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Inventory and ethnobotanical study of edible fruit plants in Uíge city, Northern Angola

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Abstract

This study aimed to identify edible fruit plants in Uíge, Angola, highlighting their nutritional and therapeutic potential. Urban vegetation, particularly fruit plants, is crucial for human well-being, offering supplementary food and income opportunities. Conducted from November 2022 to October 2023, the botanical survey documented 51 fruit plant species from 37 genera and 25 families. Prominent families included Anacardiaceae, Annonaceae, and Rutaceae, with 72.5% of species being exotic. Commonly found plants were Mangifera indica (13.08%), Persea americana (11.99%), Pachylobus edulis (9.50%), Carica papaya (8.41%), and Psidium guajava (7.63%). The majority of the flora comprised phanerophytes (90.20%). Most fruits (52.9%) are consumed directly, with decoction (51.2%) being the main preparation method and oral consumption (78.9%) the predominant administration route. The primary plant parts used in herbal medicine were leaves (29.9%) and fruits (22.9%), targeting ailments such as diarrhea (15.2%) and diabetes (13.1%). This study provides a valuable database for plants with nutritional and therapeutic benefits, emphasizing the need for further research into their fruiting seasonality, species richness, market value, and nutritional content. Domesticating these species could ensure a sustainable food supply and advance phytochemical and pharmacological research.

Key words: *Inventory, fruit plants, Uíge city, Angola*

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1. Introduction

The world is becoming increasingly urbanized. If current trends continue, the world's urban population is expected to reach 6.3 billion people by 2050, almost double the 3.5 billion urban residents in 2010 (Secretariat of the Convention on Biological Diversity, 2012). Currently, almost 55.3% of the world's population lives in cities. By 2035, the urban population will account for 62.5% of the total population, and by 2050, nearly 70% of the population is expected to live in cities (United Nations, 2018). In Angola, the majority of the population (63%) lives in urban areas (INE, 2016).

Vegetation, especially trees, shrubs, and grasses, is an important part of urban ecosystems (Folega *et al.*, 2017). In agreement with Laille *et al.* (2013), urban green spaces contribute to improving the quality of the living environment and the attractiveness of cities. They address not only social and ecological issues, but also economic ones. The presence of plants in cities provides many benefits. These include reducing air pollutants (Nowak *et al.*, 2006), heat islands (Akbari *et al.*, 2001), reducing carbon dioxide levels through humidity, precipitation, radiation and carbon sequestration (Wanderley and Miguel, 2019; Buriol *et al.*, 2019; Vroh *et al.*, 2014), erosion control, land delimitation, and land marking (Tourey *et al.*, 2020).

Plants in urban areas also address social, environmental and economic challenges by providing shade and meeting nutritional needs, thereby promoting food and nutritional security (Secretariat of the Convention on Biological Diversity, 2012; CEMIG, 2011; Wu *et al.*, 2010). In addition, plants help to reduce hunger, protect the environment and redirect the wind, provide genetic protection for native flora, conserve fauna and flora, improve people's physical and mental health and form visual or acoustic barriers. Plants also provide bioenergy, plant-based medicines (CEMIG, 2011), and a habitat for wildlife (Barth *et al.*, 2015). They have the potential to reduce stress, and promote a happier, healthier living environment (Camps-Calvet *et al.*, 2016).

Fruit consumption plays an important role in human nutrition and health. Fruit is a rich source of vitamins, minerals, folic acid, dietary fiber, antioxidants, and thiamine (Van Duyn and Pivonka, 2000). They also contribute to the proper functioning of the body, particularly the digestive tract, and protect against various types of disease. Also, eating fruit helps prevent diseases such as cervical cancer, heart disease, stroke, skin problems, and other chronic illnesses (Collese *et al.*, 2017). Fruits are rich in antioxidants and function to modify metabolic activity and detoxification (Iqbal *et al.*, 2019; Slavin and Lloyd, 2012). The essential nutrients found in fruits are necessary for the normal functioning of the body. These include iron, calcium, vitamins, magnesium, fiber, protein, potassium, sodium, phytonutrients, and antioxidants (Riordan *et al.*, 2017).

Moreover, fruit sales are a source of income that can be used to solve many household problems, such as purchasing goods and services, such as food and clothing, and school equipment (Mawunu *et al.*, 2023a).

Besides, urban ecosystems can support a remarkable richness of plant species (Schwartz *et al.*, 2014), in some cases more abundant than adjacent non-urban landscapes (Ives *et al.*, 2016). Although cities still have distinct communities of native species (Aronson *et al.*, 2014), urban species communities have been significantly impacted by species invasions and extinctions (Duncan *et al.*, 2011).

Urban biodiversity is influenced not only by the state of the native natural ecosystem but also by the planning, design and management of the built environment, which is influenced by economic, social, and cultural values and human demographics (Secretariat of the Convention on Biological Diversity, 2012). And globally, the diversity of exotic or introduced species in urban environments is greater than the diversity of native plants (Mawunu *et al.*, 2022b; Wang *et al.*, 2020; Esteves and Corrêa, 2018). In agreement with Wanderley and Miguel (2019), Yang *et al.* (2014); Palma *et al.* (2016), uncontrolled urbanization can affect plant diversity, decreasing the richness of native plant species and increasing the richness of exotic plant species. According to Hou *et al.* (2023), urbanization increases the richness of exotic species while decreasing the richness of native species.

However, little research has been carried out into the dual nutritional and therapeutic value of food plants. The present study investigating the ethno-nutritional and ethno-medicinal heritage would therefore be a first in the province of Uíge, particularly in the city of Uíge. The aim of the current study is to investigate nutraceutical plants and confirm their dual nutritional and therapeutic potential, in order to help strengthen national and global scientific databases on the use of plants for human well-being.

The aim of this study is to inventory and characterize the various wild and cultivated fruit species present in the town of Uíge. In addition, this study will provide information on the following aspects of the wild and exotic fruit food flora in the town of Uíge: (1) an assessment of the diversity of native and introduced edible fruit flora in the city; (2) knowledge of the ecological characteristics of the species inventoried, their edible organs, consumption methods, methods of preparation and administration of phytomedicinal recipes, the diseases they treat and their nativity status, etc.

2. Materials and methods

2.1. Study area

The species were inventoried in Uíge city, in northern Angola. In this article, we present only the species of edible fruit plants recorded in this city (urban and peri-urban neighborhoods).

2.2. Materials

The biological material includes all the plant species of the wild and exotic flora of the city of Uíge, which produce fruit used for food purposes. These plants were found in the avenues, hut gardens, schoolyards, administrative bodies and green spaces of the city. Linked to urban horticulture, this study covers arborescent and non-arboreal taxa (trees, shrubs, sub-shrubs, lianas and grasses). Plant material was identified directly in the field and, where this was not possible, samples were transported to the herbarium of the agronomy department of the Kimpa Vita University Polytechnic Institute for identification by botanists. At the taxonomic level, the treatment follows the systematic ordering of POWO (2023).

2.3. Methods

2.3.1. Botanical prospecting

Data collection took place in the city of Uíge, between latitudes 7° 35’49.9203" and 7° 37’30.80388" and longitudes between 15° 2’30.876" and 15° 3’36.15012" in 10 urban and peri-urban neighborhoods. The field survey was conducted in Uíge City from November 2022 to October 2023 (Figure 1).The botanical survey also included the creation of an inventory of edible fruit trees in the city of Uíge. This qualitative inventory includes plants on boulevards, plants in rows along highways, plants in gardens and green spaces, plants in courtyards list and schools, plants in hedges bordering private or public property, and plants in open spaces in urban areas. During this inventory phase, the life form of each species (trees, shrubs, lianas, grasses), the consumption methods and other uses of each species were documented, local names are recorded (Ngbolua *et al*. 2023a, b; Mawunu *et al*., 2022a, b; Masengo *et al*., 2024; Pisco *et al*., 2024).

2.3.2. Ethnobotanical Surveys

The research was based on personal interviews with property owners, local authority officials, particularly those responsible for environmental management, and neighborhood leaders. The interviews were semi-structured and open-ended. The approach of the research is, on the one hand, to identify the resources and to question the inhabitants of Uíge about their origin and associated characteristics.

2.4. Data analysis

All data collected in this study were processed using Microsoft Office Excel (version 2016), and presented in the form of graphs or tables. Various variables covered are: plant species cited, recipes, diseases treated, growth forms, plant organs used, consumption modes, preparation and administration methods, etc. In order to be able to compare the data recorded with other studies, calculations of descriptive statistics, in particular frequencies, have been made: Relative Frequency of Citations (RFC) and Relative Frequency of Citations as a Percentage (RFC%). The relative frequency of citations shows the local importance of each plant species and is calculated for each species. (Formula 1). RFCs = FCs/N (Formula 1). Formula 1: Calculation of the relative frequency of citations (RFC): s = species, FC = frequency of citations by an informant; N = total number of informants (Ahmad *et al*., 2014).

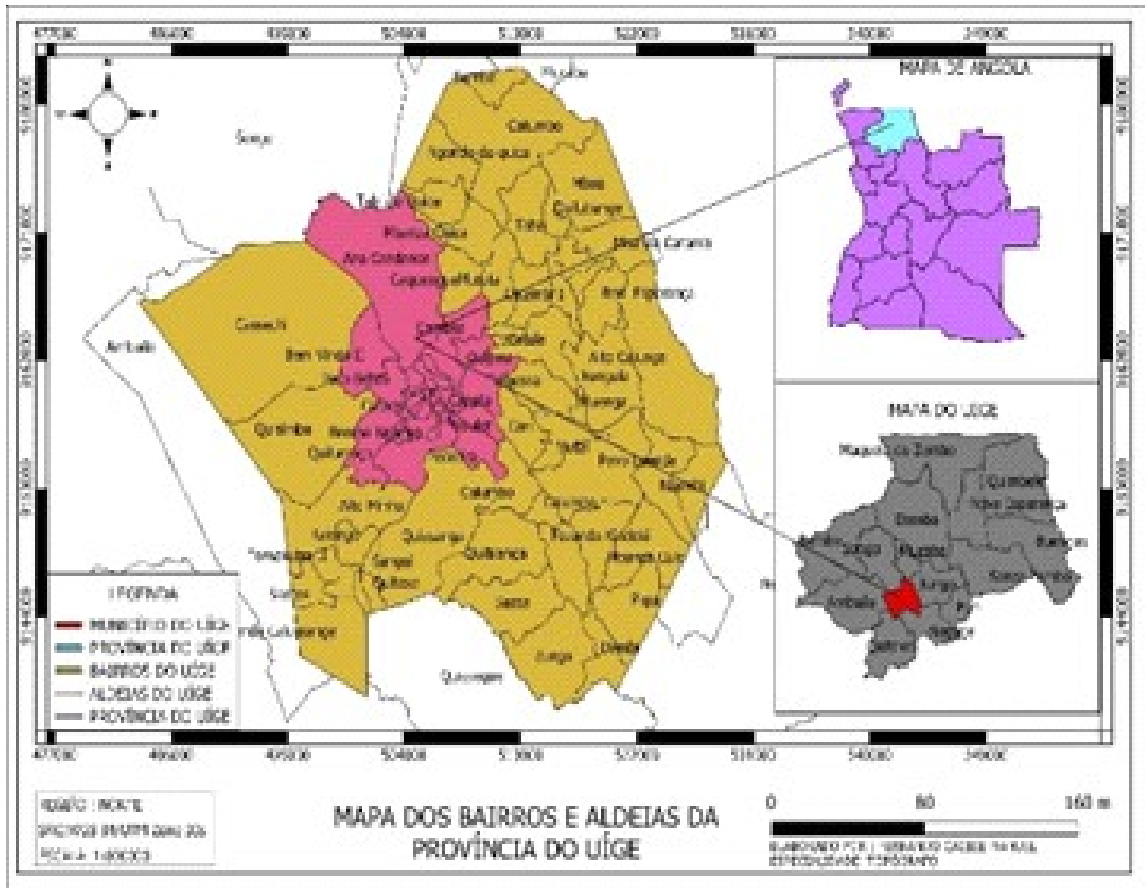

Figure 1: Location of sampling sites in the city of Uíge, Angola

3. Results and discussion

Table 1 presents data on the inventory, floristic diversity, consumption patterns, and economic value of edible fruit plants in the city of Uíge.

Table 1: Taxonomic inventor, and floristic diversity of edible fruit plants in the city of Uíge

Family	Vernacular name	Species	GF	NS	ES	BT	PD	CM	FR(%)
Anacardiaceae	Mangueira (Port.), Manga (Kik)	*Mangifera indica* L.	Tree	Exotic	Marketable	MsPh	Pan	Raw, juice, boiling	13.08
Anacardiaceae	Gajajiera (Port.), mungiengie (Kik.)	*Spondias monbim* L.	Tree	Exotic	Marketable	MsPh	Pan	Raw, juice	6.37
Anacardiaceae	Manga gajajiera (Port.), Manga sende (Ling.)	*Spondias dulcis* Parkinson	Tree	Exotic	Marketable	MsPh	Pan	Raw	1.87
Anacardiaceae	Cajueira (Port.), Nkaziwa (Kik.)	*Anacardium occidentale* L.	Shrub	Exotic	No marketable	MsPh	NT	Raw	0.87
Anacardiaceae	Mviwa (Kik.)	*Pseudospondias microcarpa* (A. Rich.)	Tree	Exotic	No marketable	MsPh	GC	Raw	0.05
Annonaceae	Fruta pinha (Port.)	*Annona squamosa* L.	Shrub	Exotic	Marketable	McPh	Pan	Raw	0.53

Table 1 (Cont.)

Family	Vernacular name	Species	GF	NS	ES	BT	PD	CM	FR(%)
Annonaceae	Sapi sapi (Port.)	*Annona muricata* L.	Shrub	Native	Marketable	McPh	Pan	Raw, juice	2.66
Annonaceae	Sapi sapi (Port.)	*Annona reticulata* L.	Shrub	Exotic	Marketable	McPh	Pan	Raw, juice	2.02
Annonaceae	Lomboloka (Kik.)	*Annona senegalensis* Pers.	Shrub	Native	Marketable	McPh	AT	Raw	0.98
Annonaceae	Lolo kiambulu,	*Annona stenophylla* Engl. & Diels	Sub shrub	Native	Marketable	NaPh	AT	Raw	0.63
Arecaceae	Lomboloka kia nkufi (Kik.)	*Elaeis guineensis* Jacq.	Palm tree	Native	Marketable	MsPh	Pan	Raw, boiling, grilled	5.14
Arecaceae	Ngazi, ba dia ngazi (Kik.)	*Cocos nucifera* L.	Palm tree	Exotic	Marketable	MgPH	Pal	Raw	1.78
Arecaceae	Coqueiro (Kik.)	*Raphia matombe* De Wild.	Palm tree	Native	Marketable	MsPh	GC-Z	Raw, boiling	0.92
Bromeliaceae	Bordão (Port.), Matombe (Kik.)	*Ananas comosus* (L.) Merr.	Herb	Exotic	Marketable	Chd	Pan	Raw, juice	0.52
Burseraceae	Abacaxi (Port.), Nanazi (Kik.)	*Pachylobus edulis* G.Don	Tree	Native	Marketable	MsPh	BGC	Raw, Heating (warm water)	1.51
Burseraceae	Safueiro (Port.), N'safu (Kik.)	*Canarium schweinfurthii* Engl.	Tree	Native	Marketable	MgPh	GC	Heating (warm water)	0.75
Caricaceae	Mbidi, mumbidi (Kik.) Mamoeiro (Port.), Kikila (Kik.)	*Carica papaya* L.	Tree	Exotic	Marketable	MsPh	Pan	Raw, juice	8.41
Combretaceae	Castanholeira (Port.)	*Terminalia catappa* L.	Tree	Exotic	Marketable	MaPh	Pal	Raw	0.95
Cucurbitaceae	Melancia (Port.), Ntetu (Kik)	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Creeping	Exotic	Marketable	Thgr	AM	Raw, juice	0.65
Fabaceae	Tamarino (Port.)	*Tamarindus indica* L.	Tree	Exotic	Marketable	MsPh	Pan	Raw, juice	0.95
Flacourtiaceae	Confiture (Fr.)	*Flacourtia jangomas* (Lour.) Raeusch.	Tree	Exotic	Marketable	MsPh	AT	Raw	0.80
Lamiaceae	Mfilu, mufilu (Kik.)	*Vitex madiensis* Oliv.	Shrub	Native	No marketable	McPh	AT	Raw	1.71

Table 1 (Cont.)

Family	Vernacular name	Species	GF	NS	ES	BT	PD	CM	FR(%)
Lauraceae	Abacateiro (Port.), mvoka (Kik.)	*Persea americana* Mill.	Tree	Exotic	Marketable	MsPh	Pan	Raw	11.99
Malvaceae	Cacao (Port.)	*Theobroma cacao* L.	Shrub	Exotic	Marketable	McPh	AA	Toast	1.08
Malvaceae	Makazu, Nkazu (Kik.)	*Cola acuminata* (P.Beauv.) Schott & Endl.	Tree	Native	Marketable	MsPh	GC	Raw	1.95
Malvaceae	Imbondeiro (Port.), Nkondo (Kik.)	*Adansonia digitata* L.	Tree	Native	Marketable	MsPh	AT	Raw, juice	1.56
Malvaceae	Lunguba lua mputu (Kik.)	*Pachira glabra* Pasq.	Tree	Exotic	Marketable	McPh	Pan	Boiled, toast	1.59
Moraceae	Figueira (Kik.)	*Ficus carica* L.	Tree	Exotic	No Marketable	McPh	Pan	Raw	1.55
Moraceae	Fruta pão (Port.)	*Artocarpus altilis* (Parkinson) Fosberg	Tree	Exotic	Marketable	MsPh	GC	Boiled, chips	1.95
Moraceae	Jacqueira (Kik.)	*Artocarpus heterophyllus* Lam.	Tree	Exotic	Marketable	MsPh	GC	Raw, juice	1.60
Musaceae	Banana pão (Port.), Mankondo mangioka (Kik.)	*Musa* × *paradisiaca* L.	Herb	Exotic	Marketable	MG	Pan	Raw, chips, toast, boiling	5.76
Musaceae	Banana de mesa (Port.), banane dessert (Fr.)	*Musaacuminata* Colla	Herb	Exotic	Marketable	MG	Pan	Raw, chips, boiled	5.76
Myrtaceae	Jambo (Port.)	*Syzygium malaccense* (L.) Merr. & L.M.Perry	Tree	Exotic	Marketable	MsPh	AT	Raw	1.55
Myrtaceae	Jambo (Port.)	*Syzygium samarangense* (Blume) Merr. & L.M.Perry	Tree	Exotic	Marketable	MsPh	AT	Raw	1.59
Myrtaceae	Goiabeira (Port.), Ngavua, Mfuluta (Kik.)	*Psidium guajava* L.	Shrub	Exotic	Marketable	MsPh	AT	Raw	7.63
Myrtaceae	Pitangueira (Port.)	*Eriobotrya japonica* (Thunb.) Lindl.	Shrub	Exotic	Marketable	McPh	Pan	Raw	1.50
Oxalidaceae	Carambole (Port.)	*Averrhoa carambola* L.	Shrub	Exotic	Marketable	MsPh	Pan	Raw, juice	1.25
Passifloraceae	Maracujá-de-Cheiro (Port.)	*Passiflora foetida* L.	Liana	Exotic	No Marketable	Phgr	Pan	Raw	0.50

Table 1 (Cont.)

Family	Vernacular name	Species	GF	NS	ES	BT	PD	CM	FR(%)
Passifloraceae	Maracujajeira grande (Port.)	*Passiflora quadrangularis* L.	Liana	Exotic	Marketable	Phgr	Pan	Raw, juice	1.52
Passifloraceae	Maracujajeira pequena (Port.)	*Passiflora edulis* Sims	Liana	Exotic	Marketable	Phgr	Pan	Raw, juice	1.97
Phyllanthaceae	Mwindu.nkangati (Kik.)	*Bridelia ferruginea* Benth.	Shrub	Native	No Marketable	McPh	Pan	Raw	1.05
Rosaceae	Nespereira (Port.)	*Eugenia uniflora* L.	Tree	Exotic	Marketable	McPh	Pan	Raw	0.99
Rubiaceae	Cafeiro (Port.), Cafeier (Fr.)	*Coffea canephora* Pierre ex A.Froehner	Shrub	Native	Marketable	McPh	Pan	Toast	0.59
Rutaceae	Tanjarina (Kik.)	*Citrus reticulata* Blanco	Shrub	Exotic	Marketable	McPh	Pan	Raw, juice	0.91
Rutaceae	Laranjeira (Port.)	*Citrus sinensis* (L.) *Osbeck*	Shrub	Exotic	Marketable	MsPh	Pan	Raw, juice	1.04
Rutaceae	Pamplemousse (Fr.)	*Citrus maxima* (Burm.) Merr.	Shrub	Exotic	Marketable	McPh	Pan	Raw, juice	0.87
Rutaceae	Limoeiro grande (Port.)	*Citrus* sp.	Shrub	Exotic	Marketable	McPh	Pan	Raw, juice	0.91
Rutaceae	Limoeiro pequena	*Citrus* × *limon* (L.) Osbeck	Shrub	Exotic	Marketable	McPh	Pan	Raw	1.25
Urticaceae	Bonzua, Mabuba (Kik.)	*Myrianthus arboreus* P.Beauv.	Tree	Native	No marketable	MsPh	CG	Raw	0.63
Vitaceae	Videira (Kik.)	Vitis vinifera L.	Liana	Exotic	Marketable	LPh	Med	Raw	0.93
Zingiberaceae	Mansansa malonde (Kik.)	*Aframomum alboviolaceum* (Ridl.) K.Schum.	Herb	Native	Marketable	Grh	AT	Raw, Juice	1.27

Note: Legend: Fr. = french, Kik. = Kikongo, Ling. = Lingala, Port. = Portuguese, GF = Growth forms, NS = Nativity status, ES = Economical status, BT = Biological types, FR% =Relative frequency in percentage, CM = Consumption modes, PD = Phytogeographical distribution.

Flora of the city of Uíge is a rich source of fruit species of various apply. A total of fifty-one edible fruit plants have been formally identified in the city of Uíge, all Angiosperms, including 45 Dicots, and 6 Monocotyledons. The 51 documented fruit plants are distributed in 37 genera, and 25 botanical families (Table 1). The most represented botanical families are *Annonaceae* (five species), *Anacardiaceae* (five species), *Rutaceae* (five species), *Malvaceae* (four species), *Myrtaceae* (four species), *Arecaceae* (three species), and *Moraceae* with three species. The rest of the botanical families have fewer than three species, or one or two species of fruit plants. Regarding the frequency of citation of fruit plant species (Table 1), *Mangifera indica* was the plant most frequently found in the study area with 13.08%, followed by *Persea america* (11.99%), *Pachylobus edulis* (9.5%), *Carica papaya* (8.41%), *Psidium guajava* (7.63%), *Spondias mombin* (6.37%), *Musa acuminata* (5.76%), *Musa paradisiaca* (5.45%), *Elaeis guineensis* (5.14%), *Annona muricata* (2.66%), *A. senegalensis* (2.65%), *A. reticulata* (2.02%), *Spondias dulcis* (1.87%), *Vitex madiensis* (1.71%), and *Adansonia digitata* with a frequency of 1.56%. Alike, the other fruit plants documented in the Uíge city have a citation frequency of less than one percent.

3.1. Distribution of morphological types and origin of species

Figure 2 shows the different morphological types of fruit plants inventoried in the city of Uíge.

When classifying taxa into morphological types, trees (47.1%) were the main morphological type, followed by shrubs (33.3%), lianas (7.9%), and herbs (7.8%). Subshrubs (2%), and creepings (2%) are very rare in this flora (Figure 2).

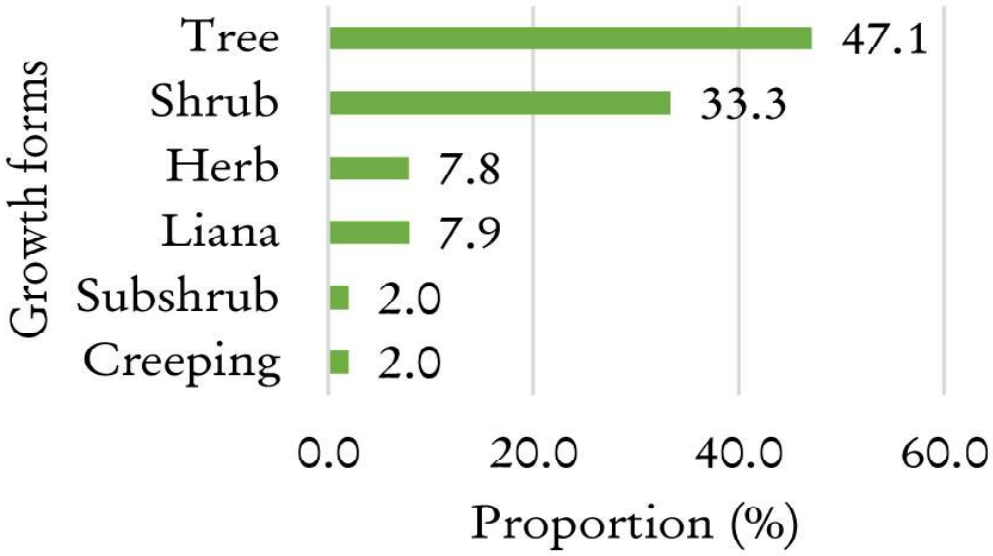

Figure 2: Growth forms (%)

Analysis of the flora based on the Nativity status of the species shows that 72.5% are exotic species or species introduced consciously or involuntarily within the indigenous flora of Uíge, and 27.5% are native species. Mawunu *et al.* (2022a) reported that the greatest of medicinal plants used in the small town of Songo were of exotic origin. Similar results were reported by Walter *et al.* (2009) in their in their study on effects of urbanization on plant species diversity in central Arizona, USA. In contrast, Mawunu *et al.* (2023b) reported a dominance of indigenous plants in the ethnobotanical survey of herbal teas consumed in the province of Uíge, Angola: part 1. The predominance of exotic plants may be due to human activities, uncontrolled growing urbanization, and adaptability to various environmental conditions, particularly soil, and climate. Human activities are contributing to the decline in the native urban flora of the city of Uíge. The urban ecosystem in the city of Uíge, in which humans are the most active biological species, directly, and indirectly, influences changes in all other ecosystems. Finally, this result provides ample proof of the human footprint on natural ecosystems.

3.2. Vernacular names of edible fruit plants

Some species of edible fruit plants have more than one vernacular name (e.g. *Canarium schweinfurthii* - mbidi or mumbidi, *Persea americana*-Abacateioro or mvoka). Also, other botanical species were designated by a single vernacular name, for example *Citrullus lanatus* (Melancia), *Pachira glabra* (Lunguba lua mputu) (Table 1).

3.3. Biological types and phytogeographical distribution

Figures 3 and 4 show the biological types, and phytogeographical distribution of edible fruit plants in the city of Uíge.

Of the 51 species of edible fruiting plants recorded, phanerophytes (Figure 3) were the most abundant at 90.20% (26.0% mesophanerophytes, 15.1% nanophanerophytes, 15.1% microphanerophytes, 6.9% liana phanerophytes, 4.1% climbing phanerophytes, 2.7% macrophanerophytes, and 2.7% megaphanerophytes), followed by geophytes with 5.88% of total species. Therophytes, and chamaephytes were very poorly represented, with barely one species each, i.e., 1.96%. Mawunu et al. (2023a) reported that phanerophytes are the dominant biological type in Uíge province. Similar results were reported by Mawunu et al. (2023b) in their ethnobotanical survey of herbal teas consumed in the province of Uíge, Angola: part 1.

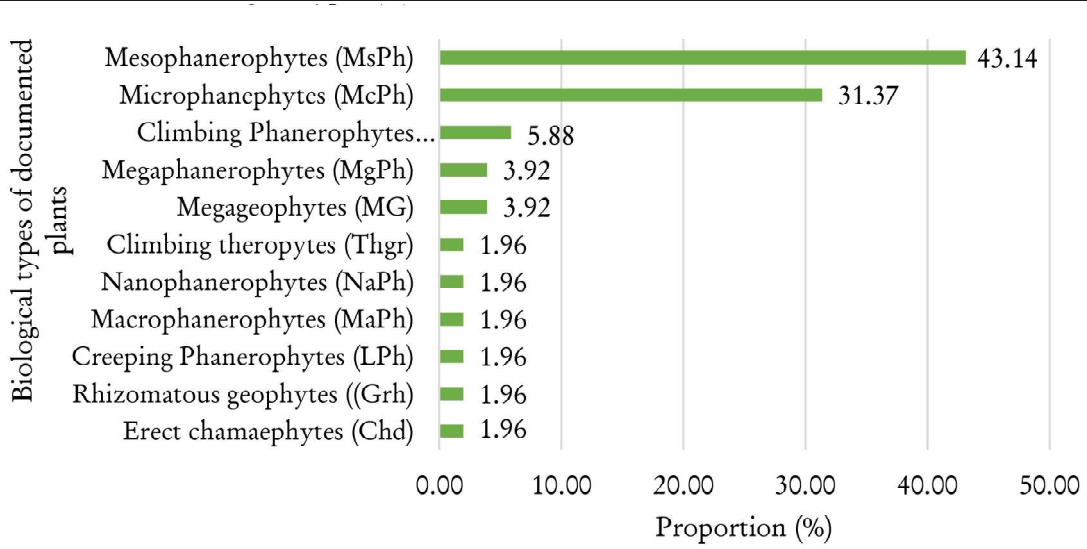

Figure 3: Distribution of biological types (%)

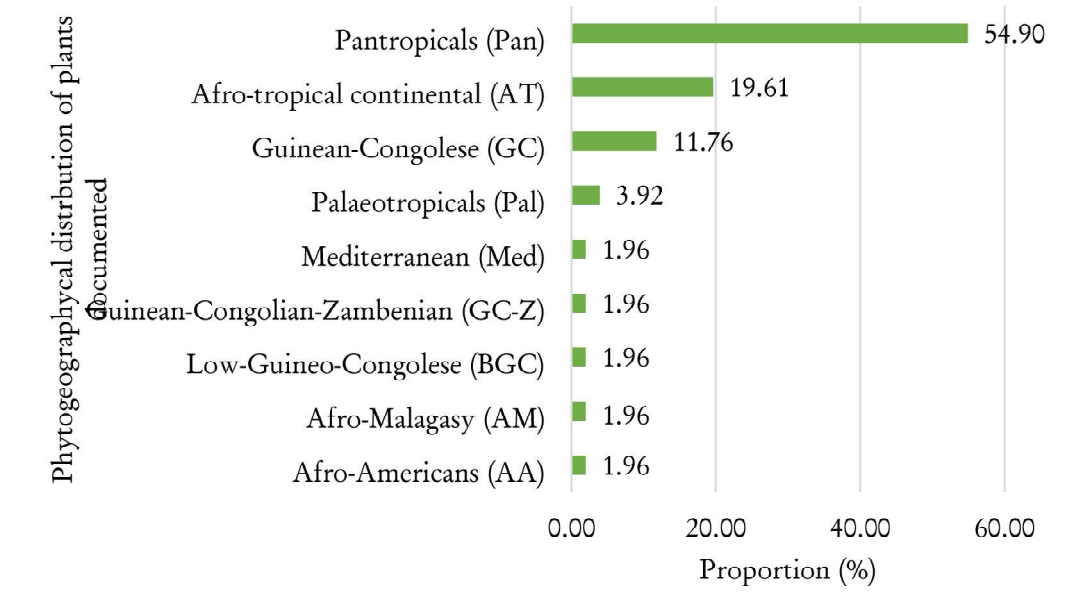

Figure 4: Phytogeographical distribution of taxa (%)

Regarding the phytogeographical distribution of the studied flora, the data in Figure 4 show that they are essentially tropical plants. Pantropical species (54.9%) were the most common in the studied area, followed by continental Afrotropical species (19.61%), Guinea-Congo species (11.76%), and Paleotropical species with 3.92%. Also, Guinea-Congo-Zambezian species (1.96%), Mediterranean species (1.96%), Low-Guineo-Congo species (1.96%), and Afro-Malagasy species with 2.7%. Mawunu *et al.* (2023a) reported the predominance of Pantropical species in a study on fruit, and leafy vegetable marketing in the city of Uíge. Similar results were reported by Mawunu *et al.* (2023b) in the ethnobotanical study of herbal teas consumed in the Uíge province of Angola: Part 1. Also, Kimpouni *et al.* (2017) in their study of allochthonous tree flora and urban forestry in Brazzaville (Congo) reported the predominance of pantropical species.

3.4. Fruit consumption habits

Figure 5 shows the different ways in which fruit is consumed in the city of Uíge.

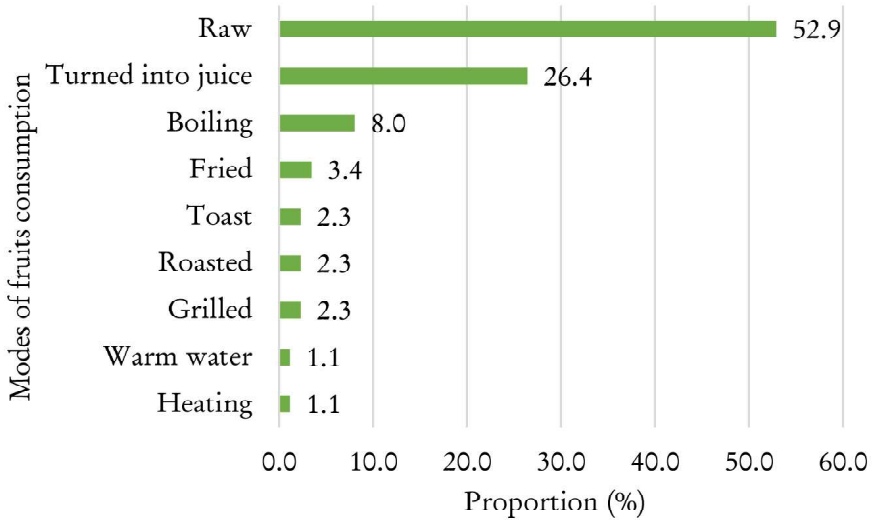

Figure 5: Fruit consumption modes (%)

Most fruits (52.9%) are consumed raw (Figure 5). However, some fruits consumed raw can be processed into juice (26.4%). In particular, *Adansonia digitata*, *Annona muricata*, *Ananas comosus*, *Aframomum alboviolaceum*, *Passiflora edulis*, *Passiflora quadrangularis*, and *Tamarindus indica*. Other fruits were consumed boiled (8.0%), fried (3.4%), grilled (4.6%), roasted (2.3%), or heated in warm water with 2.2%. Some fruits can be eaten two ways (boiled and fried, e.g. *Artocarpus altilis*) or four ways (raw, fried, roasted/grilled and cooked, e.g. *Musa*). Finally, in the city of Uíge, some fruits can only be eaten raw, such as *Eugenia uniflora*, *Myrianthus arboreus*, and *Syzygium malaccense*. Similar findings were reported by Abbasi *et al*. (2013) in Pakistan in their study ethnobotanical survey on edible wild fruits of medical importance used by tribal communities of the Lesser Himalayas that the fruits are more consumed raw.

3.5. Other uses of fruit plants studied in the city of Uíge

Edible fruit plants, both native and exotic, are used for a variety of purposes in the town of Uíge. Figure 6 shows the other fruit plants documented in the city of Uíge.

Figure 6 shows that edible fruit plants in the town of Uíge are also used as a source of herbal remedies with 22.8%, followed by bioenergy (firewood, charcoal) (19.6%), shading (18.5%), windbreaks (16.3%), herbal teas

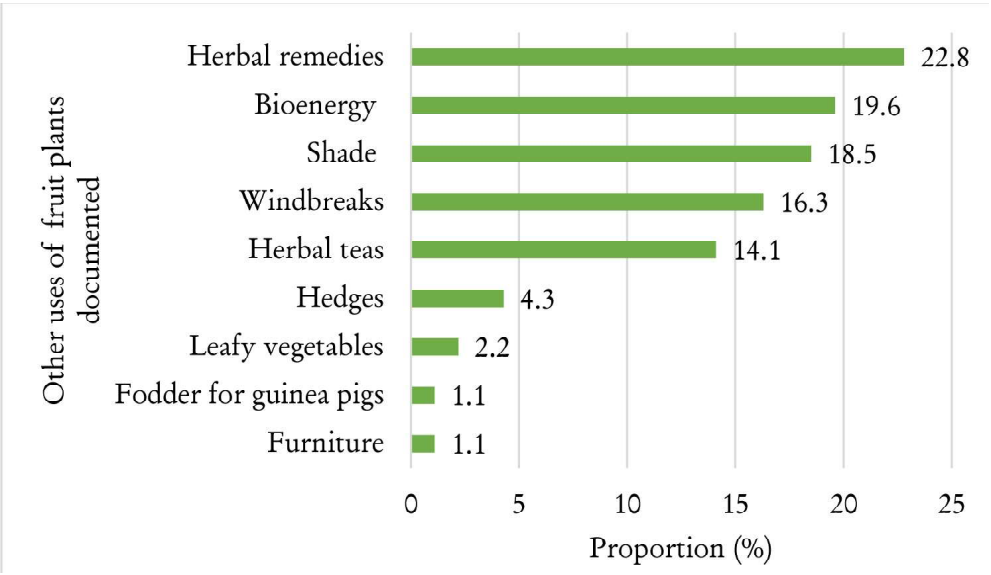

Figure 6: Other uses of fruit plants documented in Uíge city (%)

(14.1%), hedges (4.3%), leafy vegetables (2.2%), furnishings (1.1%) and guinea pig fodder with 1.1%. Similar results were also reported by Mawunu *et al.* (2022b) in their study of medicinal plants in the small town of Songo. However, our results are in contrast to those of Mawunu *et al.* (2022a), who reported that food plants were also used as traditional medicines (32%) and bioenergy (firewood, 24%; charcoal, 12%).

Table 2 lists the nutraceutical fruit plants found in the city of Uíge, including the organs used in the preparation of phytomicinal recipes, the methods of preparation and administration of medicinal herbs and the various human diseases treated.

Table 2: List of nutraceutical fruit plants found in the city of Uíge

Family	Species	Parties used	Preparation modes	Administration methods	Treated illnesses and symptoms
Anacardiaceae	*Mangifera indica* L.	Leaf, stem bark	Decoction, infusion	Oral intake, Bath	Diabetes, diarrhoea, hypertension, low haemoglobin, haemorrhoid, stomach ache, backache
Anacardiaceae	*Spondias monbim* L.	Leaf, stem bark	Decoction	Bath, enema	Diarrhoea, watery breastmilk, yellow fever
Anacardiaceae	*Spondias dulcis* Parkinson	Fruit	Chewing	Oral intake	Pregnancy symptoms
Anacardiaceae	*Anacardium occidentale* L.	Stem bark, leaf	Decoction	Oral intake	Backache, diabetes, toothache
Anacardiaceae	*Pseudospondias microcarpa* (A. Rich.)	Stem bark, leaf	Decoction, maceration	Enema, oral intake	Haemorrhoid, diarrhoea
Annonaceae	*Annona muricata*L.	Leaf	Decoction	Oral intake	Low haemoglobin, fatigue
Annonaceae	*Annona squamosa* L.	Leaf	Decoction	Oral intake	Low haemoglobin
Annonaceae	*Annona reticulata* L.	Leaf	Decoction	Oral intake	Low haemoglobin, fatigue
Annonaceae	*Annona senegalensis* Pers.	Leaf, root	Decoction	Oral intake	Diarrheoa, Low haemoglobin, fatigue
Annonaceae	*Annona stenophylla* Engl. & Diels	Leaf, root	Decoction	Oral intake	Diarrhoea, constipation, stomach ache, low haemoglobin levels
Arecaceae	*Elaeis guineensis* Jacq.	Nuts	Decoction, Chewing	Oral intake	Splenomegaly, cryptorchidism, poisoning
Arecaceae	*Cocos nucifera* L.	Root	Decoction	Oral intake	Diarrheoa, diabetes, urogenital inflamation
Arecaceae	*Raphia matombe* De Wild.	Fruit	Crudité	Oral intake	Diabetes, bladder pain

Table 2 (Cont.)

Family	Species	Parties used	Preparation modes	Administration methods	Treated illnesses and symptoms
Bromeliaceae	*Ananas comosus* (L.) Merr.	Fruit	Chewing	Oral intake	Diabetes
Burseraceae	*Pachylobus edulis* G.Don	Leaf	Decoction	Mouth Wash	Toothache
Burseraceae	*Canarium schweinfurthii* Engl.	Resin, stem bark	Decoction, infusion, burn incense	Oral intake, enema	Diarrhoea, stomach ache, cough, constipation
Caricaceae	*Carica papaya* L.	Leaf, root, seed	Decoction, chewing	Oral intake, mouth wash	Cough, diabetes, caries,worms
Combretaceae	*Terminalia catappa* L.	Root	Decoction	Oral intake	Stomachache
Cucurbitaceae	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Fruit, seed	Chewing	Oral intake	Diarrhoea, dehydration, worms, urinary infection
Fabaceae	*Tamarindus indica* L.	Fruit	Maceration, infusion	Oral intake	Low breast milk production, diabetes
Flacourtiaceae	*Flacourtia jangomas* (Lour.) Raeusch.	Fruit	Chewing	Oral intake	Diarrhoea, toothache, diabetes
Lamiaceae	*Vitex madiensis* Oliv.	Leaf, stem bark, root	Decoction, infusion	Oral intake	Fatigue, cough, diabetes, diarrhoea, constipation, low haemoglobin levels, low production of breast milk, body pains
Lauraceae	*Persea americana* Mill.	Leaf, seed	Decoction, Grinding	Oral intake, dermal	Hypertension, low haemoglobin levels, measles
Malvaceae	*Theobroma cacao* L.	Seed	Torified	Oral intake	Hypertension, fatigue
Malvaceae	*Cola acuminata* (P.Beauv.) Schott & Endl.	Seed, stem bark	Chewing	Oral intake	Diabetes, fatigue
Malvaceae	*Adansonia digitata* L.	Fruit	Decoction, maceration	Oral intake	Low haemoglobin, cough, sores, diarrhoea, fever, inflammation, kidney disease, diabetes, asthma
Malvaceae	*Pachira glabra* Pasq.	Stem bark	Maceration	Oral intake	Diabetes
Moraceae	*Ficus carica* L.	Fruit, Leaf	Maceration	Oral intake	Diabetes, cough, constipation

Table 2 (Cont.)

Family	Species	Parties used	Preparation modes	Administration methods	Treated illnesses and symptoms
Moraceae	*Artocarpus altilis* (Parkinson) Fosberg	Root	Maceration	Oral intake	Diarrhoea, worms, fever
Moraceae	*Artocarpus heterophyllus* Lam.	Root, stem bark	Maceration	Oral intake	Diarrhoea, dysentery
Musaceae	*Musa* × *paradisiaca* L.	Fruit	Decoction, Cooking	Oral intake	Bronchitis, diarrhoea, cough, dysentery
Musaceae	*Musa acuminata* Colla	Fruit	Decoction, Cooking	Oral intake	Diarrhoea, cough, dysentery
Myrtaceae	*Psidium guajava* L.	Fruit, leaf	Maceration, infusion	Oral intake, vaginal wash	Diarrhoea, vaginal wall dilation, insomnia
Myrtaceae	*Syzygium malaccense* (L.) Merr. & L.M.Perry	Leaves, stem bark	Decoction	Oral intake	Diarrhoea
Rutaceae	*Citrus* spp.	Leaf, fruit peel	Infusion	Orale intake	Cough, constipation, angina

3.6. Ethnomedicinal use of edible fruit plants studied

The great majority (98.04%) of edible fruit plants documented in the city of Uíge are also used as medicinal plants - nutraceutical plants (Table 2).

3.7. Parts of plants used to prepare drugs

Figure 7 shows the parts of nutraceutical fruit plants used in phytotherapy in the city of Uíge.

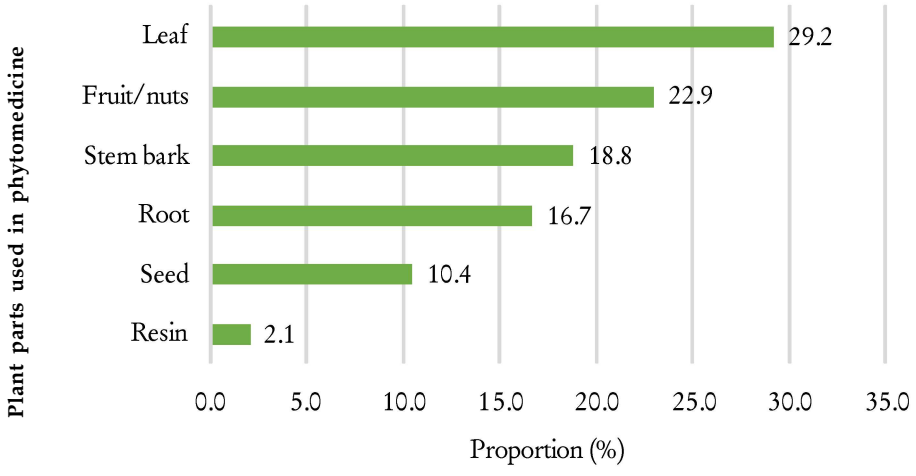

Figure 7: Parts of edible plants used in traditional medicine in Uíge City (%)

The number of organs produced per species varied from 1 to 3. *Carica papaya*, and *Vitex madiensis* were the taxa that provided the most phytomechanical organs, with three each: leaves, roots and seeds for the first species, and leaves, stem bark and roots for the second. The remaining species have one or two organs (Table 2). Several organs of edible fruit plants are used in the preparation of phytomedicinal recipes. These are mainly leaves (31.5%), followed by fruits, fruit peel and nuts (24.1%), stem barks (18.5%), roots (13.0%), seeds (9.3%), and resin with 1.9% (Figure 7). Our results corroborate the findings of similar studies carried out in Angola and elsewhere in the world (Camacho-Hernández *et al.*, 2022; Canga *et al.*, 2022; Djoza *et al.*, 2021; Lautenschläger *et al.*, 2018; Liyongo *et al.*, 2023; Mawunu *et al.*, 2022; Mobale *et al.*, 2023) in which the part of the plant most commonly used in traditional medicine was the leaves for the treatment of various human ailments.

Likewise, the preference for leaves for medicinal production is a positive result for the conservation of plant resources.

Indeed, collecting leaves in moderation neither harms nor affects the plant's health, reproduction or development. This practice is linked to the abundance and convenience of using leaves compared to other parts of the plant, as well as to confidence in the effectiveness of their use (Santos *et al.*, 2008).

3.8. Methods of preparation and administration used in herbal medicine

Figures 8 and 9 show the different methods of preparing and admnistrating phytoremedies from nutraceutical fruit plants in the city of Uíge.

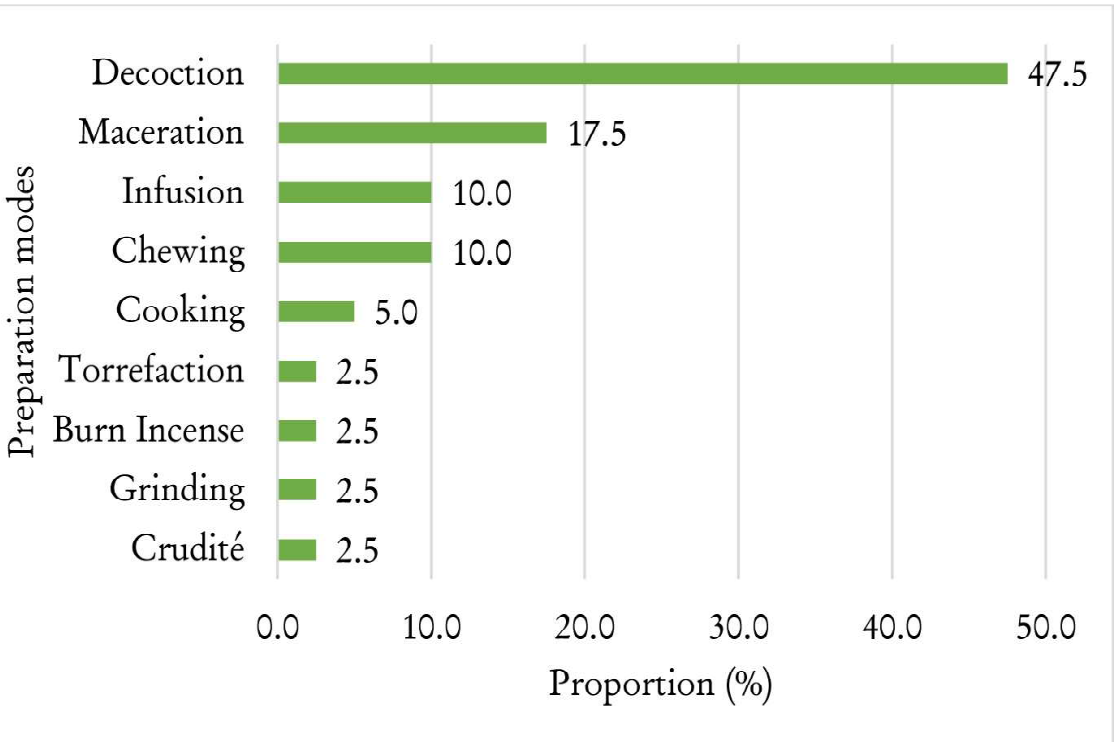

Figure 8: Preparation modes of remedies (%)

With regard to galenic forms (Figure 8), 51.2% of phytotherapeutic recipes are in the form of decoction, followed by maceration (17.5%), infusion (10.0%), chewing (10.0%), cooking (5.0%), crudité (2.5%), burn incense (2.5%), grinding (2.5%), and torrefaction (2.5%). Our results corroborate other studies such as those by Jendras *et al.* (2020), Liyongo *et al.* (2023), and Ngbolua *et al.* (2023a; 2023b) that decocotion is the most widely used method of preparing herbal medicines.

Figure 9 shows the different methods of administering herbal medicines from nutraceutical fruit plants in the city of Uíge.

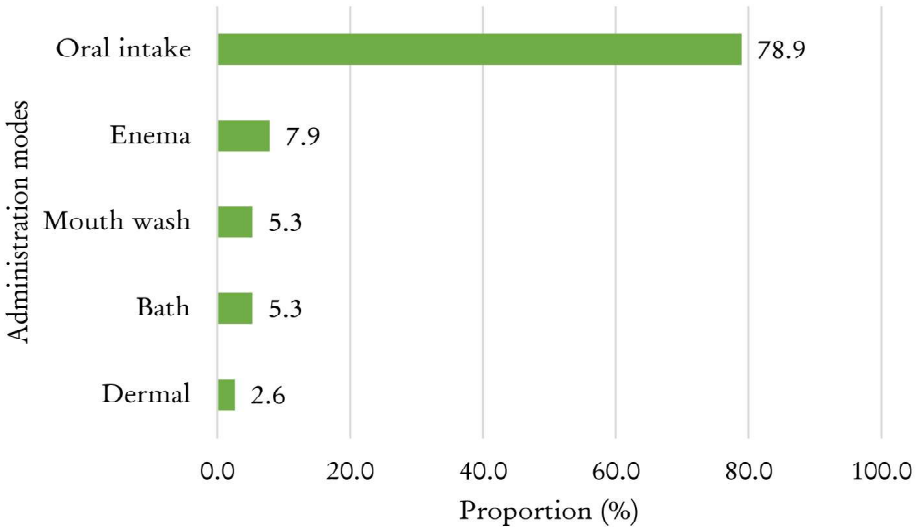

Figure 9: Administration modes of herbal drug (%)

The main mode of administration was oral (78.9%), followed by enema (7.9%), mouthwash (5.3%), bath (5.3%), and dermal (2.6%) (Figure 9). Similarly, Mawunu *et al.* (2024 in press) reported that decoction is the dominant used preparation method in the medicinal traditional treatment. Our results are in agreement with other studies such as Canga *et al.* (2022), and Lautenschläger *et al.* (2018) who reported that the oral route of administration *(per os)* is the most widely used in northern Angola. Again, Effoe *et al.* (2020) in their ethnobotanical study of food plants used in traditional medicine in the Maritime region of Togo reported that the oral route is the main method of administering phytomedicines.

3.9. Human diseases and symptoms treated with nutraceutical fruit plants

Figure 10 shows the different human illnesses treated in the town of Uíge using nutraceutical fruit plants-nutraceutiques.

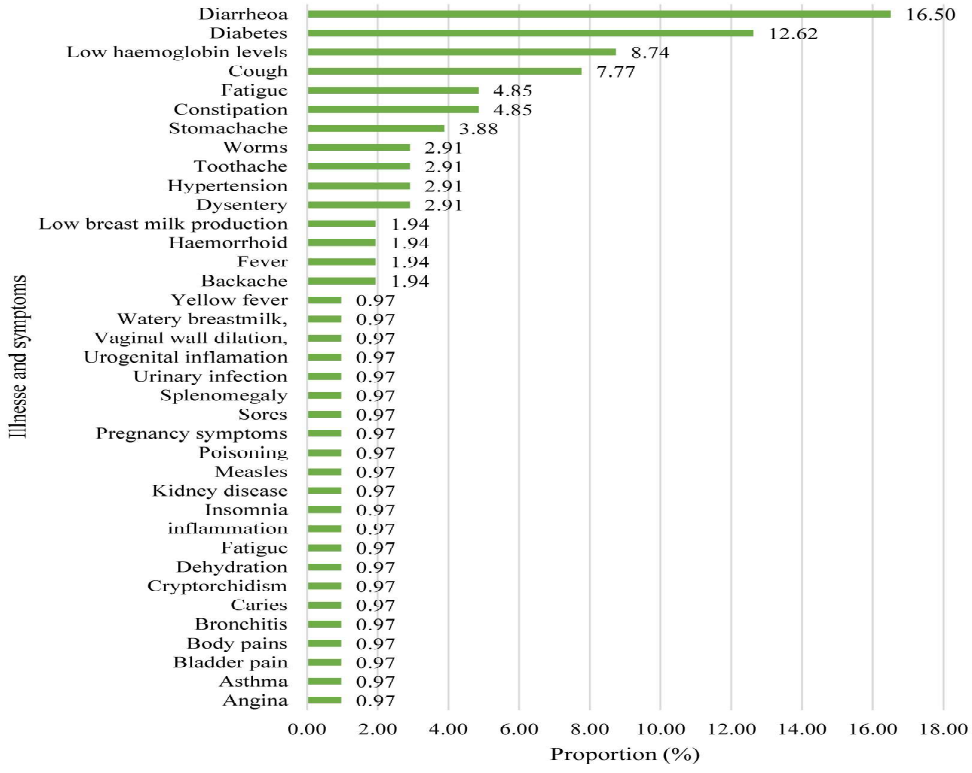

Figure 10: Human illnesses and symptoms treated nutraceuticals fruit plant in Uge city (%)

A total of 36 human diseases and symptoms treated using nutraceutical fruit plants in the town of Uíge were listed (Figure 10). According to the frequency with which they were cited, diarrhoea was the ailment most frequently treated by the nutraceutical fruit plants documented in the present study (16.50%), followed by diabetes (12.62%), anaemia/low haemoglobin (8.74%), cough (7.77%), fatigue (4.85%), constipation (4.85%), stomachache (3.88%), toothache (2.91%), hypertension (2.91%), and dysentery (2.91%). The other diseases documented in this study were less frequently cited, namely low breast milk production, haemorroid, fever, and backache each representing 1.94% of the frequency of citations. Lastly, yellow fever, watery breastmilk, vaginal wall dilation, urogenital inflammation, urinary infection, splenomengaly, sores, early pregnancy nausea, word poisoning, varicella, kidney disease, insomnia, inflammation, fatigue, dehydration, cryptorchidism, caries, bronchitis, body pain, bladder pain, asthma and angina each representing 0.97%.

Moreover, studies carried out by Mawunu *et al.* (2022b) reported from the small town of Songo that medicinal plants were most commonly used to treat coughs, anemia, malaria and diarrhea. Canga *et al.* (2022), reported the dominance of infectious and parasitic diseases, notably infectious and parasitic diseases (e.g., malaria, leprosy, and cholera). Besides, Pathy *et al.* (2021) in the city of Mbanza Ngungu in the DRC reported that hemorrhoid, hernia and sexual impotence were the most dominant diseases.

3.10. Relationships between the botanical families of edible fruit plants and the diseases they treat

Table 3 shows the relationship between the botanical families of medicinal fruit plants studied in the town of Uíge and the different diseases they treat.

Table 3: Relationships between the botanical families of plants documented and the diseases treated

Botanical species	Illnesses	Number of illnesses treated
Anacardiaceae	Abdominal pain, diabetes, toothache, diabetes, diarrhoea, hypertension, low haemoglobin, haemorrhoid, stomach ache, backache, watery breastmilk, nausea during pregnancy, yellow fever	13
Malvaceae	Low haemoglobin, cough, sores, diarrhoea, fever, inflammation, kidney disease, diabetes, asthma, hypertension, fatigue	11
Lamiaceae	Fatigue, cough, diabetes, diarrhoea, constipation, low haemoglobin levels, low production of breast milk, body pains	8
Arecaceae	Bladder pain, diarrheoa, diabetes, urogenital inflamation, splenomegaly, cryptorchidism, poisoning	7
Moraceae	Diabetes, cough, constipation, diarrhoea, worms, fever, dysentery	7
Annonaceae	Diarrheoa, low haemoglobin, fatigue, constipation, stomach ache	5
Cucurbitaceae	Diarrhoea, dehydration, worms, urinary infection	4
Burseraceae	Diarrhoea, stomach ache, cough, constipation	4
Caricaceae	Cough, diabetes, caries, worms	4
Musaceae	Bronchitis, diarrhoea, cough, dysentery	4
Flacourtiaceae	Diarrhoea, toothache, diabetes	3
Lauraceae	Hypertension, low haemoglobin levels, measles	3
Fabaceae	Diabetes, low breast milk production	2
Bromeliaceae	Diabetes	1
Burseraceae	Toothache	1
Combretaceae	Stomachache	1

The results in table 3 show that edible fruit plants from the *Anacardiaceae* family are the most commonly used phytoremedes in the town of Uíge, treating thirteen human diseases (abdominal pain, diabetes, toothache, diabetes, diarrhoea, hypertension, low haemoglobin, haemorrhoid, stomach ache, backache, watery breastmilk, nausea during pregnancy, yellow fever); *Anacardiaceae* treat eleven human diseases (low haemoglobin, cough, sores, diarrhoea, fever, inflammation, kidney disease, diabetes, asthma, hypertension, fatigue), *Lamiaceae* treat eight human diseases (fatigue, cough, diabetes, diarrhoea, constipation, low haemoglobin levels, low production of breast milk, body pains), *Arecaceae* treat seven human pathologies (Bladder pain, diarrheoa, diabetes, urogenital inflammation, splenomegaly, cryptorchidism, poisoning), *Moraceae* treat seven pathologies (diabetes, cough, constipation, diarrhoea, worms, fever, dysentery), *Annonaceae*treat five pathologies (diarrheoa, low haemoglobin, fatigue, constipation, stomach ache). The other botanical families documented in the current study treat just one to four human diseases.

3.11. Relationships with botanical species and illnesses treates

Table 4 shows the nutraceutical fruit plants that have been used to treat human pathologies in the city of Uíge.

Table 4: Relationships between edible fruit plants for medicinal use and diseases treated

Botanical species	Illnesses	Number of illnesses treated
Adansonia digitata	Low haemoglobin levels, cough, wounds, diarrhoea, fever, inflammation, kidney disease, diabetes, asthma	9
Vitex madiensis	Fatigue, cough, diabetes, diarrhoea, constipation, low haemoglobin levels, low production of breast milk, body pains	8
Mangifera indica	Diabetes, diarrhoea, hypertension, low haemoglobin, haemorrhoid, stomach ache, backache	7
Annona stenophylla	Diarrhoea, constipation, stomach ache, low haemoglobin levels	4
Canarium schweinfurthii	Diarrhoea, stomach ache, cough, constipation	4
Carica papaya	Cough, diabetes, caries, malaria, worms	4
Citrullus lanatus	Diarrhoea, dehydration, worms, urinary infection	4
Musa paradisiaca	Bronchitis, diarrhoea, cough, dysentery	4
Spondias monbim	Diarrhoea, watery breastmilk, yellow fever	3
Anacardium occidentale	Abdominal pain, diabetes, toothache	3
Annona senegalensis	Diarrheoa, Low haemoglobin, fatigue	3
Elaeis guineensis	Splenomegaly, cryptorchidism, poisoning	3
Cocos nucifera	Diarrheoa, diabetes, urogenital inflamation	3
Flacourtia jangomas	Diarrhoea, toothache, diabetes	3
Persea americana	Hypertension, low haemoglobin levels, measles	3
Ficus carica	Diabetes, cough, constipation	3
Artocarpus altilis	Diarrhoea, worms, fever	3
Musa acuminata	Diarrhoea, cough, dysentery	3
Psidium guajava	Diarrhoea, vaginal wall dilatation, insomnia	3

Table 4 (Cont.)

Botanical species	Illnesses	Number of illnesses treated
Pseudospondias microcarpa	Hemorrhoid, diarrhoea	2
Annona muricata	Low haemoglobin, fatigue	2
Annona reticulata	Low haemoglobin, fatigue	2
Raphia matombe	Diabetes, Bladder pain	2
Theobroma cacao	Hypertension, fatigue	2
Cola acuminata	Diabetes, fatigue	2
Artocarpus heterophyllus	Diarrhoea, dysentery	2
Psidium guajava	Diarrhoea, vaginal wall dilatation, insomnia	3
Spondias dulcis	Pregnancy symptoms	1
Annona squamosa	Low haemoglobin	1
Ananas comosus	Diabetes	1
Pachylobus edulis	Toothache	1
Terminalia catappa	Stomachache	1
Tamarindus indica	Diabetes, low breast milk production	1
Pachira glabra	Diabetes	1

The results in Table 4 show that *Adansonia digitata* is the edible fruit plant most commonly used in phytotherapy to treat nine different human diseases (low haemoglobin, cough, wounds, diarrhoea, fever, inflammation, kidney disease, diabetes, asthma), followed by *Vitex madiensis* used to treat eight different human diseases (fatigue, cough, diabetes, diarrhoea, constipation, low haemoglobin levels, low production of breast milk, body pains); *Mangifera indica* treats seven human diseases (diabetes, diarrhoea, hypertension, low haemoglobin, haemorrhoid, stomach ache, backache); *Annona stenophylla* treats four diseases (diarrhoea, constipation, stomach ache, low haemoglobin level); *Canarium schweinfurthii*, treats four diseases (diarrhoea, stomach ache, cough, constipation); *Carica papaya*, treats four diseases (cough, diabetes, caries, malaria, worms); *Citrullus lanatus*, treats four diseases (diarrhoea, dehydration, worms, urinary infection) and *Musa* × *paradisíaca*, treats four diseases (bronchitis, diarrhoea, cough, dysentery). Additionally, the other edible fruit plants documented in the current study are used in the treatment of one to three human diseases (Table 4).

3.12. Relationships between human diseases and the plants species studied

Table 5 shows the relationships documented in this study between human diseases and the edible fruit plants studied in the city of Uíge.

Table 5 shows that diarrhoea was the condition treated with the greatest number of nutraceutical plants (fourteen species), in particular: *Adansonia digitata, Annona senegalensis, Annona stenophylla, Artocarpus altilis, Canarium schweinfurthii, Citrullus lanatus, Cocos nucifera, Flacourtia jangomas, Mangifera indica, Musa* × *paradisiaca, Musa acuminata, Pseudospondias microcarpa, Spondias mombin, Vitex madiensis*; followed by diabetes, treated with twelve nutraceuticals (*Adansonia digitata, Ananas comosus, Anacardium occidentale, Carica papaya, Cola acuminata, Cocos nucifera, Flacourtia jangomas, Ficus carica, Mangifera indica, Pachira glabra, Raphia matombe, Vitex madiensis*); Low haemoglobin, treated with nine nutraceuticals (*Adansonia digitata, Annona muricata, Annona reticulata, Annona senegalensis, Annona squamosa, Annona stenophylla, Mangifera indica, Persea americana, Vitex madiensis*);

Table 5: Relationships between human diseases and edible fruit plants studied in the city of Uíge

Illmesses	Botanical species	Number of nutraceuticals used
Diarrheoa	*Adansonia digitata, Annona senegalensis, Annona stenophylla, Artocarpus altilis, Canarium schweinfurthii, Citrullus lanatus, Cocos nucifera, Flacourtia jangomas, Mangifera indica, Musa × paradisiaca, Musa acuminata, Pseudospondias microcarpa, Spondias mombin, Vitex madiensis*	14
Diabetes	*Adansonia digitata, Ananas comosus, Anacardium occidentale, Carica papaya, Cola acuminata, Cocos nucifera, Flacourtia jangomas, Ficus carica, Mangifera indica, Pachira glabra, Raphia matombe, Vitex madiensis*	12
Low haemoglobin	*Adansonia digitata, Annona muricata, Annona reticulata, Annona senegalensis, Annona squamosa, Annona stenophylla, Mangifera indica, Persea americana, Vitex madiensis*	9
Cough	*Adansonia digitata, Canarium schweinfurthii, Carica papaya, Ficus carica, Musa acuminata, Musa × paradisiaca*	6
Fatigue	*Annona muricata, Annona reticulata, Annona senegalensis, Cola acuminata, Theobroma cacao, Vitex madiensis*	6
Constipation	*Annona stenophylla, Canarium schweinfurthii, Ficus carica, Psidium guajava, Vitex madiensis*	5
Stomach ache	*Annona stenophylly, Canarium schweinfurthii, Mangifera indica, Terminalia catappa*	4
Dysentery	*Artocarpus heterophyllus, Musa acuminata, Musa × paradisiaca*	3
Hypertension	*Mangifera indica, Persea americana, Theobroma cacao*	3
Toothache	*Anacardium occidentale, Flacourtia jangomas, Pachylobus edulis*	3
Worms	*Artocarpus altilis, Carica papaya, Citrullus lanatus*	3
Fever	*Adansonia digitata, Artocarpus altilis*	2
Haemorrhoid,	*Mangifera indica, Pseudospondias microcarpa*	2
Low breast milk production	*Tamarindus indica, Vitex madiensis*	2
Angina	*Psidium guajava*	1
Backache	*Anacardium occidentale*	1
Asthma	*Adansonia digitata*	1
Backache	*Mangifera indica*	1
Bladder pain	*Raphia matombe*	1
Body pains	*Vitex madiensis*	1
Bronchitis	*Musa × paradisiaca*	1
Caries	*Carica papaya*	1
Cryptorchidism	*Elaeis guineensis*	1

Table 5 (Cont.)

Illmesses and symptoms	Botanical species	Number of nutraceuticals used
Dehydration	*Citrullus lanatus*	1
Inflammation	*Adansonia digitata*	1
Kidney disease	*Adansonia digitata*	1
Varicella	*Persea americana*	1
Poisoning	*Elaeis guineensis*	1
Pregnancy symptoms	*Spondias dulcis*	1
Splenomegaly	*Elaeis guineensis*	1
Urinary infection	*Citrullus lanatus*	1
Urogenital inflamation	*Cocos nucifera*	1
Watery breastmilk	*Spondias monbim*	1
Wounds	*Adansonia digitata*	1
Yellow fever	*Spondias monbim*	1

Cough, treated with six nutraceuticals (*Adansonia digitata*, *Canarium schweinfurthii*, *Carica papaya*, *Ficus carica*, *Musa acuminata, Musa paradisiaca*); fatigue, treated with six nutraceuticals (*Annona muricata*, *Annona reticulata*, *Annona senegalensis*, *Cola acuminata*, *Theobroma cacao*, *Vitex madiensis*); constipation treated with four nutraceutical plants (*Annona stenophylla*, *Canarium schweinfurthii*, *Ficus carica*, *Vitex madiensis*) and Stomach ache, treated with four nutraceuticals (*Annona stenophylly*, *Canarium schweinfurthii*, *Mangifera indica*, *Terminalia catappa*). Besides, the other diseases (Table 5) documented in this research are treated with only one or three nutraceuticals.

3.13. Economic values of edible fruit plants studied and destination of Uíge's fruit and income

The results of this study show that 86.3% (Table 1) of the edible fruit plants provide fruits that are sold in the market of Uígecity, including, *Adansonia digitata*, *Annona muricata*, *Ananas comosus*, *Aframomum alboviolaceum*, *Averroa carambola*, *Carica papaya*, *Citrus sinensis*, *Cola acuminata*, *Musa x paradisiaca*, *Passiflora edulis*, *Passiflora quadrangularis*, *Psidium guajava*, and *Tamarindus indica*. This was made possible through observations made during daily visits to urban and peri-urban markets in Uíge city. Besides, 13.7% of edible fruits are not sold. So, proceeds from fruit sales are used to solve specific problems, such as purchasing food, school supplies, and medical care. Similar results were reported by Mawunu *et al.* (2023a) reported on the sale of fruits, and leafy vegetables in Uíge city. Also, the fruits harvested in the city of Uíge are mainly used for home consumption and then sold and given to neighbors, friends, and parents. The sale of fruit is mainly used to buy goods and services such as food, clothing, school supplies, medical care and donations to churches. Similar results were reported by Mawunu *et al.* (2022b) and Mawunu *et al.* (2023a) reported on the sale of fruits, and leafy vegetables in Uíge city.

4. Conclusion and perspectives

The rich fruit-bearing vegetation of the town of Uíge abounds in 51 woody species. Of the 25 families inventoried, the most abundant are *Anacardiaceae*, *Annonaceae*, *Malvaceae*, *Myrtaceae*, and *Rutaceae*. The most species-rich genera are *Annona*, *Citrus*, and *Passiflora*. The results of this study show that urbanization is particularly threatening to native plant species, while exotic species are benefiting from urban land use. Trees and shrubs

make up the majority of this flora, which is dominated by Pantropical species (54.9%) and phanerophytes (90.20%). A rich biodiversity of fruit species provides certain benefits to urban ecosystems, including the ability to provide food and income to humans and feeding and attracting new species of birds. The main galenic form was decoction (51.2%), and the main mode of administration was oral (78.9%). The parts of the plant most commonly used in herbal medicines were the leaves (29.9%), and the fruits (22.9%). In terms of human diseases treated with nutraceutical fruit plants, diarrhoea (16.5%) were the most common pathologies, followed by diabetes (12.62%). The current study provides a database of plants with nutritional and therapeutic potential for humans. Chemical, toxicological and pharmacodynamic analyzes of these fruit plants could form the basis for the production of drugs to treat human diseases. This is the reason for this preliminary study, based on an inventory of edible fruit plants in urban areas.

Ethics 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 experiment (s) on humans and 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 is presented in the article. There is no supplementary data. The raw data without the names of informants can be provided by authors.

Conflict of interest

Authors declare that there is no conflict of interest.

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Author contributions

MM conceived and designed the study.MM, JLM, JTD and MFB carried out data collection, integrated the inventory, and performed the analysis, as well as contributed to manuscript writing. MM and JLM identified the plants. MM, KTN, MK, PMM, LN, LL reviewed, and edited the manuscript. All authors, have read and approved the final published version.

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