrated good knowledge (mean score:  $4.97 \pm 1.95$  out of 11). Knowledge levels were significantly associated with age, gender, and institutional location. This study also revealed that pharmacy students had higher knowledge scores than medical/dental students, but this was not statistically significant after adjusting for confounders (AOR = 0.33,  $p = 0.108$ ).

**Conclusion:** Despite students' general awareness of herbal medicines, their formal knowledge was limited, highlighting critical gaps in the depth and structure of current phytomedicinal education in Nigeria. Therefore, it is crucial to strengthen undergraduate academic curricula to include evidence-based traditional medicine training that is contextual to the Nigerian health system. This is imperative in preparing the next generation of health professionals for safe, informed, and contextually responsive healthcare delivery.

**Keywords:** Curriculum, Herbal Medicine, Medicinal Plant, Medical Education, Pharmacy Education, Traditional Medicine, Phytomedicine, Health Policy.

## INTRODUCTION

Traditional Medicine (TM) plays a critical role in global health care systems and continues to influence medical practices across regions and generations (Ohemu et al., 2021). The World Health Organization (WHO, 2023) defined traditional medicine as “the sum of the knowledge, skills, and practices based on theories, beliefs, and experiences indigenous to different cultures used for maintaining health and for the prevention, diagnosis, improvement, or treatment of physical and mental illnesses.” TM involves the use of natural substances, such as plants, animals, and minerals, and is deeply intertwined with cultural heritage, spiritual beliefs, and practical skills (Iqbal, 2022).

Among the natural resources used in TM, medicinal plants and herbal medicines are some of the most widely used components (Ahad et al., 2021; Zeng et al., 2013). They form the basis of many traditional therapeutic practices and are often the first line of treatment in numerous communities (Chattopadhyay & Maurya, 2015). In particular, medicinal plants have long been central to primary healthcare delivery, especially in regions such as Africa, Asia, and Latin America, where up to 80% of the population relies on medicinal plants to meet basic health needs (James et al., 2018; Tilburt, 2008). In recent years, their relevance has reemerged, driven by growing antimicrobial resistance, rising rates of chronic diseases, and limitations associated with some synthetic drugs (Ekor, 2014). Furthermore, increased scientific validation of the safety and efficacy of traditional remedies has reinforced public interest in natural therapeutics (Heinrich et al., 2023). In recognition of these trends, the World Health Assembly (WHA) endorsed the WHO Traditional Medicine Strategy 2025 to 2034, which promotes the safe, evidence-based, and integrative use of Traditional Complementary and Integrative Medicine (TCIM) within health systems (WHO, 2025).

However, the effective and safe integration of TM into modern health care requires a strong understanding of herbal pharmacology, contraindications, and herb-drug interactions. For instance, herbal products modulate cytochrome P450 enzymes and P-glycoprotein transporters, potentially resulting in significant clinical interactions (Chen et al., 2012). Specific concerns have been raised regarding their interactions with cardiovascular medications, such as warfarin and digoxin, underscoring the need for robust knowledge among health care professionals (Abudalo et al., 2022). Therefore, prospective prescribers and dispensers (particularly medical and pharmacy students) must be adequately trained to prevent adverse outcomes and support safe TM integration (Amaeze et al., 2020).

Several studies have examined TM knowledge among Nigerian student populations. For instance, Amaeze et al. (2020) assessed final-year medical and pharmacy students at the University of Lagos and found limited awareness of herb-drug interactions. Similarly, Lawal and Agunu (2017) identified gaps in perception and knowledge among medical and nursing students at the University of Ilorin. Although these studies provide valuable insights, their findings are limited to specific institutions and do not adequately capture the broader educational landscape across Nigeria’s diverse geopolitical zones. To date, a significant knowledge gap remains regarding how well final-year medical and pharmacy students nationwide are prepared to contribute to integrative health care. Notably, only the study by Aboh et al. (2025) has assessed the attitudes of young health professionals on a national scale. However, the study did not examine their knowledge and awareness of traditional medicine, leaving a critical gap that this study seeks to address.

Despite the widespread use of herbal medicine in Nigeria, limited exposure during undergraduate training may contribute to poor understanding among health professional students. To bridge this gap, this study assesses the knowledge of final-year medical and pharmacy students across multiple academic institutions in Nigeria on medicinal plants and herbal products. By capturing data across the geopolitical zones and identifying patterns of knowledge, curricular inclusion, and practical exposure, the findings provide valid evidence to inform curriculum reforms and promote the safe and effective integration of traditional medicine into modern medical education. Ultimately, the study seeks to inform policy, guide curriculum reform, and develop strategies for harmonizing traditional and modern medicine within Nigeria's health care system.

## **METHODS**

### **Study Design and Setting**

This quantitative study adopted a cross-sectional design. The study population comprised pharmacy and medical/dental students in the final year of their undergraduate program from selected universities across Nigeria's geopolitical zones.

### **Study Tool and Validation**

The questionnaire was developed following a comprehensive literature review (Alsayari et al., 2018; Jamshed et al., 2016; Lawal & Agunu, 2017; Oshikoya et al., 2013). The questionnaire consisted of a sociodemographic section, multiple-response items on awareness of medicinal plants and herbal medicinal products, and 11 knowledge questions with "True/False/I do not know" as options. The instrument was designed to determine the knowledge of students regarding the sources, interactions, therapeutic indications, and effects of herbal products. An expert panel of three researchers with relevant experience in these thematic areas conducted face and content validations of the instruments. Only items that passed the assessment were used for the final questionnaire. A pilot test was conducted by administering the questionnaire to an initial cohort of 10 final-year students whose feedback did not require any major change to the study tool.

### **Sampling**

A minimum sample size of 354 was calculated from the population of final-year medical and pharmacy students, estimated as 4,495 annually from the documented workforce reports (Awire & Okumagba, 2020; Ekpenyong et al., 2018; Aboh et al., 2025). This was performed using Epi Info™ Version 7 set at a 95% confidence level, 5% margin of error, and 50% expected frequency. A multistage simple random sampling technique was employed to recruit the participants.

### **Inclusion and Exclusion Criteria**

Respondents included in the study were final-year students currently enrolled in either Medicine and Surgery/Dentistry or Pharmacy professional programs at the selected institutions in Nigeria, who were 18 years old and above. Respondents who did not meet these criteria were excluded from the study.

### **Ethical Consideration**

Approval for this study was issued by the National Institute for Pharmaceutical Research and Development Health Research Ethics Committee. All participants provided informed consent before filling out the questionnaire. Participation was strictly voluntary, and responses were treated confidentially and anonymized.

### **Data Collection**

Trained research assistants distributed the link to the Google Forms to the randomly selected students willing to participate in the study. Paper-based questionnaires were also administered to participants who preferred hard

copies. Data collection lasted from April to May 2025. The links and paper-based questionnaires were distributed to 400 students.

### Data Analysis

The electronic responses were exported from Microsoft Excel into Statistical Package for the Social Sciences (SPSS) version 23 and coded. In addition, the paper-based data were entered into the software using the codes. Univariate analysis yielded descriptive statistics, which were presented as frequencies and percentages. Given that the awareness questions required multiple responses, relative frequencies were used to determine the frequency of each category in relation to the total number of observations. For the knowledge aspect, each correct response was assigned 1 point, whereas incorrect answers and ‘I do not know’ responses were recorded as 0 points. To facilitate categorical comparisons, total knowledge scores were dichotomized as ‘Good’ or ‘Poor’, using 50% of the total obtainable points as a benchmark, on account that Bloom’s cut-off point (Ahmad & Halim, 2017) resulted in statistically incomparable skewed categories. Furthermore, a multivariate binary logistic regression analysis was performed to assess the independent predictors of good knowledge. Additionally, a Chi-square test was conducted to determine the association between the academic program and curricular provision for the study of herbal/TM. A  $p$ -value of 0.05 was considered statistically significant.

## RESULTS

### Demography

A total of 362 participants responded to this survey, accounting for a 91% response rate. Medicine and surgery/dentistry students constituted 37.8% of the sample, while 62.2% were studying pharmacy. The majority of the study cohort (62.7%) were aged between 22 and 25 years. Approximately two-thirds of the respondents (63.8%) indicated that herbal/traditional medicine is included in their academic curriculum. A strong majority of the students (84.8%) reported that herbal/traditional medicine clinics were absent from their academic institutions. Table 1 presents further details on the sociodemographic characteristics of the participants.

### Awareness of Medicinal Plants

The data of the relative frequency of the participants’ choice of identifiable medicinal plants (**Figure 1**) showed that ginger (*Zingiber officinale*) was the most known plant (13.1%), whereas creat (*Andrographis paniculata*) was the least known plant (1.9%). Other plants identified by a higher proportion of the participants were garlic (*Allium sativum*) (12.7%), moringa (*Moringa oleifera*) (12.3%), aloe vera (*Aloe barbadensis Miller*) (12%), bitter leaf (*Veronia amygdalina*) (10.5%), neem (*Azadirachta indica*) (10.3%), and bitter kola (*Garcinia kola*) (10.3%).

### Awareness of Herbal Medicinal Products

The participants’ awareness of herbal products indicates that the prospective health professionals were more aware of Ginseng (17.5%), Alomo bitter® (17.2%), and Yoyo Cleanser bitters® (14.3%). Tianshi® product (Capsilite) (1.5%) and Niclovix® (2.1%) were the least well-known herbal medicines. Further details are presented in **Figure 2**.

### Knowledge of the Sources, Interactions, Therapeutic Indications, and Effects of Herbal Medicines

**Table 2** presents the proportion of participants who indicated correct responses to each knowledge statement. Regarding the sources of herbal medicines, close to two-thirds of the participants (62.7%) were knowledgeable that they are obtained from medicinal plants, and less than half (45.5%) answered correctly regarding not obtaining them from animal sources. A strong majority (91.7%) affirmed that herb-drug interaction may occur

when herbal medicines are used with conventional medicine. Less than one-third of the respondents provided correct answers to all questions about the therapeutic indication of some herbal remedies. Notably, only 17.7% of the students knew that Niclovix® is an herbal medicine for sickle cell anemia. Similarly, less than one-tenth of the study cohort (8.8%) knew the effect of St. John's wort on blood digoxin levels.

The range of the knowledge score of the participants was 10, with a minimum of 0 and a maximum of 11, and the mean  $\pm$  standard deviation was  $4.97 \pm 1.95$ . Following the 50% benchmark of the scores, **Figure 3** depicts the overall knowledge category of the students. Less than one-third of the participants (31.5%) had good knowledge, whereas more than two-thirds (68.5%) had poor knowledge of herbal medicines.

### Inferential Statistics

The association between the sociodemographic characteristics of the participants and their knowledge level was determined using multivariate binary logistic regression analysis. The cross-tabulation, Crude Odds Ratio (COR), and Adjusted Odds Ratio (AOR) are presented in Table 3. The independent factors influencing the knowledge level of the participants included gender, age, and location of the academic institution by geopolitical zone. Male students were 2.08 times significantly less likely to have a good knowledge level than female students ( $p = 0.045$ ). Similarly, participants whose academic institutions were located in the North West ( $p < 0.001$ ), North Central ( $p < 0.001$ ), South West ( $p = 0.005$ ), and South South ( $p < 0.001$ ) regions were significantly less likely to have good knowledge of herbal products than those in the South East region. Conversely, younger participants aged 18–21 years were 4.58 times likely to be more knowledgeable than older participants (26–35 years), and this was significant ( $p = 0.006$ ). Although a lower proportion of the medicine and surgery/dentistry students had better knowledge of herbal products than the pharmacy students, this difference was not significant ( $p = 0.108$ ). Further details are presented in **Table 3**.

To understand the differences in knowledge levels between the students, a chi-square analysis was conducted between the academic program and the curricular provision for herbal/traditional medicine study. As presented in **Table 4**, a significant difference ( $p < 0.001$ ) was observed in the frequencies between the variables. While 97.3% of the pharmacy students indicated that herbal/traditional medicine was included in their curriculum, 91.2% of the medical/dentistry students had a contrary opinion.

### DISCUSSION

This study provides novel insights into the awareness and knowledge of medicinal plants and herbal medicine among final-year medical and pharmacy students. The relative frequencies showed that commonly known medicinal plants were ginger (*Zingiber officinale*), garlic (*Allium sativum*), moringa (*Moringa oleifera*), neem (*Azadirachta indica*), bitter leaf (*Veronia amygdalina*), bitter kola (*Garcinia kola*), and aloe vera (*Aloe barbadensis Miller*). Notably, some of these plants, especially garlic and ginger, which are culinary spices, are often used in households and are easily found in markets, suggesting that informal exposure, rather than formal education, may contribute to higher levels of awareness of the plants. Conversely, lower relative frequencies were observed for sweet wormwood (*Artemisia annua*), basil (*Ocimum gratissimum*), creat (*Andrographis paniculata*), candle bush (*Senna alata*), and Jacob's coat (*Acalypha wilkesiana*). This can be attributed to the familiarity with the regional or local names of these medicinal plants compared with the common English or botanical nomenclature. Basil is popularly known as a scent leaf in Nigeria (Emodi et al., 2014). Another reason is the relative abundance of plants in other regions. *Artemisia annua* is native to China and is sparingly domesticated in Nigeria, despite being the source of artemisinin used in the pharmaceutical manufacturing of artemisinin-based combination therapy for the management of malaria, a disease prevalent in the country (Shen et al., 2018).

The students demonstrated higher levels of awareness for herbal medicines such as Ginseng, Alomo Bitters®, Yoyo Cleanser Bitters®, and Dr. Aladdin 7 Keys herbal mixture. Ginseng is incorporated into consumables such as sweets and energy drinks sold across Nigerian streets, accounting for its popularity (Ichim & de Boer, 2021). The familiarity with other herbal interventions, such as Yoyo Cleanser Bitters, Dr Aladdin 7 Keys Herbal Mixture, and Alomo Bitters®, can be correlated with aggressive street-level marketing and cultural factors reported by Ekor (2010) and Illamola et al. (2020). Conversely, the students had lower levels of awareness of clinically significant products, such as Niclovix® and Ciklavit®, which have been scientifically validated and approved for the management of Sickle Cell Disease (SCD) (Adigwe et al., 2023; Imaga et al., 2013). This depicts a disconnect between the innovation and publicity of essential health care interventions. Similarly, a decline in the recognition of popular multi-level-marketed supplements such as GNLD and Tianshi® emerged, suggesting that visibility and media presence can outweigh clinical validation in influencing awareness of herbal medicines. These findings also indicate the need to strengthen academic and industry collaboration to promote phytotherapy. Herbal medicines include various products, such as raw herbs, herbal preparations, and finished products containing plant parts or combinations thereof as active ingredients (Miranda, 2021). Although this definition clearly places herbal medicine within botanical origins, only approximately two-thirds of the respondents in this study correctly identified medicinal plants as the source of herbal products. This aligns with the distribution of students reported by Adomi (2014), who affirmed that herbal medicines contained plant materials as pharmacologically active components. However, these proportions are lower than the findings of Onwujekwe et al. (2015), where almost all participants appropriately defined herbal products. Interestingly, almost half of the medical and pharmacy students in this study indicated that animal-derived herbal products can be obtained. This confusion likely stems from the overlap between herbal and traditional remedies, where plant-based treatments are sometimes combined with animal-derived substances, such as snake fat (Bullitta et al., 2018; Mukherjee et al., 2017). Students familiar with such practices may conflate all traditional remedies with herbal medicine, blurring the line between phytomedicines and broader traditional therapies. Additionally, the term “herbal” is often used loosely in local markets to describe various natural remedies regardless of their actual source, which may further reinforce this misconception. The participants’ responses on the sources of herbal products emphasize the need to strengthen foundational education on constituents of herbal medicines to ensure appropriate identification of the sources and classifications.

The students showed good knowledge of the potential risks associated with the use of herbal medicines. A strong majority correctly identified that herb-drug interactions can occur when herbal medicines are used alongside conventional drugs. Herb-drug interactions can alter drug pharmacokinetics and pharmacodynamics by affecting enzymes, such as CYP450, and transporters, such as P-glycoprotein (Neergheen-Bhujun, 2013). These changes can reduce drug efficacy or increase toxicity (Jeong et al., 2012). Similarly, more than three-quarters of the cohort recognized that herb–herb interactions are also possible. This is supported by findings from Traditional Chinese Medicine (TCM), where Euphorbia kansui and Glycyrrhiza combinations can enhance bioavailability but also increase toxicity (Enioutina et al., 2016; Shen et al., 2013). Other studies have also demonstrated that herb combinations can either intensify or weaken therapeutic effects (Bunel et al., 2015; Enioutina et al., 2016; Fan et al., 2016; Gong et al., 2015; Hu et al., 2016). Moreover, almost all studies implied that herbal medicines can be contraindicated in pregnancy, indicating high safety awareness among students. This is consistent with clinical evidence showing that some herbal compounds can cross the placenta and pose developmental risks to the fetus

(Balarastaghi et al., 2022; Frawley et al., 2015; Gunn et al., 2016; Illamola et al., 2020). This awareness may reflect curricular emphasis on the risks and safety profiles of herbal medicines among students.

The frequency of correct responses to knowledge statements on selected herbal medicines revealed significant gaps in the understanding of students. Less than a third accurately identified the role of Ginkgo in delaying the onset of dementia and the therapeutic indication of Yoyo Cleanser Bitters® as an immune booster. Moreover, knowledge of Niclovix®, an indigenous herbal medicine developed by Nigerian scientists at the National Institute for Pharmaceutical Research and Development (NIPRD) for the management of sickle cell anemia (Iyamu et al., 2002; Kasilo et al., 2019; Wambebe et al., 2001), was much lower. Nigeria bears the highest global burden of sickle cell disease and contributes to approximately 74.5% of global publications on the condition (Adigwe et al., 2023; Fleming et al., 1979; Galadanci et al., 2014). Despite the local innovation and disease burden, cultural and religious beliefs in Nigeria may contribute to the limited open discussion of SCD, subsequently affecting how such treatments are publicized, perceived, and integrated into health education (Anie et al., 2010; Nzewi, 2001). Altogether, these findings highlight the urgent need to integrate evidence-based education on herbal and traditional medicine into health training programs to equip future professionals with adequate knowledge.

Additionally, the lowest correct response rate was observed with St. John's Wort, where only about one-tenth of the students accurately implied that it is not used for controlling mild or moderate hypertension. St. John's Wort (*Hypericum perforatum*) is a well-researched herbal antidepressant widely used across countries (Alzahrani et al., 2023; Kumar et al., 2010). It is also used to treat menopausal symptoms, attention-deficit hyperactivity disorder, somatic symptom disorder, obsessive-compulsive disorder, wound healing, and male reproductive health (Alzahrani et al., 2023). Despite its widespread use and clinical relevance, less than one-tenth of respondents correctly identified that St. John's Wort does not increase digoxin blood levels, a misunderstanding, since it induces metabolism and may reduce digoxin levels (Mueller, 2004). This highlights the low level of knowledge regarding specific herb interactions. Similarly, only a few respondents recognized that Ginkgo can increase the risk of bleeding when used with warfarin. These results reflect limited awareness of clinically significant interactions involving common herbal medicines, reinforcing the need for improved pharmacological education to ensure their safe use in clinical settings.

Overall, less than a third of the students demonstrated good knowledge of herbal medicines, despite twice the proportion indicating the inclusion of herbal/traditional medicine in their curriculum. The knowledge level of the students in this study highlights a critical gap in herbal medicine education in Nigeria's medical and pharmacy programs. A plausible explanation for this outcome is the perception that traditional medicines are less scientifically validated than orthodox medicines (Aboh et al., 2025). Furthermore, the lack of practical exposure or clinical integration is a considerable factor that points to a limited scholarship in this area of healthcare intervention, as over three-quarters of the study cohort attested to the absence of an herbal medicine clinic in their academic setting. These cognitive and infrastructural gaps underscore the urgent need to review educational models for prospective health care professionals to ensure evidence-based and culturally relevant TM training.

Factors that independently predicted good knowledge levels were gender, age, and academic institution location by geopolitical zone. The gender representation of the participants in this study aligns with previous reports (Aboh et al., 2025; Okoronkwo et al., 2014). However, male students were twice as likely to have good knowledge as female students. This is consistent with the suggestion of Almech et al. (2024) in Saudi Arabia, that female students may exhibit greater engagement with herbal remedies due to higher health consciousness, cultural influences, or a stronger inclination toward complementary health practices. These insights call for gender-

responsive teaching strategies to ensure inclusive knowledge acquisition. Interestingly, more of the younger students were in the good knowledge category, indicating that they may be more engaged with herbal medicines, correlating with earlier reports by Almech et al. (2024) and Hasan et al. (2009). This can be ascribed to more digital fluency, curiosity, and early exposure to wellness trends, such as detox teas and herbal supplements, compared to older students who may focus more narrowly on formal curricula. In addition, students from Southeast institutions were significantly more likely to possess good knowledge than their peers in all other geopolitical zones. Differences in curriculum depth, faculty expertise, and local cultural attitudes toward herbal medicine, influence these regional disparities. Although Nigeria's university admissions span ethnic lines, institutional populations often reflect regional demographics due to catchment policies (Aboh et al., 2025), which may in turn shape exposure and knowledge levels.

In this study, more than three-quarters of the students reported personal use of herbal medicines, closely aligning with the findings of Nworu et al. (2015) and Osuchukwu et al. (2017). However, personal use was not an independent predictor of good knowledge levels. Although personal experience may influence attitudes or spark interest and familiarity with herbal medicines, structured education is also critical, particularly when preparing students for clinical practice competence. In line with reports on the use of herbal medicines, the participants' academic program had no significant effect on the knowledge levels, despite pharmacy students demonstrating better understanding than those in Medicine and Surgery/Dentistry, supporting the findings of Alehegn et al. (2022) in Ethiopia and Ashraf et al. (2019) in Pakistan. A major factor determining this outcome is the remarkable differences between both groups, as almost all the medical students indicated that herbal medicines are not contained in their curriculum, whereas the pharmacy students acknowledged otherwise. This disparity highlights the need for a curriculum reform in the medical program to ensure proper harmonization of traditional medicine knowledge and practice among health care practitioners.

## **CONCLUSION**

Despite widespread personal use, final-year medical and pharmacy students in Nigeria demonstrate suboptimal levels of knowledge about herbal medicines. The significant predictors of knowledge included age, gender, and geopolitical zone, with female, younger students, and those in certain regions performing better. Curriculum inclusion and the availability of herbal clinics were not independently associated with higher knowledge levels. The findings identify critical gaps in the quality, structure, and clinical integration of traditional medicine in the Nigerian medical and pharmacy academic settings. These gaps highlight a missed opportunity for prospective health care providers to safely and effectively prescribe and dispense herbal medicines in Nigeria. If harnessed properly, interventions in this area constitute a significantly valuable addition to healthcare delivery. Emergent evidence from the field must therefore be leveraged to align with other ongoing proactive reforms. Contextual implementation monitoring, and evaluation must also be prioritized, to ensure the expedited achievement of Nigeria's overarching medicines security goals.

## **RECOMMENDATIONS**

TCM should be fully integrated into health curricula, particularly for medical students, through clearly defined competencies, hands-on training using functional herbal clinics, and outcome-based assessments. Content should reflect local health needs and ensure equitable delivery across regions. Stronger policy support and collaboration between universities, communities, and industry are essential to raise awareness of validated herbal products and connect research with training and public health practice.

## **LIMITATIONS**

The cross-sectional design restricts causal interpretations, and the reliance on self-reported data introduces potential recall and social desirability biases. Although participants were drawn from all six geopolitical regions, the uneven distribution of students may have influenced regional comparisons. Lastly, the knowledge assessment focused on the recognition of specific herbal medicines and may not fully capture conceptual or clinical understanding.

### ETHICS

Ethical approval for this study was obtained from the National Institute for Pharmaceutical Research and Development Health Research Ethics Committee.

### CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

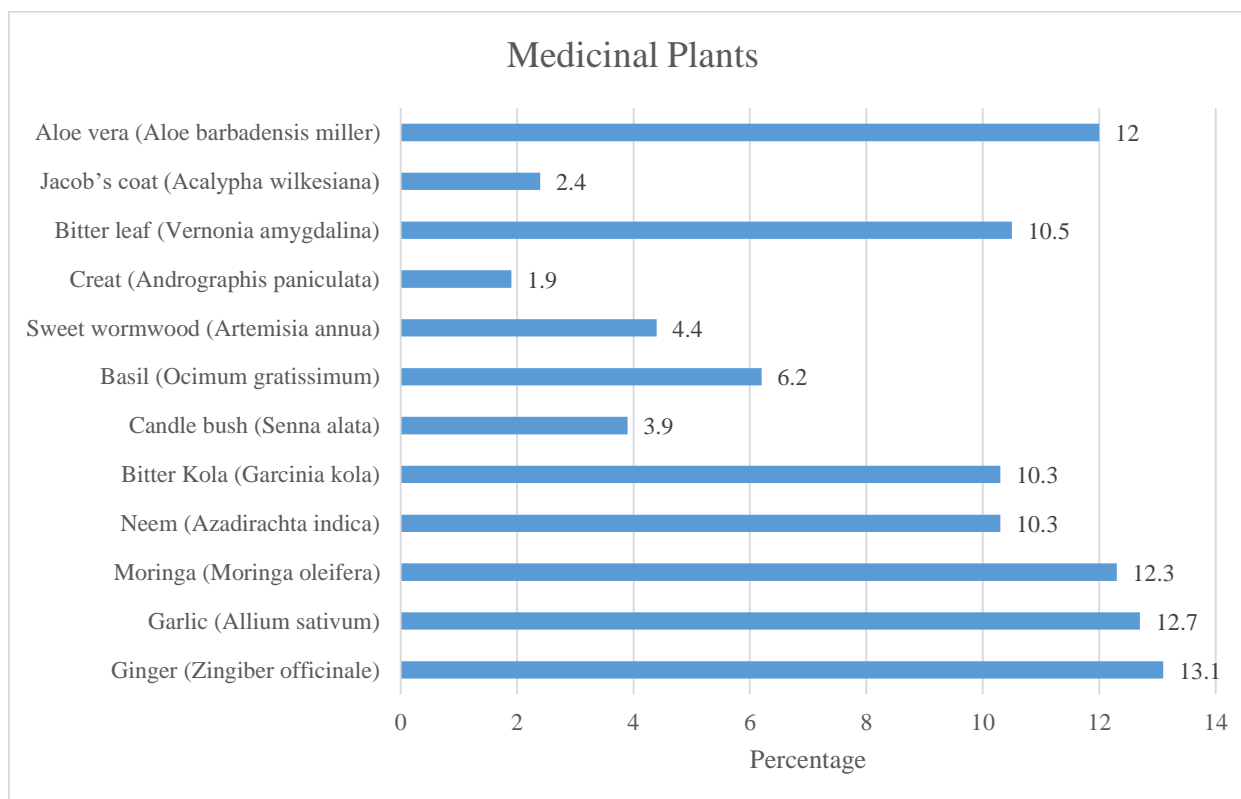
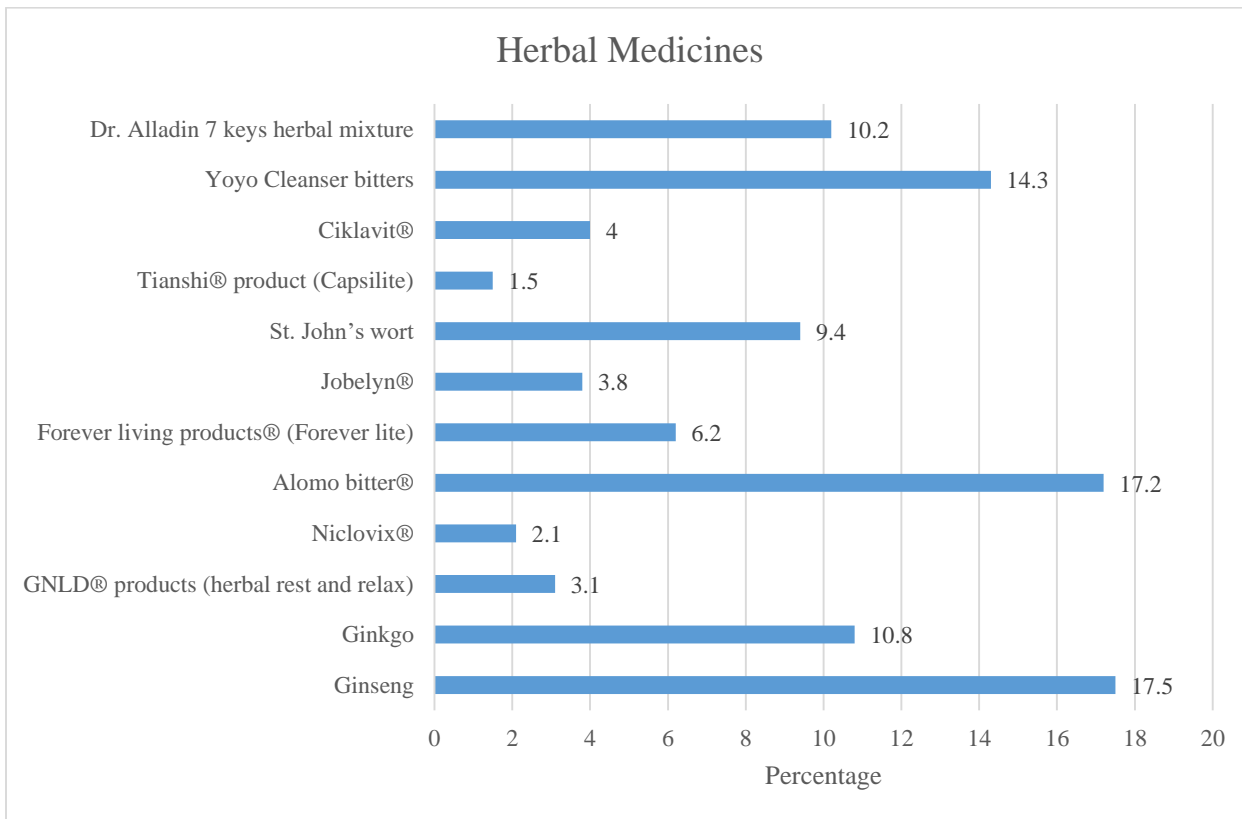
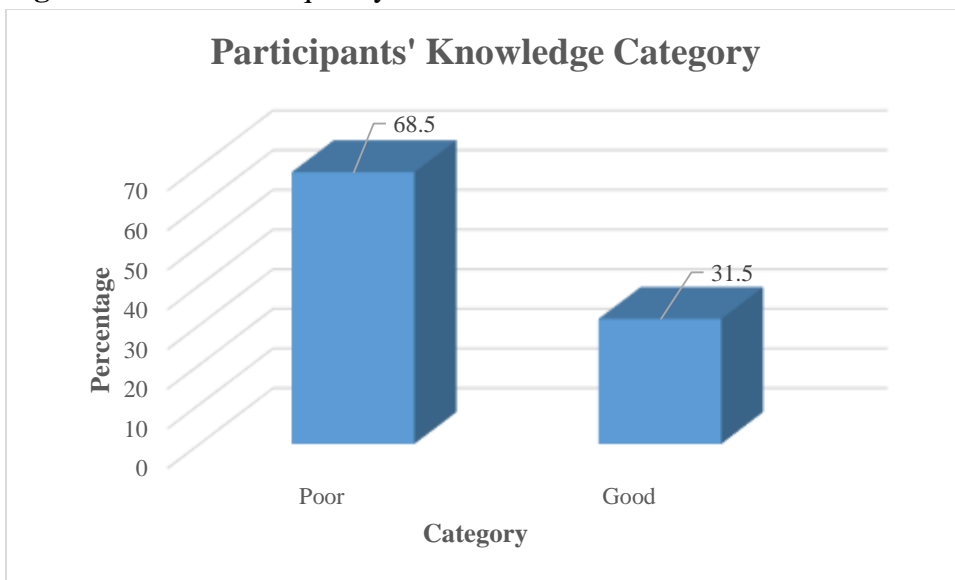


Figure 1: Relative frequency of identified medicinal plants



**Figure 2:** Relative Frequency of Awareness of Herbal Medicines



**Figure 3:** Participants' Herbal Medicine Knowledge Level

**Table 1:** Sociodemographic Characteristics of Participants

<b>Demography</b>	<b>Frequency (%)</b>
<b>Gender</b>	
Male	132 (36.5)
Female	230 (63.5)
<b>Academic Program</b>	
Medicine and Surgery/Dentistry	137 (37.8)
Pharmacy	225 (62.2)
<b>Age</b>	
18–21	56 (15.5)
22–25	227 (62.7)
26–35	79 (21.8)
<b>Academic Institution Location by Geopolitical Zone</b>	
Northwest	70 (19.3)
North Central	63 (17.4)
North East	39 (10.8)
Southwest	62 (17.1)
South South	106 (29.3)
South East	22 (6.1)
<b>Curricular Provision for the Study of Herbal/Traditional Medicine</b>	
Present	231 (63.8)
Absent	131 (36.2)
<b>Herbal/Traditional Medicine Clinic within an academic institution</b>	
Present	55 (15.2)
Absent	307 (84.8)
<b>Ever used medicinal plants or herbal medicines</b>	
Yes	304 (84.0)
No	58 (16.0)

**Table 2:** Frequency of Correct Responses to Knowledge Statements on Herbal Products

<b>Scope</b>	<b>Statements (Correct Response)</b>	<b>Frequency (%)</b>
Sources	Herbal products are obtained from medicinal plants. [True]	227 (62.7)
	Herbal products can be obtained from animals. [False]	164 (45.3)
Interaction	Herb-drug interaction can occur when conventional medicine is combined with herbal medicine. [True]	332 (91.7)
	Herb-herb interaction can occur with the use of herbal medicine. [True]	293 (80.9)
	Herbal medicines can be contraindicated during pregnancy. [True]	335 (96.8)
Therapeutic indication	Yoyo Cleanser Bitters® is an immune booster. [True]	87 (24.0)
	Ginkgo may delay the onset of dementia. [True]	105 (29.0)
	St John’s wort is used to control mild or moderate hypertension. [False]	40 (11.0)
	Niclovix® is an herbal medicine for sickle cell anemia. [True]	64 (17.7)
Effect	St. John’s wort can increase blood digoxin levels. [False]	32 (8.8)
	Ginkgo can increase the risk of bleeding when used concurrently with warfarin. [True]	86 (23.8)

**Table 3:** Multivariate Binary Logistic Regression Analysis of Factors Associated with Good Knowledge Level

Demography	Knowledge Level		COR (95% CI)	p-value	AOR (95% CI)	p-value
	Poor n (%)	Good n (%)				
<b>Gender</b>						
Male	101(76.5)	31 (23.5)	- 0.56 (0.34 – 0.91)	0.019*	2.08 (1.02– 4.29)	0.045*
Female	147 (63.9)	83 (36.1)	Ref	Ref	Ref	Ref
<b>Academic Program</b>						
Medicine and Surgery/Dentistry	125 (91.2)	12 (8.8)	- 0.12 (0.06 – 0.22)	<0.001*	- 0.33 (0.08 – 1.28)	0.108
Pharmacy	123 (54.7)	102 (45.3)	Ref	Ref	Ref	Ref
<b>Age</b>						
18–21	32 (57.1)	24 (42.9)	+ 4.79 (2.11– 10.88)	<0.001*	+ 4.58 (1.55– 13.49)	0.006*
22–25	149 (65.6)	78 (34.4)	+ 3.18 (1.62– 6.24)	0.001*	+ 2.09 (0.90–4.85)	0.085
26–35	67 (84.8)	12 (15.2)	Ref	Ref	Ref	Ref
<b>Academic Institution Location by Geopolitical Zone</b>						
Northwest	63 (90.0)	7 (10.0)	- 0.25 (0.01 – 0.94)	<0.001*	- 0.03 (0.01 – 0.13)	< 0.001*
North Central	51 (81.0)	12 (19.0)	- 0.06 (0.02 – 0.20)	<0.001*	- 0.04 (0.01 – 0.17)	< 0.001*
North East	39 (100.0)	0 (0.0)	- <0.00 (<0.00 – <0.00)	0.997	- <0.00 (<0.00 – <0.00)	0.997
Southwest	30 (48.4)	32 (51.6)	- 0.24 (0.07 – 0.78)	0.018*	- 0.13 (0.03 – 0.55)	0.005*
South South	61 (57.5)	45 (42.5)	- 0.18 (0.06 – 0.58)	0.004*	- 0.07 (0.02 – 0.29)	< 0.001*
South East	4 (18.2)	18 (81.8)	Ref	Ref	Ref	Ref
<b>Curricular Provision for the Study of Herbal/Traditional Medicine</b>						

Present	128 (55.4)	103 (44.6)	+ 8.74 (4.46–17.13)	<0.001*	+ 2.74 (0.60–12.52)	0.194
Absent	120 (91.6)	11 (8.4)	Ref	Ref	Ref	Ref
<b>Herbal/Traditional Medicine Clinic within an academic institution</b>						
Present	22 (40.0)	33 (60.0)	+ 4.32 (2.34–7.96)	<0.001*	+ 1.56 (0.73–3.34)	0.256
Absent	226 (73.6)	81 (26.4)	Ref	Ref	Ref	Ref
<b>Ever used medicinal plants or herbal medicines</b>						
Yes	201 (66.1)	103 (33.9)	+ 2.25 (1.12–4.55)	0.023*	+ 1.14 (0.37–3.51)	0.815
No	47 (81.0)	11 (19.0)	Ref	Ref	Ref	Ref

**Table 4:** Association between Academic Program and Curriculum Provision for Herbal/Traditional Medicine

Academic Program	Curricular Provision for the Study of Herbal/Traditional Medicine		$X^2$	<i>p</i> -value
	Present [n (%)]	Absent [n (%)]		
Medicine and Surgery/Dentistry	12 (8.8)	125 (91.2)	289.296	< 0.001
Pharmacy	219 (97.3%)	6 (2.7)		

## REFERENCES

- Aboh, M. I., Uzuh, N. R., Adikwu, V., Oparaugo, P., & Adigwe, O. P. (2025). Complementary and Alternative Medicine: A Cross-sectional Study on Prospective Healthcare Professionals' Herbal Medicine Attitudes Asian Journal of Advanced Research and Reports, 19(7), 14–31. <https://doi.org/10.9734/ajarr/2025/v19i71078>
- Aboh, M. I., Oparaugo, P., Uzuh, N. R., & Adigwe, O. P. (2025). Young Health Professionals' Perception of Training and Capacity Building for Improved Phytomedicinal Antimalarial Use: A Cross-Sectional Survey Journal of Complementary and Alternative Medical Research, 26(6), 113–125. <https://doi.org/10.9734/jocamr/2025/v26i6669>
- Abudalo R, Abudalo R, Alqudah A, Abuqamar A, Abdelaziz A, Alshawabkeh M, Taha L. 2022. Pharmacy practitioners' practice, awareness and knowledge about herbal products and their potential interactions with cardiovascular drugs. F1000Research, 11, 912. <https://doi.org/10.12688/f1000research.121709.2>
- Adigwe, O. P., Onoja, S. O., & Onavbavba, G. (2023). A Critical Review of the Burden and Challenges of Sickle Cell Disease in Sub-Saharan Africa Journal of Blood Medicine, 14, 367–376. <https://doi.org/10.2147/JBM.S406196>
- Adomi, P. O. (2014). Student's perception, attitude and use of herbal medicine in a tertiary institution in Nigeria. Journal of the American Medical Association. Journal of Pharmaceutical and Allied Sciences, 11(2), 2057–2066. [https://www.researchgate.net/publication/381483624\\_Student](https://www.researchgate.net/publication/381483624_Student)
- B. Ahad, W. Shahri, H. Rasool, Z. A. Reshi, S., & Hussain, T. (2021). Medicinal Plants and Herbal Drugs: An Overview In: Medicinal and Aromatic Plants, 1–40. Springer International Publishing. [https://doi.org/10.1007/978-3-030-58975-2\\_1](https://doi.org/10.1007/978-3-030-58975-2_1)
- Ahmad, H., & Halim, H. (2017). Determining the sample size for research activities. Selangor Business Review, 2(1), 20–34.
- Alehegn, H. Z., Asiferaw, E. T., Welda, Z. G., Emiru, Y. K., Hussen, S. M., Kifle, Z. D., Demeke, C. A., 2022. Knowledge, attitude, and practice of medical and health science students toward complementary and alternative medicine at the University of Gondar Clinical Epidemiology and Global Health, 17, 101148. DOI: 10.1016/j.cegh.2022.101148
- Almech M, Alissa A, Baghdadi R, Abujamai J, Hafiz W, Alwafi H, Shaikhomer M, Alshanberi A, Alshareef M, Alsanosi S. 2024. Knowledge and Perceptions of Herbal Medicine in Saudi Arabia by Medical Students: Should Medical Schools Take Immediate Action? Advances in Medical Education and Practice, 15, 1243–1253. doi: 10.2147/AMEP.S497642
- Alsayari, A., Almghaslah, D., Khaled, A., Annadurai, S., Alkhairy, M. A., Alqahtani, H. A., Alsayed, B. A., Alasiri, R. M., & Assiri, A. M. (2018). Community Pharmacists' Knowledge, Attitudes, and Practice

of Herbal Medicines in Asir Region, Kingdom of Saudi Arabia. Evidence-Based Complementary and Alternative Medicine, 2018, 1–7. <https://doi.org/10.1155/2018/1568139>

- Alzahrani, M. A., Ofisan, S. Bin, N. I. Alshumaymiri, M. Alghuwainem, M. Altamimi, A. Y. Alali, M. Rabie, A. K. AboSkena, K. Almaymuni, R. Almannie, and S. Binsaleh. 2023. Effect of St. John's Wort (*Hypericum perforatum* L.) on Male Sexual and Reproductive Health: A Narrative Review. *Biomedicines*, 11(10), 2800. <https://doi.org/10.3390/biomedicines11102800>
- Amaeze, O. U., Olugbake, O. A., & Lawal, M. (2020). Knowledge of Herbal Medicines and Herb-drug Interaction Among Medical and Pharmacy Students of the University of Lagos, Nigeria *Nigerian Journal of Pharmaceutical Research*, 16(1), 61–70. <https://doi.org/10.4314/njpr.v16i1.7>
- Anie, K. A., Egunjobi, F. E., & Akinyanju, O. O. (2010). The psychosocial impact of sickle cell disorder: perspectives from a Nigerian setting *Globalization and Health*, 6(1), 2. doi: 10.1186/1744-8603-6-2
- Ashraf M, Saeed H, Saleem Z, Rathore HA, Rasool F, Tahir E, Bhatti T, Khalid J, Bhatti I, Tariq A. 2019. A cross-sectional assessment of knowledge, attitudes and self-perceived effectiveness of complementary and alternative medicine among pharmacy and non-pharmacy university students. *BMC Complementary and Alternative Medicine*, 19(1), 95. <https://doi.org/10.1186/s12906-019-2503-y>
- Awire, E., & Okumagba, M. T. (2020). Medical education in Nigeria and migration: a mixed-methods study of how the perception of quality influences migration decision-making [Version 2] [*Journal of Medicine & Public Health*, 2019] *MedEdPublish*, 9(1). <https://doi.org/10.15694/mep.2020.000001.2>
- Balarastaghi S, Delirrad M, Jafari A, Majidi M, Sadeghi, M., Zare-Zardini, H., Karimi, G., & Ghorani-Azam, A. (2022). Potential benefits versus hazards of herbal therapy during pregnancy: a systematic review of available literature *Phytotherapy Research*, 36(2), 824–841. DOI: 10.1002/ptr.7363
- Bullitta, S., Re, G. A., Manunta, M. D. I., and Piluzza, G. (2018). Traditional knowledge about plant-, animal-, and mineral-based remedies for the treatment of cattle, pigs, horses, and other domestic animals in the Mediterranean island of Sardinia *Journal of Ethnobiology and Ethnomedicine*, 14(1), 50. <https://doi.org/10.1186/s13002-018-0250-7>
- Bunel, V., Antoine, M.-H., Nortier, J., Duez, P., & Stévigny, C. (2015). In Vitro Effects of Panax Ginseng on Aristolochic Acid-Mediated Renal Tubulotoxicity: Apoptosis versus Regeneration *Planta Medica*, 81(05), 363–372. DOI: 10.1055/s-0035-1545839
- Chattopadhyay, N. and Maurya, R. (2015). Herbal Medicine. In the Reference Module in Biomedical Sciences. Elsevier. <https://doi.org/10.1016/B978-0-12-801238-3.05061-3>
- Chen, X.-W., K. B. Sneed, S.-Y. Pan, C. Cao, R. Kanwar, H. Chew, and S.-F. Zhou. 2012. “Herb-Drug Interactions and Mechanistic and Clinical Considerations.” *Current Drug Metabolism*, 13(5), 640–651. DOI: 10.2174/1389200211209050640

- Ekor. (2010). Evaluation of the Toxicity of Yoyo “Cleanser” Bitters and Fields Swedish Bitters Herbal Preparations following Sub-Chronic Administration in Rats American Journal of Pharmacology and Toxicology, 5(4), 159–166. <https://doi.org/10.3844/ajptsp.2010.159.166>
- Ekor, M. (2014). The growing use of herbal medicines: issues related to adverse reactions and safety monitoring challenges *Frontiers in Pharmacology*, 4 (2019). <https://doi.org/10.3389/fphar.2013.00177>
- Ekpenyong, A., Udoh, A., Kpokiri, E. and Bates, I. (2018). An analysis of Nigeria’s pharmacy workforce capacity *Journal of Pharmaceutical Policy and Practice*, 11(1), 20. <https://doi.org/10.1186/s40545-018-0147-9>
- Emodi, A. I., & Obiora, C. J. Otene, R. N. (2014). Use of basil (*Ocimum gratissimum*) among rural households in Ika South Local Government Area of Delta State, Nigeria. Available from: <https://www.cabidigitallibrary.org/doi/pdf/10.5555/20153308914>
- Enioutina, E. Y., Salis, E. R., Job, K. M., Gubarev, M. I., Krepkova, L. V., and Sherwin, C. M. T. (2016). Herbal Medicines: Challenges in the Modern World Part 5. Status and current directions of complementary and alternative herbal medicine worldwide. *Expert Review of Clinical Pharmacology*, 1–12. <https://doi.org/10.1080/17512433.2017.1268917>
- Fakeye, T. O., & Onyemadu, O. (2008). Evaluation of hospital pharmacists and physicians’ knowledge base on herbal medicines in southwestern Nigeria *Pharmacy Practice (Internet)*, 6(2). doi: 10.4321/S1886-36552008000200005
- Fan, Y., Man, S., Li, H., Liu, Y., Liu, Z., and Gao, W. (2016). Bioactive component analysis and pharmacokinetic study of herb–herb interactions in the traditional Chinese patent medicine Tongmai Yangxin Pill *Journal of Pharmaceutical and Biomedical Analysis*, 120, 364–373. <https://doi.org/10.1016/j.jpba.2015.12.032>
- Fleming, A. F., J. Storey, L. Molineaux, E. A. Iroko, and E. D. E. Attai. 1979. Abnormal hemoglobin levels in the Sudan savanna of Nigeria *Annals of Tropical Medicine & Parasitology*, 73(2), 161–172. DOI: 10.1080/00034983.1979.11687243
- Frawley, J., Adams, J., Steel, A., Broom, A., Gallois, C., & Sibbritt, D. (2015). Women’s use and self-prescription of herbal medicine during pregnancy: An examination of 1,835 pregnant women. *Women’s Health Issues*, 25(4), 396–402. <https://doi.org/10.1016/j.whi.2015.03.001>
- Galadanci, N., Wudil, B. J., Balogun, T. M., Ogunrinde, G. O., Akinsulie, A., Hasan-Hanga, F., Mohammed, A. S., Kehinde, M. O., Olaniyi, J. A., Diaku-Akinwumi, I. N., Brown, B. J., Adeleke, S., Nnodu, O. E., Emodi, I., Ahmed, S., Osegbue, A. O., Akinola, N., Opara, H. I. O., Adegoke, S. A., ... Adekile, A. D. (2014). Sickle cell disease management practices in Nigeria *International Health*, 6(1), 23–28. <https://doi.org/10.1093/inthealth/iht022>

- Gong, C., Yang, H., Wei, H., Qi, C., & Wang, C. (2015). Pharmacokinetic comparisons by UPLC-MS/MS of isomer paeoniflorin and albiflorin after oral administration decoctions of single-herb Radix Paeoniae Alba and Zengmian Yiliu prescription to rats. *Biomedical Chromatography*, 29(3), 416–424. DOI: 10.1002/bmc.3292
- Gunn, J. K. L.; Rosales, C. B.; Center, K. E., Nuñez, A.; Gibson, S. J.; Christ, C.; Ehiri, J. E. (2016). Prenatal exposure to cannabis and maternal and child health outcomes: a systematic review and meta-analysis *BMJ Open*, 6(4), e009986. doi: 10.1136/bmjopen-2015-009986
- Hasan, S. S., Ahmed, S. I., Bukhari, N. I., & Loon, W. C. W. (2009). Use of complementary and alternative medicine among patients with chronic diseases at outpatient clinics: A retrospective study *Complementary Therapies in Clinical Practice*, 15(3), 152–157. <https://doi.org/10.1016/j.ctcp.2009.02.003>
- Hu, P., Yue, P., Zheng, Q., Yang, M., Zhang, G., Wu, B., & Liu, D. (2016). Pharmacokinetic comparative study of gastrodin after oral administration of Gastrodia elata Bl. extract and its compatibility with different Ligusticum chuanxiong Hort. indigents in rats *Journal of Ethnopharmacology*, 191, 82–86. <https://doi.org/10.1016/j.jep.2016.06.007><https://doi.org/10.1016/j.jep.2016.06.007>
- Ichim, M. C., & de Boer, H. J. (2021). Review of the Authenticity and Authentication of Ginseng Herbal Medicines and Food Supplements *Frontiers in Pharmacology*, 11, <https://doi.org/10.3389/fphar.2020.612071>.
- Illamola, S. M., Amaeze, O. U., Krepkova, L. V., Birnbaum, A. K., Karanam, A., Job, K. M., Bortnikova, V. V., Sherwin, C. M. T., and Enioutina, E. Y. (2020). Use of herbal medicine by pregnant women: What physicians need to know *Frontiers in Pharmacology*, 10. <https://doi.org/10.3389/fphar.2019.01483>
- Imaga, N. A., C. E. Chukwu, A. Blankson, and G. O. Gbenle. 2013. Biochemical assessment of Ciklavit®, a nutraceutical used in the management of sickle cell anemia *Journal of Herbal Medicine*, 3(4), 137–148. <https://doi.org/10.1016/j.hermed.2013.05.003>
- Iqbal, M. (2022). *Complementary and Alternative Medicinal Approaches for Enhancing Immunity*. CRC Press. <https://doi.org/10.1201/9781003261520>
- Iyamu, E. W., Turner, E. A., & Asakura, T. (2002). In vitro effects of NIPRISAN (Nix-0699): a naturally occurring, potent antisickling agent *British Journal of Hematology*, 118(1), 337–343. <https://doi.org/10.1046/j.1365-2141.2002.03593.x><https://doi.org/10.1046/j.1365-2141.2002.03593.x>
- James, P. B., Wardle, J., Steel, A., & Adams, J. (2018). Traditional, complementary and alternative medicine use in Sub-Saharan Africa: a systematic review. *BMJ Global Health*, 3(5), e000895. <https://doi.org/10.1136/bmjgh-2018-000895><https://doi.org/10.1136/bmjgh-2018-000895>

- Jamshed, S., Khan, M., Ahmad, A., & Elkalmi, R. (2016). Knowledge, perceptions, and attitudes toward complementary and alternative medicines among pharmacy students of a public university in Malaysia *Journal of Pharmacy and Bioallied Sciences*, 8(1), 34. <https://doi.org/10.4103/0975-7406.171686>
- Jeong, T. Y., Park, B. K., Cho, J. H., Kim, Y. I., Ahn, Y. C., & Son, C. G. (2012). A prospective study on the safety of herbal medicines used alone or in combination with conventional medicines *Journal of Ethnopharmacology*, 143(3), 884–888. DOI: 10.1016/j.jep.2012.08.016
- Kasilo, O. M. J., Wambebe, C., Nikiema, J.-B., & Nabyonga-Orem, J. (2019). Toward universal health coverage: advancing the development and use of traditional medicines in Africa. *BMJ Global Health*, 4(Suppl 9), e001517. <https://doi.org/10.1136/bmjgh-2019-001517>
- Kumar, A., Garg, R., Prakash, A. K., 2010. Effect of St. John's Wort (*Hypericum perforatum*) treatment on restraint stress-induced behavioral and biochemical alteration in mice. *BMC Complementary and Alternative Medicine*, 10(1), 18. <https://doi.org/10.1186/1472-6882-10-18>
- Lawal, B. A., & Agunu, A. (2017). Perception of the knowledge of traditional and herbal medicine among students in the College of Medicine, University of Ilorin, Nigeria. *Nigerian Journal of Natural Products and Medicine*, 20(0), 81. DOI: 10.4314/njnpm.v20i1.14
- Miranda, J. J. M. (2021). Medicinal plants and their traditional uses in different areas of the world In *Phytomedicine* (pp. 207–223). Elsevier. <https://doi.org/10.1016/B978-0-12-824109-7.00014-5>
- Mueller, S. (2004). Effect of St. John's wort dose and preparations on digoxin pharmacokinetics\*1 *Clinical Pharmacology & Therapeutics*, 75(6), 546–557. DOI: 10.1016/j.clpt.2004.01.014
- Mukherjee, S., Gomes, A., & Dasgupta, S. (2017). Therapeutic uses of Snake Body Parts in Folk and Traditional Medicine *Journal of Zoological Research*, 1(1), 1–9. <https://doi.org/10.22259/2637-5575.0101001><https://doi.org/10.22259/2637-5575.0101001>
- Neergheen-Bhujun, V. S. (2013). Underestimating the Toxicological Challenges Associated with the Use of Herbal Medicinal Products in Developing Countries. *BioMed Res Int*, 2013, 1–9. <https://doi.org/10.1155/2013/804086>
- Nworu, C. S., Udeogaranya, P. O., Okafor, C. K., Adikwu, A. O., & Akah, P. A. (2015). Perception, usage and knowledge of herbal medicines by students and academic staff of University of Nigeria: A survey. *Journal of the American Medical Association. European Journal of Integrative Medicine*, 7(3), 218–227. DOI: 10.1016/j.eujim.2015.01.005
- Nzewi, E. (2001). Malevolent Ogbanje: recurrent reincarnation or sickle cell disease? *Social Science & Medicine*, 52(9), 1403–1416. DOI: 10.1016/S0277-9536(00)00245-8

- Ohemu, T. L., Shalkur, D., Ohemu, B. O., & Daniel, P. (2021). Knowledge, attitude, and practice of traditional medicine among the people of the Jos South Local Government Area of Plateau State, Nigeria *Journal of Pharmacy & Bioresources*, 18(2), 147–154. <https://doi.org/10.4314/jpb.v18i2.7>
- Okoronkwo, I., Onyia-pat, J., Okpala, P., Agbo, M.-A., and Ndu, A. (2014). Patterns of Complementary and Alternative Medicine Use, Perceived Benefits, and Adverse Effects among Adult Users in Enugu Urban, Southeast Nigeria, Nigeria. *Evidence-Based Complementary and Alternative Medicine*, 2014(1). <https://doi.org/10.1155/2014/239372>
- Onwujekwe O, Mangham-Jefferies L, Cundill B, Alexander N, Langham J, Ibe O, Uzochukwu B, Wiseman V. 2015. Effectiveness of Provider and Community Interventions to Improve Treatment of Uncomplicated Malaria in Nigeria: A Cluster Randomized Controlled Trial. *PLOS ONE*, 10(8), e0133832. <https://doi.org/10.1371/journal.pone.0133832>
- Oshikoya, K. A., Oreagba, I. A., Ogunleye, O. O., Oluwa, R., Senbanjo, I. O., & Olayemi, S. O. (2013). Herbal medicines supplied by community pharmacies in Lagos, Nigeria: pharmacists' knowledge. *Pharmacy Practice (Internet)*, 11(4), 219–227. <https://doi.org/10.4321/S1886-36552013000400007>
- Osuchukwu, N., Eko, J., Abia, R., & Ochei, K. (2017). Use of herbal medicine among adult residents in Calabar Metropolis, Cross River State, Nigeria *Journal of Complementary and Alternative Medical Research*, 2(3), 1–14. <https://doi.org/10.9734/JOCAMR/2017/31725>
- Shen, J., Mo, X., Tang, Y., Zhang, L., Pang, H., Qian, Y., Chen, Y., Tao, W., Guo, S., Shang, E., Zhu, S., Ding, Y., Guo, J., Liu, P., Su, S., Qian, D., & Duan, J. (2013). Analysis of herb–herb interaction during decoction using ultra-high-performance liquid chromatography–tandem mass spectrometry and fuzzy chemical identification strategy with poly-proportion design. *Journal of Chromatography A*, 1297, 168–178. DOI: 10.1016/j.chroma.2013.05.001
- Shen, Q., Zhang, L., Liao, Z., Wang, S., Yan, T., Shi, P., Liu, M., Fu, X., Pan, Q., Wang, Y., Lv, Z., Lu, X., Zhang, F., Jiang, W., Ma, Y., Chen, M., Hao, X., Li, L., and Tang, Y. Tang, K. (2018). *Artemisia annua* Genome Provides Insights into the Evolution of the Asteraceae Family and Artemisinin Biosynthesis *Molecular Plant*, 11(6), 776–788. <https://doi.org/10.1016/j.molp.2018.03.015>
- Tilburt, J. (2008). Herbal medicine research and global health: An ethical analysis *Bulletin of the World Health Organization*, 86(8), 594–599. DOI: 10.2471/BLT.07.042820
- Wambebe, C. O., Bamgboye, E. A., Badru, B. O., Khamofu, H., Momoh, J. A., Ekpeyong, M., Audu, B. S., Njoku, S. O., Nasipuri, N. R., Kunle, O. O., Okogun, J. I., Enwerem, N. M., Gamaniel, S. K., Obodozie, O. O., Samuel, B., Fojule, G., & Ogunyale, P. O. (2001). Efficacy of niprisan in the prophylactic management of sickle cell disease *Current Therapeutic Research*, 62(1), 26–34. <https://doi.org/10.1016/j.ctr.2013.09.010>. [https://doi.org/10.1016/S0011-393X\(01\)80039-4](https://doi.org/10.1016/S0011-393X(01)80039-4)

World Health Organization (WHO). (2023). WHO global report on traditional and complementary medicine 2023. Available from: <https://www.who.int/news-room/questions-and-answers/item/traditional-medicine>.

World Health Organization (WHO). (2025). WHA78: Traditional medicine takes center stage. <https://www.who.int/news/item/02-06-2025-wha78--traditional-medicine-takes-centre-stage>.

Zeng, Y., Guo, L.-P., Chen, B.-D., Hao, Z.-P., Wang, J.-Y., Huang, L.-Q., Yang, G., Cui, X.-M., Yang, L., Wu, Z.-X., Chen, M.-L., Zhang, Y., 2013. Arbuscular mycorrhizal symbiosis and medicinal plant active ingredients: current research status and prospectives *Mycorrhiza*, 23(4), 253–265. doi: 10.1007/s00572-013-0484-0