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Ethnobotanical Study of Medicinal Plant Species Traditionnally used in Negage City, Northern Angola

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Abstract

The aim of this study was to inventory the plants traditionally used to treat common diseases in Negage City. The survey was conducted in 2022 from September to December. Data were collected using a semi-structured questionnaire, interviews and discussions with residents of the town of Negage. A total of 60 medicinal plant species belonging to 53 genera, in 31 botanical families, were documented as being used in the treatment of various ailments. The main families identified were: Solanaceae with 7 species, Euphorbiaceae (5 species), and Fabaceae (5 species). Of these, 40 species (65.6%) were exotic and 21 were indigenous (34.4%), and all plants were collected in the residential area of Negage city. Herbaceous plants (29.5%), and trees (28.0%) were the most commonly used life forms, while leaves were the most used plant tissue (71%). Phanerophytes were the most used life form in Negage City, comprising 47.7% of the species; followed by therophytes contributing 23.1% of the species. Most (61.6%) of the plant species in use had a very wide world distribution; for example, 50.8% of species were pantropical. Decoction (50%), and oral intake (44%) were the main methods of drug preparation and administration used. Fifty ailments were documented, of which abdominal pain (8%) and malaria (7.4%), were the most commonly treated. In the town of Negage, traditional and modern medicines have coexisted for centuries and are used to treat human illnesses. The therapeutic uses of the documented plants provide a foundation for further research focused on pharmacological studies and conservation of the most important species.

Key words: *Ethnobotany, Plant remedies, Human ailments, Negage City, Northern Angola*

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1. Introduction

Since ancient times, humans have relied on the plants around them for medicinal purposes. This knowledge has been passed down through generations, with different civilizations and cultures developing their expertise in medicinal plants through experience and observation. Medicinal plants play a crucial role in treating and preventing human ailments and have beneficial effects on healthcare (Srivastava *et al*., 1996). Currently, two-thirds of the world's pharmacopeia is based on plant-derived remedies, and phytotherapy is regaining prominence as synthetic drugs like antibiotics lose effectiveness due to increasing resistance among bacteria and viruses (Dhingra *et al*., 2020). However, it is important to recognize that while medicinal plants might seem accessible and straightforward to use, some can have side effects, be toxic, or even deadly (Zeggwagh *et al*., 2013). Thus, like any medicine, they should be used cautiously and preferably under the guidance of a specialist.

Herbal remedies, also known as botanical medicines or phytomedicines, are defined by the World Health Organization (WHO) as plants, plant materials, herbal preparations, and finished herbal products containing whole plants, parts of plants, or other plant materials, including leaves, barks, berries, flowers, and roots, or their extracts as active ingredients intended for therapeutic use (WHO, 2001). Due to their affordability and accessibility, herbal healthcare systems are increasingly popular worldwide (Sureshkumar *et al*., 2017).

Plant-based therapy is essential in the primary healthcare of about 80% of the world's population (Ozioma and Chinwe, 2019). According to the WHO (2011), 70-95% of people in developing countries heavily rely on herbal medicine for primary healthcare, and about 80% of people in Africa depend on medicinal plants for their health care (WHO, 2002). Herbal medicine is integral to traditional African medicine, the oldest and most widespread medical system globally, used in all societies and cultures (Natako, 2006). Throughout history, humans have developed knowledge about plants and their uses, significantly influencing modern medicine and the treatment of many diseases (Rangel and Bragança, 2009).

In sub-Saharan Africa, the history of civilizations is primarily marked by oral tradition, passed down from parents to children or from the elderly to the young, resulting in a scarcity of ethnobiological and ethnopharmacological records. Traditional knowledge is also tied to biodiversity conservation. Plants have been used for food, curing diseases, and making various tools since ancient times (Monizi *et al*., 2018a). In Angola, medicinal plants are commonly used for primary healthcare in both rural and urban areas, contributing to the development of the pharmaceutical industry (Costa and Pedro, 2013; Heinze *et al*., 2017). Despite the lack of written records, the practice of using plant, animal, and mineral resources to prevent or cure diseases is ancient and has been transmitted orally from older to younger generations (Heinze *et al*., 2017).

For economically disadvantaged populations, access to industrialized health services and medicines is limited. Therefore, medicinal plants, often easy to obtain and considered safe and beneficial, are a natural alternative (Welz *et al*., 2018). However, scientific knowledge about the safety and reliability of most medicinal plants is limited (Rocha *et al*., 2021). The knowledge of medicinal plant uses is typically acquired through long experience and passed down through generations (Klotoé *et al*., 2013). Unfortunately, this knowledge is under threat as it has not yet been fully validated by the scientific community, leading to its loss in developing countries, particularly in Africa (Anyinam, 1995; Akabassi *et al*., 2017).

In Angola, traditional medicine is prevalent, and empirical knowledge is maintained in some families (Heinze *et al*., 2017). As the global population increasingly turns to natural pharmaceutical products for sustainable living, Angola, with its rich and diverse flora, must use this knowledge rationally to address health problems through therapeutic exploration of its ethnomedicinal knowledge. In northern Angola, particularly in Negage City, knowledge about medicinal plants is transmitted orally from generation to generation, but this practice is in danger of being lost. Expanding the study and documentation of medicinal plants can help preserve this knowledge. Documenting indigenous knowledge through ethnobotanical studies is crucial for protecting biodiversity and ensuring its sustainable use for present and future generations.

This study aims to document the traditional use of medicinal plants found in Negage City to provide safe and effective information on their use as alternative therapeutic sources for managing human diseases. The specific objectives are: (1) To document the socio-demographic profile of the respondents; (2) To inventory the medicinal plants in the study area; (3) To identify and characterize these species taxonomically and ecologically; and (4) To collect information on human diseases treated with medicinal plants, including the plant organs used, methods of preparation and administration of therapeutic prescriptions, and the relationship between medicinal plants and the ailments they treat.

2. Materials and methods

2.1. Study area

Negage City is located about 37 km from the city of Uíge and is also the second largest City (Figure 1) of the Uíge province after Uíge, the capital city of Uíge. Negage City is located between 4° 18' and 4° 25' South latitude and between 15° 18' and 4° 22' East longitude.

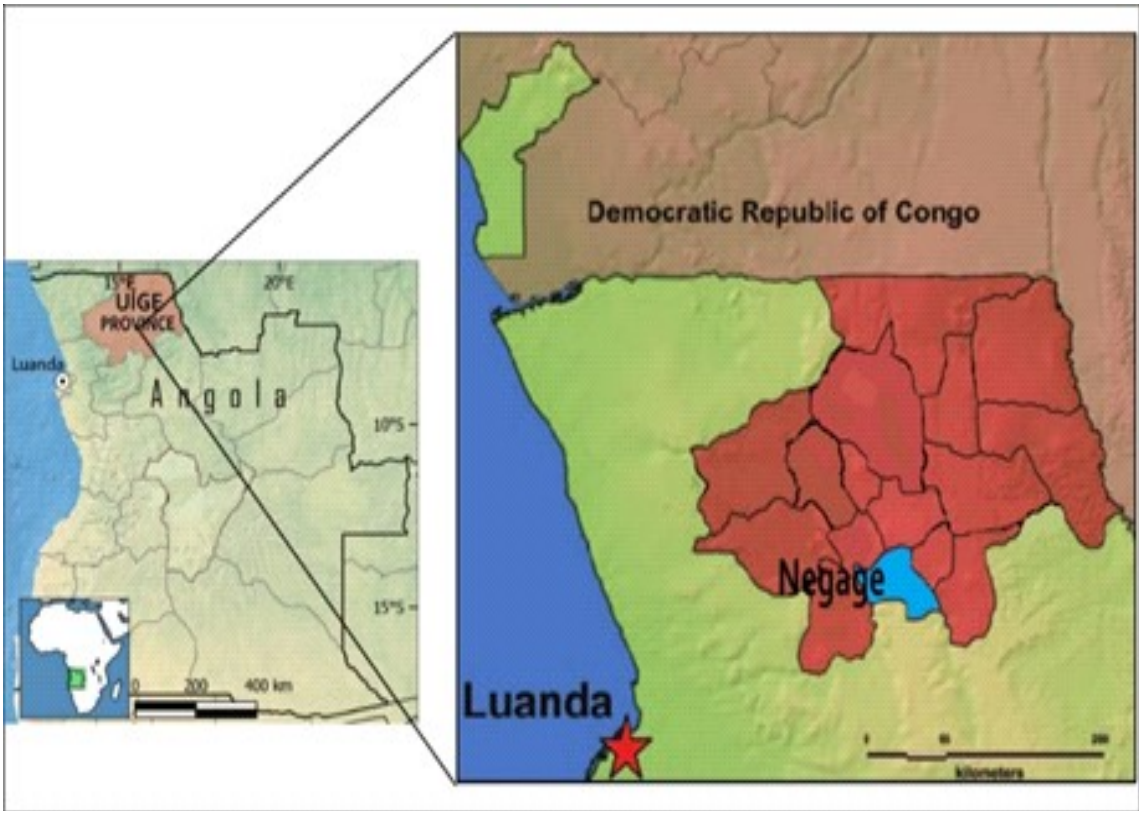

Figure 1: Location map of Uíge province in Northern Angola, and study area of Negage City in blue and Uíge city in yellow

The people of Negage City are mainly of Bantu origin and belong to the Bakongo ethnolinguistic group. Kikongo, Portuguese, and Kimbundu are the most widely spoken languages. Subsistence farming is the main source of income, food, and employment.

The predominant climate in Negage City is a humid subtropical climate with a long and well-defined rainy season from September or October to May. The months of April and November are characterized by more rain, with annual rainfall ranging from 1300-1600 mm/year, with an annual average of 1450 mm. It should be noted that Negage City is one of the coldest places in the Uíge province. It is evident there is much less rainfall during the dry season than in the rainy season. The high values of relative humidity oscillate around 95%, and the average annual temperature ranges from 20 to 22°C (Peel *et al.*, 2007).

2.2. Methods

2.2.1. Plant material collection and identification

Medicinal plants were collected from garden plots in the city of Negage. The specimens were prepared, taxonomically recognized, and voucher specimens were deposited in the Herbarium of Kimpa Vita University. Plants were identified utilizing illustrated books, theses, and scientific journals particularly, Lautenschläger *et al*. (2018), Latham and Konda ku Mbuta (2017), and Mawunu *et al*. (2022a, b). The appropriate taxonomy of the medicinal species of the documented plants was confirmed by the POWO (2023).

The identified plants were classified into two groups, namely native species and exotic species. Furthermore, the identification of biological types followed Raunkiaer's classification (1934), as modified for application to tropical regions (Habiyaremye, 1997). This approach essentially takes into account both the position and degree of protection of the buds, as well as the size of the individual plant. Finally, phytogeographic groups, indicating the origin and range of distribution of each species across the globe were identified (Pisco *et al.*, 2024; POWO, 2023; Habiyaremye, 1997).

2.2.2. Socio-demographic survey

The survey was conducted in 2022 from September to December. A total of 250 randomly selected informants were interviewed, including 158 women and 92 men, all residents of Negage City, and at least 18 years of age. The informants were chosen at random, in order to give everyone the same chance, without favouritism. The interviews were oral, but there were also written forms. These informants were approached using semi-structured interviews that were conducted in the Portuguese language. Semi-structured interviews and direct field observations were used to collect ethnobotanical data (Monizi *et al.* 2019, Monizi *et al.* 2018a, Mawunu *et al.* 2023a, Mawunu *et al.* 2023b, Mawunu *et al.* 2022a, Mawunu *et al.* 2022b), and based on the open-ended interview guide, which avoids influencing the informant's response (Martin, 2004).

2.2.3. Questionnaire

The questionnaire was divided into two sections: (1) attributes of the personal informant (including, gender, age, education level, and source of income); and (2) ethnomedicines data (including, local names of medicinal plants, life forms, and the status of medicinal plants used, plant organs used, ailments treated, and in each case the methods of preparation and administration were also recorded (Mawunu *et al.* 2022b). During the fieldwork, plant samples were collected, and photographs were taken for later identification. The individual anthropological interviews were conducted in the local languages Kikongo and Kimbundu and Portuguese, the languages spoken by the informants. It should be noted that some of the informants interviewed spoke all three languages, while others spoke only one. For this reason, during the interview, the informant was questioned in the language he or she spoke best. Besides, the selection criteria of the surveyed people were based on the age of informants (aged 18 years old and over) who had knowledge of the utilization of medicinal plants under investigation and uses of those plants in the management of human diseases, and who were available at the time of the survey. Finally, direct observations and the semi-structured questionnaire were submitted orally to the different informants (20-80 years old).

2.2.4. Data analysis

The ethnomedicinal data collected were analyzed using descriptive statistics. Microsoft Office Excel (version 2016), and, finally, presented in the form of graphs or tables.

3. Results and discussion

3.1. Socio-demographic characterization of informants

Among the respondents in this survey, women (63.2%) outnumber men (36.8%). During the ethnobotanical surveys, more women than men were present in the residential plots. This may be related to the matrilineal nature of the Bantu society, particularly the Bakongo of northern Angola. A study by Badke *et al.* (2011) highlighted the role of women as holders and disseminators of knowledge on the use of plants in health-care as women are responsible for family care. Similarly, Mawunu *et al.* (2022b) reported that women outnumbered men in the use of medicinal plants in the small city of Songo. Besides, in the Kongo tradition, women have a historical and socio-cultural value that they acquired from their mothers and grandmothers, which allows them to play an important role in providing health care and food security for members of the household. Furthermore, in the northern part of Angola, women practicing traditional herbal medicine and protecting family health outnumber men (Monizi *et al.* 2019). Consistent with Monizi *et al.* (2019), and Vasconcelos *et al.* (2001), the preponderance of female responders is attributed to the societal expectation that women undertake domestic responsibilities, child-rearing, and main household care.

Furthermore, the results of the general census carried out in 2014 showed that the majority of the Angolan population were women (52%). In the province of Uíge, women outnumbered men were in the majority (51%)

than men (49%). Finally, in the municipality of Negage, the majority of the population was female with 52.5%. (NIS, 2016). The predominance of women in the area in this study would be due to their demographic superiority, their availability for our study, and their and their knowledge of phytotherapy. Studies conducted in Morocco (Sekkat *et al*. 2023), in Brazil (González-Ball *et al*., 2022), in Nigeria (Borokini *et al*., 2013) have reported that women are familiar with phytotherapy because they have a great deal of know-how and have and have learnt to make better use of the role of plants as medicinal remedies in caring for their families.

3.2. Translated with DeepL.com (free version)

Most (77%) of the traditional knowledge holders are in the older age group, while 19% are adults and 4% of informants were youth. The fact that the young inhabitants of Negage City were also holders of ethnobotanical knowledge related to medicinal plants, ensures that this knowledge will be passed on to future generations.

Regarding the level of education of respondents, most (79%) were literate, leaving 21% as illiterate. Among the 79% who were literate, 35% had completed primary education, 29% had completed secondary education, 8% had participated in adult literacy programs established by the Angolan government to assist individuals who missed formal schooling due to the prolonged civil war in acquiring reading and writing skills, and 7% were university graduates. The fact that ethnobotanical knowledge about medicinal plants is held by literate people shows that it is possible to preserve it in writing as well as transmitting through oral traditions. Among the informants, agriculture is the main (51%) source of income, food, and employment, followed by trade (25%), odd jobs (19%), and public service for 5% of them. Negage City is a region with a long agricultural tradition. The relationship with the land is based on subsistence production, and the sale of surplus produce, using mainly family labour as in other towns in the province of Uíge. Similarly, Mawunu *et al*. (2022a), and Mawunu *et al.* (2016) reported that agriculture was the main source of income and employment in the rural municipalities of Ambuila and Mucaba in the same province of Uíge. Data from the 2014 national census conducted in Angola (NIS, 2016), reported that, nationally, agriculture is the largest source of income and employment (46%).

3.3. Diversity of the ethnomedicinal flora of Negage City

The current study identified 60 species of medicinal plants used to treat various human health problems and illnesses, belonging to 53 genera and 31 botanical families. Scientific names, local names, botanical families, life forms, biological types, phytogeographical distribution, treatment of diseases, parts of the plant, methods of preparation and administration, as well as the nativity status of the species (native, exotic or introduced) are also given in table 1. This shows that members of the Solanaceae (7 species) were most used as herbal medicine for various health problems in the study area, Negage City. Other well-represented plant families were Euphorbiaceae, Fabaceae, and Asteraceae (with 5 species each), and Lamiaceae, with 4 species. The dominance of these families might be due to their abundance in the study area. Anacardiaceae and Poaceae were each represented by three (3) species, and the Acanthaceae, Arecaceae, Burseraceae, and Zingiberaceae each had two (2) species each. The remaining botanical families were represented by only one species : the Amaranthaceae, Annonaceae, Apiaceae, Basellaceae, Brassicaceae, Caricaceae, Combretaceae, Commelinaceae, Convolvulaceae, Costaceae, Crassulaceae, Ebenaceae, Lauraceae, Malvaceae, Meliaceae, Musaceae, Myrtaceae, Passifloraceae, Rosaceae and Rutaceae. With regard to the native status of the medicinal plants documented in the current study, the majority (40 species or 65.6%) of these plants are of exotic origin, i.e. plants introduced voluntarily or involuntarily by human. The remaining medicinal plants (21 species or 34.4%) are native species (Table 2).The abundance of exotic plants in this study area is linked to their adaptability to different environments, their ability to spread over long distances and the fact that they have long-lasting diaspores. Fifteen (15) of the twenty (20) families represented by a single species are exotic. The Negage City population's preference for Solanaceae, Euphorbiaceae, Fabaceae, Asteraceae and Lamiaceae as phytomedicines can be attributed to their availability and abundance, but also to the various socio-cultural uses of plants in these families by local populations. Again the majority of species in these more commonly used families are introduced (18 out of 26 species. According to Thomas *et al*. (2009), the diversity of plant species used in plant medicines depends on the biodiversity of the regional flora, the availability, accessibility of plant resources, and the knowledge

associated with their use as medicinal plants. Based on our observation of the high frequency of exotic species, it is reasonable to suggest that communities have shared and transferred their knowledge of medicinal plants, and have traded plant material across considerable distances, over time.

The taxa documented in the City of Negage come from 5 different continents of the world, with Africa in first place (37.9%), followed by species from the Americas (Central and Latin) with 34.8% and Asia (22.7%) as the largest suppliers of allochthonous species in the current study area. Also, Europe (3.0%) and Oceania (1.5%) contributed very little to the enrichment of the medicinal flora of the town of Negage.

Besides, the migration of these various exotic plant species to the town of Negage is thought to have been facilitated by several abiotic and biotic factors, in particular trade between the different continents, the slave trade, the wind and pollinating agents (insects, birds, mammals including humans) and their adaptation to the ecological conditions, in particular the pedoclimatic conditions, of the host area. So the introduction of new species into the local flora has had the effect of "extending the geographical range" of exotic taxa. It should also be pointed out that the transatlantic trade from Africa to the Americas had consequences that cannot be summed up simply as the deportation of people, but also of plants (Villapoll, 1984). Throughout the world, it has led to changes in phytogeography (Devineau and Guillaumet, 1992; Fleury, 1994; Puig, 1994).

Lastly, Africa, which received much from Asia and America, distributed species such as *Abelmoschus esculentus*, *Aframomum melegueta*, *Hibiscus sabdariffa*, *Sesamum orientale*, *Solanum macrocarpon*, *Vigna unguiculata* and *V. subterranea* (Devineau and Guillaumet, 1992; Fleury, 1994; Puig, 1994; Katz, 1994). As the history of plant migration closely parallels that of mankind, these plants bear witness to the ecological, economic and cultural factors that governed their choice (Fleury, 1994). Despite the transcontinental traffic in plants, there have also been exchanges between neighbouring regions within territories.

Table 1: Ethnomedicinal flora, family, preparation method, route of administration, life forms, biological types, phytogeographical distribution, and plant status collected in the Negage City

Family	Species plant	Local names	Life form	Parts used	Ailments and symptoms	Preparation method	Nativity Status	Administration method	Frequency of species cited and RFC
Acanthaceae	*Brillantaisia owariensis* P.Beauv.	Malemba lemba (Kik.)	Herb	Leaves	Stomachache, body weakness, open fontenelle, hypertension, bellyache	Grinding	Native	Oral intake	97 (0.045)
Acanthaceae	*Dianthera secunda* (Lam.) Griseb.	Folha de jeová (Port.), Makayama menga (Kik.)	Herb	Leaves	Anaemia/low haemoglobin level	Decoction, infusion	Exotic	Oral intake	31(0.014)
Amaranthaceae	*Dysphania ambrosioides* (L.) Mosyakin & Clemants	Santa maria (Port.), Kinsidinsimba (Kik.)	Herb	Leaves	Bellyache, cough, headache, stomachache, malaria	Grinding	Exotic	Enema	119(0.056)
Anacardiaceae	*Lannea welwitschii* (Hiern) Engl.	Makumbi, Nkumbi (Kik.)	Shrub	Stem bark	Backache, cough	Grinding	Native	Oral intake	9(0.004)
Anacardiaceae	*Mangifera indica* L.	Mangueira (Port.), Nti a manga (Kik.)	Tree	Stem bark	Hemorrhoid, backache, diarrhoea, typhoid, cough	Maceration	Exotic	Oral intake	127(0.059)
Anacardiaceae	*Spondias mombin* L.	Gajajeira (Port.), Mungiengie (Kik.)	Tree	Leaves	Mastitis	Decoction, infusion	Exotic	Oral intake	52(0.024)
Annonaceae	*Annona muricata* L.	Sapi sapi (Port.), Mbundu ya ngombe (Kik.)	Shrub	Leaves	Stomachache	Decoction	Native	Oral intake	33(0.015)
Apiaceae	*Steganotaenia araliacea* Hochst.	Mukula mvumbi (Kik.)	Shrub	Root	Backache	Decoction	Native	Bathing	11(0.005)
Arecaceae	*Cocos nucifera* L.	Coqueiro (Port.), Kokoti (Ling.)	Tree	Root	Hepatitis	Decoction	Exotic	Enema	22(0.010)
Arecaceae	*Elaeis guineensis* Jacq.	Palmeira (Port.), Ba dia ngazi (Port.)	Tree	Fruit	Eye problems	Decoction	Native	Eating	27(0.013)
Asteraceae	*Chromolaena odorata* (L.) R. M. King & H. Rob.	Kongo ya sika (Ling.)	Shrub	Leaves	Injury, fever, stomachache	Grinding, decoction	Exotic	Wound dressing, oral intake	20(0.009)
Asteraceae	*Emilia coccinea* (Sims) G.Don	Malalulalu (Kik.)	Herb	Leaves	Tinea capitis	Grinding	Native	Rubbing	15(0.007)

Table 1 (Cont.)

Asteraceae	*Erigeron sumatrensis* Retz.	Madiambadiaba (Kik.)	Herb	Leaves	Malaria	Decoction, infusion	Exotic	Enema	11(0.005)
Asteraceae	Unidentified	Kafuku (Kik.)	Shrub	Leaves	Backache	Grinding	Exotic	Enema	17(0.008)
Asteraceae	*Gymnanthemum amygdalinum* (Delile) Sch.Bip	Malulua, Malulu (Kik.)	Small Tree	Leaves	Infections, stomachache, allergies, swollen belly, measles, bellyache	Grinding	Native	Rubbing, oral intake	98(0.046)
Basellaceae	*Basella alba* L.	Espinafre (Port.), Epinard (Fr.)	Climbing	Leaves	Anaemia	Decoction	Exotic	Oral intake	5(0.002)
Brassicaceae	*Brassica oleracea* L.	Couve mil folhas (Port.)	Herb	Leaves	Diabetes	Cooking	Exotic	Eating	4(0.002)
Burseraceae	*Canarium schweinfurthii* Engl.	Mumbidi, mbidi (Kik.)	Tree	Leaves, resin	Spleen, toothache	Decoction	Native	Oral intake, mouth wath	3(0.001)
Burseraceae	*Pachylobus edulis* G.Don	Safuciro (Port.), Nsafu (Kik.)	Tree	Leaves	Dental caries, toothache, diarrhoea	Decoction	Native	Mouthwash	94(0.044)
Caricaceae	*Carica papaya* L.	Mamoeiro (Port.), Kikila (Kik)	Shrub	Root	Hemorrhoid, bellyache, typhoid, constipation, toothache, kidney pain, urinary infection, hypertension	Decoction, infusion	Exotic	Oral intake	98(0.046)
Combretaceae	*Terminalia catappa* L.	Figueira-da-índia (Port.)	Tree	Leaves	Hemorrhoid, diarrhoea	Decoction	Exotic	Oral intake	11(0.005)
Commeliaceae	*Commelina diffusa* Burm.f.	Lankazi (Kik.)	Herb	Leaves	Open fontenelle, eye problems	Grinding	Native	Tie Around head, eye drops	3(0.001)
Convolvulaceae	*Ipomoea batatas* (L.) Lam.	Batata doce (Port.), Mbalazanzenzo (Kik.)	Creeping	Leaves	Stomachache, anaemia	Decoction, grinding	Exotic	Oral intake	81(0.038)
Costaceae	*Costus afer* Ker Gawl.	Sangalavua (Kik.)	Herb	Stem	Hepatitis	Courting	Native	Chewing	13(0.006)
Crassulaceae	*Kalanchoe crenata* (Andrews) Haw.	Ntotozi (Kik.)	Herb	Leaves	Leprosy, diabetes	Heating, grinding	Exotic	Rubbing, oral intake	33(0.015)
Ebenaceae	*Diospyros heterotricha* (Welw. ex Hiern) F.White	Lufua lua Ndombe, Munkoki (Kik.)	Shrub	Root	Toothache	Decoction	Native	Mouthwash	3(0.001)
Euphorbiaceae	*Alchornea cordifolia* (Schumach. &Thonn.) Müll.Arg.	Mbunze, gunze (Kik.)	Shrub	Leaves	Fevers	Decoction	Native	Oral intake	4(0.002)
Euphorbiaceae	*Croton mubango* Müll.Arg.	Bango bango (Kik.)	Tree	Leaves	Malaria	Decoction	Exotic	Steam bath	17(0.008)
Euphorbiaceae	*Jatropha curcas* L.	Mpuluka (Kik.)	Shrub	Sap	Tinea capitis,mastitis, stomachache, typhoid	Incision	Exotic	Rubbing	55(0.026)
Euphorbiaceae	*Manihot esculenta* Crantz	Mandioqueira (Port.), Ntiadioko (Kik.)	Shrub	Tuber, leaves	Eyes parasite, open cervix, hepatitis	Grinding	Exotic	Eye drops	38(0.018)
Euphorbiaceae	*Ricinus communis* var. africanus MÜLL. Arg.	Gimono (Kimb.)	Shrub	Leaves	Kidney pain, stomachache	Grinding	Exotic	Tie Around head, oral intake	14(0.007)
Fabaceae	*Erythrina variegata* L.	Lungolungo (Kik.)	Tree	Leaves	Anaemia/ low haemoglobin level, spleen, hepatitis, backache, haemorrhoid, hemorrhage	Decoction, infusion	Exotic	Oral intake	19(0.009)
Fabaceae	*Millettia versicolor* Welw. ex Baker	Mbota (Kik.)	Tree	Stem bark	Thrombosis, joint pain, body weakness	Tying	Native	Tie Around head	26(0.012)
Fabaceae	*Senna hirsuta* (L.) H.S. Irwin & Barneby	Maniokanioka (Kik.)	Shrub	Leaves	Fevers, colic, yellow fever	Decoction, infusion	Exotic	Oral intake	12(0.006)
Fabaceae	*Senna occidentalis* (L.) Link	Manioanioka (Kik.)	Subshrub	Root	Bellyache, stomachache, colic, swollen belly	Grinding	Exotic	Enema	69(0.032)
Fabaceae	*Senna spectabilis* (DC.) H.S.Irwin & Barneby	Ndunga (Kik.)	Tree	Leaves	Toothache	Decoction, infusion	Exotic	Mouthwash	12(0.006)

Table 1 (Cont.)

Lamiaceae	*Clerodendrum splendens* G.Don	Mankinda Ngolo (Kik.)	Climbing	Leaves	Pain in legs	Decoction	Native	Dermal route	17(0.008)
Lamiaceae	*Leonotis nepetifolia* (L.) R.Br.	Tuta dia mvula, Kumba dia mvuala (Kik.)	Subshrub	Leaves	Earache	Grinding	Native	Ear drops	4(0.002)
Lamiaceae	*Mentha x piperita* L.	Hortelão (Port.), Manguentena (Kik.)	Herb	Leaves	Malaria, stomach ache	Grinding	Exotic	Enema, oral intake	11(0.005)
Lamiaceae	*Ocimum gratissimum* L.	Mansudinsudi (Kik.)	Shrub	Leaves	Malaria, fever, headache, cough	Decoction, infusion	Native	Rubbing	71(0.033)
Lauraceae	*Persea americana* Mill.	Abacateiro (Port.), Mvoka (Kik.)	Tree	Leaves	Hypertension, measles, anemia/high blood pressure, swollen feet	Decoction	Exotic	Oral intake	117(0.055)
Malvaceae	*Abelmoschus esculentus* (L.) Moench	Quiabo (Port.), Kingombo (Kik.)	Herb	Fruit	Stomachache	Cooking	Exotic	Eating	45(0.021)
Meliaceae	*Azadirachta indica* A.Juss	Cura tudo (Port.)	Tree	Leaves	Typhoid	Decoction	Exotic	Oral intake	7(0.003)
Musaceae	*Musa* spp.	Bananeira (Port.), Dinkondo, mankondo (Kik.)	Herb	Root	Diarrhoea	Decoction	Exotic	Oral intake	21(0.010)
Myrtaceae	*Psidium guajava* L.	Goiabeira (Port.), Mfuluta, Ngavua (Kik.)	Small tree	Leaves	Bellyache, diarrhoea, stomachache, dysentery	Chewing, decoction	Exotic	Oral intake	77(0.036)
Passifloraceae	*Passiflora edulis* Sims	Maracujajeira (Port.)	Climbing	Leaves	Hypertension	Decoction	Exotic	Oral intake	14(0.007)
Poaceae	*Cymbopogon citratus* (DC.) Stapf	Chá cachinde (Port.), Nsinde dia mputu (Kik.)	Herb	Leaves	Cough	Decoction, infusion	Exotic	Oral intake	101(0.047)
Poaceae	*Saccharum officinarum* L.	Cana-de-açúcar (Port.), Mukuku, Munse (Kik.)	Herb	Stem	Hepatitis, yellow fever	Peeling, chewing	Exotic	Chewing	43(0.020)
Poaceae	*Zea mays* L.	Milho (Port.), Mansangu (Kik.)	Herb	Silks	Swollen feet, stomachache, sexual impotence	Decoction	Exotic	Oral intake	48(0.022)
Rosaceae	*Eriobotrya japonica* (Thunb.) Lindl.	Nespera (Port.)	Tree	Leaves	Cryptorchidism	Grinding	Exotic	Oral intake	8(0.004)
Rutaceae	*Citrus × limon* (L.) Osbeck	Limoeiro (Port.), Lala dia nsa/dia ngani (Kik.)	Shrub	Fruit, leaves	Typhoid, angina, cough, conjunctivitis	Decoction	Exotic	Oral intake	29(0.014)
Solanaceae	*Capsicum frutescens* L.	Gindungo (Kimb.), Ndungu (Kik.)	Shrub	Fruit	Panariasis, malaria	Grinding	Exotic	Putting on infected fingers	17(0.008)
Solanaceae	*Datura stramonium* L.	Tebo (Kik.)	Herb	Leaves	Body weakness	Grinding	Exotic	Rubbing	5(0.002)
Solanaceae	*Nicotiana tabacum* L.	Tabaco (Port.), Mfomo, Mfumu (Kik.)	Herb	Leaves	Cryptorchidism, haemorrhoids, inflammation testicles	Grinding	Exotic	Enema	28(0.013)
Solanaceae	*Solanum aethiopicum* L.	Mbolongua (Kik.)	Shrub	Fruit	Stomachache	Grinding	Exotic	Oral intake	33(0.015)
Solanaceae	*Solanum lycopersicum* L.	Tomateiro (Port.), Lumantu, Mantu (Kik.)	Subshrub	Leaves	Fevers, headache, haemorrhoid, high fever	Grinding	Exotic	Rubbing, oral intake	21(0.010)
Solanaceae	*Solanum macrocarpon* L.	Couve-preta (Port.), Lezo (Kik.)	Shrub	Leaves	Hypertension	Cooking	Native	Eating	44(0.021)
Solanaceae	*Solanum mauritianum* Scop.	Daniela (Port.), Mbonzua, Mumbonzua (Kik.)	Shrub	Leaves	Open fontenelle	Grinding	Exotic	Tie Around head	17(0.008)
Zingiberaceae	*Aframomum alboviolaceum* (Ridl.) K. Schum.	Ntundo, Ntundulu (Kik.)	Herb	Leaves	Spleen	Decoction, infusion	Native	Enema	13(0.006)
Zingiberaceae	*Aframomum melegueta* K.Schum.	Nungu za nzo (Kik.)	Herb	Leaves	Traumatism	Maceration, infusion	Native	Rubbing	49(0.023)

3.4. Life forms and nativity status of medicinal plants

Life forms analysis of medicinal plants (Figure 2) revealed that herbs (29.5%) were more often used than other plants. Other life forms used for phytomedicines were trees (27.9%), shrubs (23%), small trees (8.2%), sub-shrubs (6.6%), climbers (3.3%), and creeping plants (1.6%).

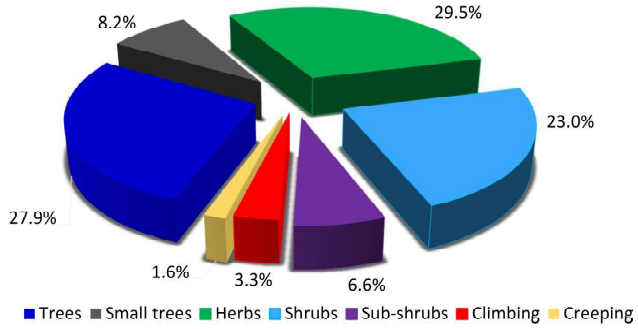

Figure 2: The Proportion of life forms medicinal plants in use in Negage City (%)

The high use of herbs in traditional medicine would be due an indication of their abundance in the study area and also of their ease of harvesting, and collection. In addition, herbaceous plants are often abundant and widely distributed, which contribute to their frequent use in herbal medicine. Heavy use of herbs in traditional medicine has been reported in various previous studies (Lawal *et al.*, 2022; Mukaila *et al.*, 2021). The results of this survey are in agreement with other studies which reported high medicinal use of herbaceous plants, shrubs, and trees (Johnny *et al.*, 2022; Qaseem *et al.*, 2019). Many studies have shown that various herbaceous plants have healing properties and are dominant in traditional herbal remedies (Ali *et al.*, 2020). In contrast, Mawunu *et al.* (2022b) found shrubs to be the most widely used life form in phytotherapy in Songo City, Angola. In the present study, in Negage City, most medicinal plants (40 species, i.e. 65.6%) were of exotic (or introduced) origin, and 21 (34.4%) of the species were native. The predominance of exotic plants in Negage City may be due to anthropic activities, and their great adaptability to various environmental conditions, i.e. pedoclimatic. Analysis of these results shows that the traditional pharmacopoeia of the city of Negage is mainly based on cultivated exotic plants (introduced voluntarily by humans) or non-cultivated plants (introduced involuntarily by humans such as, introduced by wind, birds, insects, etc.). Also, the predominance of exotic plants may be due to human activities, in particular to increasing uncontrolled urbanisation and the adaptability of exotic plants to various environmental conditions, including soil and climate. Human activities are contributing to the decline in the city's native urban flora. The urban ecosystem of the city of Negage, in which man is the most active biological species, directly and indirectly influences changes in all the other ecosystems. Wild plants have become rare, as wild vegetation in cities is destroyed or replaced by exotic plants. Similarly, Mawunu *et al.* (2022b), reported that most of the herbal medicines used in the small city of Songo were also of exotic origin. Human activities had contributed to the depletion of the small City of Songo's native urban flora.

Native plants have not disappeared; on the contrary, they are present in smaller numbers than exotic plants. Finally, the exotic plants have taken over from the native plants and have established themselves in this habitat. Perhaps they have a greater capacity for adaptability than the wild plants of the region.

3.5. Plant parts used in therapeutic recipes

Figure 3 shows the different plant organs used by the inhabitants of Negage to prepare herbal medicines.

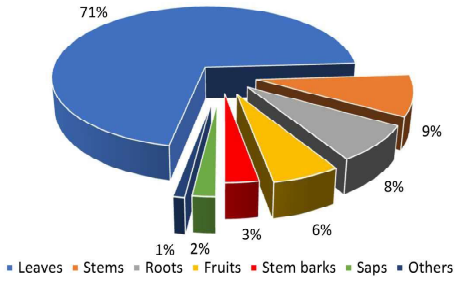

Figure 3: Proportion (%) of medicinal plant parts used in Negage City, Uíge Province, Angola

The plant parts used in traditional medicine by the inhabitants of Negage City are illustrated in Figure 3. Leaf was the dominant part (71.0%) of documented medicinal plants. Other plant parts used were stems (9.0%), roots (8.2%), and fruits (5.7%). The use of other plant parts was less common and ranged from 0.4 to 2.9%. The predominant use of leaves is attributed to the ease of harvesting. Harvesting of leaves puts less pressure on plant regeneration than removing roots, stems, seeds, flowers, and scraping stem and root bark. As noted by Srivastava et al. (1996) and Moyo et al. (2015), taking away bark, roots, seeds, and flowers can lead to significant harm. The use of leaves in phytomedicine protects the plants and then ensures the sustainability of their use. Besides, leaves are used because of their high therapeutic potency, their ability to regenerate quickly, as well for their abundance, and ease of harvesting for their high contents of compounds with various medicinal properties (Mawunu *et al.*, 2022b). In Angola (Mawunu *et al.*, 2022b ; Lautenschläger *et al.* 2018), and in other parts of the world such as the Democratic Republic of the Congo (Liyongo *et al.*, 2023; Ngbolua *et al.*, 2023a; Mobale *et al.*, 2023, Djoza *et al.*, 2021), and in Pakistan (Gulzar *et al.*, 2019) the use of leaves in the preparation of herbal medicine is common. According to Ahmad *et al.* (2014), leaves are the principal photosynthetic organs, and also serve as storage for exudates, some of which have therapeutic value. So, from the point of view of conservation, preservation, and sustainability, leaves are chosen over others plant components such as bark, and roots (Moyo *et al.*, 2015).

3.6. Biological types and phytogeographical distribution

The analysis of the different biological types and the phytogeographical distribution related to this flora are shown in Figures 4 and 5.

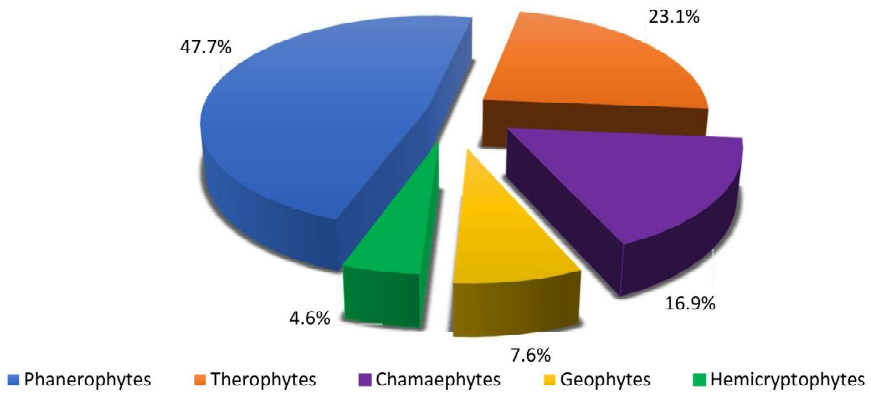

Figure 4: Proportion (%) of biological types of medicinal plants in Negage City, Uíge province

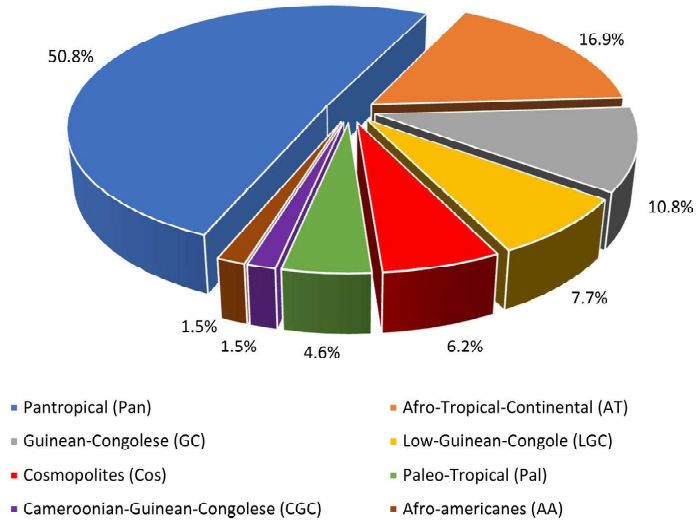

Figure 5: Proportion (%) of the phytogeographical distribution of medicinal plant species collected in Negage City, Uíge province

Of the 60 species, phanerophytes (mesophanerophytes, microphanerophytes, and nanophanerophytes) were the most represented biological types in the flora of Negage City with 47.7% of the species (Figure 4). They were followed by the therophytes (erect therophytes, climbing therophytes, making up 23.1% of all species reported) then the chamephytes (erect, crawling, and sucking chamephytes) with 16.9%. Finally, geophytes (rhizomatous geophytes, tuberous geophytes, and megageophytes), and hemicryptophytes followed, contributing 7.6%, and 4.6% of the species, respectively. The perennial nature of these species ensures their on going availability, as medicinal plants. The predominance of phanerophytes reflects the fact that the edapho-climatic conditions of the study area are generally favourable to these life forms. Finally, the predominance of phanerophytes in the medicinal flora of Negage City reflects the state of vegetation in the tropics. These results are in agreement with those of an earlier study in the Democratic Republic of the Congo (Ngbolua *et al.* 2023b; 2019).

Based on the analysis of the phytogeographical spectrum of the flora studied, the results of the present study (Figure 5) show that most (61.6%) of the medicinal plants in use belong to groups of species with a very wide world distribution, i.e. pantropical (50.8%), cosmopolitan (6.2%), and paleo-tropical (4.6%) species. These are followed by a group of regional species with 20% (Guinean-Congolese, Lower Guinean-Congolese, and Cameroonian-Guinean-Congolese), followed by continental Afrotropical species with 16.9%, and Afro-American species with 1.5%. Similar results were obtained in studies on diversity floristic and socio-economic value of fruits and leafy vegetables sold in the municipality of Uíge in Angola (Mawunu *et al.* 2023a) and the medicinal plants traded in Kinshasa City, Democratic Republic of the Congo, by Ngbolua *et al.* (2023b; 2019). Our results show that the plant taxa documented in Negage City are widely distributed in tropical regions of the world, and particularly in Africa. Thus, their protection should be the subject of a concerted effort at a national and international level.

3.7. Relative frequency of species cited

Figure 6 illustrates the relative frequency of citation (RFC) for the species of the 19 principal medicinal plants identified in this study. In the present study, the relative citation frequency values vary from 0.001 (*Canarium schweinfurthii*, *Commelina diffusa* and *Diospyros heterotricha*) to 0.059 which is for *Mangifera indica* (Table 1). The most important and widely used medicinal plant species (Figure 6) was *Mangifera indica* with a relative citation frequency of 0.059, followed by *Dysphania ambrosioides* (0.058), *Persea americana* (0.055), *Cymbopogon*

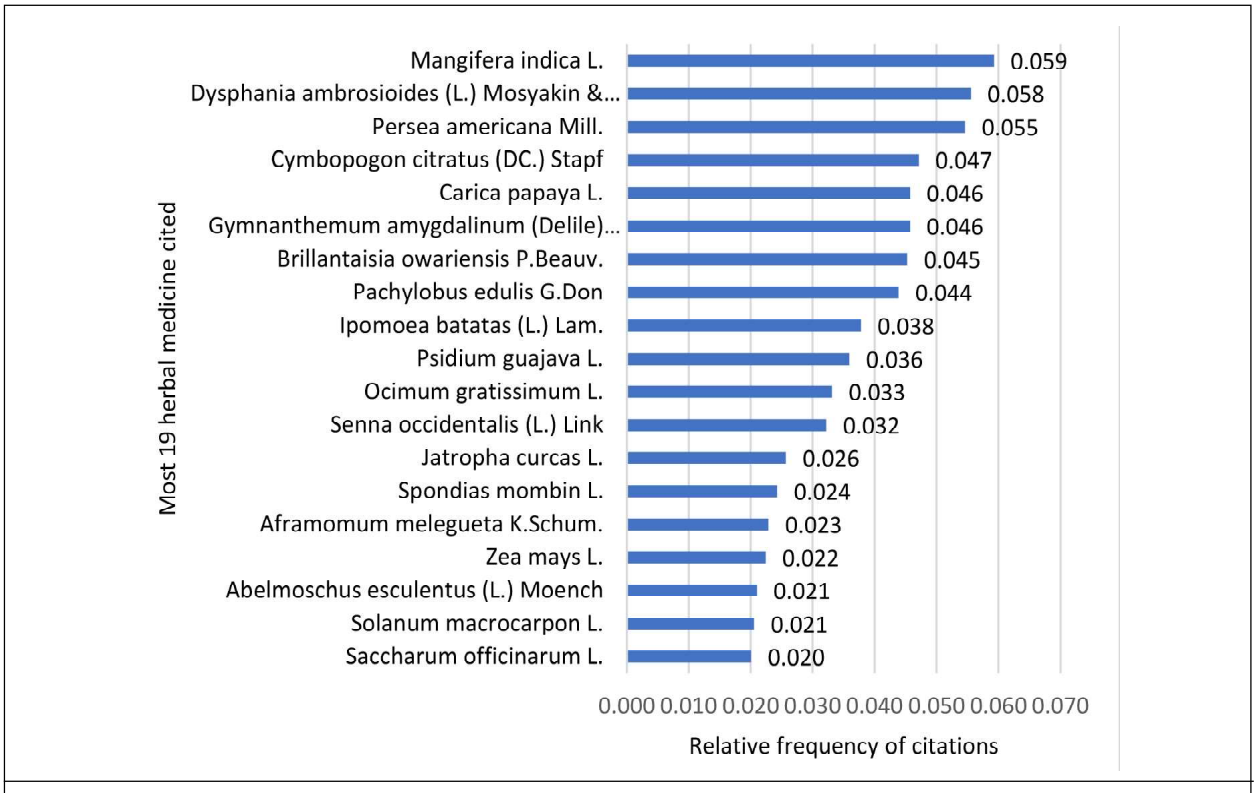

Figure 6: Relative frequency of citations of the most cited medicinal plants in Negage city

citratus (0.047), *Carica papaya* (0.046), *Gymnanthemum amygdalinum* (0.046), *Brillantaisia owariensis* (0.045), *Pachylobus edulis* (0.044), *Ipomoea batatas* (0.038), *Psidium guajava* (0.036), *Ocimum gratissimum* (0.033), *Senna occidentalis* (0.032), *Jatropha curcas* (0.026), *Spondias mombin* (0.024), *Aframomum meleguenta* (0.023), *Zea mays* (0.022), *Abelmoschus esculentus* (0.021), *Solanum macrocarpon* (0.021) and *Saccharum officinarum* with 0.020 relative frequency of citations. Furthermore, other medicinal plants from this city used in the treatment of human diseases had a relative frequency of citations less than 0.020. Ethnomedicinal plant species with high RFC values indicate that they are abundantly used and widely known and spread by the local community. Our results corroborate Mawunu *et al.* (2022) carried out in the small town of Songo who reported the abundance of *Mangifera indica*. Lasty, the mango tree's dominance in this location is due to its ability to adapt to ecological conditions, the accessibility of plants in the region and its multiple uses as an edible fruit plant and for shade.

3.8. Ethnomedicinal surveys

3.8.1. Methods of preparation and administration of phytomedicines

In Negage City, plant materials (organs) are used either in a fresh or dry state, but the methods of preparing phytomedicines may vary according to the culture of the people, and the experience gained (Figure 7).

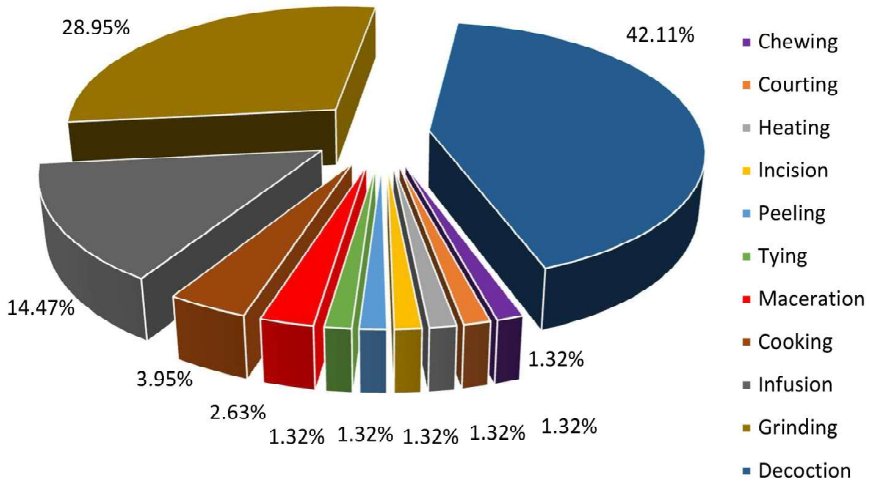

Figure 7: Methods used for preparation of phytomedicines in Negage City, as a percentage (%).

Several methods of preparation are employed in traditional medicine by the inhabitants of Negage City (Figure 7). Decoction was the most frequently (42.11%) used method of preparing phytoremedes, followed by grinding (28.95%), infusion (14.47%), cooking (3.95%), maceration (2.63%), tying (1.32%), peeling (1.32%), heating (1.32%), courting (1.32%), chewing (1.32%), incision with 1.32% (incision is a wound or cut made in the stem of a plant to collect its sap). It should be noted that, in the study area, new or tender leaves are prepared by infusion, while mature, hard or tough leaves are prepared by decoction in order to extract the active ingredients efficiently. The leaves of most of the plants documented in the study area are tender when young, hardening as adults. Liyongo *et al.* (2023), Jendras *et al.* (2020), Ngbolua *et al.* (2023a, 2023b), Mawunu *et al.* (2022b), Nankaya *et al.* (2019), and Lautenschläger *et al.* (2018) reported that decoction is the dominant used preparation method in traditional treatment. Also, this preparation method could be the reason for the predominance of use of decoction (El Amri *et al.*, 2015). The active compounds may be increasing due to heating, which accelerates biological activities (Siew *et al.*, 2014).

Regarding the method of drug administration (Figure 8), oral intake was the dominant method (44.12%) used in Negage City, followed by rubbing (11.76%), enema (11.76%), tie around head (5.88%), mouth wash (5.88%), eating (5.88%), eye drops (2.94%), chewing (2.94%), and others with 8.82% (wound dressing (1.47%), steam bath (1.47%), putting on infected fingers (1.47%), ear drops (1.47%), dermal route (1.47%), bathing with 1.47%). Moreover, frequent use of oral intake as a main administration method of herbal medicines may be related to the fact that it is rapid, and provides a large surface area for the absorption of drugs (Gulzar *et al.*, 2019).

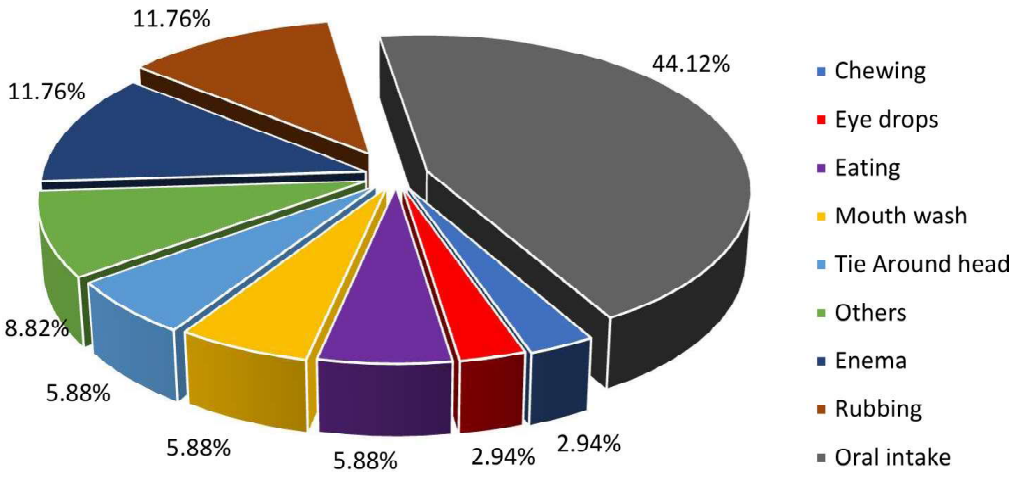

Figure 8: Proportion of medicinal plant administration methods (%)

3.8.2. Ailments treated with medicinal plants

In Negage City, a total of 50 diseases and symptoms were treated with medicinal plant species (Table 1). The top nine conditions treated were stomachache (8.1%), malaria (7.4%), bellyache (7.0%), fevers (6.3%), hepatitis (5.9%), toothache (5.9%), diarrhea (5.1%), backache (4.0%), cough (3.7%) and infections (3.7%). According to Gruca *et al*. (2015) and WHO (2008), malaria, caused by parasitic protozoa, is one of the main causes of death in Angola, and in Sub-Saharan Africa. In contrast, Mawunu *et al.* (2022b) reported cough, and anaemia as the main ailments recorded in the small city of Songo, northern Angola. Finally, the preponderance of abdominal aches was a serious health concern due to the presence of intestinal worms (roundworms, ankylostomiasis, amoebae, etc.), and typhoid, which are prevalent in many parts of Angola. Another potential source of abdominal pain in girls is menstrual cramps.

3.8.3. Relationship between plant families and the number of different therapies they provide

The dominant botanical families investigated in Negage City were Asteraceae and Fabaceae, which were used to treat 15 different ailments (Figure 9). Other important families, with their respective number of medicinal

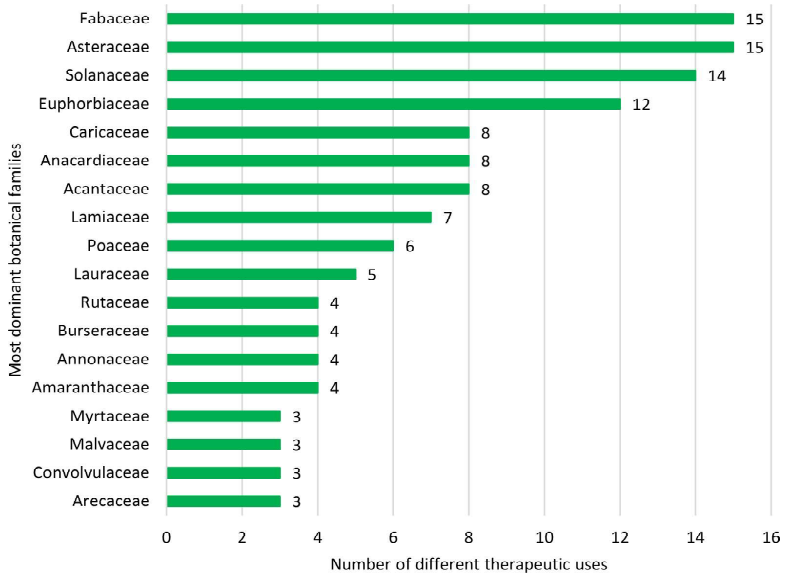

Figure 9: Herbal medicine plant families and the number of ailments treated in Negage city, Uíge province

uses indicated in brackets, were Solanaceae (14), Euphorbiaceae (12), Acanthaceae (8), Caricaceae (8), Anacardiaceae (8), Lamiaceae (7), Poaceae (6) and Lauraceae (5). In addition, Figure 8 shows that other botanical families were used in the treatment of up to four different ailments, namely Amaranthaceae, Annonaceae, Apiaceae, Arecaceae, Basellaceae, Burseraceae, Commelinaceae, Combretaceae, Convolvulaceae, Costaceae, Crassulaceae, Ebenaceae, Malvaceae, Meliaceae, Musaceae, Myrtaceae, Passifloraceae, Rosaceae, Rutaceae, and Zingiberaceae. In an earlier study conducted in Uíge province (Mawunu *et al.* 2022b), we found the Solanaceae were the main botanical family, used to treat 15 ailments.

3.8.4. Relationship between herbal species and number of ailments treated

Of the top 21 of the 60 species used in phytotherapy, *Carica papaya* was used to treat the most (7) different ailments in Negage City (Figure 10). The other majorplant species used, with their respective number of medicinal uses in brackets, were: *Gymnathemum amygdalinum* (6) conditions treated, *Brillantaisia owariensis* (6), *Citrus x limon* (5), *Erythrina variegata* (5), *Mangifera indica* (5), *Dysphania ambrosioides* (4), *Jatropha curcas* (4), *Manihot esculenta* (4), *Ocimum gratissimum* (4), *Solanum lycopersicum* (4), *Persea americana* (4), *Annona muricata* (3), *Chromolaena odorata* (3), *Mellittia versicolor* (3), *Nicotiana tabacum* (3), *Psidium guajava* (3), *Pachylobus edulis* (3), *Senna hirsuta* (3), *Senna occidentalis* (3), and *Zea mays* (3). Similarly, in the small city of Songo, in republic of Angola, Mawunu *et al.* (2022b), reported that *Carica papaya* and *Gymnathemum amygdalinum* were used in the traditional treatment of 13, and 8 ailments respectively.

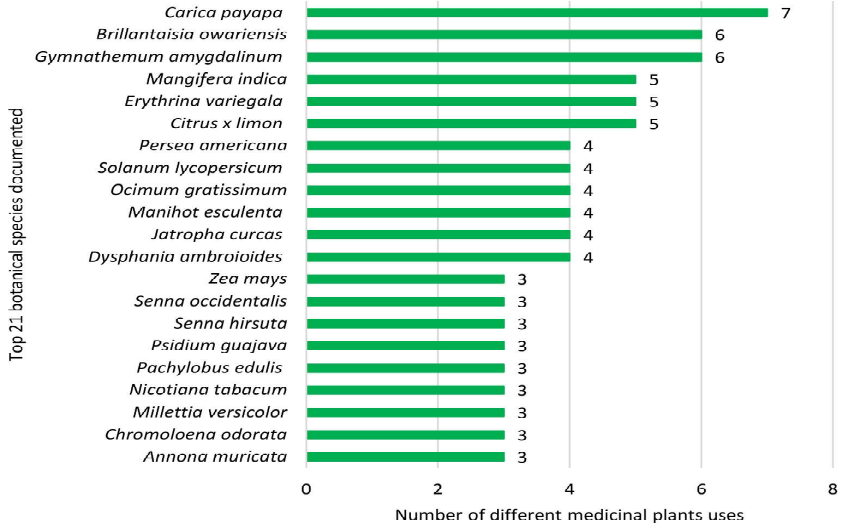

Figure 10: Herbal medicines species and the ailments treated in Negage City, Uíge province

3.8.5. Relationship between socio-demographic categories and herbal medicine documented in this study

Table 2 shows the relationship between the numbers of herbal medicine cited by socio-demographic categories, for example, gender (female, male), and age groups. With regard to informants sex, the results in table 2 show that women cited more herbal medicine species than men, 13 (21.67%) and 4 (6.67%) respectively. In addition, both sexes cited 43 (71.67%) species of herbal medicine. The superiority of women in this city can be justified by the fact that in this part of Angola, women are the main pillars of household healthcare and food security.

In addition, the elderly cited more species (11 or 18.33%) of medicines than the adults (7 or 11.67%) and young people (2 or 3.33%). Adults and the elderly cited 27 species of medicinal plants, or 45%. Older people are considered to be living libraries, which is why they cited more medicinal plants than the other two groups, young people and adults. The results in Table 2 can be justified by the fact that ethnobotanical knowledge of medicinal plants and their uses is generally acquired through long experience accumulated with age, so that the older you are, the more you know about medicinal plants, and the older you are, the less you know about medicinal plants. Also, the results of this study show that the older people get, the more knowledge they accumulate about their biological and physical environment, and in particular about medicinal plants. It is therefore imperative to protect the elderly, especially in traditional societies such as ours. The ethnobotanical knowledge of certain medicinal plants known only to the elderly in the study area would be in danger if they

disappeared without being documented. Indeed, Mawunu *et al*. (2023) state that "when an old man dies in Africa, a whole library goes up in flames".

Table 2: Relationship between some socio-demographic categories and herbal medicine documented in this study

Socio-demographical characteristics		Herbal medicine cited	Frequency (%)
Sex	Female	*Steganotaenia araliacea* Hochst.	13 (21.67%)
		Erigeron sumatrensis Retz.	
		Lannea welwitschii (Hiern) Engl.	
		Cocos nucifera L.	
		Emilia coccinea (Sims) G.Don	
		Basella alba L.	
		Brassica oleracea L.	
		Diospyros heterotricha (Welw. ex Hiern) F.White	
		Alchornea cordifolia (Schumach. &Thonn.) Müll.Arg.	
		Erythrina variegata L.	
		Clerodendrum splendens G.Don	
		*Eriobotrya japonica (*Thunb.) Lindl.	
	Male	*Terminalia catappa* L.	4(6.67%)
		Commelina diffusa Burm.f.	
		Passiflora edulis Sims	
		Datura stramonium L.	
	Both sexes	*Brillantaisia owariensis* P.Beauv.	43(71.67%)
		Dianthera secunda (Lam.) Griseb.	
		Dysphania ambrosioides (L.) Mosyakin & Clemants	
		Mangifera indica L.	
		Spondias mombin L.	
		Annona muricata L.	
		Elaeis guineensis Jacq.	
		Chromolaena odorata (L.) R. M. King & H. Rob.	
		Unidentified	
		Gymnanthemum amygdalinum (Delile) Sch.Bip	
		Canarium schweinfurthii Engl.	
		Pachylobus edulis G.Don	
		Carica papaya L.	

Table 2 (Cont.)

Socio-demographical characteristics		Herbal medicine cited	Frequency (%)
		Ipomoea batatas (L.) Lam.	
		Kalanchoe crenata (Andrews) Haw.	
		Croton mubango Müll.Arg.	
		Jatropha curcas L.	
		Manihot esculenta Crantz	
		Ricinus communis var. africanus MÜLL. Arg.	
		Millettia versicolor Welw. ex Baker	
		Senna hirsuta (L.) H.S. Irwin & Barneby	
		Senna occidentalis (L.) Link	
		Senna spectabilis (DC.) H.S.Irwin & Barneby	
		Leonotis nepetifolia (L.) R.Br.	
		Mentha x piperita L.	
		Ocimum gratissimum L.	
		Persea americana Mill.	
		Abelmoschus esculentus (L.) Moench	
		Azadirachta indica A.Juss	
		Musa spp.	
		Psidium guajava L.	
		Cymbopogon citratus (DC.) Stapf	
		Saccharum officinarum L.	
		Zea mays L.	
		Citrus × *limon* (L.) Osbeck	
		Capsicum frutescens L.	
		Nicotiana tabacum L.	
		Solanum aethiopicum L.	
		Solanum lycopersicum L.	
		Solanum macrocarpon L.	
		Solanum mauritianum Scop.	
		Aframomum alboviolaceum (Ridl.) K. Schum.	
		Aframomum melegueta K.Schum.	
	Adults	*Chromolaena odorata* (L.) R. M. King & H. Rob.	7 (11.67%)

Table 2 (Cont.)

Socio-demographical characteristics		Herbal medicine cited	Frequency (%)
	Adults, oldest people	*Emilia coccinea* (Sims) G.Don	27 (45.00%)
		Canarium schweinfurthii Engl.	
		Costus afer Ker Gawl.	
		Alchornea cordifolia (Schumach. &Thonn.) Müll.Arg.	
		Datura stramonium L.	
		Solanum mauritianum Scop.	
		Lannea welwitschii (Hiern) Engl.	
		Spondias mombin L.	
		Annona muricata L.	
		Cocos nucifera L.	
		Elaeis guineensis Jacq.	
		Unidentified	
		Kalanchoe crenata (Andrews) Haw.	
		Croton mubango Müll.Arg.	
		Manihot esculenta Crantz	
		Ricinus communis var. africanus MÜLL. Arg.	
		Erythrina variegata L.	
		Millettia versicolor Welw. ex Baker	
		Senna hirsuta (L.) H.S. Irwin & Barneby	
		Senna occidentalis (L.) Link	
		Senna spectabilis (DC.) H.S.Irwin & Barneby	
		Clerodendrum splendens G.Don	
		Mentha x piperita L.	
		Abelmoschus esculentus (L.) Moench	
		Psidium guajava L.	
		Saccharum officinarum L.	
		Zea mays L.	
		Citrus × *limon* (L.) Osbeck	
		Nicotiana tabacum L.	
		Solanum aethiopicum L.	
		Solanum lycopersicum L.	

Table 2 (Cont.)

Socio-demographical characteristics		Herbal medicine cited	Frequency (%)
	Oldest people	*Solanum macrocarpon* L.	11 (18.33%)
		Aframomum melegueta K.Schum.	
		Steganotaenia araliacea Hochst.	
		Erigeron sumatrensis Retz.	
		Basella alba L.	
		Brassica oleracea L.	
		Terminalia catappa L.	
		Commelina diffusa Burm.f.	
		Leonotis nepetifolia (L.) R.Br.	
		Musa spp.	
		*Eriobotrya japonica (*Thunb.) Lindl.	
		Capsicum frutescens L.	
		Aframomum alboviolaceum (Ridl.) K. Schum.	
	Young people	*Diospyros heterotricha* (Welw. ex Hiern) F.White	2 (3.33%)
		Passiflora edulis Sims	
	All age group (adults, young people, oldest people)	*Azadirachta indica* A.Juss 13(21.67%)	
		Brillantaisia owariensis P.Beauv.	
		Dianthera secunda (Lam.) Griseb.	
		Dysphania ambrosioides (L.) Mosyakin & Clemants	
		Mangifera indica L.	
		Gymnanthemum amygdalinum (Delile) Sch.Bip	
		Pachylobus edulis G.Don	
		Carica papaya L.	
		Ipomoea batatas (L.) Lam.	
		Jatropha curcas L.	
		Ocimum gratissimum L.	
		Persea americana Mill.	
		Cymbopogon citratus (DC.) Stapf	

3.8.6. Relationship between diseases and medicinal plants documented in the city of Uíge

The main illnesses and the medicinal plants used to treat them in Negage are shown in Table 3. Of the fifty-two (52) diseases documented, the most frequent ailments, treated by the largest number of medicinal plants in Negage, were stomach ache, with 8 species, typhoid fever and stomach ache, with 7 species each. The other

main diseases treated by local medicinal plants were: cough (6 species), malaria (6 species), hepatitis (5 species), fevers (5 species), diarrhoea (5 species) and anaemia (5 species). Finally, the rest of the illnesses were treated with one or more medicinal plants. In contrast, in the city of Songo, Angola, Mawunu *et al*. (2022b) reported that cough was the disease treated with the highest number of medicinal plants, with 17 species.

Table 3: The nine major ailments treated with phytomedicines in Negage City, province of Uíge

Ailments	Medicinal plants species
Bellyache	*Brillantaisia owariensis* P. Beauv.
	Chromolaenaodorata (L.) R. M. King & H. Rob.
	Dysphania ambrosiosides (L.) Mosyakin & Clemants
	Gymnanthemum amygdalinum (Delile) Sch.Bip.
	*Mentha x piperita*L.
	Psidium guajava L.
	Ricinus communis var. *africanus* Müll. Arg.
	Senna occidentalis (L.) Link
Stomach ache	*Abelmoschus esculentus* (L.) Moech
	Annona muricata L.
	Brillantaisia owariensis P. Beauv.
	Ipomoea batatas (L.) Lam.
	Jatropha curcas L.
	Solanum aethiopicum L.
	Zea mays L.
Typhoid	*Annona muricata* L.
	Azadirachta indica A. Juss.
	Carica papaya L.
	Citrus x limon (L.) Osbeck
	Jatropha curcas L.
	Mangifera indica L.
Malaria	*Capsicum frutensis*L.
	Dysphania ambrosiosides (L.) Mosyakin & Clemants
	Croton mubango Müll.Arg.
	*Erigeron sumatrensis*Retz.
	Mentha x piperta L.
	Ocimum gratissimum L.
Cough	*Citrus x limon* (L.) Osbeck
	Cymbopgon citratus (DC.) Stapf

Table 3 (Cont.)

Ailments	Medicinal plants species
	Dysphania ambrosiosides (L.) Mosyakin & Clemants
	Lannea welwitschii (Hiern) Engl.
	Mangifera indica L.
	Ocimum gratissimum L.
Fevers	*Alchornea cordifolia* (Schumach. & Thonn.) Müll. Arg.
	Chromolaena odorata (L.) R.M. King & H. Rob.
	Ocimum gratissimum L.
	Senna hirsute (L.) H.S. Irwin& Barneby
	Solanum lycopersicum L.
Hepatitis	*Cocos nucifera* L.
	Costus afer Ker Gawl.
	Erythrina variegata L.
	Manihot esculenta Crantz
	Saccharum officinarum L.
Diarrhoea	*Pachylobus edulis* G.Don
	Mangifera indica L.
	Musa spp.
	Psidium guajava L.
	Terminalia catappa L.
Anaemia/low haemoglobin level	*Basella alba* L.
	Erythrina variegata L.
	Ipomoea batatas (L.) Lam.
	Jatropha curcas L.
	Persea americana Mill.

3.9. Medicinal species and ailments treated

Table 4 shows the Twenty-one (21) phytomedicines most commonly used to treat ailments in Negage City. Clearly, *Carica papaya* is more frequently used than the other plants listed. The six ailments treated were toothache, bellyache, kidney pain, typhoid fever, urinary infections, and intestinal constipation. The other nine (9) major species used to treat various ailments were *Brillantaisia owariensis* used for 5 ailments (open fontenelle, stomachache, body weakness, bellyache, hypertension), *Erythrina variegata* used for 5 ailments (spleen pain, anaemia or low haemoglobin level, back pain, hepatitis, hemorrhage), *Mangifera indica* used for 5 ailments (hemorrhoids, back pain, diarrhea, typhoid fever, cough), *Gymnantthemum amygdalinum* used for 5 ailments (allergies, infections, belly stuffing, bellyache, measles). Several species were used to treat 4 ailments, with different lists in each case: *Dysphania ambrosioides* (used for headache, bellyache, malaria, cough), *Citrus x limon* (used for angina, conjunctivitis, typhoid, cough), *Jatropha curcas* (used for tricophyton, mastitis,

stomachache, typhoid), *Ocimum gratissimum* (used for headache, fevers, malaria, cough), *Persea americna*(used for hypertension, swollen feet, anaemia/low haemoglobin level, measles), and *Senna occidentalis* (used for stomachache, colic, fevers, belly stuffing), *Chromolaena odorata* (wound, fever, stomachache, hypertension); *Psidium guajava* (tomach ache, diarrhoea, dysentery, insomnia).Finally, the remaining 47 medicinal plants inventoried in Negage City were used to treat one to three ailments (Table 1).

Table 4: Twenty-one (21) Top medicinal plants associated with the diseases they are used to treat in Negage City

Medicinal plant species	Ailments and symptoms	Number of aiments and symptoms treated
Carica papaya L.	Bellyache, typhoid fever, constipation, toothache, kidney pain, urinary infection, hypertension	6
Gymnanthemum amygdalinum (Delile) Sch.Bip.	Stomachache, infections, allergies, swollen belly, measles, bellyache	6
Mangifera indica L.	Haemorrhoid, backache, diarrhoea, typhoid fever, cough	5
*Erythrina variegata*L. *Brillantasia owariensis*	Anaemia, spleen, hepatitis, backache, haemorrhoid, hemorrhage Stomachache, body weakness, high blood pressure, open fontenelle, hypertension, bellyache	5 5
Zea mays L.	Stomachache, sexual impotence, swollen feet	4
Solanum lycopersicum L.	Fever, headache, haemorrhoid, high fever	4
Senna hirsuta (L.) H.S. Irwin and Barneby	Fevers, colic, fever, yellow fever	4
*Persea americana*Mill.	High blood pressure/anemia, swollen feet, hypertension, measles	4
Ocimum gratissimum L.	Malaria, fever, headache, cough	4
Jatropha curcas L.	Tinea capitis, mastitis, stomachache, typhoid fever	4
Citrus X limon Swing	Typhoid fever, angina, cough, conjunctivitis	4
Dysphania ambrosiosides (L.) Mosyakin & Clemants	Cough, headache, stomachache, malaria	4
Senna occidentalis (L.) Link	Stomach ache, bellyache, colic, swollen belly	4
*Psidium guajava*L.	Stomach ache, diarrhoea, dysentery, insomnia	4
Chromolaena odorata (L.) R.M.King & H.Rob.	Wound, fever, stomachache, hypertension	4
Nicotima tabacum L.	Cryptorchidism, haemorrhoids, testicular inflammation in children	3
Millettia versicolor Welw. ex Baker	Thrombosis, joint pain, body weakness	3
Manihot esculenta Crantz	Eye parasite, open cervix, hepatitis	3
Pachylobus edulis G.Don	Dental caries, toothache, diarrhoea	3
Annona muricata L.	Stomachache, yellow fever, typhoid fever	3

3.10. Other uses of medicinal plants in the study area

Apart from therapeutic use, medicinal plants found in Negage City were also used as sources of bioenergy, i.e. food (53%), shade, and windbreaks (20%), tea herbal/substitute (7%), guinea pig fodder (7%), ornamentation

(6%), fencing (3%), firewood (2%), and as stimulants (2%). Similarly, in Songo City, Mawunu *et al.* (2022a) reported that medicinal plants were also used to provide shade, food, herbal tea, bioenergy, windbreaks, stimulants (e.g. tobacco), and fodder for livestock.

3.11. Sources of knowledge and main reasons for the use of medicinal plant

Most (95%) of the people interviewed in Negage City acquired their ethnomedicinal knowledge from their parents (father, mother, grandfather, uncle, etc.) or older people in the community, 3% from their department or school colleagues, and 2% from their friends. In Songo City, Mawunu *et al.* (2022a, b), reported that traditional knowledge was acquired from parents (grandparents, uncles, and aunts), friends, healers, and elders. As a result, the vast majority (98%) of the Negage City residents acquired their ethnomedicinal knowledge orally, with only 2% acquiring it in writing. Similar findings were also reported by Mawunu *et al.* (2022a), Mawunu *et al.* (2022b), Monizi *et al.* (2018a), Monizi *et al.* (2018b), and Monizi *et al.* (2019) who showed that the oral tradition was the dominant mode of transmission of knowledge used by the local people and is also a tradition of the region, a thousand-year-old way of preserving know-how. It should be noted that the reasons why the inhabitants of the city of Negage use herbal medicine are diverse, but the most dominant are affordability, accessibility, tradition, habits, culture, poverty, and trust in local products.

3.12. Similarity of medicinal use of documented species with previous studies from the same region

Table 5 shows the similarities between the therapeutic use of the medicinal plant species documented in the current study and those reported in previous research carried out in the same region.

It should be noted that some of the medicinal species (Table 5) cited by the informants in this study are also used to treat the same human diseases by other communities in the same region, i.e. northern Angola. This

Table 5: Similarities between the medicinal uses of the documented species and previous studies carried out in northern Angola

Medicinal plants species	Medicinal uses of documented plants		References of the previous research in the same region
	Current research	Previous research in the same region	
Abelmoschus esculentus	Stomachache	Stomach ache	Mawunu *et al.* 2022
Aframomum alboviolaceum	Spleen	No similar citations	
Aframomum melegueta	Traumatism	No similar citations	Mawunu *et al.* 2022
Alchornea cordifolia	Fevers	No similar citations	
Annona muricata	Stomachache	Stomach ache	
Azadirachta indica	Typhoid	No similar citations	
Basella alba	Anaemia	No similar citations	
Brassica oleracea	Diabetes	No similar citations	
Brillantaisia owariensis	Stomachache, body weakness, open fontenelle, hypertension, bellyache	Open fontanella, hypertension, stomach ache	Mawunu *et al.* 2022; Lautenschläger *et al.* 2018
Canarium schweinfurthii	Spleen, toothache	Toothache	Göhre *et al.* 2016
Capsicum frutescens	Panariasis, malaria	Malaria	Mawunu *et al.* 2022

Table 5 (Cont.)

Medicinal plants species	Medicinal uses of documented plants		References of the previous research in the same region
	Current research	Previous research in the same region	
Carica papaya	Hemorrhoid, bellyache, typhoid, constipation, toothache, kidney pain, urinary infection, hypertension	Hemorrhoid, typhoid, toothache	Mawunu *et al.* 2022; Göhre *et al.* 2016; Lautenschläger *et al.* 2018
Chromolaena odorata	Injury, fever, stomachache	Injury, fever, stomach ache	Mawunu *et al.* 2023; Mawunu *et al.* 2022; Lautenschläger *et al.* 2018
Citrus × limon	Typhoid, angina, cough, conjunctivitis	Cough	Mawunu *et al.* 2023; Mawunu *et al.* 2022; Canga *et al.* 2022; Lautenschläger *et al.* 2018
Clerodendrum splendens	Pain in legs	No similar citations	
Cocos nucifera	Hepatitis	No similar citations	
Commelina diffusa	Open fontenelle, eye problems	Eye problems	Göhre *et al.* 2016
Costus afer	Hepatitis	Hepatitis	Göhre *et al.* 2016
Croton mubango	Malaria	Malaria	Lautenschläger *et al.* 2018
Cymbopogon citratus	Cough	No similar citations	
Datura stramonium	Body weakness	No similar citations	
Dianthera secunda	Anaemia/low haemoglobin level	Anaemia	Mawunu *et al.* 2022; Mawunu *et al.* 2023
Diospyros heterotricha	Toothache	Toothache	Lautenschläger *et al.* 2018
Dysphania ambrosioides	Bellyache, cough, headache, stomachache, malaria	Cough, headache, malaria	Mawunu *et al.* 2022; Canga *et al.* 2022; Göhre *et al.* 2016; Lautenschläger *et al.* 2018
Elaeis guineensis	Eye problems	No similar citations	
Emilia coccinea	Tinea capitis	No similar citations	
Erigeron sumatrensis	Malaria	No similar citations	

Table 5 (Cont.)

Medicinal plants species	Medicinal uses of documented plants		References of the previous research in the same region
	Current research	Previous research in the same region	
Eriobotrya japonica	Cryptorchidism	No similar citations	
Erythrina variegata	Anaemia/ low haemoglobin level, spleen, hepatitis, back-ache, haemorrhoid, hemorrhage	No similar citations	
Gymnanthemum amygdalinum	Infections, stomachache, allergies, swollen belly, measles, bellyache	Swollen belly, stomach ache, measles	Mawunu *et al.* 2022; Lautenschläger *et al.* 2018; CISA, 2012
Ipomoea batatas	Stomachache, anaemia	Anaemia, gastric	Mawunu *et al.* 2022
Jatropha curcas	Tinea capitis, mastitis, stomachache, typhoid	Tinea capitis, stomach ache	Mawunu *et al.* 2022
Kalanchoe crenata	Leprosy, diabetes	Leprosy	Lautenschläger *et al.* 2018
Lannea welwitschii	Backache, cough	Cough	Canga *et al.* 2022
Leonotis nepetifolia	Earache	No similar citations	
Mangifera indica	Hemorrhoid, backache, diarrhoea, typhoid, cough	Backache, diarrhoea, hemorroids	Mawunu *et al.* 2023; Mawunu *et al.* 2022; Canga *et al.* 2022; Lautenschläger *et al.* 2018
Manihot esculenta	Eyes parasite, open cervix, hepatitis	Hepatitis, eye parasites	Mawunu *et al.* 2022; Lautenschläger *et al.* 2018
Mentha x piperita	Malaria, stomach ache	No similar citations	
Millettia versicolor	Thrombosis, joint pain, body weakness	No similar citations	
Musa spp.	Diarrhoea	No similar citations	
Nicotiana tabacum	Cryptorchidism, haemorrhoids, inflammation testicles	Cryptorchism, haemorroids	Mawunu *et al.* 2022; Lautenschläger *et al.* 2018
Ocimum gratissimum	Malaria, fever, headache, cough	Cough, malaria, fever	Mawunu *et al.* 2023; Mawunu *et al.* 2022; Canga *et al.* 2022; Göhre *et al.* 2016; Lautenschläger *et al.* 2018
Pachylobus edulis	Dental caries, toothache, diarrhoea	Toothache, caries, diarrhoea	Mawunu *et al.* 2022; Canga *et al.* 2022; Lautenschläger *et al.* 2018

Table 5 (Cont.)

Medicinal plants species	Medicinal uses of documented plants		References of the previous research in the same region
	Current research	Previous research in the same region	
Passiflora edulis	Hypertension	No similar citations	
Persea americana	Hypertension, measles, anaemia/high blood pressure, swollen feet	Anaemia, measles, hypertension	Mawunu *et al.* 2023; Mawunu *et al.* 2022; Canga *et al.* 2022
Psidium guajava	Bellyache, diarrhoea, stomachache, dysentery	Diarrhoea, bloody diarrhoea, stomach ache	Mawunu *et al.* 2022; Canga *et al.* 2022; Göhre *et al.* 2016; Lautenschläger *et al.* 2018; CISA, 2012
Ricinus communis var. Africanus	Kidney pain, stomachache	Stomach ache	Lautenschläger *et al.* 2018
Saccharum officinarum	Hepatitis, yellow fever	Yellow fever, hepatitis	Mawunu *et al.* 2022
Senna hirsuta	Fevers, colic, yellow fever	No similar citations	
Senna occidentalis	Bellyache, stomachache, colic, swollen belly	Stomach ache, colic	Mawunu *et al.* 2023; Mawunu *et al.* 2022; Lautenschläger *et al.* 2018; CISA, 2012
Senna spectabilis	Toothache	No similar citations	
Solanum aethiopicum	Stomachache	No similar citations	
Solanum lycopersicum	Fevers, headache, haemorrhoid, high fever	Fever, headache	Mawunu *et al.* 2022
Solanum macrocarpon	Hypertension	Hypertension	Mawunu *et al.* 2022
Solanum mauritianum	Open fontenelle	No similar citations	
Spondias mombin	Mastitis	No similar citations	
Steganotaenia araliacea	Backache	Backache	Lautenschläger *et al.* 2018
Terminalia catappa	Hemorrhoid, diarrhoea	Diarrhoea	Mawunu *et al.* 2022
Zea mays	Swollen feet, stomachache, sexual impotence	No similar citations	

constant would be justified by socio-cultural exchanges between communities in the same region or neighboring or even distant regions, and also by the globalization of knowledge conveyed by the media such as social networks, television, newspapers, etc.

For the 60 medicinal plant species documented in the current study, local informants have provided new information on treatments for various human diseases that differ from the uses found in regional and local pharmacopoeias. The following plant species have been used in new ways: *Abelmoschus esculentus* (used for treating stomachache), *Aframomum alboviolaceum* (used for treating spleen), *Aframomum melangueta* (used for treating traumatism), *Annona muricata* (used for treating stomachache), *Azardirachta indica* (used for treating typhoid), *Cocos nucifera* (used for treating hepatitis), *Basella alba* (used for treating anaemia), *Brassica oleracea* (used for treating diabetes), *Brillantaisia* owariensis (body weakness, hypertension, open fontenelle, bellyache), *Capsicum frutescens* (used for treating malária, panariasis), *Carica papaya* (used for treating bellyache, constipation, kidney pain, hypertension, urinary infection), *Citrus x limon* (used for treating angina, conjunctivitis, typhoid), *Costus afer* (used for treating hepatitis), *Commelina diffusa* (used for treating open fontenelle), *Clerodendrum splendens* (used for treating leg pain), *Chromolaena odorata* (used for treating hypertension, stomachache), *Canarium schweinfurthii* (used for treating spleen, toothathe), *Datura stramonium* (used for treating body weakness), *Dysphania ambrosioides* (used for treating bellyache, stomachache), *Emilia coccinea* (used for treating tinea capitis), *Erythrina variegata* (used for treating anaemia/ low haemoblobin level, spleen, hepatitis, backache, haemorrhoid, hemorrhage), *Millettia versicolor* (used for treating thrombosis), *Eriobotrya japonica* (used for treating cryptorchidism), *Gymnanthemum amygdalinum* (used for treating infections, allergies, bellyache), *Kalanchoe crenata* (used for treating diabetes), *Jatropha curcas* (used for treating tinea capitis, mastitis, typhoid), *Lannea welwitschii* (used for treating backache, cough), *Leonotis nepetifolia* (used for treating earche), *Mangifera indica* (used for treating typhoid, cough), *Manihot esculenta* (used for treating hepatitis, open cervix), *Mentha x piperita* (used for treating malária, stomachache), *Millettia versicolor* (used for treating thrombosis, joint pain, body weakness), *Nicotiana tabacum* (used for treating haemorrhoid, inflammation testicles), *Persea americana* (used for treating hypertension, measles, anaemia, swollen feet), *Passiflora edulis* (used for treating hypertension), *Psidium guajava* (used for treating bellyache, stomachache, insomnia), *Ricinus communis* (used for treating kidney pain), *Senna hirsuta* (used for treating fever, colic, yellow fever), *Senna occidentalis* (used for treating bellyache, colic, swollen belly), *Senna spectabilis* (used for treating toothache), *Solanum aethiopicum* (used for treating stomachache), *Solanum lycopersicum* (used for treating fever, headache, high fever, hemorrhoid), *Solanum mauritianus* (used for treating open frontenella), *Solanum macrocarpon* (used for treating hypertension), *Terminalia catappa* (used for treating haemorrhoid), *Saccharum officinarum* (used for treating hepatitis, yellow fever), *Zea mays* (used for treating swollen feet, stomachache). The information mentioned in the present part of the study has never been provided in any of the previous studies carried out in Angola, such as (Lautenschläger *et al.*, 2018; Catarino *et al.*, 2019; Jandras *et al.*, 2020; Mawunu *et al.*, 2022b; Mawunu *et al.*, 2023b; Göhre *et al.*, 2016; Urso *et al.*, 2016), or in those carried out in countries in the region, notably the DRC, Congo-Brazzaville (Ngbolua *et al.*, 2023a,b; Liyongo *et al.*, 2023; Djoza *et al.*, 2021; Pathy *et al.*, 2021; Kimpouni *et al.*, 2011), in Namibia (Cheikhyoussef *et al.*, 2011; Cheikhyoussef and Embashu, 2013), and in Zambia (Chinsembu, 2016; Nyirenda and Chipuwa, 2024).

4. Conclusion

This survey aimed to document indigenous knowledge of medicinal plants used by the local population in Negage City. The present study documented 60 medicinal plants, 53 genera, and 31 botanical families. Despite the number of health facilities in the study area, the inhabitants still rely on their traditional medical knowledge for human health care. Also, the people of Negage City have a great knowledge of medicinal plants and use them in the treatment of various health problems. The most-represented botanical families were Solanaceae, Euphorbiaceae, Fabaceae, Asteraceae, and Lamiaceae. In addition, the most cited medicinal species were *Carica papaya*, *Gymnanthemum amygdalinum*, and *Brillantaisia owariensis*. Results on biological types show that Phanerophytes and Therophytes were the most used in Negage City. In terms of region of origin, Pantropical, Continental Afrotropical, and Guinean-Congolese were the most represented phytogeographical types. Most medicinal plants were in the form of herbs, while the leaf was the plant organ most frequently used in the preparation of therapeutic recipes. In addition, our study revealed that decoction and oral route were respectively the main methods of preparation and administration of herbal medicines. Fifty ailments were documented, the most frequent of which were bellyache, malaria, stomachache, fever, hepatitis, toothache, and diarrhea. Thus, the documented therapeutic use of these plants provides the first baseline data for Negage City and suggests further avenues of research into pharmacological, and conservation studies.

List of abbreviations

Afro-american (AA); Afro-tropical continental (AT); Low Guinean-Congolese (LGC); Guineo-congolese (GC); Paleotropics (Pal); Pantropical (Pan); Cameroonian-Guinean-Congolese (CGC); Cosmopolytes (Cos); Fr.= French; Kik.= Kikongo; Kim.= Kimbundu; Ling.= Lingala; Port.= Portuguese.

Ethical approval and consent to participate

This study has been conducted under the provisions of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization of the Convention on Biological Diversity. Oral prior consent was obtained from each participant. This study does not contain any experiments on humans or animals. This study has been conducted under the provisions of the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. During the ethnobotanical data collection from informants a prior oral consent was taken.

Consent for publication

Not applicable-this manuscript has no personal data from the authors.

Availability of data and materials

The original data are presented in the article. There are no supplementary data. The raw data without the names of informants can be provided by authors.

Conflicts of interests

The authors declare that there are no conflits of interest between them or other authors.

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