Ethnobotany and quantitative analysis of medicinal plants used by the people of Malava sub-county, Western Kenya

Lindsay Mwalati Sikuku, Mwangi Brian Njoroge, Vincent Ochieng Suba, Emily Achieng Oluoch, Josephat Rutere Mbogo and Yuelin Li

Correspondence

Lindsay Mwalati Sikuku[1,2,3,4], Mwangi Brian Njoroge[1,2,3,4], Vincent Ochieng Suba[1,2,3,4], Emily Achieng Oluoch[1,2,3,4], Josephat Rutere Mbogo[5] and Yuelin Li[1,2,3,4*]

[1]Key Laboratory of Vegetation Restoration and Management of Degraded Ecosystems, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, 510650, China
[2]Guangdong Provincial Key Laboratory of Applied Botany, South China Botanical Garden, Chinese Academy of Sciences, Guangzhou, 510650, China
[3]University of Chinese Academy of Sciences, Beijing, 100039, China
[4]South China National Botanical Garden, Guangzhou, 510650, China[5]Department of Botany, Jomo Kenyatta University of Agriculture and Technology, P.O Box 62000-00200, Nairobi, Kenya

[*]Corresponding Author: yuelin@scib.ac.cn / yuelin.li@uni-bayreuth.de

Ethnobotany Research and Applications 26:55 (2023) - http://dx.doi.org/10.32859/era.26.55.1-20
Manuscript received: 28/08/2023 – Revised manuscript received: 23/10/2023 - Published: 25/10/2023

Research

Abstract

Background: This research aims to identify and document medicinal plants used by locals in Malava sub-county, Western Kenya, and explore their traditional knowledge and transmission. The ethnomedicinal knowledge in this area is on the brink of extinction due to the increasing prevalence and usage of modern medicine, changing livelihoods, rapid modernization, and urbanization.

Methods: The survey was conducted between July and December 2022, using semi-structured open-ended questionnaires and guided field walks. A total of 102 respondents, including Traditional Medical Practitioners (TMPs), participated. The quantitative analysis involved calculating the use value (UV), frequency of citation (FC), family use value (FUV), and informant agreement ratio (IAR) to assess the significance of each medicinal plant and understand its acceptance.

Results: The study documented 62 vascular medicinal plant species from 30 families. The most represented families were Asteraceae and Fabaceae, with seven species each (11.3%). Families with the highest FUV values were Xanthorrhoeaceae (0.235) and Meliaceae (0.612). Leaves were the most commonly used plant part (40%), while trees were the most prevalent plant form (39%). Crushing was the highest recorded mode of preparation (46.2%) with oral administration being common (76.9%). *Azadirachta indica* A. Juss. was the most utilized plant species medicinally, with the highest use value (UV=0.25). The majority of plant species were used for curing stomachaches (18 species) and malaria (15 species).

Conclusions: The findings of this study underscore the urgent need to document traditional knowledge before it becomes lost with the decline of rural practitioners. Therefore, there is a pressing need for ethnobotanical research, policy initiatives, and community programs to protect the biocultural diversity associated with the traditional medical system and ensure the well-being of both the environment and human populations in this region.

Keywords: Ethnobotany, medicinal plants, quantitative analysis, traditional medical practitioners, Malava sub-county, Western Kenya

Background

Plants have served as integral components of diverse cultural practices for centuries, contributing to human well-being (Xiong *et al*. 2020). Across the globe, traditional medicine systems, rooted in unique theories, beliefs, and accumulated experiences, continue to rely prominently on plants as fundamental treatment methods (WHO 2012). Remarkably, the World Health Organization (WHO) estimates that more than 60% of the global population embraces traditional medicine, with African healthcare notably hinging on traditional medicinal plants, which constitute a central element for 80% of the population (WHO 2012). This cultural legacy is increasingly acknowledged even in Westernized societies, and it bears economic significance, particularly in developing nations where it is deeply interwoven within belief systems (WHO 2013). Within the remote rural contexts of developing countries, traditional remedies frequently stand as the sole accessible and affordable healthcare recourse (Mbuni *et al.* 2020).

In Kenya, the tapestry of traditional medical practices and the utilization of herbal remedies intricately weaves into the fabric of healthcare, especially in locales where Western medical services remain limited in availability and accessibility (Abdullahi 2011). Traditional Medical Practitioners (TMPs) play an indispensable role in delivering culturally appropriate care that resonates with the community's needs (Mbuni *et al*. 2020). The utilization of plant-based remedies, including homemade medicines, is widespread in Kenya, underscoring the significance of traditional knowledge within healthcare practices (Kipkore *et al*. 2014). However, the risk of extinction looms over these medicinal plants and their associated indigenous wisdom without proper documentation, stemming from various anthropogenic factors (Bogale *et al.* 2023).

In this context, the preservation of traditional ethnobotanical knowledge emerges as a pivotal endeavor, aligning with sustainable development objectives and nurturing the interconnection between individuals, society, and the natural environment (Kumar *et al.* 2021). Ethnobotanical studies notably serve as cornerstones for documenting and safeguarding the historical use of medicinal plants within indigenous communities. This documentation not only conserves traditional wisdom but also contributes to the exploration of novel medications, harnessing the wealth of plant biodiversity accessible to local populations (Kathambi *et al.* 2020). Notably, the past decades have witnessed a significant surge in ethnobotanical research within Kenya (Mbuni *et al.* 2020). Various studies have unearthed the knowledge and application of medicinal plants in distinct corners of the nation: from Northern Kenya (Ichikawa 1987) and Siaya District (Johns *et al.* 1990) to Tharaka-Nithi County (Kathambi *et al.* 2020) and Elgeyo Marakwet County (Munguti 1997; Kigen *et al.* 2017; Kipkore *et al.* 2014), Eastern Province (Keter *et al*. 2012; Kisangau *et al*. 2017; Mutwiwa *et al*. 2018), in Western Kenya (Fischer *et al.*2010; Mourine 2022; Okello *et al*. 2010; Olembo *et al.* 1995) among others. However,, numerous regions and ethnic societies in Kenya remain relatively unexplored from an ethnobotanical perspective.

Malava Sub-county, nestled within the biodiverse and culturally rich landscape of Western Kenya, beckons as an exceptional terrain for unraveling and recording ethnobotanical wisdom. This region hosts the Malava forest, a tropical rainforest fragment nested within the famed Kakamega rainforest. The Kakamega rainforest stands as Kenya's sole tropical rainforest and one of the few remaining rainforests across East Africa, embracing an array of endemic flora and fauna (Agevi 2016). The inhabitants of Malava Sub-county staunchly uphold Luhya cultural traditions, including traditional male circumcision, a pivotal rite of passage signifying the transition from childhood to adulthood among males. Herbal remedies predominantly cater to individuals undergoing this traditional male circumcision. Despite the promising richness of this region, the documentation of ethnobotanical knowledge in Western Kenya remains limited (Odongo *et al.* 2018). Thus, an expedition to unearth and conserve information regarding medicinal plant species, particularly within Malava Sub-county, becomes imperative. This research endeavors to meticulously document the utilization of medicinal plants within the ethnic communities of Malava Sub-county and to critically assess the spectrum of medicinal plant species endemic to the study area. These pursuits align with the broader goals of preserving indigenous knowledge concerning medicinal plants and conducting a quantitative analysis of the intricate relationships between medicinal species and diseases. This documentation assumes paramount importance in safeguarding natural resources for the long term, including the Malava forest and its associated biodiversity, while also laying the groundwork for potential drug discoveries. Moreover, the findings of this study can inform policy decisions encompassing the conservation and sustainable utilization of natural resources, concurrently fostering local economic development. Given the established studies conducted in specific regions of Kakamega County, this research notably sets its sights on the relatively underexplored terrain of Malava Sub-county.

Materials and Methods

Study Area

This study was conducted in Malava sub-county, which is situated within the administrative boundaries of Kakamega County, Kenya (Figure 1). Malava sub-county is the largest sub-county in Kakamega County, covering an area of 423.3 km2, and has the highest population, with a total of 205,166 residents and a population density of 566/km2 (County Government of Kakamega 2018, Kenya National Bureau of Statistics 2019). The dominant ethnic group in the area is the Kabras people, who belong to the larger Luhya community. The sub-county's altitude ranges from 1600m to 1800m above sea level, and it experiences a mean annual temperature of approximately 21.6 °C. The rainfall in the area is reliable and well-distributed, with peak seasons in April/May and August/September, and an average annual rainfall of around 1900 mm (Agevi 2016). Agriculture serves as the primary economic activity in the region, with sugarcane being the main cash crop (Masayi 2021).

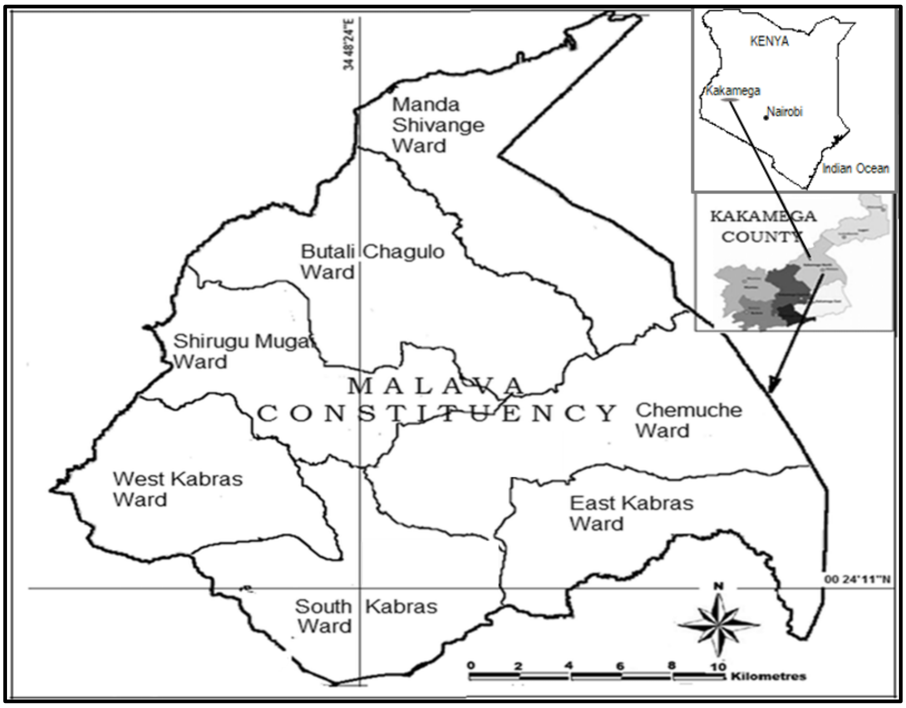

Figure1. Map depicting the location of the study site in Malava sub-county, Kakamega County, Kenya.

Ethnobotanical Data Collection

Field surveys were conducted between July and December 2022, employing a combination of semi-structured open-ended questionnaires, guided field walks for direct observations and sample collection. Knowledgeable key informants, particularly TMPs, were selected based on recommendations from local residents and community leaders. Prior to data collection, necessary permissions were obtained from local authorities, including chiefs, and informed consent was obtained from all participants. The field visits, interviews, discussions, official and informal dialogues, and field trips were conducted in the native Luhya dialect and Swahili, and subsequently translated into English. These activities were led by the first author, assisted by Mr. Dennis Matolo, who offered translation services.

In addition to primary data collection, relevant information revolving around species' scientific names, traditional ecological knowledge, and cultural context was gathered through an extensive review of published literature, including journal articles and books. The collected data encompassed various aspects, including the botanical names and local names of plants, the diseases or conditions for which they were used, the preparation methods and modes of administration, the sources of medicinal knowledge, the plant habits, the specific plant parts utilized, and the socio-economic characteristics of the respondents.

Preliminary identification was carried out in the field following the interviews, and those unable to be identified in the field collected for further identification by a taxonomist and literature confirmation, and voucher specimens deposited at the herbarium of the School of Biological Sciences, Jomo Kenyatta University of Agriculture and Technology. To facilitate future reference, supplementary Table 2 provides a summary of all the identified medicinal plant species in the study area, with the scientific names recognized according to the " Plants of the World " Database.

Data Analysis

The collected data were entered into Microsoft Excel 2019 for analysis. Descriptive statistical methods, such as percentages and frequencies, were employed to analyze the data and explore the indigenous knowledge of medicinal plants used by the Luhya people of Malava, Western Kenya. The results were presented using graphs, tables, and charts to enhance clarity and facilitate understanding.

Quantitative Analyses

Informant Agreement Ratio (IAR)

The informant agreement ratio (IAR) was calculated using the formula:

$$IAR = \frac{Nur - Nt}{Nur - 1} \text{ .... Equation 1;}$$

where Nur represents the total number of citations for each disease group, and Nt is the number of plant species utilized in that category (Trotter & Logan 2019). The IAR values range from 0.00 to 1.00. Lower IAR values indicate disagreement among informants regarding the choice of plant medication for a particular disease/condition, while higher IAR values indicate that a limited number of plant species are known to treat a specific disease according to a significant number of informants (Canales *et al.* 2005, *Collins et al*. 2006).

Use Value (UV)

The Use Value (UV) is a quantitative measure used to determine the relative significance of locally recognized species (Vitalini *et al.* 2013). It is calculated using the formula below (Phillips and Gentry 1993):

$$UV = \frac{\sum Ur}{N}$$ ….. Equation 2;

where Ur represents the number of user reports mentioned by each informant for a certain medicinal plant, and N is the total number of respondents.

Family Use Value (FUV)

The Family Use Value (FUV) is used in ethnobotany to identify the importance of plant families as a measure of their cultural significance (Sreekeesoon *et al*. 2014). The FUV is calculated using the formula described by Hoffman and Gallaher (2007):

$$FUV = \frac{\sum UVs}{\text{Ns}}$$ ….. Equation 3;

where UVs represent the sum of use values for all species belonging to a particular family, and Ns is the total number of species within that family.

Frequency of Citation (FC)

The Frequency of Citation (FC) for each plant species was calculated using the following formula (Tardío & Pardo-de-Santayana 2008).

$$FC = \frac{\text{Number of times a certain species was mentioned}}{\text{total number of times all species were mentioned}} \times 100$$ …. Equation 4.

Results

Socio-demographic Characteristics of Respondents

A total of 102 participants took part in the study, with 68 (67%) males and 34 (33%) females. The age range of the respondents was between 20 and 88 years, with 16% of respondents falling in the age group of 20 to 35 years, 29% in the age group of 36 to 50 years, and 55% aged 51 years and above.

Regarding education, approximately 40% of the participants had completed basic primary education, 30% secondary education, 20% tertiary education, and those without formal education were about 10%. Regarding the sources of traditional medicinal knowledge, around 52% of the respondents acquired their knowledge from relatives, 35% from practicing TMPs, and 10% from literature.

Total Flora

A comprehensive survey documented a total of 62 plant species, representing 30 families, which were recorded for their traditional medicinal uses in treating various ailments and conditions. For each plant listed, the scientific name, family, local name, plant form, part used, disease/condition cured, and method of preparation and administration were recorded (Table 2).

Plant Parts Used

The specific part(s) of each plant species utilized for their medicinal properties were carefully documented. Analysis revealed that leaves accounted for the largest proportion (40%), followed by roots (26%) and bark (22%). Flowers, on the other hand, constituted the least utilized part (1%) (Figure 2). Other plant parts, such as fruits, shoots, seeds, and whole plants, were also employed in certain cases. Shoot is herein referred to plant part bearing the leaves, flower buds, lateral buds, and flowering stems.

Plant Growth Habits

The analysis of plant growth habits for the identified medicinal plants demonstrated that trees constituted the largest proportion (39%), followed by shrubs (34%). Herbs represented 24% of the species, while climbers were the least represented, accounting for only 3% (Figure 3).

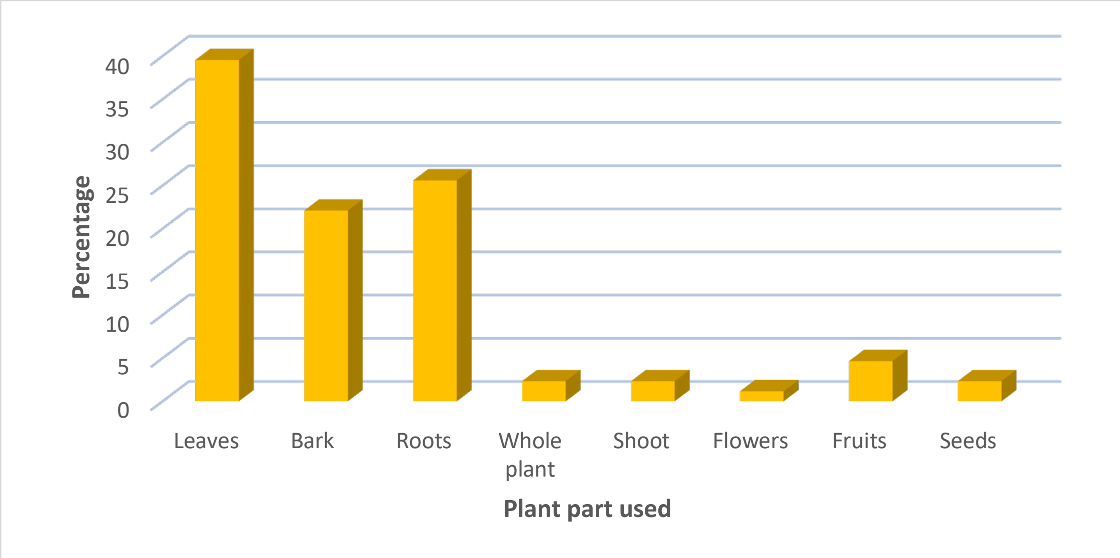

Figure 2. Percentage distribution of plant parts used for medicinal purposes

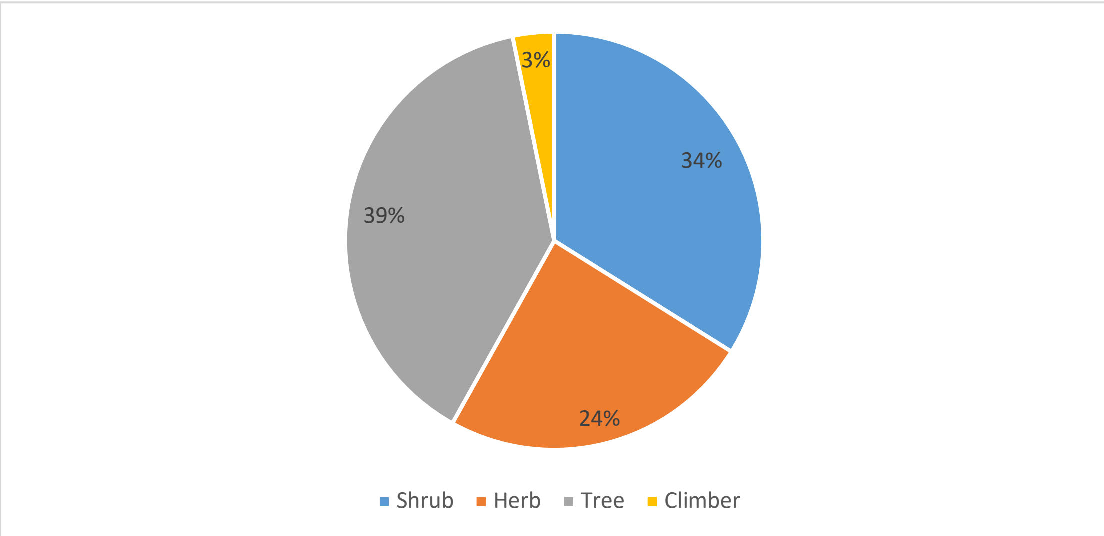

Figure 3. Percentage distribution of plant growth habits among the collected medicinal plants.

Mode of preparation and administration

This study documented different methods used to prepare and administer plant medicines collected. The most common preparation method was crushing or grinding (46.62%), followed by boiling (38.5%). Some plants were recorded to be utilized while raw (12.3), with other preparation methods recorded being the least used (3.1%), which included roasting into ash and pounding into powder (Figure 4).

The medicinal preparations were recorded to be administered in various ways, including orally (76.9%), eye, ear, and nose drops (9.2%), swabs, and through inhaling (4.6% each). Other administration modes included massaging, steam-bathing and rinsing, all combined accounting for 4.6% (Figure 4).

Quantitative Analysis

The current study conducted the first quantitative analysis of the medicinal flora in the region, including the assessment of Frequency of Citation (FC), Use Value (UV), Use Report (UR), Informant Agreement Ratio (IAR), and Family Use Value (FUV). To determine the relative significance of the reported medicinal plants, UV was calculated based on the citations provided by the respondents for each specific plant under study (Table 1). The calculated UV values ranged from 0.01 to 0.25. From the results, *Azadirachta indica* A. Juss. exhibited the highest UV (0.25), followed by *Aloe sp* (UV=0.24*), Mondia whitei* (Hook. f.) Skeels (UV=0.20), *Albizia gummifera* (J.F. Gmel.) C.A. Sm. (UV=0.19), and *Eucalyptus globulus* Labill. (UV=0.18). On the other hand, *Leucas calostachys* Oliv. and *Paullinia pinnata* D.R. Simpson had the lowest UV index, both recording 0.01(Figure 5).

Table 1. Quantitative representation of plant species per family, User reports (Ur), Frequency of citation (Fc), Use value (UV), and Family Use Value (FUV)

Family and Species	No. of species	Percentage (%)	Ur	Fc	UV	FUV
Acanthaceae	3	4.8				0.033
Acanthus eminens			5	0.92	0.049	
Justicia flava			3	0.55	0.029	
Thunbergia alata			2	0.37	0.020	
Anacardiaceae	2	3.2				0.054
Mangifera indica			9	1.65	0.088	
Rhus vulgaris			2	0.37	0.020	
Apocynaceae	2	3.2				0.118
Carissa edulis			4	0.73	0.039	
Mondia whitei			20	3.67	0.196	
Asteraceae	7	11.3				0.090
Acmella caulirhiza			7	1.28	0.069	
Aspilia pluriseta			13	2.39	0.127	
Chrysocephalum sp			11	2.02	0.108	
Conyza floribunda			4	0.73	0.039	
Senecio moorei			7	1.28	0.069	
Tagetes minuta,			12	2.20	0.118	
Tithonia diversifolia			10	1.83	0.098	
Bignoniaceae	2	3.2				0.088
Kigelia Africana			2	0.37	0.020	
Markhamia lutea			16	2.94	0.157	
Combretaceae	1	1.6				0.147
Combretum molle			15	2.75	0.147	
Ebenaceae	1	1.6				0.049
Diospyros abyssinica			5	0.92	0.049	
Euphorbiaceae	4	6.5				0.096
Bridelia micrantha			11	2.02	0.108	
Croton macrostachuys			15	2.75	0.147	
Erythrococca atrovirens			8	1.47	0.078	
Sapium ellypticum			5	0.92	0.049	
Fabaceae	7	11.3				0.094
Albizia grandibracteata			7	1.28	0.069	
Albizia gummifera			19	3.49	0.186	
Desmodium adscendens			6	1.10	0.059	
Desmodium repandum			3	0.55	0.029	
Entada abyssinica			4	0.73	0.039	
Erythrina abyssinica			16	2.94	0.157	
Senna occidentalis			12	2.20	0.118	
Flacourtiaceae	1	1.6				0.059
Dovyalis macrocalyx			6	0.64	0.059	
Lamiaceae	6	9.7				0.092
Ajuga integrifolia			17	3.12	0.167	
Leucas calostachys			1	0.18	0.010	
Leucas deflexa			4	0.73	0.039	
Ocimum kilimandscharicum			8	1.47	0.078	
Plectranthus barbatus			17	3.12	0.167	
Vitex keniensis			9	1.65	0.088	
Lauraceae	1	1.6				0.098
Persea Americana			10	1.83	0.098	
Malvaceae	1	1.6				0.049
Hibiscus sp			5	0.92	0.049	
Melastomataceae	1	1.6				0.059
Dissotis speciosa			6	1.10	0.059	
Meliaceae	2	3.2				0.162
Azadirachta indica			25	4.59	0.245	

Trichilia emetica			8	1.47	0.078	
Moraceae	1	1.6				0.088
Ficus thonningii			9	1.65	0.088	
Myrtaceae	2	3.2				0.152
Eucalyptus globulus			18	3.30	0.176	
Psidium guajava			13	2.39	0.127	
Oleaceae	1	1.6				0.039
Olea capensis			4	0.73	0.039	
Oxalidaceae	1	1.6				0.049
Oxalis corniculata			5	0.92	0.049	
Paulowniaceae	1	1.6				0.059
Paulownia tomemtosa			6	1.10	0.059	
Piperaceae	2	3.2				0.034
Piper capense			3	0.55	0.029	
Piper umbellatum			4	0.73	0.039	
Ranunculaceae	1	1.6				0.049
Clematopsis scabiosifolia			5	0.92	0.049	
Rosaceae	2	3.2				0.083
Prunus africana			6	1.10	0.059	
Rubus pinnatus			11	2.02	0.108	
Rubiaceae	1	1.6				0.029
Coffea eugenioides			3	0.55	0.029	
Rutaceae	2	3.2				0.088
Toddalia asiatica			13	2.39	0.127	
Zanthoxylum gilletii			5	0.92	0.049	
Sapindaceae	1	1.6				0.010
Paullinia pinnata			1	0.18	0.010	
Sapotaceae	1	1.6				0.039
Bequartiodendron oblanceolata			4	0.73	0.039	
Solanaceae	2	3.2				0.127
Physalis peruviana			12	2.20	0.118	
Solanum incanum			14	2.57	0.137	
Verbenaceae	2	3.2				0.078
Clerodendrum pygmaeum			4	0.73	0.039	
Lantana trifolia			12	2.20	0.118	
Xanthorrhoeaceae	1	1.6				0.235
Aloe sp			24	4.40	0.235	
Total	**62**	**100**	**545**			

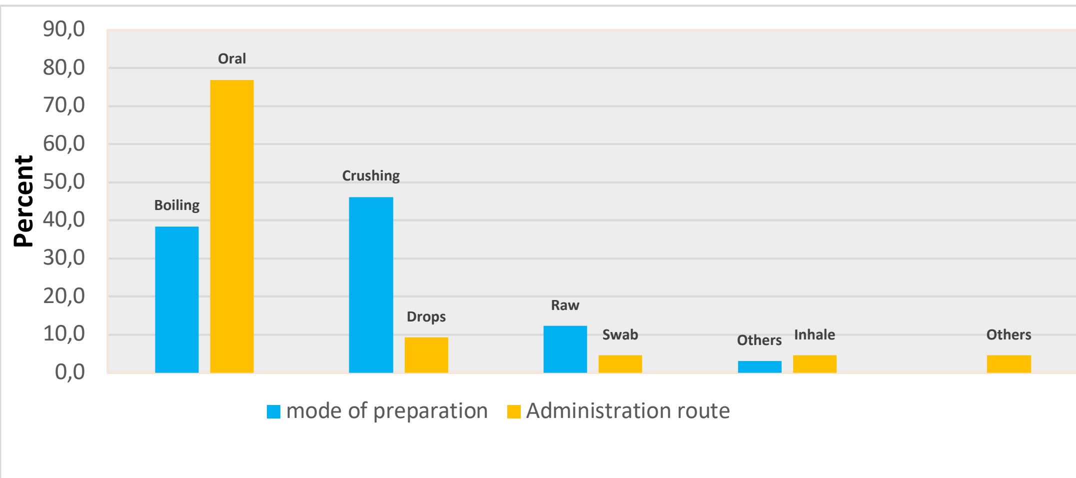

Figure 4. Percentage distribution for modes of preparation and routes of administration of the collected medicinal plants.

The value of a plant family increases in relation to the frequency of citations for all species within that family (Supplementary Table 3). Among the families represented in the study, Asteraceae and Fabaceae had the highest representation, with each recording seven plant species (11.3%). Lamiaceae followed closely with six species (9.7%), and Euphorbiaceae had four species (6.5%). Conversely, 15 families were least represented, with only one species (1.6%) recorded per family (Supplementary Table 3). Family Use Values were further calculated, with Xanthorrhoeaceae recording the highest FUV index (0.235), followed by Meliaceae (0.162) and Myrtaceae (0.152). Sapindaceae recorded the lowest FUV index (0.010) (Figure 6).

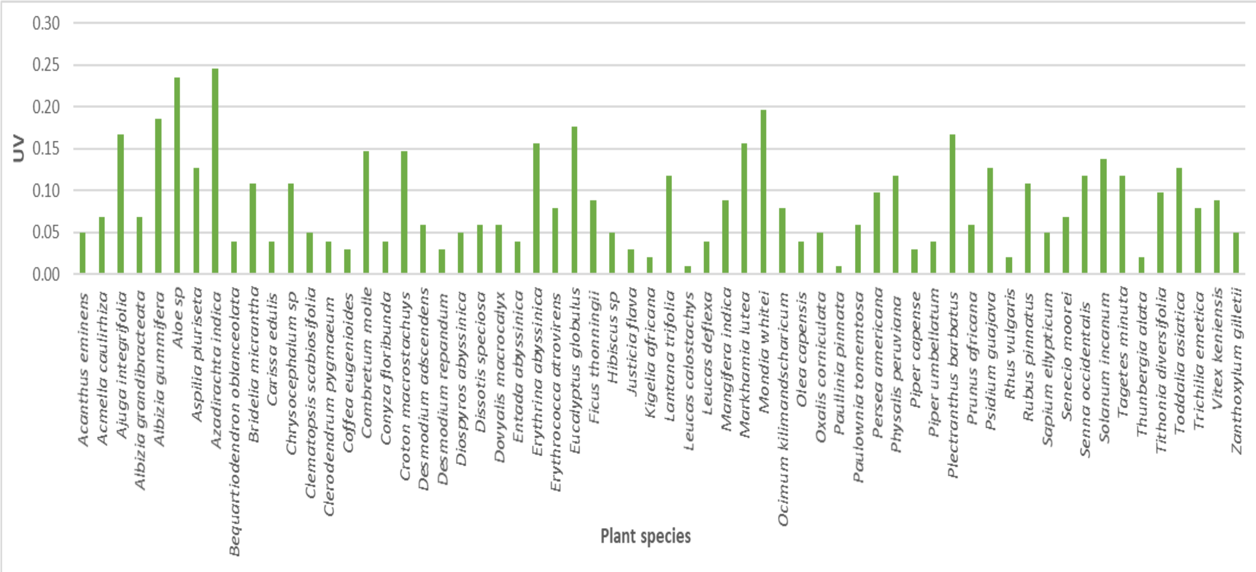

Figure 5. Plant species and their corresponding Use Values (UV) in the study

Diseases and their IAR Values

In this study, the plants with the highest IAR values were those consistently mentioned by all informants for the treatment of the same disease, particularly when targeting a specific ailment. A total of 32 diseases and conditions were recorded and categorized into 21 groups. Prominent among them were malaria, stomachache, headache, sexually transmitted infections (STIs), colds, and flu. Additionally, ailments such as cancer, peptic ulcers, allergies, and skin infections were also documented (Table 1). The IAR in this study ranged from 0.80 to 1.00 per use category. Categories such as headache, cancer, ear problems, snake bites, and mineral deficiency had the highest IAR value of 1.00, indicating unanimous agreement among informants for the use of specific plants in treating these conditions. On the other hand, the peptic ulcers category had the lowest IAR value of 0.80, as shown in Table 2.

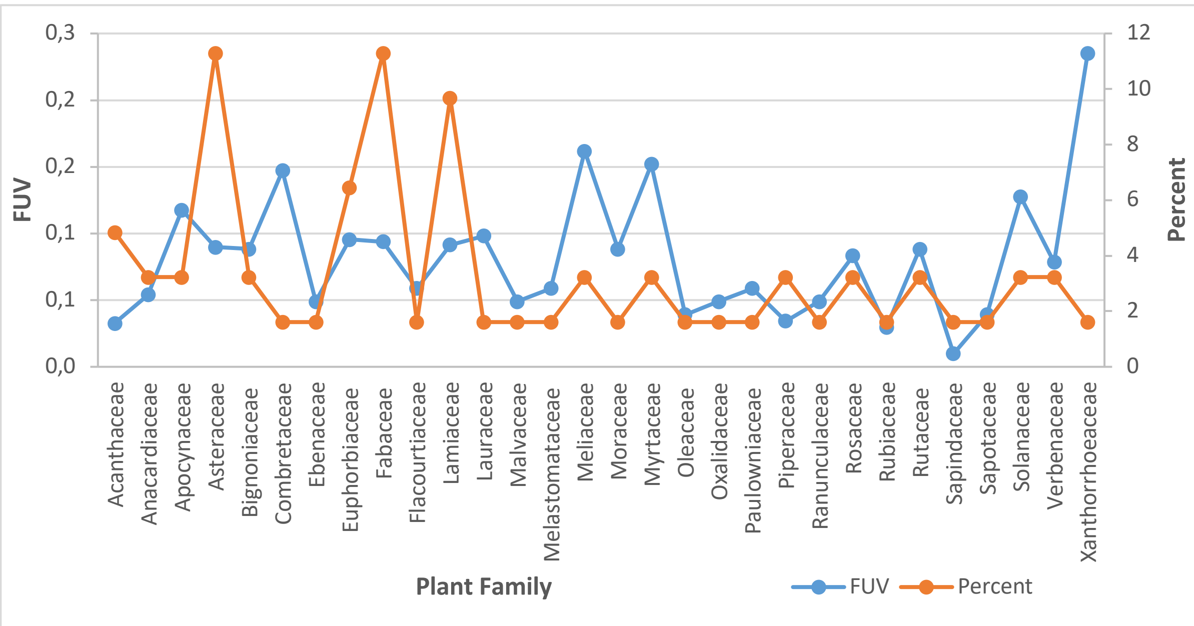

Figure 6. Plant families and their respective Family Use Values (FUV) in the study

Table 2. Disease categories with their respective species, Nur, Nt, and IAR.

Disease/Condition	Plant species used and number of uses	Nur	Nt	IAR
Malaria	*Ajuga integrifolia (17), Albizia gummifera (19), Aloe sp (24), Azadirachta indica (25), Carissa edulis (4), Croton macrostachyus (15), Erythrina abyssinica (16), Ficus thonningii (9), Lantana trifolia (12), Markhamia lutea (16), Physalsis peruviana (12), Plectranthus barbatus (17), Rubus pinnatus (11), Senna occidentalis (12), Trichilia emetica (8)*	217	15	0.94
Stomachache	*Acanthus eminens (5), Albizia gummifera (19), Bridelia micrantha (11), Chrysocephalum sp (11), Desmodium adscendens (6), Desmodium repandum (3), Entada abyssinica (4), Hibiscus sp (5), Olea capensis (4), Paulownia tomemtosa (6), Persea Americana (10), Prunus africana (6), Psidium guajava (13), Solanum incanum (14), Tithonia diversifolia (10), Toddalia asiatica (13), Trichilia emetica (8), Vitex keniensis (9)*	157	18	0.89
Fever	*Azadirachta indica (25), Hibiscus sp (5), Lantana trifolia (12), Piper umbellatum (4), Rubus pinnatus (11), Trichilia emetica (8)*	65	6	0.92
Headache	*Piper umbellatum (4)*	4	1	1.00
Joint pains/Inflammation	*Azadirachta indica (25), Justicia flava (3), Thunbergia alata (2)*	30	3	0.93
Sexually Transmitted Infections (STIs)	*Albizia grandibracteata (7), Albizia gummifera (19), Chrysocephalum sp (11), Combretum molle (15), Erythrina abyssinica (16), Mangifera indica (9), Persea Americana (10), Trichilia emetica (8)*	95	8	0.93
Skin infections and acne	*Aloe sp (24), Azadirachta indica (25), Bridelia micrantha (11), Eucalyptus globulus (18), Kigelia africana (2), Tagetes minuta (12)*	92	6	0.95
Eye problems	*Coffea eugenioides (3), Leucas deflexa (4) Plectranthus barbatus (17), Sapium ellypticum (5)*	29	4	0.89
Cancer	*Prunus Africana (6)*	6	1	1.00
Diabetes	*Acanthus eminens (5), Aloe sp (24), Kigelia africana (2)*	31	3	0.93
Toothache	*Acmella caulirhiza (7), Conyza floribunda (4), Persea Americana (10)*	21	3	0.90
Peptic Ulcers	*Bequartiodendron oblanceolate (4), Dovyalis macrocalyx (6), Kigelia africana (2), Olea capensis (4), Oxalis corniculata (5)*	21	5	0.80
Snake bites	*Combretum molle (15)*	15	1	1.00
Allergies and Asthma	*Bridelia micrantha (11), Clematopsis scabiosifolia (5), Eucalyptus globulus (18)*	34	3	0.94
Diarrhea	*Dissotis speciose (6), Kigelia africana (2), Lantana trifolia (12), Leucas calostachys (1), Mangifera indica (9), Psidium guajava (13), Tithonia diversifolia (10)*	53	7	0.88
Wounds	*Aspilia pluriseta (13), Diospyros abyssinica (5), Erythrococca atrovirens (8), Tithonia diversifolia (10)*	36	4	0.91
Coughs/cold, flu and fever	*Albizia gummifera (19), Clematopsis scabiosifolia (5), Clerodendrum pygmaeum (4), Ocimum kilimandscharicum (8), Piper capense (3), Rhus vulgaris (2), Rubus pinnatus (11), Senecio moorei (7), Zanthoxylum gilletii (5)*	64	9	0.87
Ear problems	*Markhamia lutea (16)*	16	1	1.00
Boils & Swellings	*Erythrina abyssinica (16), Paulownia tomemtosa (6)*	22	2	0.95
Constipation	*Acanthus eminens (5), Dovyalis macrocalyx (6)*	11	2	0.90
Mineral deficiency	*Mondia whitei (20)*	20	1	1.00

Note: Nur represents the total number of citations in a specific disease category, Nt represents the total number of plant species utilized in that category, and IAR represents the Informant Agreement Ratio.

Discussion

Transmission and Preservation of Traditional Medicinal Knowledge

Preserving traditional medicinal knowledge by passing it from older community members to the younger generation is crucial (Lambert *et al.* 2011). However, this study observed that older TMPs were more recognized and possessed extensive knowledge about medicinal plants. This observation aligns with other studies conducted in various parts of Kakamega County (Mukungu *et al*. 2016, Odongo *et al.* 2018, Otieno & Analo 2012, Shiracko *et al*. 2016). The majority of respondents were advanced in age, and close relatives, particularly parents and grandparents, were frequently mentioned as the primary sources of traditional knowledge. This underscores the essential role of the family institution in preserving traditional knowledge, which is typically transmitted vertically within families through practical experience (Mattalia *et al.* 2020). Traditional healing is generally a male-dominated practice, though in certain areas both men and women practice (Maroyi 2015). This study recorded more male respondents than females (33%). This might be attributed to the fact that Luhya culture considers the traditional position of a man in a family as the head of family, and is the major breadwinner, hence men are expected to provide for their families while women care for the children. Also, traditional cultural teachings to men after circumcision are vital in Luhya society, thus men spend a lot of time with elderly men during these sessions of transition to adulthood, during which they are taught also about the traditional medications. Gender-based knowledge variations have been observed globally and even within specific countries, influenced by the interactions of each gender with natural resources (Torres-Avilez *et al*. 2016). Unfortunately, traditional medicinal knowledge and expertise within Malava Subcounty face the looming risk of extinction. The younger generation shows limited interest in traditional medicine due to factors such as mistrust, the influence of modernization, and the allure of exotic cultures. Additionally, the migration of numerous young individuals to urban areas exacerbates the decline in traditional medicinal practices. Swift actions are imperative to transfer knowledge from the elderly to younger generations and prevent the loss of invaluable traditional wisdom.

Utilization of Plant Parts and Conservation Considerations

In this study, leaves emerged as the most utilized plant parts, accounting for 40% of the reported uses. Local communities mentioned that leaves were easy to harvest and caused less damage to the plants. Leaves are known to contain beneficial compounds such as insulins, tannins, and alkaloids, which may contribute to their therapeutic qualities (Usman 2023). The preference for leaves aligns with previous studies that emphasized their primary use due to less harmful harvesting methods compared to roots and barks, thereby promoting the conservation of medicinal plants (Mukungu *et al*. 2016, Odongo *et al*. 2018). Roots constituted 26% of the plant parts used in this study. The over-exploitation of medicinal plants valued for their root parts and stem bark raises concerns regarding conservation (Shopo *et al*. 2022). To address this issue, implementing sustainable harvesting practices becomes pivotal in safeguarding these plant parts from overuse and ensuring their long-term availability. Plant medications were mostly prepared through crushing and grinding (46.2%) as infusions or concoctions or through boiling (38.5%) as decoctions. Infusions were made on fragile plant components such as leaves, flowers, and stem buds. The benefit of this approach is that numerous active principles are extracted with little to no change in their chemical structure, preserving almost all of their properties (Okello *et al.* 2010). Decoctions, on the other hand, were used to make herbal teas from the plant's hard parts (roots, seeds, and stem barks). It was discovered that some plants were prepared using more than one method and, in some cases, more than one plant part was used (Table 3). In addition to pure herbal concoctions and decoctions, we noted that the medicines were sometimes mixed with milk, honey, black tea, and beer. These supplement ingredients may be used to boost the effectiveness of herbal treatments or simply to make them more palatable (Okello *et al.* 2010). However, the exact role of these materials in illness treatment is unknown because no systematic examination into the characterization of the active components has been conducted. The majority (76.9%) of the herbal medicines were taken orally, 9.2% were used as eye, ear, and nose drops, and 4.6% were inhaled and swabbed. Because most plants are used to treat digestive or peptic, respiratory, or vector-borne illnesses, the oral route is generally used (Odongo *et al.* 2018, Otieno *et al*. 2012). On all the modes of preparation and administration recorded, regardless of the plant part(s) or mixtures utilized, water was the major medium for all medicinal preparations.

Table 3. Checklist of the medicinal plant species identified in Malava Subcounty, Kakamega County, Kenya.
L= leaves, R= roots, B= bark, F= flower, S=seed, Sh=shoot, Wp=whole plant

Botanical Name & and voucher number	Family	Local name	Common Name	Plant form	Part Used	Diseases/conditions targeted	Method of Preparation and Administration
***Acanthus eminens* C.B. Clarke MLV/2022/01**	Acanthaceae	**Lirakhalu**	Bear's breeches	Shrub	L, R	High blood pressure, stomach ache, constipation	Boiled and orally administered
***Acmella caulirhiza* Delile MLV/2022/02**	Asteraceae	**Shituti**	Toothache plant	Herb	Wp	Toothache	Chewed raw against the affected tooth
***Ajuga integrifolia* Buch.-Ham. ex D. Don MLV/2022/03**	Lamiaceae	**Imbuli yomtakha**	Small-flowered bugleweed	Herb	L	Malaria	Pounded and orally administered
***Albizia grandibracteata* Taub. MLV/2022/04**	Fabaceae	**Mukhunzuli**	Large-leaved Albizia	Tree	B	STIs	Crushed and infusion orally administered
***Albizia gummifera* (J.F. Gmel.) C.A. Sm. MLV/2022/05**	Fabaceae	**Omusenzeli**	Peacock flower	Tree	R, B	STI, malaria, flu, Stomach ache	Crushed and orally administered
***Aloe sp* MLV/2022/06**	Xanthorrhoeaceae	**Eshikakha**	Aloe vera	Herb	L	Malaria, diabetes, nausea, blood cleanser, acne	Boiled and orally administered
***Aspilia pluriseta* Schweinf. ex Engl. MLV/2022/07**	Asteraceae	**Shiralambila**	Dwarf Aspilia	Herb	L	clotting fresh wounds,	Fresh leaves crushed and pressed onto the wound
***Azadirachta indica* A. Juss. MLV/2022/08**	Meliaceae	**Mwarubaini**	Neem tree	Tree	L, R, B, F	Fever, joint pains, Malaria, Insect bites, skin infections	Boiled and orally administered
***Bequartiodendron oblanceolate* MLV/2022/09**	Sapotaceae	**Musamia**	Not Established	Tree	B, L	Ulcers,	Boiled, orally administered
***Bridelia micrantha* (Hochst.) Baill. MLV/2022/010**	Euphorbiaceae	**Omunyerenyende**	Coast gold leaf	Tree	L, B, R	Skin diseases, allergies, stomach ache	Boiled/crushed and orally administered
***Carissa eduli* (Forssk.) Vahl MLV/2022/011**	Apocynaceae	**Shikata/achoka**	Christ’s thorn	Shrub	R, B	Malaria	Boiled and taken orally

Chrysocephalum sp **MLV/2022/012.**	Asteraceae	**Mwikalo**	Yellow Buttons	Herb	R	Stomachache, STIs	Boiled and decoction administered orally
Clematopsis scabiosifolia **(DC.) Hutch MLV/2022/013**	Ranunculaceae	**Lunyiri**	Feather duster	Shrub	Sh, F	Stuffy nose, allergy	Crushed and inhaled
Clerodendrum pygmaeum **Merr. MLV/2022/014**	Lamiaceae	**Mutsetse**	Cashmere Bouquet	Shrub	R	Flu	Crushed and orally taken
Coffea eugenioides **S. Moore MLV/2022/015**	Rubiaceae	**Itikwa**	Nandi coffee	Shrub	L	Eye problems in livestock	Crushed and exudate squeeze-dropped into the affected eye
Combretum molle **R. Br. ex G. Don MLV/2022/016**	Combretaceae	**Muhungula**	Velvet bushwillow	Tree	R, B	STIs, Snake bites	Boiled and administered orally
Conyza floribunda **Kunth MLV/2022/017**	Asteraceae	**Liposhe**	Asthma weed	Herb	L	Tooth-ache,	Raw leaves chewed, around the affected tooth-teeth
Croton macrostachyus **Hochst. ex Delile MLV/2022/018**	Euphorbiaceae	**Musutsa**	Broad-Leaved Croton	Tree	B	Malaria	Boil in water and decoction taken orally
Desmodium adscendens **(Sw.) DC. MLV/2022/019**	Fabaceae	**Matite**	strongback	Herb	L	Stomach-ache	Crushed and concoction administered orally
Desmodium repandum **(Vahl) Poir. MLV/2022/020**	Fabaceae	**Shandanguvo**	Tick clover	Herb	L	Stomach upset	Crushed and concoction administered orally
Diospyros abyssinica **(Hiern) F. White MLV/2022/021**	Ebenaceae	**Lusui**	Giant Ebony	Tree	L	wounds/sores	Crushed and infusion swabbed/squeezed into the wound
Dissotis speciosa **Taub. MLV/2022/022**	Melastomataceae	**Unyili**	Pink lady	Herb	L	Diarrhea	Crushed and extract administered orally
Dovyalis macrocalyx **(Oliv.) Warb. MLV/2022/023**	Flacourtiaceae	**Shinamuterwa**	Shaggy-fruited dovyalis	Tree	R, L	Constipation, Peptic ulcers	Crushed and the extract taken orally
Entada abyssinica **Steud. ex A. Rich.**	Fabaceae	**Shivayamboga**	Abyssinia Entada	Tree	B	Stomach ache	Boiled and administered orally

MLV/2022/024							
***Erythrina abyssinica* Lam. MLV/2022/025**	Fabaceae	**Omurembe**	Coral tree	Tree	B	STI, Malaria, swellings	Boiled and administered orally
***Erythrococca atrovirens* (Pax) Prain MLV/2022/026**	Euphorbiaceae	**Shirietso**	Not Established	Shrub	L	Wounds, especially septic	Crushed and the juice swabbed/squeezed onto the wound
***Eucalyptus globulus* Labill. MLV/2022/027**	Myrtaceae	**Mti-mbao**	Blue gum	Tree	L	Skin infections, asthma	Fresh leaves boiled and the patient inhales the steam
***Ficus thonningii* Blume MLV/2022/028**	Moraceae	**Mutoto**	Common wild fig	Tree	B	Malaria	Boiled in water and orally administered
***Hibiscus sp* MLV/2022/029**	Malvaceae	**Lubulwa**	Roselle	Herb	R	Stomach ache, General fever	Boiled and the extract orally taken
***Justicia flava* (Forssk.) Vahl MLV/2022/030**	Acanthaceae	**Lihululwa**	Yellow Justicea	Herb	R	Post-natal pains	Crushed and concoction taken orally after delivery
***Kigelia Africana* (Lam.) Benth. MLV/2022/031**	Bignoniaceae	**Mnyika**	Sausage tree	Tree	B, R	Skin diseases, ulcers, diabetes, diarrhea	Boiled and decoction administered orally
***Lantana trifolia* L. MLV/2022/032**	Verbenaceae	**Shimenenwa**	Three-leaf Shrub	Shrub	R	Malaria, diarrhea	Crushed, orally administered when cold
***Leucas calostachys* Oliv. MLV/2022/033**	Lamiaceae	**Lumetsani**	Not Established	Shrub	L	Severe diarrhea	Crushed and extract administered orally
***Leucas deflexa* Hook. f. MLV/2022/034**	Lamiaceae	**Shitsunzune**	Not Established	Herb	L	Eye infection in livestock	Crushed and infusion squeeze-dropped into the affected eye
***Mangifera indica* L. MLV/2022/035**	Anacardiaceae	**Muembe**	Mango tree	Tree	B, L, S	STIs, diarrhea	Boiled, orally administered
***Markhamia lutea* (Benth.) K. Schum. MLV/2022/036**	Bignoniaceae	**Lusiola**	Nile Tulip tree	Tree	L	Malaria and ear problems	Boiled, orally taken for Malaria. Crushed, squeeze-dropped into the affected ear

***Mondia whitei* (Hook. f.) Skeels MLV/2022/037**	Apocynaceae	**Mukombero**	White's ginger	Climber	R	Loss of appetite, Low libido, Fatigue, Mineral deficiency	Fresh epidermal layer chewed raw
***Ocimum kilimandscharicum* Gürke MLV/2022/038**	Lamiaceae	**Omwonyo**	Kilimanjaro basil	Herb	L	Nasal congestion, colds, flu,	Grounded into powder, mixed with hot water and orally taken.
***Olea capensis* L. MLV/2022/039**	Oleaceae	**Mutukhuyu**	Elgon Olive	Shrub	B	Stomach ache, Peptic ulcers	Boiled, decoction orally administered
***Oxalis corniculata* R. Knuth MLV/2022/040**	Oxalidaceae	**Nyamnyam**	Oxalis	Herb	Wp	Ulcers	Chewed raw while fresh
***Paullinia pinnata* L. MLV/2022/041**	Sapindaceae	**Mkhayu**	Bread and cheese plant	Shrub	R	Hiccup	Crushed, concoction orally administered
***Paulownia tomentosa* (Thunb.) Steud. MLV/2022/042**	Paulowniaceae	**Musembe**	Foxglove tree	Tree	Sh, R	Stomach problems, Boils	Crushed, concoction orally administered
***Persea Americana* Mill. MLV/2022/043**	Lauraceae	**Mwovacado**	Avocado	Tree	B, L, R, S	STIs, Toothache, stomachache	Boiled/crushed and orally administered
***Physalis peruviana* L. MLV/2022/044**	Solanaceae	**Mayengo**	Chinese Gooseberry	Shrub	L	Malaria	Boiled and the steam inhaled by the patient
***Piper capense* L. f. MLV/2022/045**	Piperaceae	**Pilipili yomwisimo**	Wild Pepper	Shrub	F	Cough	Eaten raw while fresh
***Piper umbellatum* L. MLV/2022/046**	Piperaceae	**Indava**	Cow-foot leaf	Shrub	L	Headache and fever	Crushed and infusion dropped into the nose
***Plectranthus barbatus* Andrews MLV/2022/047**	Lamiaceae	**Lilokha**	Woolly plectranthus	Shrub	L	Malaria and Eye infection in livestock	Boiled and decoction taken orally for humans. Crushed and extract dropped in the affected eye of livestock
***Prunus africana* (Hook. f.) Kalkman MLV/2022/048**	Rosaceae	**Mwiritsa**	Red Stinkwood	Tree	R, B	Prostate cancer, Stomach-ache	Boiled or crushed and infusion taken orally

***Psidium guajava* L. MLV/2022/049**	Myrtaceae	**Mupera**	Common guava	Tree	L	Diarrhea, Stomachache	Crushed and infusion orally administered
***Rhus vulgaris* Meikle MLV/2022/050**	Anacardiaceae	**Omusangula**	Desert date	Shrub	L, R	Coughs, cold	Crushed and infusion orally administered
***Rubus pinnatus* Willd. MLV/2022/051**	Rosaceae	**Butunduli**	South African blackberry	Shrub	L, F	Malaria, flu, fever	Chewed raw
***Sapium ellypticum* MLV/2022/052**	Euphorbiaceae	**Musasa**	Jumping seed tree	Tree	L	Eye problems in livestock	Extract squeeze-dropped into the affected eye
***Senecio moorei* R.E. Fr. MLV/2022/053**	Asteraceae	**Oluvumbi**	Not Established	Herb	L	Cough	Roasted into ash, and orally licked
***Senna occidentalis* (L.) Link MLV/2022/054**	Fabaceae	**Imbindi**	Stinking Weed	Shrub	R	Malaria	Crushed, mixed with water, and orally administered
***Solanum incanum* L. MLV/2022/055**	Solanaceae	**Indalundalu**	Sodom Apple	Shrub	R	Stomach-ache	Chewed raw and juice swallowed
***Tagetes minuta* L. MLV/2022/056**	Asteraceae	**Inzaka**	Mexican marigold	Shrub	L	Skin diseases	Boiled and steam-bathed
***Thunbergia alata* Bojer ex Sims MLV/2022/057**	Acanthaceae	**Indereresia**	Black-eyed Susan vine	Climber	L	Joint dislocation in humans and livestock	Crushed, bound into a ball, heated then massaged firmly onto the affected joint area while still hot
***Tithonia diversifolia* (Hemsl.) A. Gray MLV/2022/058**	Asteraceae	**Mavinzo**	Mexican sunflower	Shrub	L	Stomachache, diarrhea, wounds	Crushed, mixed with water, and orally administered for stomachache and diarrhea. Crushed and squeeze-pressed against the wound.
***Toddalia asiatica* (L.) Lam. MLV/2022/059**	Rutaceae	**Oluavari**	Orange climber	Shrub	R, L	Stomachache	Boiled and decoction orally taken
***Trichilia emetica* Vahl MLV/2022/060**	Meliaceae	**Munyama**	Natal mahogany	Tree	B	Fever, Stomach ache, STIs, Malaria	Crushed and boiled with water, the

							concoction orally administered
***Vitex keniensis* Turrill MLV/2022/061**	Lamiaceae	**Mfutu**	Meru Oak	Tree	F	Stomach ache	Eaten raw
***Zanthoxylum gilletii* (De Wild.) P.G. Waterman MLV/2022/062**	Rutaceae	**Shikhoma**	East African satingwood	Tree	B	Cough and chest complications	Crushed and mixed with water, orally taken when cold

Cultural Relevance of Plant Species and Families in Traditional Medicine Practices

Within traditional medicine applications, herbs and shrubs assumed dominance, representing over half (59%) of the recorded plant species. This prevalence can be attributed to the likelihood of herbs and shrubs containing pharmacologically active compounds (Thomas *et al.* 2009). On the other hand, trees accounted for 34% of the recorded plant species, potentially influenced by the tropical climate in Malava that supports the growth of a wide variety of large trees. Understanding the cultural relevance of plant species is pivotal in ethnobotanical studies, as it sheds light on the rationale behind human reliance on particular plants (Sulaiman *et al.* 2020). The use value index, shaped by use frequency (frequency of citation) and quality perception, revealed the most valuable plant species among the locals. Notably, *Azadirachta indica* A. Juss*, Aloe sp, Mondia whitei* (Hook. f.) Skeels*, Albizia gummifera* (J.F. Gmel.) C.A. Sm*.* and *Eucalyptus globulus* Labill. emerged as the most utilized species, underscoring their profound cultural significance.

The prominence of certain species in traditional medicine indicates a wealth of information regarding their therapeutic benefits. However, low use values for certain species may be attributed to plant scarcity or the gradual loss of traditional knowledge about them (Dapar *et al.* 2020). Identifying valuable plant species in this study can assist in prioritizing their conservation and management. Medicinal plants with high use values should undergo further investigation through phytochemical and pharmaceutical screening to explore their potential as sources of active components for drug extraction (El Khomsi *et al.* 2022).

Importance of Plant Families and Informant Agreement Ratio (IAR)

The evaluation of plant families' importance within the study area utilized the FUV concept. Family use value is dependent on the number of species within a family and the number of people frequently mentioning those species to be of medicinal value (Hoffman & Gallaher 2007). Species of Xanthorrhoeaceae and Meliaceae may be very familiar, more abundant, and easily accessible in the local environment in Malava compared to Sapindaceae, resulting in their higher use values as people can easily collect and utilize these plants. The well-representation of the Asteraceae (11.3%) and Fabaceae (9.7%) families remains consistent with previous studies across different parts of Kakamega County (Mukungu *et al.* 2016, Odongo *et al.* 2018, Otieno *et al*. 2012). This similarity may be attributed to shared vegetational characteristics resulting from similar climatic conditions and knowledge exchange among communities in the county. The preference for specific plant families over others within the local community underscores their cultural significance based on the families' use value. The study's findings emphasize the importance of considering plant families when investigating traditional medicinal practices.

The informant agreement ratio (IAR) is determined by the availability of plants in the study area for illness treatment (Chaachouay *et al.* 2019). The value ranges from 0 to 1, where high IAR values indicate a consensus among informants regarding taxonomic selection, while low values suggest disagreement (Chaachouay *et al.* 2019). The IAR was employed to assess the availability of plants for treating diseases in the research area. The prevalence of malaria (which recorded a significant IAR value of 0.94) in Western Kenya, coupled with significant poverty levels and reports of drug resistance (Wanjala *et al*. 2011), likely underpins the use of specific plants for malaria treatment in this study. Corresponding with previous research, plants such as *Aloe sp, Ajuga integrifolia* Buch.-Ham. ex D. Don*, Croton macrostachyus* Hochst. ex Delile*, Erythrina abyssinica* Lam.*,* and *Plectranthus barbatus* Andrews were cited as remedies for malaria (Mukungu *et al.* 2016, Odongo *et al*. 2018). Remedies for joint pains and inflammation can be attributed to the aging population and economic activities like farming, which is the main activity in the study area. Meanwhile, ailments such as diarrhea, boils, stomach problem, and skin diseases may be linked to elevated poverty levels and inadequate sanitation (Otieno *et al.* 2012). This study's IAR results indicated that diseases prevalent in Malava sub-county had a higher informant agreement ratio (values ranging from 0.80 to 1.00). These high IAR values showed a reasonable reliability of informants on the use of medicinal plant species. The informant agreement values also suggested that the people in the research region shared knowledge of the most important medicinal plant species for treating the most commonly encountered ailments. As a result, species with high IAR should be focused on for further pharmacological and phytochemical research.

Multifunctionalities of plant species

Furthermore, select plants within the collection demonstrated non-medicinal uses, revealing their multifaceted nature. These versatile plants contribute to the diversity of plant uses and serve as indicators of regional biocultural variation (Woo *et al.* 2023). For instance, *Tithonia diversifolia* (Hemsl.) A. Gray and *Acanthus eminens* C.B. Clarke were recognized as fodder, while fruits of *Persea Americana* Mill.*, Mangifera indica* L.*, Physalis peruviana* L.*, Psidium guajava* L., *Rhus vulgaris* Meikle, *Rubus pinnatus* Willd., and *Vitex keniensis* Turrill were found to be edible. Woody species were primarily utilized as sources of firewood fuel and construction materials. Recognizing the multipurpose value of plants is essential for recording regional or ethnic traditional ecological knowledge, identifying potential applications, and fostering the protection of natural and cultural diversity (Xiong *et al.* 2020). However, the multifunctionality of medicinal plants raises concerns about potential overexploitation, which could endanger their long-term presence in the area.

Conclusion

Ethnobotanical knowledge plays a pivotal role in conserving and harnessing indigenous plants for their medicinal properties. This study conducted in Malava sub-county sheds light on the local understanding of medicinal plants used for primary healthcare, underscoring the imperative to document and preserve this invaluable ethnomedicinal wisdom. The quantitative ethnobotanical survey yields crucial insights into the biodiversity and medicinal plant species within the study area, revealing a total of 62 medicinal plant species across 30 families. While this study advances our comprehension, further research is warranted to delve deeper. Local traditional medicine practitioners and community members harbor extensive ethnopharmacological insights. Yet, the very practices that harbor this wisdom are in jeopardy due to the sway of modernization. Particularly noteworthy are the plant species employed for malaria treatment. To validate traditional uses and uncover potential bioactive compounds, pharmacological investigations merit exploration. The conservation of medicinal plant resources necessitates concerted conservation endeavors, community engagement initiatives, and ongoing research. These collective efforts are pivotal for upholding sustainable utilization practices, safeguarding these vital resources, and advancing healthcare modalities.

Declarations

Abbreviations: FC=Frequency of citation***,*** FUV=Family use value***,*** IAR=Informant agreement ratio**,** TMPs= Traditional Medical Practitioners**,** UR=Use Report, UV=Use value

Ethics Statement: Prior to data collection, necessary permissions were obtained from local authorities, including chiefs, and informed consent was obtained from all participants

Consent for Publication: Not Applicable

Availability of data and materials: The figures and tables (including supplementary tables) supporting the results of this study are included in the article, and the original data sets are available from the first author upon request.

Competing interests: The authors declare that they have no financial and non-financial competing interests.

***Funding*;** This work was funded by the National Natural Science Foundation of China (Grant No. 31961143023), and the Alliance of International Science Organizations (ANSO) fellowship.

Author's contributions

Lindsay Sikuku: designed and conceptualized the study, and writing; Brian Njoroge and Vincent Suba: data collection and processing; Emily Achieng and Josephat Rutere Mbogo; data collection, identification, and manuscript review; Yuelin Li: designed, administered, and supervised the project.

Acknowledgments

We would like to thank the Jomo Kenyatta University of Agriculture and Technology (JKUAT), Kenya for providing their School of Biological Sciences Herbarium for the deposition of the voucher specimens. Special thanks to Mr. Dennis Luvonga Matolo for his assistance during fieldwork. We would like to thank the ANSO Scholarship for Young Talents for its generous support to students pursuing scientific research. Our Special thanks goes to the National Natural Science Foundation of China (Grant No. 31961143023) for funding this work.

Literature Cited

Abdullahi AA. 2011. Trends and Challenges of Traditional Medicine in Africa. African Journal of Traditional, Complementary and Alternative Medicines 8(5S). doi: 10.4314/ajtcam.v8i5S.5

Agevi H. 2016. PELIS Forestry Programme as a Strategy for Increasing Forest Cover and Improving Community Livelihoods: Case of Malava Forest, Western Kenya. American Journal of Agriculture and Forestry 4(5):128-135. doi: 10.11648/j.ajaf.20160405.13

Bogale M, Sasikumar JM, Egigu MC. 2023. An Ethnomedicinal Study in TuloDistrict, West Hararghe zone, Oromia region, Ethiopia. Heliyon 9(4). https://doi.org/10.1016/j.heliyon.2023.e15361

Canales M, Hernández T, Caballero J, De Vivar AR, Avila G, Duran A, Lira R. 2005. Informant Consensus Factor and Antibacterial Activity of the Medicinal Plants Used by the People of San Rafael Coxcatlán, Puebla, México. Journal of Ethnopharmacology 97(3):429-439.

Chaachouay N, Benkhnigue O, Fadli M, El Ibaoui H, Zidane L. 2019. Ethnobotanical and Ethnopharmacological Studies of Medicinal and Aromatic Plants Used in the Treatment of Metabolic Diseases in the Moroccan Rif. Heliyon 5(10):e02191.

Collins S, Martins X, Mitchell A, Teshome A, Arnason JT. 2006. Quantitative Ethnobotany of two East Timorese Cultures. Economic Botany, 60(4):347-361.

County Government of Kakamega. 2018. Department of Finance Economic Planning & Investments. Kakamega County Integrated Development Plan 2018 to 2022._https://kakamega.go.ke/publicparticipation-county-development-plans/ (Accessed on 10/06/2023)

Dapar MLG, Alejandro GJD, Meve U, Liede-Schumann S. 2020. Quantitative Ethnopharmacological Documentation and Molecular Confirmation of Medicinal Plants used by the Manobo tribe of Agusan del Sur, Philippines. Journal of Ethnobiology and Ethnomedicine, 16(1):1-60.

Dharani N, Yenesew A. 2010. Medicinal Plants of East Africa: An illustrated guide. Najma Dharani in association with Drongo Editing and Publishing, Nairobi, Kenya.

El Khomsi, M, Dandani Y, Chaachouay N, Hmouni D. 2022. Ethnobotanical Study of Plants Used for Medicinal, Cosmetic, and Food Purposes in the Region of Moulay Yacoub, Northeast of Morocco. Journal of Pharmacy & Pharmacognosy Research, 10(1):13-29.

Fischer E, Rembold K, Althof A, Obholzer J, Malombe I, Mwachala G, Theisen I. 2010. Annotated Checklist of the Vascular Plants of Kakamega Forest, Western Province, Kenya. Journal of East African Natural History, 99(2):129-226.

Hoffman B, Gallaher T. 2007. Importance Indices in Ethnobotany. Ethnobotany Research and Applications 5: 201-218.

Hussain S, Hamid A, Ahmad KS, Mehmood A, Nawaz F, Ahmed H. 2019. Quantitative Ethnopharmacological Profiling of Medicinal Shrubs Used by Indigenous Communities of Rawalakot, District Poonch, Azad Jammu and Kashmir, Pakistan. Revista Brasileira de Farmacognosia, 29:665-676.

Ichikawa M. 1987. A Preliminary Report on the Ethnobotany of the Suiei Dorobo in Northern Kenya. African Study Monographs. Supplementary issue 7:1-52.

Johns T, Kokwaro JO, Kimanani EK. 1990. Herbal Remedies of The Luo of Siaya District, Kenya: Establishing Quantitative Criteria for Consensus. Economic Botany 44(3):369-381.

Kathambi V, Mutie FM, Rono PC, Wei N, Munyao JN, Kamau P, Wang QF. 2020. Traditional Knowledge, Use and Conservation of Plants by the Communities of Tharaka-Nithi County, Kenya. Plant Diversity 42(6):479-487.

Kenya National Bureau of Statistics. 2019. Kenya Population and Housing Census: Distribution of Population by Socio-Economic Characteristics. Vol. IV. 2019.https://www.knbs.or.ke/download/2019-kenya-population-and-housing-census-volume-iv-distribution-of-population-by-socio-economic-characteristics/ (Accessed 10/06/2023).

Keter LK, Mutiso PC. 2012. Ethnobotanical Studies of Medicinal Plants Used by Traditional Health Practitioners in the Management of Diabetes in Lower Eastern Province, Kenya. Journal of Ethnopharmacology 139(1):74-80.

Kigen G, Kipkore W, Wanjohi B, Haruki B, Kemboi J.2017. Medicinal Plants Used by Traditional Healers in Sangurur, Elgeyo Marakwet County, Kenya. Pharmacognosy Research 9(4):333-347. https://doi.org/10.4103/pr.pr_42_17

Kipkore W, Wanjohi B, Rono H, Kigen G. 2014. A Study of the Medicinal Plants Used by the Marakwet Community in Kenya. Journal of Ethnobiology and Ethnomedicine 10(1):1-22.

Kisangau DP, Kauti M, Mwobobia R, Kanui T, Musimba N. 2017. Traditional knowledge on Use of Medicinal Plants in Kitui County, Kenya. International Journal of Ethnobiology & Ethnomedicine 4(1):1-10.

Kokwaro JO. 2009. Medicinal Plants of East Africa. University of Nairobi press, Nairobi, Kenya.

Kumar A, Kumar S, Komal, Ramchiary N, Singh P. 2021. Role of Traditional Ethnobotanical Knowledge and Indigenous Communities in Achieving Sustainable Development Goals. Sustainability 13(6):3062.

Lambert J, Leonard K, Mungai G, Omindi-Ogaja E, Gatheru G, Mirangi M, Lemiere C. 2011. The Contribution of Traditional Herbal Medicine Practitioners to Kenyan Healthcare Delivery: Results from Community Health-seeking Behavior Vignettes and a Traditional Herbal Medicine Practitioner Survey. Health, Nutrition and Population (HNP) discussion paper. doi: 10.13140/RG.2.2.33913.88164

Maroyi A. 2015. A comparative Study of Medicinal Plants Used in Rural Areas of Namibia and Zimbabwe. Indian Journal of Traditional Knowledge14(3):401-406

Masayi N. 2021. Assessment of Land Use-Land Cover Changes in Kabras Division, Western Kenya (2013-2021). Iconic Research and Engineering Journals 5(5):1-7.

Mattalia G, Stryamets N, Pieroni A, Sõukand R. 2020. Knowledge Transmission Patterns at the Border: Ethnobotany of Hutsuls Living in the Carpathian Mountains of Bukovina (SW Ukraine and NE Romania). Journal of Ethnobiology and Ethnomedicine 16(1): 1-40.

Mbuni YM, Wang S, Mwangi BN, Mbari NJ, Musili PM, Walter NO, Wang Q. 2020. Medicinal Plants and their Traditional Uses in Local Communities around Cherangani Hills, Western Kenya. Plants 9(3):331.

Mourine M. 2022. Ethnobotanical Survey and Characterization of Antimicrobial Producing Fungal Endophytes from Selected Medicinal Plants found in Cherangani forest, Elgeyo-Marakwet County, Kenya. PhD dissertation, Kenyatta University, Kenya.

Mukungu N, Abuga K, Okalebo F, Ingwela R, Mwangi J. 2016. Medicinal Plants Used for Management of Malaria Among the Luhya community of Kakamega East sub-County, Kenya. Journal of Ethnopharmacology 194:98-107.

Munguti KJ. 1997. Indigenous knowledge in the management of Malaria and Visceral leishmaniasis among the Tugen of Kenya. Indigenous Knowledge and Development Monitor 5(1):10-12.

Mutwiwa C, Rotich B, Kauti M, Rithaa J. 2018. Ethnobotanical survey of Medicinal Plants in Mwala sub-county, Machakos County, Kenya. Journal of Diseases and Medicinal Plants 4(4):110-119. doi: 10.11648/j.jdmp.20180404.12

Nankaya J, Gichuki N, Lukhoba C, Balslev H. 2019. Medicinal Plants of the Maasai of Kenya: a review. Plants 9(1):44.

Odongo E, Mungai N, Mutai P, Karumi, E, Mwangi J, Omale J. 2018. Ethnobotanical Survey of the Medicinal Plants Used in Kakamega County, Western Kenya. Applied Medical Research 4(1):22.

Okello SV, Nyunja RO, Netondo GW, Onyango JC. 2010. Ethnobotanical study of Medicinal Plants Used by Sabaots of Mt. Elgon Kenya. African Journal of Traditional, Complementary and Alternative Medicines 7(1):1-10

Olembo NK, Fedha SS, Ngaira ES. 1995. Medicinal and Agricultural Plants of Ikolomani Division, Kakamega District. Kenya. IRIS, Nairobi, Kenya.

Otieno NE, Analo C. 2012. Local indigenous knowledge about some medicinal plants in and around Kakamega forest in western Kenya. F1000Research 1. doi: 10.3410/f1000research.1-40.v2

Phillips O, Gentry AH. 1993. The useful plants of Tambopata, Peru: I. Statistical Hypotheses Tests with a new Quantitative Technique. Economic Botany 47(1):15-32.

Shiracko N, Owuor BO, Gakuubi MM, Wanzala W. 2016. A Survey of Ethnobotany of the Abawanga People in Kakamega County, Western province of Kenya. Indian Journal of Traditional Knowledge 15(1):93-102

Shopo B, Mapaya RJ, Maroyi A. 2022. Ethnobotanical Study of Medicinal Plants Traditionally Used in Gokwe South District, Zimbabwe. South African Journal of Botany 149:29-48.

Sreekeesoon DP, Mahomoodally MF. 2014. Ethnopharmacological Analysis of Medicinal Plants and Animals Used in the Treatment and Management of Pain in Mauritius. Journal of Ethnopharmacology, 157:181-200.

Sulaiman, Shah S, Khan S, Bussmann RW, Ali M, Hussain D, Hussain W. 2020. Quantitative Ethnobotanical Study of Indigenous Knowledge on Medicinal Plants Used by the Tribal Communities of Gokand Valley, District Buner, Khyber Pakhtunkhwa, Pakistan. Plants, 9(8):1001.

Tardío J, Pardo-de-Santayana, M. 2008. Cultural Importance Indices: A Comparative Analysis based on the Useful Wild Plants of Southern Cantabria (Northern Spain). Economic Botany 62:24-39.

Thomas E, Vandebroek I, Sanca S, Van Damme P. 2009. Cultural Significance of Medicinal Plant Families and Species among Quechua Farmers in Apillapampa, Bolivia. Journal of Ethnopharmacology 122(1):60-67.

Torres-Avilez W, Medeiros PMD, Albuquerque UP. 2016. Effect of Gender on the Knowledge of Medicinal Plants: Systematic Review and Meta-analysis. Evidence-based complementary and alternative medicine 2016: 1-13. doi:10.1155/2016/6592363

Trotter RT, Logan MH. 2019. Informant Consensus: A new Approach for Identifying Potentially Effective Medicinal Plants. In: Etkin NL. (Ed). 1986): Plants in indigenous medicine & diet: biobehavioral approaches. Psychology Press, Routledge, UK, Pp. 91-112.

Usman Yusuf JE. 2023. Phytochemical Screening, Antioxidant and Antimicrobial Activities of Papaya (*C. papaya* L.) Leaf and Seed Extracts. Doctoral dissertation, Haramaya University.

Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G. 2013. Traditional Knowledge on Medicinal and Food Plants used in Val San Giacomo (Sondrio, Italy)-An Alpine Ethnobotanical Study. Journal of Ethnopharmacology 145(2):517-529.

Wanjala CL, Waitumbi J, Zhou G, Githeko AK. 2011. Identification of Malaria Transmission and Epidemic Hotspots in the Western Kenya Highlands: its application to Malaria Epidemic Prediction. Parasites & Vectors 4(1):1-13.

Wanyonyi PN, Tsingalia HM, Omayio DO, Mzungu E. 2021. Evidence of Climate Changes in a Tropical Rainforest: Case Study Kakamega Tropical Rainforest. International Journal of Environment and Climate Change 11(10):202-212.

Woo SL, Hermosa R, Lorito M, Monte E. 2023. Trichoderma: A multipurpose, Plant-beneficial Microorganism for Eco-sustainable Agriculture. Nature Reviews Microbiology 21(5):312-326.

World Health Organization. 2012. The regional Strategy for Traditional Medicine in the Western Pacific (2011-2020).

World Health Organization. 2013. WHO traditional medicine strategy: 2014-2023. World Health Organization.

Xiong Y, Sui X, Ahmed S, Wang Z, Long C. 2020. Ethnobotany and Diversity of Medicinal Plants used by the Buyi in Eastern Yunnan, China. Plant Diversity 42(6):401-414.