



# Ethnobiological Investigation of Plant Utilization for the Purpose of Arthritis Management in Nyamira North Sub-County of Nyamira County, Kenya

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## Research Article

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## Abstract

Traditional medical practices are common among many Kenyan communities, with herbal remedies consistently employed for arthritis treatment, despite the increased availability of conventional medicines. Therefore, it is of paramount significance to document these plants as a means of preserving the cultural knowledge of traditional medicines.

**Aim of the Study:** The study aimed to identify and document medicinal plants utilized by traditional medical practitioners (TMPs) in Nyamira North Sub- County, Nyamira County.

**Materials and Methods:** A field study was conducted in Nyamira North Sub- County. Thirty-six TMPs were selected and interviewed using semi-structured questionnaires. Information regarding the plants used was collected and documented. Frequency tables and data triangulation were employed to present the collected data.

**Results:** A total of 48 species of medicinal plants belonging to 30 families and covering 38 genera were identified for use in managing arthritis. Thirty plant species were found to have reports of similar use in the literature, while 18 species were being reported for the first time regarding their use in arthritis. The most encountered families were Asteraceae (16.67%), Solanaceae (8.33%), and Fabaceae (6.25%). Most of the growth forms used were shrubs (46%), followed by herbs (31%), trees (15%), and climbers (8%). The most frequently used plant parts were the root/root backs (56%), followed by the leaves (20%), stem bark (14%), and the whole plant (8%).

**Conclusion:** The present study identified and documented, for the first time, medicinal plants used to treat arthritis in the study area. It also revealed that eighteen (37.5%) of the traditional herbal remedies used to treat arthritis in the study area have not been reported in the literature. However, thirty (62.5%) are reported in the literature for similar use in other communities.

**Keywords:** Traditional Medical Practitioners; Arthritis; Ethnobiological Investigation; Nyamira North; Kenya

**Abbreviations:** Tmps: Traditional Medical Practitioners; OA: Osteoarthritis; RA: Rheumatoid Arthritis; NSAIDs: Non-Steroidal Anti-Inflammatory Drugs; CAM: Complementary

and Alternative Medicine; Fbos: Faith-Based Organizations; Ngos: Non-Governmental Organizations; TMPs: Traditional Medical Practitioners; PRA: Participatory Rapid Appraisal

Method; ROS: Reactive Oxygen Species; ROS: Reactive Oxygen Species.

## Introduction

Arthritis is a general term referring to the inflammation of joints, with more than 100 clinical forms characterized primarily by stiffness, warmth, swelling, redness, and pain. It is often used to denote any disease involving pain or stiffness of the musculoskeletal system. Arthritis is a prevalent and debilitating condition impacting numerous individuals worldwide, significantly contributing to the disability burden associated with musculoskeletal disorders. Among the various clinical forms, osteoarthritis (OA) and rheumatoid arthritis (RA) are the most prevalent. Research has highlighted osteoarthritis as the primary joint disease contributing to chronic disability in developed nations. In developing countries, arthritis poses an additional disease burden, especially with limited income, leading to expensive and inaccessible healthcare services. Traditionally, non-steroidal anti-inflammatory drugs (NSAIDs) are widely utilized by arthritis patients due to their effective pain and inflammation relief. However, the associated side effects with NSAIDs may limit their acceptance among many patients. Major factors contributing to mortality and morbidity, particularly among the elderly, involve side effects related to the kidney and gastrointestinal tract.

A significant number of individuals afflicted by this debilitating disease are now exploring complementary and alternative medicine (CAM) as an option [1-7]. Approximately 60–90% of arthritis sufferers are estimated

to opt for alternative medicines, among which chiropractic and herbal remedies are extensively employed [8]. Medicinal plant derivatives are an intrinsic part of the cultural customs and heritage of African populations [9]. Moreover, they play a crucial role in preserving cultural heritage, serving as a foundation for the discovery of new drugs, and safeguarding biological diversity [10]. Based on these premises, the current Ethnobiological investigation was conducted to document the traditionally used medicinal plants for the management of arthritis and related joint illnesses in Nyamira North Sub-County, Nyamira County, Kenya.

## Methodology

### Design of Study

The study was a cross sectional analytical design where a purposive sampling method was employed to identify 36 traditional medical practitioners as participants.

### Study Area

Data collection was confined to Nyamira North Sub-County, Nyamira County, which spans an area of 899.4 km<sup>2</sup> and is situated between latitude 00 30° and 00 45° South, and longitude 340 45° and 350 00° East. Nyamira North Sub-County is one of the five sub-counties constituting Nyamira County, alongside Nyamira South, Borabu, Manga, and Masaba North. As per the District Health Information System (DHIS2) population estimates for 2018, the Sub-County has a population of 150,628, with males accounting for 48.9% and females for 51.1% of the total population.

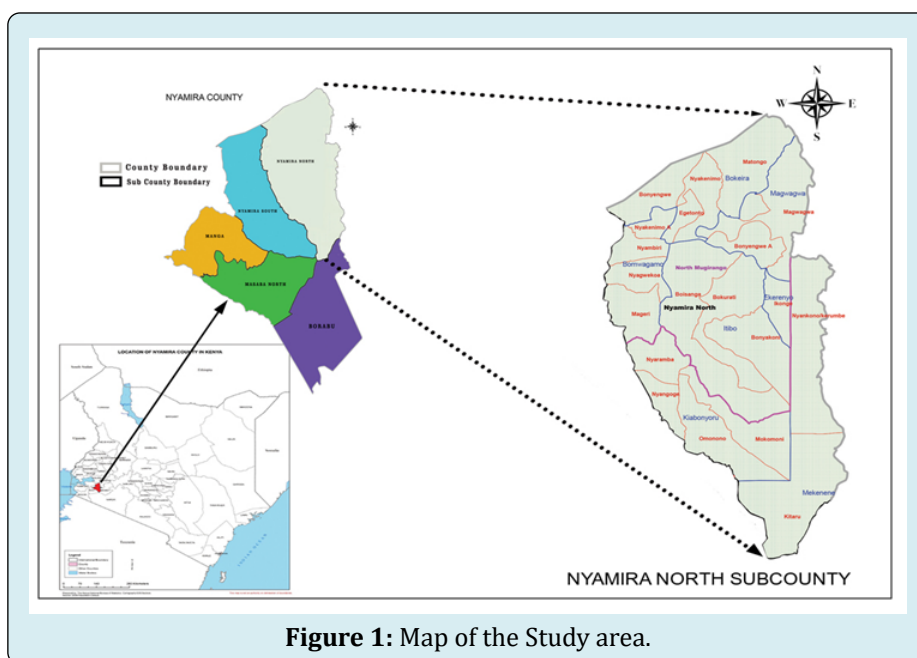


Figure 1: Map of the Study area.

The Sub- County encompasses a coverage area of 219.3 km<sup>2</sup> and exhibits a population density of 687 individuals per km<sup>2</sup>. The region experiences favorable temperate climate conditions, with temperatures ranging between 16-23°C and an average annual rainfall varying from 500-2600 mm. The conducive climate supports agricultural activities, with both subsistence farming, including the cultivation of maize, millets, beans, and fruits, and commercial farming practices such as cattle rearing, tea, and coffee production. The inhabitants of Nyamira North Sub- County predominantly belong to the Abagusii community, accessing healthcare services from 28 government facilities (DHIS2), as well as from various privately owned, faith-based organizations (FBOs), and non-governmental organizations (NGOs) healthcare facilities (Figure 1).

### Ethnobiological Investigation

The survey aimed at collecting data on medicinal plants used for treating arthritis and joint-related conditions specifically targeted traditional medical practitioners (TMPs) within this sub-county. The Participatory Rapid Appraisal method (PRA) was employed to gather information concerning the indigenous knowledge associated with the utilization of medicinal plants for managing arthritis and joint-related conditions. This approach involved personally visiting the homes of the TMPs to conduct direct interviews. The recruitment of the TMPs for the study was facilitated through their leader/chairperson and village heads. The researcher administered a guided structured questionnaire and interview guide to selected informants from each of the sub-county divisions. The recorded information encompassed details regarding the usage of the plants, as well as the demographics of the respondents. To ensure the reliability of the data, only those plants mentioned by a minimum of three informants were noted [11].

### Plant Collection and Identification

The plant materials referenced by the traditional medical practitioners (TMPs) were gathered and authenticated at the East African Herbarium (EA) located within the Nairobi National Museum of Kenya. A voucher specimen was then deposited at both the East African Herbarium and the Mount Kenya University Herbarium.

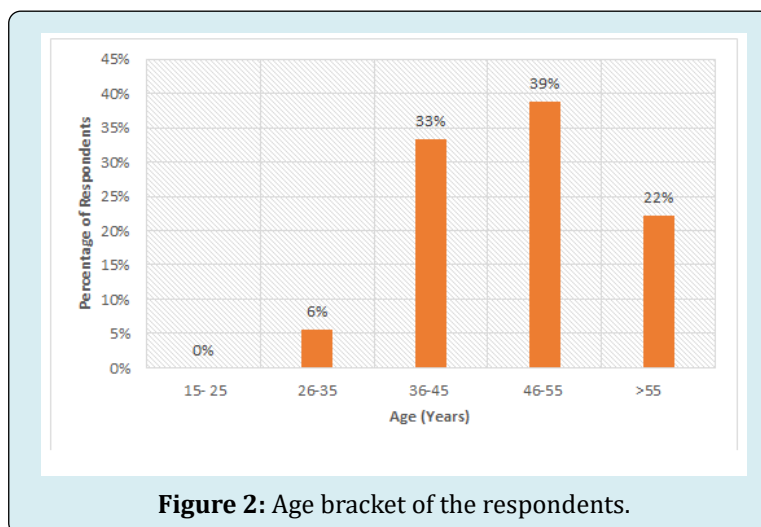
### Ethical Clearance

Prior to the commencement of the study, ethical approval was obtained from the University of Nairobi Biosafety, Animal Welfare, and Ethics Committee (Reference number, FVM BAUEC/2018/168). Written consent was procured from all the herbalists who expressed willingness to participate in the study, following a comprehensive explanation of the study's objectives. The researcher also communicated the potential benefits and risks associated with the study to the informants before the study initiation.

## Results and Discussion

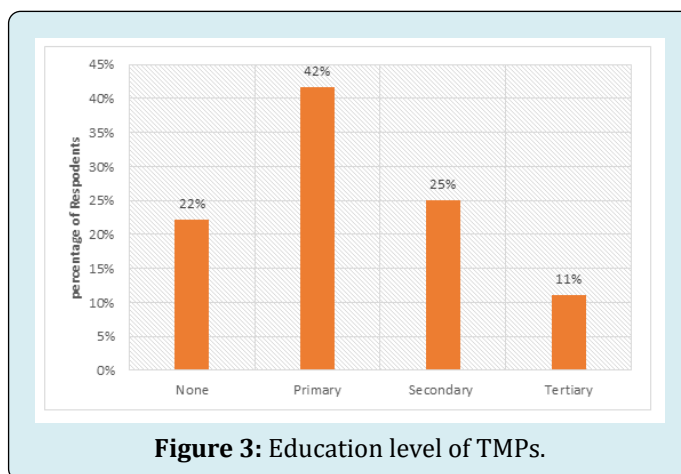
### Socio-Demographics of the Respondents

A total of 36 traditional medical practitioners (TMPs) were interviewed, comprising 29 males and 7 females. This aligns with the findings of previous studies that also indicated a predominance of male TMPs [12-14]. However, this contrasts with Omwenga's (2015)[15]report, which stated that 54% of TMPs were females. The majority of the respondents (39%) fell within the age range of 46-55 years (Figure 2). This is attributed to the community's belief that older individuals possess the requisite knowledge in traditional medicinal practices, which is orally transmitted to younger generations.



Most of the respondents were considered literate (78%), having completed either primary, secondary, or tertiary education. Only 22% were deemed illiterate, with no formal education (Figure 3). This corroborates similar studies indicating that the level of education does not significantly influence ethnomedical practices [12,13,15]. The study

revealed that all interviewed TMPs resided in rural areas, where a significant majority (80.6%) primarily engaged in farming as their source of livelihood. Additionally, 5.6% were involved in small-scale businesses, and another 5.6% were employed in formal sectors. Only three respondents (8.3%) exclusively practiced traditional medicine.



### Acquisition of Traditional Knowledge and Practices

For most of the interviewees (63.9%), traditional medicine knowledge was acquired through inheritance, passed down primarily from their parents and grandparents. This finding is consistent with the reports of Keter & Mutiso [13] and Kaingu [12], who noted that most TMPs gained knowledge of the trade through inheritance. In the study, 19.44% of the respondents obtained knowledge through apprenticeship under qualified tutor TMPs, while 16.7% acquired it through organized or formal training in seminars and workshops. Concerning experience in traditional medicine, most key informants (33.3%) had 11-19 years of experience. Six respondents (16.7%) had practiced for 1-5 years, 25% for 5-10 years, 16.7% for 20-40 years, and only 8.3% had practiced as traditional medical practitioners for more than 40 years.

This trend is consistent with other studies, indicating that the majority of TMPs have practiced for many years, emphasizing the key role of experience in accumulating ethnomedical knowledge [15]. All the herbalists interviewed resided in rural areas and conducted their practices from their homes, as none of them possessed a clinic. Only two interviewees had obtained a practice license from the Ministry of National Heritage and Culture. Additionally, two TMPs (8.3%) maintained elaborate botanical gardens, cultivating a significant portion of the medicinal plants. This practice was implemented as a mitigation measure against the substantial deforestation occurring in the county, as local inhabitants clear land for agricultural use.

### Knowledge of Arthritis among Traditional Herbal Medicine Practitioners

Many of the traditional medical practitioners (TMPs) interviewed (91.67%) demonstrated a limited familiarity with the various forms of arthritis. However, they possessed a reasonable understanding of the general manifestations of arthritis, primarily based on known clinical symptoms such as chronic joint pains, inflammations, and joint stiffness. No notable distinctions were observed regarding the management of different types of arthritis, leading to the utilization of common remedies. Alongside their personal diagnoses, all TMPs occasionally relied on patients' hospital reports and self-evaluations to establish a diagnosis. Furthermore, all TMPs indicated that their patients were typically referred to them by other patients, family members, and friends.

### Medicinal Plants and Predominant Growth Forms Utilized in the Treatment of Arthritis

The study identified a total of 48 species of medicinal plants, spanning 44 genera that were utilized in the management of arthritis, as cited by the key informants. These plants, belonging to 30 families refer to Table 1, were utilized by herbalists to create preparations administered to arthritis patients. Table 1 also displays the number of species cited within each family and their respective proportions. Table 2 outlines the plant species, their families, local names, habits, parts used, and modes of preparation.

No.	Family	Species	Percentage	No.	Families	Species	Percentage
1	Asteraceae	8	16.67%	16	Oxalidaceae	1	2.08%
2	Solanaceae	4	8.33%	17	Ebenaceae	1	2.08%
3	Fabaceae	3	6.25%	18	Euphorbiaceae	1	2.08%
8	Rubiaceae	3	6.25%	23	Musaceae	1	2.08%
4	Bignoniaceae	2	4.17%	19	Hyacinthaceae	1	2.08%
6	Lamiaceae	2	4.17%	21	Meliaceae	1	2.08%
7	Rhamnaceae	2	4.17%	22	Moraceae	1	2.08%
9	Salicaceae	2	4.17%	24	Myrtaceae	1	2.08%
5	Hypericaceae	1	2.08%	20	Loranthaceae	1	2.08%
10	Anacardiaceae	1	2.08%	25	Papilionaceae	1	2.08%
11	Apocynaceae	1	2.08%	26	Peraceae	1	2.08%
12	Asparagaceae	1	2.08%	27	Ranunculaceae	1	2.08%
13	Cucurbitaceae	1	2.08%	28	Rutaceae	1	2.08%
14	Celastraceae	1	2.08%	29	Urticaceae	1	2.08%
15	Crassulaceae	1	2.08%	30	Vitaceae	1	2.08%

**Table 1:** Number of families and species.

Family	Plant Scientific Name (Kisii Dialect)	Voucher No.	Form	Part of the Plant	Frequency of Mentions
Anacardiaceae	Searsia pyroides (Burch.) Moffett (Obosangora)	SMW/2017/11	Shrub	Root decoction	15
Apocynaceae	Carissa spinarum L. (Omonyangateti)	SMW/2017/17	Shrub	Roots decoction	27
Asparagaceae	Asparagus racemosus Willd. (A.buchananil Bak.) (Ekerebo ekiagarori)	SMW/2017/31	Climber	Roots decoction inhalation of steam	28
Asteraceae	Berkheya spekeana Oliv. (Rigeri)	SMW/2017/02	Shrub	Roots and leaves decoction and also ash	7
Asteraceae	Conyza bonariensis (L.) Cronquist. (Omosune)	SMW/2017/35	Herb	Leaves infusion	7
Asteraceae	Echinops amplexicaulis Oliv. (Rigeri nyagutwa)	SMW/2017/09	Herb	Root decoction	21
Asteraceae	Microglossa pyrifolia (Lam.) Kuntze (Nyomba ya kebaki j or Mote okebaki)	SMW/2017/18	Shrub	Root and Leaves infusion	27
Asteraceae	Solanecio manni (Hook.f.) C.Jeffrey (Omotagara)	SMW/2017/13	Shrub	Leaf poultice	9
Asteraceae	Tagetes minuta L. (Omotiokia)	SMW/2017/33	Herb	Root decoction	6
Asteraceae	Carduus chamaecephalus (Vatke) Olive & Hiern (Egetuke)	SMW/2017/01	Herb	Whole plant decoction and burnt ash	5
Asteraceae	Cirsium vulgare (Savi) Ten. (Rigeri rinene)	SMW/2017/03	Herb	Whole plant decoction and burnt ash	6
Bignoniaceae	Markhamia lutea (Benth.) K.Schum, (Omwobo)	SMW/2017/24	Tree	Root decoction	5
Bignoniaceae	Spathodea campanulata P.Beauv. (Omonyagasegane)	SMW/2017/32	Tree	Bark decoction	21



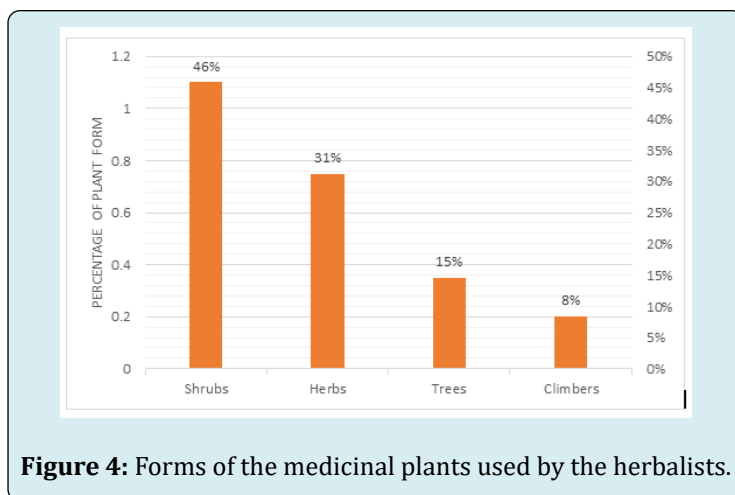
Celastraceae	Maytenus obscura (A. Rich.) Cufod. (Omosobwa)	SMW/2017/26	Shrub	Root decoction	16
Crassulaceae	Kalanchoe densiflora Rolfe (Omoneke)	SMW/2017/40	Herb	Leave poultice	17
Cucurbitaceae,	Momordica foetida Schumach (Omwaterkania)	SMW/2017/25	Climber	Root decoction	13
Ebenaceae	Euclea divinorum Hiern (Omomusi)	SMW/2017/30	Shrub	Roots decoction	3
Euphorbiaceae	Phyllanthus amarus Schumach. & Thonn. (Egesabisabi)	SMW/2017/06	Herb	Root decoction.	3
Fabaceae	Acacia abyssinica Benth. (Omonyenya)	SMW/2017/20	Shrub	Bark decoction	18
Fabaceae	Acacia gerradi Benth. (Omokonge)	SMW/2017/19	Shrub	Bark decoction	11
Fabaceae	Indigofera arrecta Hochst. ex A.Rich. (Omocheo)	SMW/2017/34	Shrub	Root and leaf decoction	9
Hyacinthaceae	Albuca abyssinica Jacq. (Egetunguu ekiagarori)	SMW/2017/08	Herb	Bulb Poultice	11
Hypericaceae	Harungana madagascariensis Lam. ex Poir.	SMW/2017/23	Tree	Back decoction	15
Lamiaceae	Ajuga remota Benth. (Omonyantira)	SMW/2017/39	Herb	Whole plant decoction	13
Lamiaceae.	Rotheca myricoides (Hochst.) Steane & Mabb. (Omonyasese)	SMW/2017/14	Shrub	Roots decoction	21
Loranthaceae	Phragmanthera usuiensis (Oliv.) M.G.Gilbert (Egete kienyoni)	SMW/2017/29	Shrub	Leave infusion	13
Meliaceae	Ekebergia capensis Sparrm (Omoturomesi)	SMW/2017/41	Tree	Roots decoction	9
Moraceae	Morus nigra L. (Omokenene)	SMW/2017/43	Shrub	Leaves infusion	7
Musaceae	Ensete ventricosum (Welw.) Cheesman	SMW/2017/22	Herb	Root decoction	4
Myrtaceae	Eucalyptus spp (Engamu ya bogere)	SMW/2017/38	Tree	Leaves infusion and warm bath	5
Oxalidaceae	Biophytum umbraculum Welw. (Ekiebundi)	SMW/2017/12	Herb	Whole plant decoction	3
Papilionaceae	Erythrina abyssinica DC. (Omotembe)	SMW/2017/45	Tree	Roots and bark decoction	28
Peraceae	Clutia abyssinica jaub & Spach (Omosambara igoro)	SMW/2017/04	Shrub	Root decoction	4
Ranunculaceae	Clematis brachiata Thunb. (Omonyaigena)	SMW/2017/48	Climber	Roots decoction	22
Rhamnaceae	Rhamnus prinoides L 'Hérit. (Omonyakige)	SMW/2017/42	Shrub	Root decoction	29
Rhamnaceae	Rhamnus staddo A. Ritch (Omongururo)	SMW/2017/05	Shrub	Root decoction	27
Rubiaceae	Rytigynia acuminatissima (K.Schum.) Robyns (Omonyinga)	SMW/2017/10	Tree	Bark decoction	4
Rubiaceae	Vangueria apiculata (K. Schum) (Omokomoni)	SMW/2017/07	Shrub	Root decoction	24
Rubiaceae	Vangueria madagascariensis J.F.Gmel. (Omwuogi)	SMW/2017/21	Shrub	Root decoction	21
Rutaceae	Toddalia asiatica (L.) Lam. (Ekenagwa ekiagarori)	SMW/2017/37	Shrub	Root decoction	27
Salicaceae	Flacourtia indica (Burm. f.) Merr. (Rikara)	SMW/2017/16	Shrub	Back decoction	5

Salicaceae	<i>Trimeria grandifolia</i> (Hochst.) Warb. (Omoatiuga)	SMW/2017/47	Shrub	Root decoction	6
Solanaceae	<i>Physalis peruviana</i> L. (Omosobosobo)	SMW/2017/44	Herb	Roots	6
Solanaceae	<i>Solanum incanum</i> L. (Omoratora)	SMW/2017/28	Herb	Root decoction	9
Solanaceae	<i>Solanum terminale</i> Forssk. (Omonyainogu)	SMW/2017/46	Herb	Root decoction	9
Solanaceae	<i>Withania somnifera</i> (L.) Dunal (Omokubinyongo)	SMW/2017/36	Shrub	Root and leaves decoction	19
Urticaceae	<i>Urtica massaica</i> Mildbr. (Rise)	SMW/2017/27	Herb	Root decoction	13
Vitaceae	<i>Rhoicissus tridentate</i> (L.f.) Wild & R.B.Drumm. (Omokorongotwa)	SMW/2017/15	Climber	Root decoction	19

**Table 2:** Medicinal Plants Used to Manage Arthritis in Nyamira North Sub-County.

According to the traditional medical practitioners (TMPs) involved in the study, the majority of the plant species employed for treating arthritis belonged to the Asteraceae family (16.67%). This was followed by the Solanaceae family (8.33%), with the Fabaceae and Rubiaceae families each representing 6.25%. Additionally, the Bignoniaceae, Lamiaceae, Rhamnaceae, and Salicaceae families accounted for 4.17% each. The remaining families comprised one species each, contributing to 2.08% of the total number of species. However, some of the plants mentioned by the herbalists were challenging to obtain. For instance, obtaining *Echinops*

*amplexicaulis* and *Rhamnus prinoides* required three days due to extensive clearance of the indigenous habitats for agricultural purposes. Notably, although *E. amplexicaulis* was mentioned by 21 respondents across the study area, it was only sourced from one region. This situation poses a risk of these medicinal plants becoming extinct unless measures are taken to preserve the knowledge and educate locals about the importance of conserving natural habitats. As depicted in Figure 4, the majority of the growth forms encountered were shrubs (46%), followed by herbs (31%), trees (15%), and climbers (8%).

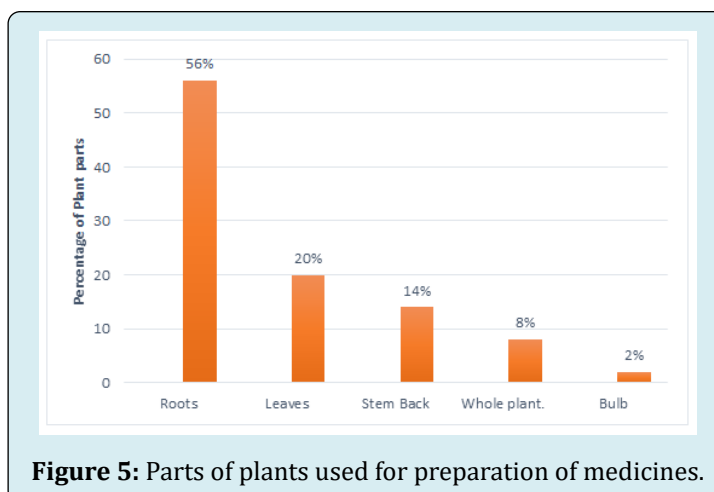


**Figure 4:** Forms of the medicinal plants used by the herbalists.

### Plant Parts used, Preparation, and Administration

The root/root bark was the most frequently used plant part (56%), followed by the leaves (20%), stem bark (14%), and the whole plant (8%). The bulb had the lowest number of mentions (2%), while flowers and fruits were not cited by any of the respondents in the study refer to Figure 5.

Most herbalists mentioned decoctions as the most common method for preparing remedies, involving the boiling, or soaking of fresh or dried plant parts in water. Other methods included poultices, ash, powder mixed with water for oral administration, and infusion. All herbal preparations were freshly made just before administration. The oral route was cited by all TMPs as the preferred method for administering the medicine in the treatment of arthritis.



**Figure 5:** Parts of plants used for preparation of medicines.

### Ethnobotanical Uses and Reported Pharmacological Activities

The study involved cross-referencing the plant species with documented traditional uses in other communities. This was conducted with the aim of determining whether these plants had been previously utilized to treat arthritis and related symptoms. The literature search refer to Table 3 revealed that 30 plant species had either been traditionally used to treat arthritis, rheumatism, and other joint-related conditions or had been reported to possess pharmacological activities relevant to arthritis management. Among these, eight were specifically reported to be used for the treatment of arthritis. These are *Flacourtia indica* [16], *Carissa spinarum* [17], *Clutia abyssinica* [17], *Phyllanthus amarus* [18], *Rhamnus prinoides* [19,20], *Rothea myricoides* [21],

*Trimeria grandifolia* [22] and *Withania somnifera* [23]. Plant species that have been reported for use in managing rheumatism include *Acacia* spp [24], *Albuca abyssinica* [25], *Asparaguss racemosus* [26], *Carissa spinarum* [27], *Harungana madagascariensis* [28], *Momordica foetida* [29], *Markhamia lutea* [30], *Physalis Peruvian* [31,32], *Urtica massaica* [33] and *Withania somnifera* [23]. The plants that have been reported to be used in treating joint conditions and symptoms related to arthritis (joint pain and inflammation) include *Asparagus racemosus* [26], *Biophytum umbraculum* [34], *Cirsium vulgare* [35], *Clematis brachiata* [36], *Eucalyptus* spp [37] *Maytenus obscura* [38], *Momordica foetida* [39], *Morus nigra* [40], *Phyllanthus amarus* [18], *Rhamnus prinoides* [19], *Rhamnus staddo* [41], *Searsia pyroides* [42], *Spathodea campanulata* [43] and *Tagetes minuta* [44]. *Vangueria apiculata* [45].

Botanical Name	Relevant Biological Activity	Chemical Constituents	Relevant Ethnomedical Uses
<i>Acacia</i> spp	Not reported	Not reported	Rheumatism [24]
<i>Albuca abyssinica</i>	No reports	No report	Treating rheumatism [59]
<i>Asparagus racemosus</i>	Not reported	Flavonoids, isoflavons, phenolic compounds [60]	Widely used in Ayurveda to treat inflammation and rheumatism [60]
<i>Biophytum umbraculum</i>	Anti-inflammatory activity [46]	Flavone-C-Glycosides [61] Tannins and flavonoids [62]	Treatment of joint pains, inflammations and fever [34]
<i>Carissa spinarum</i>	The root extract had antioxidant and anti-inflammatory activities [63]	Sesquiterpenes, Flavonoids, Sterols and triterpenes [64]	Headache, chest complaints, rheumatism [27] and arthritis [65]
<i>Cirsium vulgare</i>	Antioxidant [66]	Phenolic acids, Sterols, alkaloids, triterpenes and flavonoids [66]	Used for inflammation [35]
<i>Clematis brachiata</i>	Anti-inflammatory, antinoceptive and antipyretic activities [48]	Saponins, flavonoids and terpenoids [67]	Used to manage pain and swelling [36]



<i>Clutia abyssinica</i>	Not reported	Flavonoids, phenolic compounds and terpenoids [17]	Treatment of arthritis [65]
<i>Eucalyptus spp</i>	Antioxidant, anti-inflammatory [49] and analgesic activities	Essential oils, tannins, saponins and steroid [68]	Eucalyptus oil has been reported to be effective in reducing pain, swelling, and inflammation [69]
<i>Flacourtia indica</i>	Antioxidant [70] and anti-inflammatory activity [71]	Flavonoids, terpenoids, phenols and steroids [71]	The bark is believed to be effective in treating arthritis [16]
<i>Harungana madagascariensis</i>	Stem bark shown high antioxidant [72] and anti-inflammatory activities [51]	Alkaloids phenolics flavonoids and saponins [73]	Used for migraine and rheumatism [28]
<i>Indigofera arrecta</i>	Anti-inflammatory activity [52]	Steroids flavonoids glycosides Terpenoids and rotenoids [74]	Leaves used to treat toothache and stomachache [24]
<i>Markhamia lutea</i>	Anticancer and antioxidant activity [75]	Flavonoids, phenolic compounds and glycosides [76]	Treatment of rheumatic pain [30]
<i>Maytenus obscura</i>	Anti-inflammatory [53]	Aqueous and dichloromethane extracts contained flavonoid anthraquinone [53]	Treatment of Inflammation [38]
<i>Momordica foetida</i>	Antioxidant activity [77]	Steroids, phenolics and flavonoids and saponins [73]	Used to treat swelling [39,78] and to manage rheumatism [29]
<i>Morus nigra</i>	Antioxidant [79] and anti-inflammatory activities [54]	Two anthocyanins, cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside in the fruits [80]	Treatment of inflammation disorders [40]
<i>Phyllanthus amarus</i>	Antioxidant and anti-inflammatory activities [55]	Lignans, flavonoids, ellagitannins, alkaloids, triterpenes and sterols [18]	Used traditionally in Brazil for treating joint aches, inflammations and arthritis [18]
<i>Physalis peruviana</i>	Antioxidant [81]	Phytosterols, steroid and flavonoid [82]	The fruit is reported to be used for rheumatism [31,32]
<i>Rhamnus prinoides</i>	Antioxidants [83]	Flavonoids triterpenes and phenols [84]	Reported use in treating arthritis, back and joint aches [19,20]
<i>Rhamnus staddo</i>	No report	Flavonoids, steroids and sterols	Treatment of headaches, back and joint pain [41]
<i>Rothea myricoides</i>	No Report	Alkaloids, terpenoids and flavonoids [85]	Rheumatism and arthritis [21]
<i>Searsia pyroides</i>	Anti-inflammatory and antioxidant activity [42]	Biflavonoids [86]	To treat oxidative stress and inflammatory related conditions [42]
<i>Solanum incanum</i>	antioxidant analgesic and antipyretic activities [87]	The fruit has flavonoids and steroids [88]	Treatment of tooth-ache, stomach-ache, fever and chest pains among communities in East Africa [89]
<i>Spathodeacampanulata</i>	Antioxidant, anti-inflammatory and analgesic [56]	flavones and phenolic compound [90]	Flowers used to treat inflammation. Leaves used for urethra inflammation [43]
<i>Tagetes minuta</i>	Antioxidant and anti-inflammatory [57]	Essential oils, dihydrotagetonone, b-ocimene and tagetenone [91]	It has been used in Ayurvedic medicine in treating pain and inflammation [44]

Trimeria grandifolia	Cytotoxic activity	Contains idesin, lupenone and $\beta$ -Sitosterol	In a concoction to treat arthritis and toothache [22]
Urtica massaica	Not reported	Flavonoids and sterols	Fractures, injuries and rheumatism [33] and Stomach-ache
Vangueria apiculata	Not reported	Not reported	Used for general body strength, treating arthritis, backache and joint pains [45]
Withania somnifera	Antioxidant and anti-inflammatory activities [58]	Withanoloides, steroidal lactones [23]	Prescribed in Ayurveda for musculoskeletal disorders like arthritis and rheumatism [23]

**Table 3:** Cross-referencing of arthritis treatment candidate plant species collected from North Nyamira Sub-County with published literature.

The anti-inflammatory, analgesic and antioxidant activities of some of the plants which were cited in the study have been validated through *in vivo* and *in vitro* model studies. Plants with validated anti-inflammatory activity include Biophytum umbraculum [46], Carissa spinarum [47], Clematis brachiata [48], Eucalyptus spp [49], Flacourtia indica [50], Harungana madagascariensis [51], Indigofera arrecta [52], Maytenus obscura [53], Morus nigra [54], Phyllanthus amarus [55], Searsia pyroides [42], Spathodea campanulata [56], Tagetes minuta [57] and Withania somnifera [58]. Eighteen (37.5%) of plants species cited in this study were documented for the first time to be traditionally used in management of arthritis. These species are Ajuga remota, Berkheya spekeana, Carduus chamaecephalus, Conyza bonariensis, Echinops amplexicaulis Ekebergia capensis, Ensete ventricosum, Erythrina abyssinica, Euclea divinorum, Kalanchoe densiflora, Microglossa pyrifolia, Phragmanthera usuiensis, Rhoicissus tridentate, Rytigynia acuminatissima, Solanecio manni, Solanum terminale, Toddalia asiatica, and Vangueria madagascariensis Table 3.

### Conclusion and Recommendations

The present study identified and documented, for the first time, medicinal plants used to treat arthritis in the study area. Despite the increased use of conventional medicine to manage arthritis and other related joint problems, this study shows that the use of traditional herbal remedies continues to be embraced by many people suffering from arthritis in this modern world. Literature searches conducted to compare the claims of the herbalists in the study with reported similar uses of the plants in other communities serve to justify their use in the management of arthritis. Documented anti-inflammatory, analgesic, and antioxidant activities of most plants identified in this study also support their use in treating arthritis.

Furthermore, studies have shown that oxidative

damage and inflammation, which characterize arthritis, are due to free radicals like reactive oxygen species (ROS) and reactive nitrogen species. Validated antioxidant activities in some of the plants encountered in this study further justify their use in arthritis since they are known to neutralize these free radicals. The study identified and documented 18 plant species cited for the first time to be traditionally used for arthritis. However, further pharmacological and phytochemical investigations should be carried out to determine the bioactive compounds responsible for the claims by the TMPs. These compounds may hopefully provide lead compounds that can be utilized in drug discovery.

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