Quantitative Ethnomedicinal Study of Plants Used by the Population in the Middle Plateaux of Uvira Territory (D. R. of Congo).

Gentil Iragi Kaboyi
UNIC-LWIRO: Universite du Cinquantenaire de Lwiro
Butoto Imani wa Rusaati
Kyungpook National University https://orcid.org/0000-0001-8092-8682
Innocent Byamungu Nfizi
World Wildlife Fund
Cephas Masumbuko Ndabaga
Official University of Bukavu: Universite Officielle de Bukavu
Patience Arusi Gendusa
Independent Researcher
Astrid Furaha Matendo
Institut Superieur de Developpement Rural de Bukavu
Jun-Won Kang (jwkang15@knu.ac.kr)
Kyungpook National University

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Gentil Iragi Kaboyi[1†], Butoto Imani wa Rusaati[1,2†], Innocent Byamungu Nfizi[3], Cephas Masumbuko Ndabaga[4], Patience Arusi Gendusa[5], Astrid Furaha Matendo[6], Jun-Won Kang[2*]

[1] Centre de Recherche en Sciences Naturelles (CRSN/Lwiro), DS Bukavu, Democratic Republic of Congo

[2] School of Forest Sciences and Land Architecture, College of Agriculture and Life Sciences, Kyungpook National University, Daegu 41566, Republic of Korea.

3 World Wildlife Fund/ Congo-Goma

[4] Department of Biology, Official University of Bukavu, Bukavu BP 570, Democratic Republic of Congo

[5] Independent Researcher. Daegu, South Korea

[6] Département d'environnement et développement durable, Institut Supérieur de Développement Rural de Bukavu, B.P. 2849 Bukavu, République Démocratique du Congo

[†] These authors equally contributed to this study as first author

*__corresponding author:__ Jun-Won Kang, E-mail: jwkang15@knu.ac.kr

Abstract

Background: This work increases the ethnomedicinal plants information in the Uvira Territory and, in particular, the middle plateau. Till now little is known about ethnomedicinal researches in Uvira Territory and no previous study has surveyed the medicinal uses of plants in the middle plateau of Uvira Territory.

Methods: The plant uses information survey was collected through a direct interview conducted with 25 local healers in 7 villages. The ethnobotanical information for each species, including scientific name, family, local name, morphological type, plant parts used, preparation, disease name, plant habitat was collected. The conservation status of plant species was checked by the International Union for Conservation of Nature. various quantitative indices (Relative frequency of citation Use Value, Informant consensus factor, Family Importance Value, Pearson's correlation, Jaccard Index) were calculated

Results: Information on 69 medicinal plants belonging to 61 genera and 34 families was collected. The total number of species per family showed that Fabaceae, Asteraceae, and Myrtaceae were most represented. Most species were herbs. Leave was the most frequently used part and decoction was the principal preparation method. Significantly higher numbers of medicinal plants were used against digestive system disorders and intestinal parasites. *Tetradenia riparia, Syzygium guineense, Morella salicifolia* and *Erythrina abyssinica* were the medicinal plants with the highest UV values. The Pearson correlation coefficient between RFC and UV was 0.95 showing a highly positive significant association. A total of 14 species were recorded as vulnerable.

Conclusion: This study was able to show that this area, located in middle plateau of Uvira Territory, can provide a considerable medicinal plant diversity with an heterogenous medicinal importance to the community. With the relative high number of vulnerable species, there is a requirement for a sustainable management for these medicinal plants.

Keywords: Medicinal plants, Quantitative ethnobotany, Middle plateau of Uvira Territory, D.R of Congo.

Introduction

The use of plants to treat and cure diseases is as old as the human species [1,2]. And the earliest records concerning the usage of medicinal plants are obtained from Mesopotamian civilizations and are as old as 2600 BC [3].

The Ethnobotany is a biological, economic, and cultural interrelationship study between people and plants of an area in which they exist [4]. Furthermore, this knowledge evolves across cultures and over time and space [5]. Each ethnic group has knowledge and know-how specific to its historical, cultural, and even spatial environment [6].

The traditional plants used worldwide represent an invaluable reservoir of knowledge and a large potential for yet undiscovered use of natural resources [7]. Also, medicinal plants are considered essential in human health care [8]. According to an investigation of the World Health Organization (WHO), around 80% of the developing countries rely on medicinal plants [9,10], for the reason that the medicinal plants are still a source of medical care in developing countries [11]. Besides that, the contemporary health system and the drug are often available only to a restricted number of people because either amenity is too expensive or too few facilities are accessible for too many people [12].

Over 11,000 species had been inventoried in the DRC forest, which is full of medicinal plants [13, 14]. The use of medicinal plants is a widespread practice in urban as well as in rural populations [15]. However, since there is no regulation of the medicinal species in the forest, intensive exploitation may become harmful if it exceeds the threshold of sustainable regeneration and can lead to the reduction and/or loss of biodiversity, decreased productivity, etc. The vegetation of the middle plateau of Uvira is of vital economic, ecological, and social importance for the riparian population. The vegetation provides for the needs of the population in firewood and timber and is the main source of fodder for livestock. Beyond its primary functions, it also plays a role in traditional medicine with medicinal plants that are part of the livelihood of the population.

Previous studies have explored medicinal plants in Sud-Kivu over the last two decades [6,16-28]

However, little is known about ethnobiological researches in Uvira territory and no previous study has surveyed the medicinal plants in plateau and middle plateau of Uvira have been published. Two studies have been carried out in low altitudes of the Uvira territory: Manya et al. [29] surveyed anti-malarial herbal of Bukavu and Uvira areas, and Byavu et al. [30] focused on ethnoveterinary of cattle. Therefore, implying the assessment of ethnobotany has a great potential to provide essential new insights into the vulnerability of some plant species in Uvira Territory. Our work investigated the ethnopharmacological plants used by the local people in the middle plateau of Uvira, which are under the most human pressure.

Material and methods

Study area

The study area is located on Mitumba Mountains and it is bounded to the Nord and East by the Ruzizi plain, West by Uvira high plateau whose highest peak is Mount Munanira**.** An ethnobotanical investigation has been conducted in seven different villages namely: Kirungu, Shenge, Kalonge, Munanira, Kitala, Gomba, and Kifuta in the Territory of Uvira (Fig. **1**). A various landscape with elevations ranging from 1514 to 2261 m harbor diverse forest types. The climate can be classified as an oceanic climate (Cfb) under the Koppen climate classification [31]. The population largely depends on subsidence agriculture, livestock husbandry. Farming is based on a rain-fed cropping system and the main crops of the area are cassava *(Manihot esculanta) and* Corn *(Zea mays).*

Ethnobotanical surveys

During this investigation, 25 traditional healers were interviewed. Information on traditional knowledge related to ethnomedicine was collected through a direct interview conducted in local languages (Fuliiru and/ or Vira) with the help of interpreters. The choice of respondents relied greatly on the professionalization of traditional healers in the communities. No clear procedures or protocols related to the practice of ethnomedicinal research in D.R of Congo. An oral agreement was obtained from participating communities. A survey sheet was submitted to the traditional practitioner, and he was asked to give the various diseases for which he is often consulted, then the information on the organs of the plant that he wishes to have a recipe, the method of preparation and intake of the recipe. Each time after investigating a traditional healer, a field trip was made to collect the specimens. Ethnobotanical information for each species, including scientific name, family, local name (Fuliiru or Vira), morphological type, plant parts used, preparation, disease name, plant habitat was collected. The conservation status of plant species was checked by the International Union for Conservation of Nature [32].

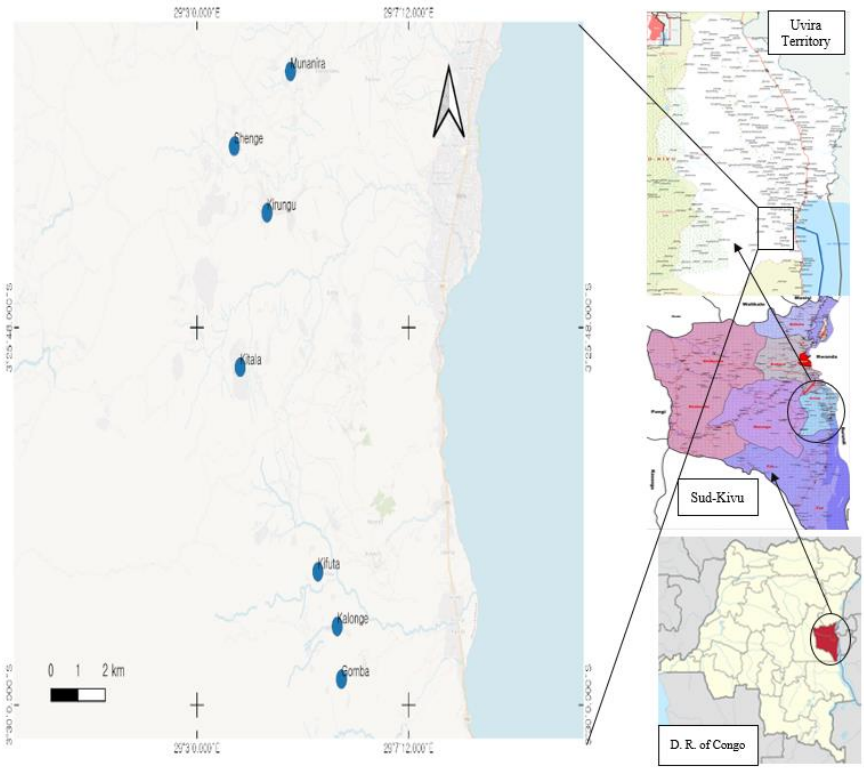

Fig. 1. Study area map

Botanical identification

We harvested the voucher specimens of the plants for identification in the field for the species recognized by using some books for spelling and name confirmation [33,34]. Scientific names were updated to currently accepted names according to the plant list [35]. For unidentified species, vouchers collected were compared with the previously specimens conserved at the herbarium of the Natural Sciences Research Center of Lwiro (CRSN / Lwiro). Family and scientific names were confirmed. Voucher specimens were prepared and deposited in the herbarium of the Natural Sciences Research Center of Lwiro.

Quantitative analysis

To test the homogeneity of the collected medicinal plant, various quantitative indices were calculated.

Relative frequency of citation (RFC): to calculate the RFC, the number of informants mentioning the use of the species (FC) was divided by the total number of informants participating in the survey (N) [36].

$$RFC = \frac{FC}{N} \quad (0< RFC<1)$$

Use value (UV): the use-value proves the relative importance regarding medicinal uses of the plant species and was calculated by using the following formula [36].

$$UV = \frac{\sum Ui}{\mathrm{N}}$$

Where Ui is the number of uses mentioned by each informant for a given species and N is the total number of informants. The UV varies from 0, which denotes that none of the informants mention any use of the plant, to 1 whereby the plant is most frequently mentioned as useful in the treatment of the highest number of illnesses [37].

Informant consensus factor (ICF): was calculated using the formula [38-40].

$$ICF = \frac{\mathrm{Nur-Nt}}{\mathrm{Nur-1}}$$

Where Nur is the number of use-reports in each disease category and Nt is the number of species used.

Family Importance Value (FIV): is the number of informants citing the family (FC) divided by the total number of informants participating in the study. It gives the local importance of a family [41].

$$FIV = \frac{\mathrm{FC(\ family)}}{N}\ x\ 100$$

Pearson's correlation coefficient was calculated as:

$$r = \frac{\mathrm{COV(X,Y)}}{\mathrm{SD(X)*SD(Y)}}$$

Where r is the Pearson correlation coefficient for a given sample, COV is the covariance, X and Y are the interested variables and SD is the standard deviation for the same variables and calculated as:

$$SD(Y) = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(Y - \bar{\mathrm{Y}})^2}$$

$$\bar{\mathrm{Y}} = \frac{\sum_{i=1}^{n} Yi}{n}$$

Where the Y bar is the mean value of Y and n is the sample size. Similarly, SD(Y) can be calculated [42,43].

Jaccard Index (JI): The Jaccard index was used to compare the similarity of named species between our data with studies already published that were conducted in other parts of the D. R. of Congo, as well as other neighboring countries. This index is based on the presence or absence of species on each list [44] and was calculated as it follows [45]:

JI=C x 100/A + B - C, where A is the recorded number of species of the current study, B is the documented number of species of another study, and C is the number of species common to both studies.

Results

Demography profile

A total of 25 healers was interviewed. Out of these, 92% were male and 8% were Female. According to age, four groups were classified. The age group of 41-60 was observed to have the highest (36%) participation rate, followed by (28%) in the age group above 60 years. Group ages 31-40 and 21-30 were respectively 24% and 12% (**Table 1**).

Diversity of the ethnomedicinal plants and habitat

Through this study, a total of 74 medicinal plants was inventoried. Of these, 63 were identified down to species level, six were identified only to the genus level (*Cassia sp, Hibiscus sp, Musa sp, Oxalis sp, Rubus sp, Syzygium sp*), and five plants were not identified. The 69 medicinal plants identified represented 61 genera and 34 botanical families. 45 species were harvested from the natural environment, 33 were either fallow or ruderal species, and 12 pants were cultivated (Fig. 2). The diversity of the plants recorded shows that out of the 69 species, 64 species were dicotyledons (93%), 4 species were monocotyledons (6 %) and 1 specie was a Pteridophyte (1%). (Table 2)

Seven families (out of 34) provided 43.5% of the medicinal species. The dominant families were the Fabaceae represented by the highest number of species (8 species), followed by the Asteraceae (6 species), Myrtaceae (4 species). The rest of the families were represented by three, two, and one species (**Table 3**).

Almost all genera (57) were represented by only one specie. Three genera were represented by two species, i.e *Ficus, Persicaria,* and *Syzygium*. The genera the most represented was *Albizia* with 3 species. The investigation on the morphological type showed that herbs were the most reported with 32 species, followed by trees and shrubs (13 species each), and sub-shrubs (11 species) (Fig. 3).

Table 1. Demography profile

Background characteristics	Categories	Frequency	%
Gender	Male	23	92
	Female	2	8
Age	21-30	3	12
	31-40	6	24
	41-60	9	36
	> 60	7	28

Table 2. Diversity of medicinal plants

	Pteridophyte	Angiosperm		Total
		Dicotyledons	Monocotyledons	
Family	1	31	2	34
Genus	1	57	3	61
Species	1	64	4	69

174 **Table 3.** List of medicinal plant species reported in Middle plateau of Uvira

175

FAMILY/ Species names	Local name	Morphology	Habitat types	Illness	Preparation mode
ACANTHACEAE					
Brillantaisia cicatricosa Lindau	Kinalwishi	H	Forest	candidiasis	Inf, Pound
Rungia grandis T.Anderson	NR	H	Forest	Sciatic nerve	ash
AMARANTHACEAE					
Dysphania ambrosioides (L.) Mosyakin & Clemants	Mugunduzimu	H	fallow, ruderal	child Convulsion	dec
ANACARDIACEAE					
Mangifera indica L.	Mwembe	Sh	cultivated	stomachache	dec,Pound
Searsia pyroides (Burch.) Moffett	Kaguguna	Ssh	Forest, Fallow	diarrhea,hernia	dec,Pound,Powder
APIACEAE					
Agrocharis incognita (C.Norman) Heywood & Jury	Majimato	H	Forest	pregnancy discomfort	dec
Steganotaenia araliacea Hochst.	Kafokoba	Sh	Forest	stomachahes,constipation	dec
APOCYNACEAE					
Plumeria alba L.	Namalimbwe	Ssh	fallow	otitis	Pound
Wrightia demartiniana Chiov.	Ngafukamwa	H	Forest	dairy insufficiency	Inf, Pound
ARECACEAE					
Raphia farinifera (Gaertn.) Hyl.	Bubondo	T	Forest	abortion	Inf,Pound
ASTERACEAE					
Acmella caulirhiza Del.	Kenda	H	Forest	teethaches	dec, Pound
Ageratum conyzoides L.	NR	H	fallow	sterility	inf, Pound
Guizotia scabra (Vis.) Chiov.	Namuhehe	H	fallow	candidiasis	dec,conc
Dichrocephala integrifolia (L.f.) Kuntze	Kitunda mbuga	H	fallow, ruderal	stomachache,diarrhea,cow sore eyes	dec,exp,Pound
Vernonia amygdalina Delile	Kibirizi	Ssh	Forest	stomacache	Inf, Pound

Crassocephalum vitellinum (Benth.) S.Moore	Chichununu, Shununu	H	Forest, Fallow	stoamachache,panaris,sterility	dec,conc,Pound
BIGNONIACEAE					
Spathodea campanulata P.Beauv.	Mujangalubiro	T	cultivated	sexual impotence	dec,Pound
CANNABACEAE					
Trema orientalis (L.) Blume	Muhefu	Sh	Forest	child Convulsion,fracturestomachaches	conc,Pound
CHRYSOBALANACEAE					
Parinari curatellifolia Planch. ex Benth.	Mukumu	Sh	Forest	stomachaches,diarrhea	Inf,Pound
CLUSIACEAE					
Lebrunia bushaie Staner	Igaja	T	Forest	epilepsy	ash
CONVOLVULACEAE					
Ipomoea batatas (L.) Lam.	Bijumbu	H	cultivated	stomachache	dec,conc
CUCURBITACEAE					
Mukia maderaspatana (L.) M.Roem.	Mugandaganda	H	Forest, Fallow	scabies	mac
CYATHEACEAE					
Cyathea manniana Hook.	Kisembekele, Kishemba nyambwe	H	Forest	diarrhea	dec
ERICACEAE					
Agarista salicifolia (Lam.) G.Don	Kafiri, kijojo	Ssh	Forest	stomacache,scabies,sterility	dec,Inf,Pound,squeezing, Powd
Erica arborea L.	Kishasha	Ssh	Forest	diarrhea	dec
EUPHORBIACEAE					
Tragia brevipes Pax	Mashusha	H	fallow and ruderal	vomiting	Inf, Pound
Euphorbia hirta L.	NR	H	fallow, ruderal	amoeba	dec
Ricinus communis L.	Magaja	H	fallow, ruderal, cultivated	detoxication,scabies,amoeba	conc,Pound
FABACEAE					
Arachis hypogaea L.	Kalanga	H	cultivated	detoxication, sexual problem	conc
cassia sp	Kavisa	Ssh	fallow	Malaria	dec
Cassia abbreviata Oliv.	Kawewe	Ssh	Forest	stomachache	dec, Pound
Albizia adianthifolia	Kashebeye	T	Forest	otitis	Pound

Albizia grandibracteata Taub.	Kashebeye	T	Forest	rheumatism	NR
Albizia gummifera (J.F.Gmel.) C.A.Sm.	Kashebeye	T	Forest	amoeba	dec
Mimosa pudica L.	Kopa	H	Forest, Fallow	evil spirits	Inf,Pound
Erythrina abyssinica DC.	Kigohwa	T	Forest, Fallow, crop fields	diarrhea,candidiasis,otitis	dec,conc,Pound,Powder
HYPERICACEAE					
Harungana madagascariensis Lam. ex Poir.	Kasombosombo	T	Forest	stomachache, furuncle, taenia,roundworms	Inf,Pound,conc
LAMIACEAE					
Tetradenia riparia (Hochst.)Codd	Mushalaba	Ssh	cultivated	diarrhea,cough,headaches,sore throat,stomachaches	Inf,mac,exp,Pound,conc,squeez
Leonotis nepetifolia (L.) R.Br.	Namafundo, Muhindohindo	H	fallow	diarrhea,mycosis	Pound
LAURACEAE					
Persea americana Mill.	Avocati	T	cultivated	stomachaches,diarrhea	dec,Pound
Maesaceae					
Maesa lanceolata Forssk.	Muhanga	Sh	Forest	child stomachache	Pound,conc,Powder
MALVACEAE					
Triumfetta rhomboidea Jacq	Mulangalanga	H	crop fields	Fracture	Pound
Hibiscus sp	Kitata	Ssh	fallow, crop fields	hemorrhoids, wound	Pound,ash
Sida acuta Burm.f.	Kadundu, Kanvunvu	Ssh	fallow, ruderal, crop field	diarrhea,hemorrhoids,sexual impotence,breasts swelling	dec,Pound,chewing
MELIACEAE					
Khaya anthotheca (Welw.) C.DC.	Kavungwe	Sh	Forest, Fallow	diarrhea	inf,Pound
MORACEAE					
Ficus exasperata Vahl	Kirondorondo Mukobe	T	cultivated	stomachache,hypertension	dec,inf,Pound
Ficus glumosa Delile	Kirondorondo	T	cultivated	sore eyes	ash
MUSACEAE					
Musa nana Lour.	Malumbungu	H	cultivated	candidiasis	Inf,Pound
Musa sp	Ndizi	H	cultivated	stomachaches	NR
Ensete ventricosum (Welw.) Cheesman	Chirembo	H	Forest	epilepsy	Pound,conc
MYRICACEAE					

Morella salicifolia (Hochst. ex A. Rich.) Verdc. & Polhill	Kinjigi	Ssh	Forest	abscess, teethaches,diarrhea	dec,mac,Pound,Powder
Psidium guajava L.	Mapera	T	fallow	stomachaches	dec,Pound
Syzygium cordatum Hochst.ex C.Krauss.	Mugote	Sh	Forest	hemorrhoids,sexual impotence	dec,Inf,Pound,squeezing
Syzygium guineense (Willd.) DC.	Mugote	Sh	Forest	stomachaches,diarrhea,dysentery,amoeba,wound	dec,Inf,Pound,conc,ash,Powder
Syzygium sp	Kashishiri	Sh	Forest	teethaches	dec
OXALIDACEAE					
Oxalis sp	Kabanga njinjira	H	fallow	teethaches	NR
Biophytum petersianum Klotzsch.	NR	T	fallow	Fracture	NR
PLANTAGINACEAE					
Plantago palmata Hook.f.	Mbatama	H	Forest, Fallow	diarrhea,amoeba,bleeding,abortion	dec,Inf,Pound
POLYGONACEAE					
Persicaria decipiens (R.Br.) K.L.Wilson	Nakazi	H	Forest	detoxication,sore throat	chewing
Rumex nepalensis Spreng.	Nakazi	H	Forest	sore throat	NR
Persicaria pulchra (Blume) Soják	NR	H	Forest, Fallow	sore throat,sexual impotence	conc,Pound,chewing
ROSACEAE					
Alchemilla cryptantha Steud. ex A.Rich.	Kanabwaso	H	Forest, Fallow	Panaris	dec, Pound
Rubus sp	Bukarata	H	Forest, Fallow	stomachaches,constipation,amoeba	Pound
RUBIACEAE					
Galiniera saxifraga (Hochst.) Bridson	Lumole	Sh	Forest	scabies	Pound
Dolichopentas longiflora (Oliv.) Kårehed & B.Bremer	Kayasa muliro	H	Forest, Fallow	Poison	conc,Pound
RUTACEAE					
Citrus lemon (L.) Burm.	Ndimu	Sh	cultivated	fever	dec,conc
Zanthoxylum usambarense (Engl.) Kokwaro	longomangoma	Sh	Forest	Hemorrhoids	Inf,Pound,squeezing
SOLANACEAE					
Physalis peruviana L.	Mbuma, Mpuho	H	Forest, Fallow	stomachaches,diarrhea	dec,Pound
URTICACEAE					
Myrianthus holstii Engl.	kiyufua	Sh	Forest	stomachaches	eat

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177 **Legend:** Plant morphology (H: Herb, T: Tree, Sh: Shrub, Ssh: Sub-shrub), part used (Le: leaves, R: root, RB: root bark, WP: whole plant, Fr: fruit, B: bark, Gr:
178 grain, inf: inflorescence, Fl: flower, S: stem, SB: stem bark,), preparation mode (Dec: decoction, Mac: maceration, Inf: infusion, Exp: expression, conc:
179 concoction), NR: Not Reported

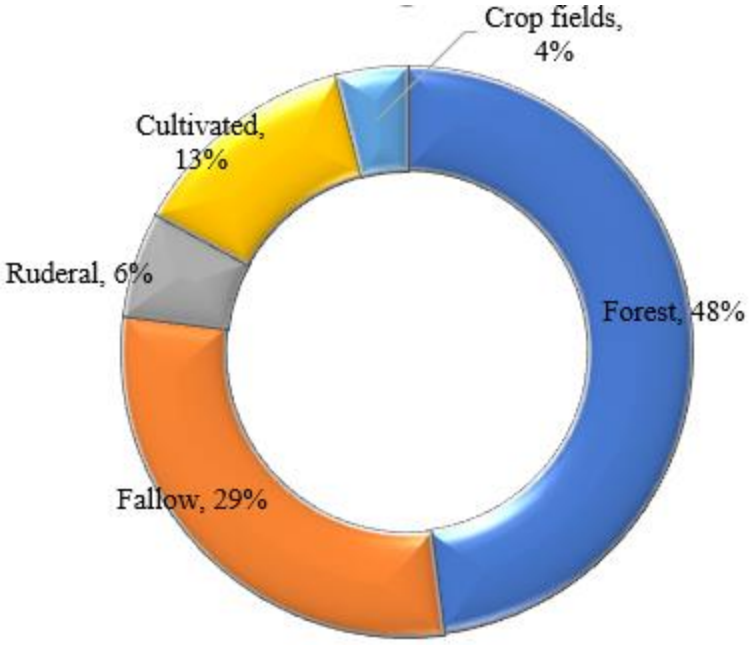
Plant part(s) used, method of preparation and route administration

The results of the analysis of the plant parts used show that the leaves were the most commonly utilized in drug preparations, which accounted for 38.9%, followed by bark (14.8%), root (13.9%), and stem (13%) (Fig. 4). Considering the Recipe preparation mode of traditional medicines, reports include decoction, infusion, pound, concoction, maceration, ash. Among these, the pound was the principal preparation method (34 %) followed by decoction. But other methods of preparation such as maceration, chewing, and squeezing are used, albeit to a lesser frequency (Fig. 3).

The majority of the preparation was done using only one single plant species. However, some others were prepared by mixing with two species or with other ingredients:

- *Persicaria pulchra* with Banana juice
- *Persicaria pulchra* mixed with local salt
- *Harungana madagascariensis* with ail
- *Sida acuta* mixed with *Arachis hypogaea* (grain)
- *Maesa lanceolata* mixed with *Biophytum umbraculum*
- *Guizotia scabra* mixed with *Erythrina abyssinica* (Bark)
- *Ricinus communis* mixed with honey
- *Syzygium guineense* mixed with *Leonotis nepetifolia*
- *Citrus limon* mixed with *Cupressus sp* (leaves) and *Eucalyptus* (leaves)
- *Erythrina abyssinica* mixed with local salt
- *Tetradenia riparia* mixed with local salt
- *Dolichopentas longiflora* mixed with milk
- *Ipomoea batatas* mixed with *Musa nana* (leaves)
- *Arachis hypogaea* mixed with *Ricinus communis* (oil)

Most of the healers suggested taking herbal medicines orally (53 %) and the dose ranges from half glass three times a day to one glass three times a day (Fig. 4).



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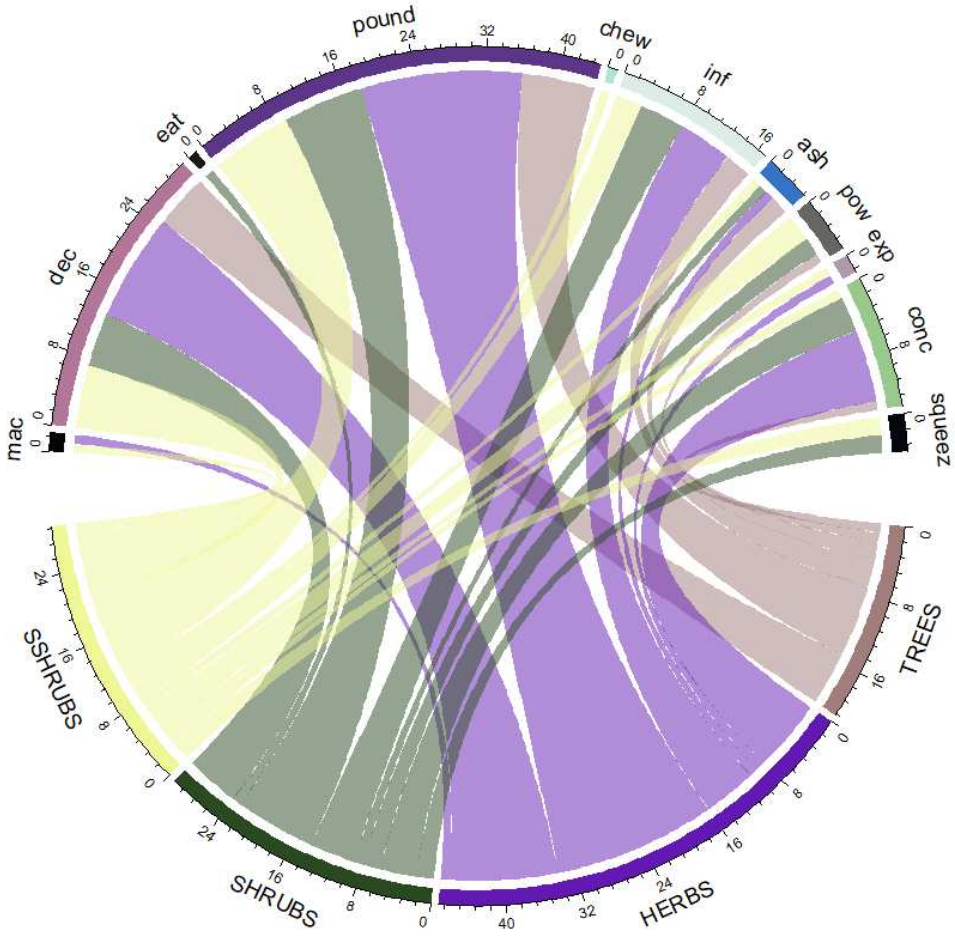
207 **Fig. 2.** The distribution of species according to their habitats



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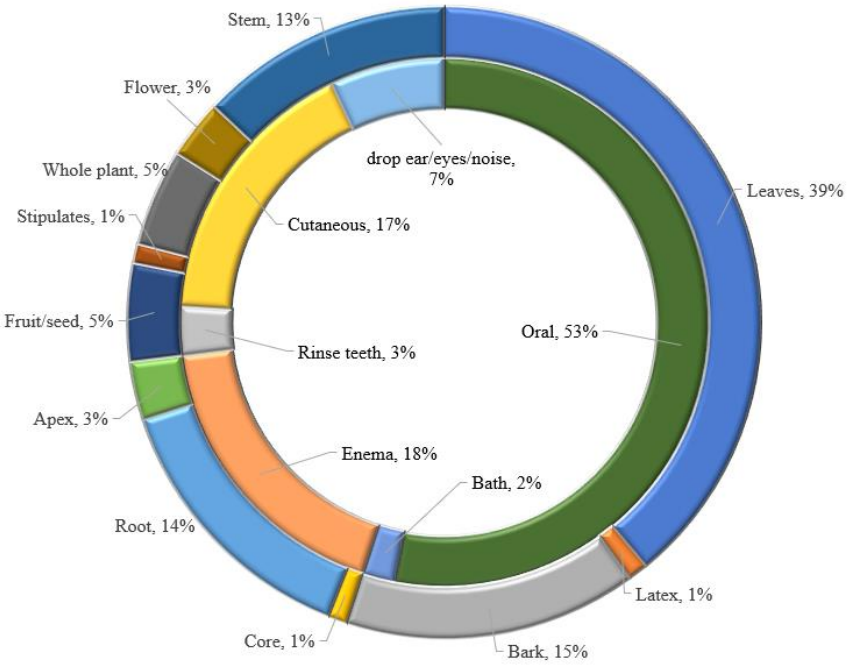
210 **Fig. 3.** Distribution of medicinal preparation mode by morphological types. Eleven parts used (top half of circle)
211 include (left to right): maceration (mac), decoction (dec), eat, pound, chewing (chew), infusion (inf), ash, powder
212 (pow), expension (exp), concoction (conc), and squeezing (squeez). Morphological types (bottom half of circle). Scale
213 numbers around the circle indicate cited time.

214



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216 **Fig. 4.** Frequencies of used Parts (outer circles) and administration modes (inner circles)

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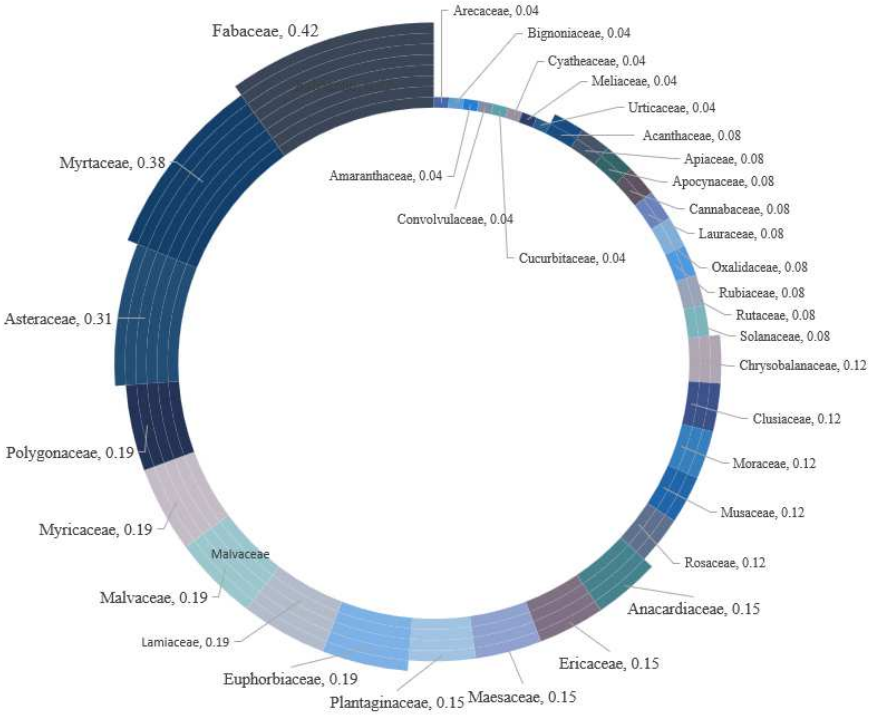

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219 **Fig. 5.** Family importance value (FIV)

Quantitative analysis

Use-value (UV) and Relative frequency of citation (RFC)

The results show that 62.3% of the species inventoried are used for only one illness, while 34.8 % are used for two to four illnesses. The remnant 2.9% are used for five illnesses. *Tetradenia riparia, Syzygium guineense, Morella salicifolia, Erythrina abyssinica,* had a UV over 0.2. Among all medicinally useful species, only 23.2 % had UV higher than 0.1 while all the rest had UV ranges from 0.04 to 0.08 (Table 3). Also, based on the value of RFC, the most consumed plant species contains *S. guineense* (0.23) with a high value of RFC, followed by *T. riparia, M. salicifilia, E. abyssinica* (0.19 respectively) (Table 3).

Correlation between UV and RFC

The significant relationship between UV and RFC were made using correlation analysis (Table 4). It is clear that UV is significantly correlated with RFC and this confirms the association between these two variables (r = 0. 956 with p-value <0.005).

Table 4. Correlation between UV and RFC

	Mean	**Standard deviation**	**Minimum**	**Maximum**
UV	.0747	.0582	.038	.26
RFC	.0669	.0465	.038	.23
Association between UV and RFC by using Pearson correlation Method				
r	.956 (0.000) *			
r^2	.915			

* P-value for the significance of correlation coefficient

Informant consensus factor

The documented medicinal plants were utilized to treat 41 different illnesses which were grouped into 9 categories and the plants were distributed according to these categories (Table 5). The Respiratory diseases and the cardiovascular category was the one the highest ICF (ICF 0.5), followed by the diseases of the digestive system disorders and intestinal parasites category (ICF 0.42), dermatological diseases (0.22). The mean FIC for all illness categories was 0.19. Among the illness categories, diseases of the digestive system disorders and intestinal parasites were dominated with 66 use-reports, followed by dermatological diseases and Diseases of the reproductive system and related disorders (19 and 16 use-reports respectively) as mentioned in Table 5. About 56.5% of plants were used to treat digestive system disorders and intestinal parasites, followed by dermatological diseases (21.7%), Diseases of the reproductive system and related disorders (18.8%).

Table 5. Informant consensus factor (ICF) by categories of illness in the study area

illness category	Description of ailments	n_{ur}	n_t	ICF
Diseases of the digestive system disorders and intestinal parasites	Diarrhea, constipation, hernia, hemorrhoids, vomiting, sore throat, stomachache, amoebae, taenia, bacillary dysentery, roundworms	66	39	0.42
Malaria and Fever	Malaria and Fever	2	2	0.00
Diseases of the reproductive system and related disorders	Bleeding, sexual impotence, sterility, pregnancy disorder, breasts swelling, abortion, dairy insufficiency	16	13	0.20
Rhumatisme and fracture	Rhumatisme and fracture	5	5	0.00
Respiratory diseases and cardiovascular	Cough, sore throat, hypertension	7	4	0.50
Dermatological diseases	Scabies, wound, pyrosis, furuncle, abscess, mycoses	19	15	0.22
Nervous system diseases	Convulsion, headache, epilepsy, sciatic nerve	7	6	0.17
Ear and eye diseases	Otitis, sore eyes,	5	5	0.00
Others	Poison, evel spirit, Detoxification	6	5	0.20

Family Importance Value (FIV)

Among 34 plant families with medicinal uses, all families had the UVf below 0.5. The botanical family with high FIV was Fabaceae with a UVf of 0.42. Other families with high family use values were Myrtaceae and Asteraceae (0.38, 0.31 respectively). Polygonaceae, Myricaceae, Malvaceae, Lamiaceae, and Euphorbiaceae had 0.19 respectively (Fig. 5).

Jaccard index

In the comparative analysis of medicinal plant use in the middle plateau of Uvira studies within RD Congo and the four neighboring countries, 24 published articles were used. Only 66 species that were identified to species level were taken into consideration for the purpose. The high degree of similarity index in the Congo area was with the study of Shalukoma et al. [27], Mangambu, Aluma, et al [25], with JI values of 10.94, 10.38, Balezi et al. [20] and Nyakabwa and Dibaluka [46], 8.63 respectively. The lowest degree of similarity index was with Bakwaye et al. [39] with JI value of 0.88 (Table 6). Comparing with the neighboring countries, the similarity index values between Ngezahayo et al. [47], Asiimwe et al. [48], and our area were 8.43 and 7.35 respectively. And the low similarity was with Munyaneza et al. [49] with JI value of 0.57 (Table 7).

Table 6. Comparison between the present study and previous studies in D.R of Congo

Previous study area	References	Total documented species	Total species in the present study	Plants common to both area	Jaccard index
Mbanza-Ngungu	Bakwaye et al. 2013	165	65	2	0.88
Kenge	Ndombe et al. 2016	22	65	1	1.16
Bushi area	Chifundera 2001	170	65	3	1.29
kinshasa	Makumbelo et al. 2008	49	65	2	1.79
ituri	Terashima and Ichikawa 2003	771	65	16	1.95
Beni and Lubero	Kasika et al. 2015	182	65	7	2.92
Dongo	Mongeke et al. 2018	35	65	3	3.09
Bas- fleuve	Ngbolua et al. 2013	25	65	3	3.45
Ruzizi valley	Byavu et al. 2000	85	65	5	3.45
Bukavu and Uvira	Manya et al. (2019)	45	65	5	4.76
Buhozi	Balezi et al. 2013	86	65	12	8.63
Kisangani	Nyakabwa and Dibaluka 1990	86	65	12	8.63
Kauzi-Biega Nat. Parc	Mangambu, Aluma et al. 2015	52	65	11	10.38
Kauzi-Biega Nat. Parc	Shalukoma et al. 2015	77	65	14	10.94

Table 7. Comparison between the present study and previous studies at neighboring countries

Previous study area	References	Total documented species	Total species in the present study	Plants common to both area	Jaccard index
Rwanda	Munyaneza et al. 2006	112	65	1	0.57
Morogoro/ Tanzania	Amri et al. 2012	82	65	5	3.52
Katabi sub-County/ Uganda	Nambejja et al. 2019	50	65	4	3.60
Volcanoes national park/ Rwanda	Nahayo et al. 2010	77	65	6	4.41
Southern Province/ Rwanda	Mukazayire et al. 2011	86	65	7	4.86
Rwanda	Kamagaju et al. 2013	28	65	5	5.68
Mabira central forest reserve/Uganda	Tugume et al. 2016	190	65	14	5.81
Sango bat area/ Uganda	Ssegawa and Kasenene 2007	186	65	16	6.81
Mbarara and Isingiro/ Uganda	Asiimwe et al. 2013	81	65	10	7.35
bujumbura/Burundi	Ngezahayo et al. 2015	115	65	14	8.43

Conservation status

The excessive collection of timber, fuelwood, food plants, and commercial exploitation of medicinal plants has provided a great deal of vulnerability to plant species [50]. The conservation status of all recorded plant species was checked using the International Union for Conservation of Nature (IUCN) Red List of Threatened Species [32]. A total of 14 species, namely *Raphia farinifera, Spathodea campanulata, Albizia adianthifolia, Albizia grandibracteata, Trema orientalis, Erythrina abyssinica, Maesa lanceolate, Myrianthus holstii, Syzygium guineense, Psidium guajava, Agarista salicifolia, Erica arborea, Tetradenia riparia, Harungana madagascariensis* were recorded as" Least Concern," while two species (*Lebrunia bushaie* and *Khaya anthotheca*) were recorded as "vulnerable", one specie (*Mangifera indica*) was recorded as " data deficient". While the rest of the species have not been evaluated yet.

Discussion

This study revealed the medicinal use of 69 ethnopharmacological species, distributed among 61 genera and 34 botanical families to treat 9 categories of ailments. The results showed that the botanical families including Fabaceae, Asteraceae, Myrtaceae, and Euphorbiaceae have accounted for the high number of used species in the area. Our results agree with similar research conducted in Uvira Territory [29] and other regions of D. R. of [51,52,53], which reported Fabaceae, Asteraceae, and Euphorbiaceae to be among the dominant families in the treatment of various diseases. The reason for the dominance of these families in medicinal plants could be attributed to their species richness. Fabaceae and Asteraceae are known to be the highest diversified families not only in the D. R of Congo flora [39] but also, more than any other plant family in the world [45, 54]. Similar findings were observed also in the neighboring countries [47,55-57]. Most of the medicinal plants of the area grow wild. That is similar to other studies that reported that almost all plants were harvested from nature [58]. The most utilized growth forms were herbs. The frequent use of herbaceous species could be a result of their relative abundance as compared to trees and shrubs [59]. The leaves were used more frequently than the other plant part in the preparation of remedies. And is in line with several studies reported in Congo [14, 60,61], and elsewhere in Africa [9, 62,63], Asia [64,65], or Europe [66]. It is supposed that leaves are easier to collect [45] and could contain more easily extractable phytochemicals, crude drugs, and many other mixtures which may be proven as valuable in phytotherapy [64]. The pound was the commonly herbal preparation method. These findings are also in agreement with Inta et al. [67], who reported that the pound was the common way of herbal

preparation in the Chinese Akha communities. However, opposite to other researches which found decoction to be the most commonly used method [68,69].

The diseases of the digestive system disorders and intestinal parasites, dermatological diseases, and diseases of the reproductive system and related disorders were mentioned by a large number of healers.

Quantitative analyses (UV and RFC) showed that *Tetrademia riparia, Syzygium guineense*, *Erythrina abyssinica* and *Myruca salicifilia* are important in the traditional medicinal plant in the middle plateau of Uvira. The result of Pearson correlation showed that the relationship between UV and RFC was positively correlated. And this was similar to other studies [42,43, 70].

The Jaccard index was used to compare our study with 24 previous studies. The JI was calculated for 14 studies done in Congo with Kauzi Biega national park as most similar to our study area with JI= 10.94 [27], while the lowest JI (0.88) was found with the study conducted at Mbanza-Ngungu [39]. On the other hand, among four neighboring countries (Burundi, Tanzania, Uganda, and Rwanda), the highest similarity was found in Bujumbura town, Burundi (Ji= 8.43) while the lowest (JI= 0.57) was from Rwanda.

Conclusion

This present study has revealed that this area, located in middle plateau of Uvira Territory, can provide a considerable medicinal plant diversity with an heterogenous medicinal importance to the community. With the relative high number of vulnerable species, there is a requirement for a sustainable management for these medicinal plants.

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Figures

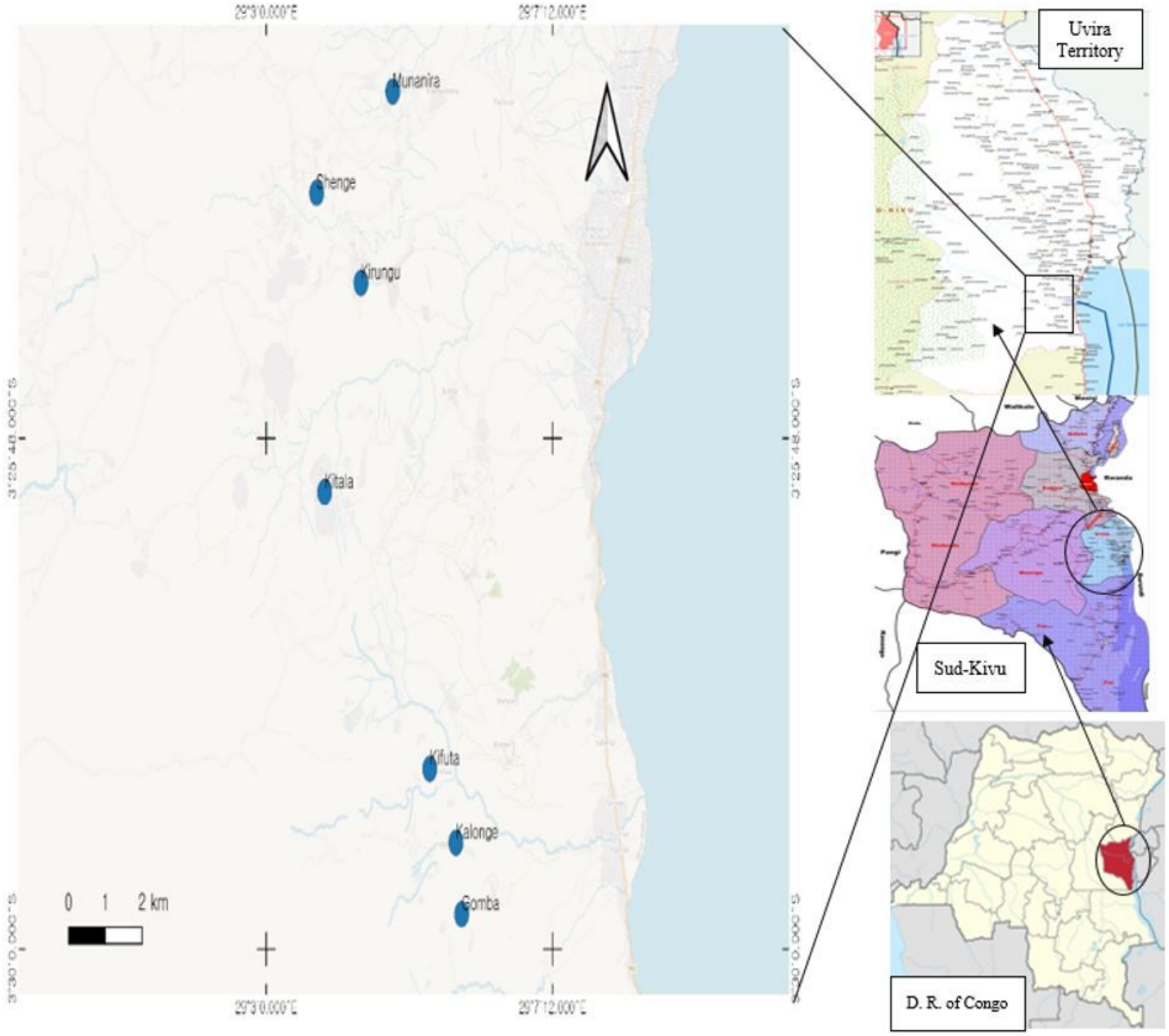

Figure 1

Study area map. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

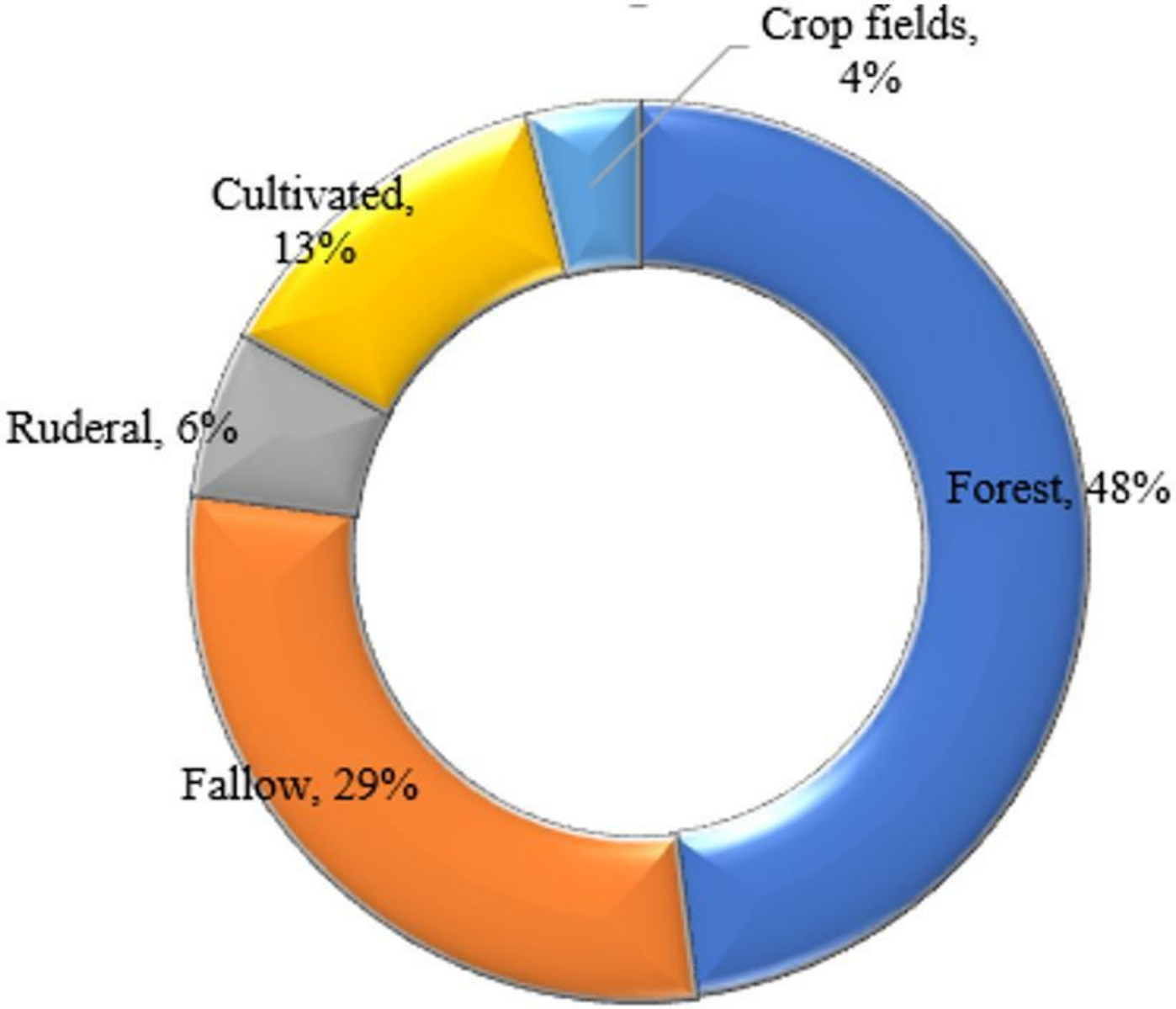

Figure 2

The distribution of species according to their habitats.

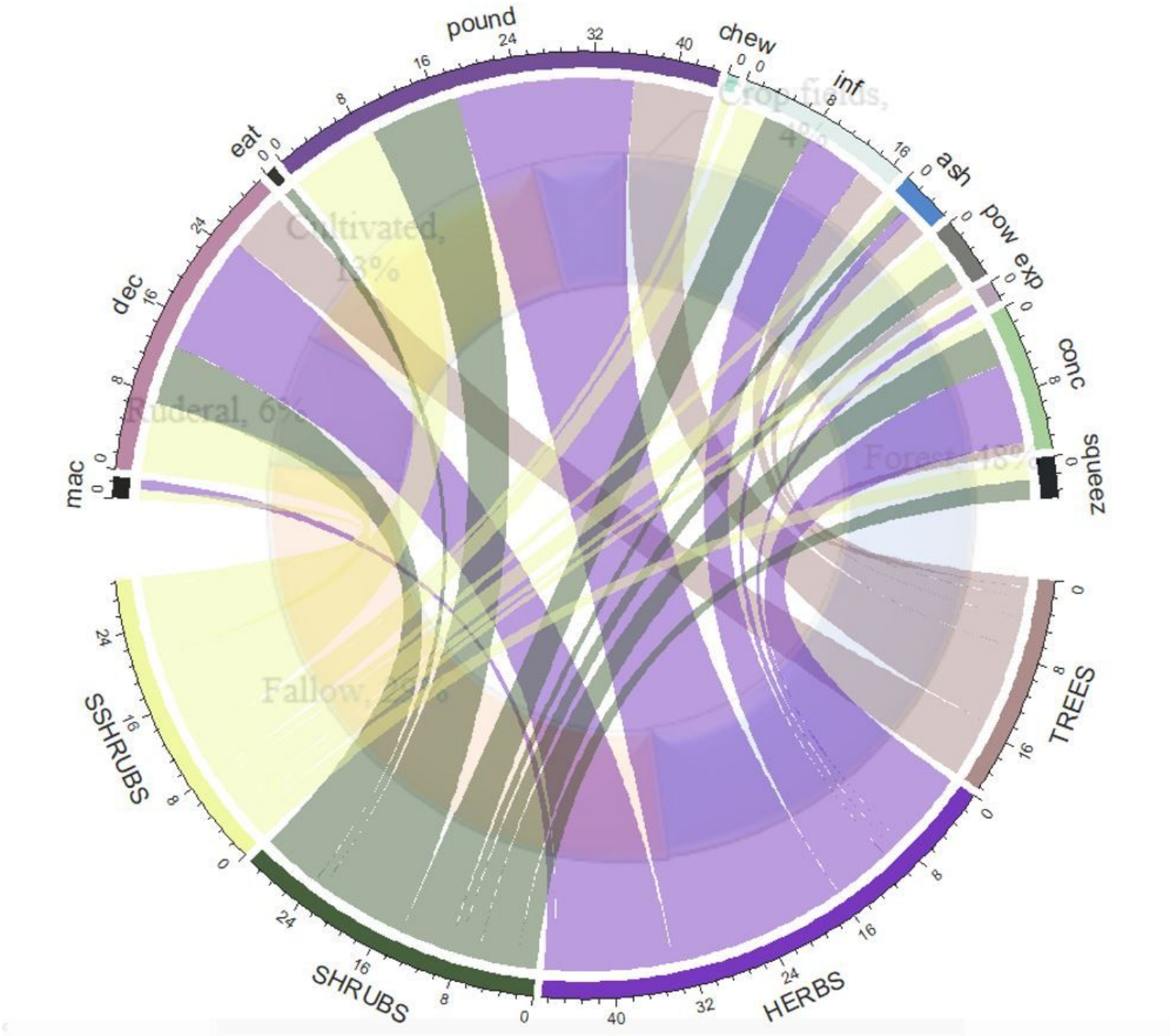

Figure 3

Distribution of medicinal preparation mode by morphological types. Eleven parts used (top half of circle) include (left to right): maceration (mac), decoction (dec), eat, pound, chewing (chew), infusion (inf), ash, powder (pow), expension (exp), concoction (conc), and squeezing (squeez). Morphological types (bottom half of circle). Scale numbers around the circle indicate cited time.

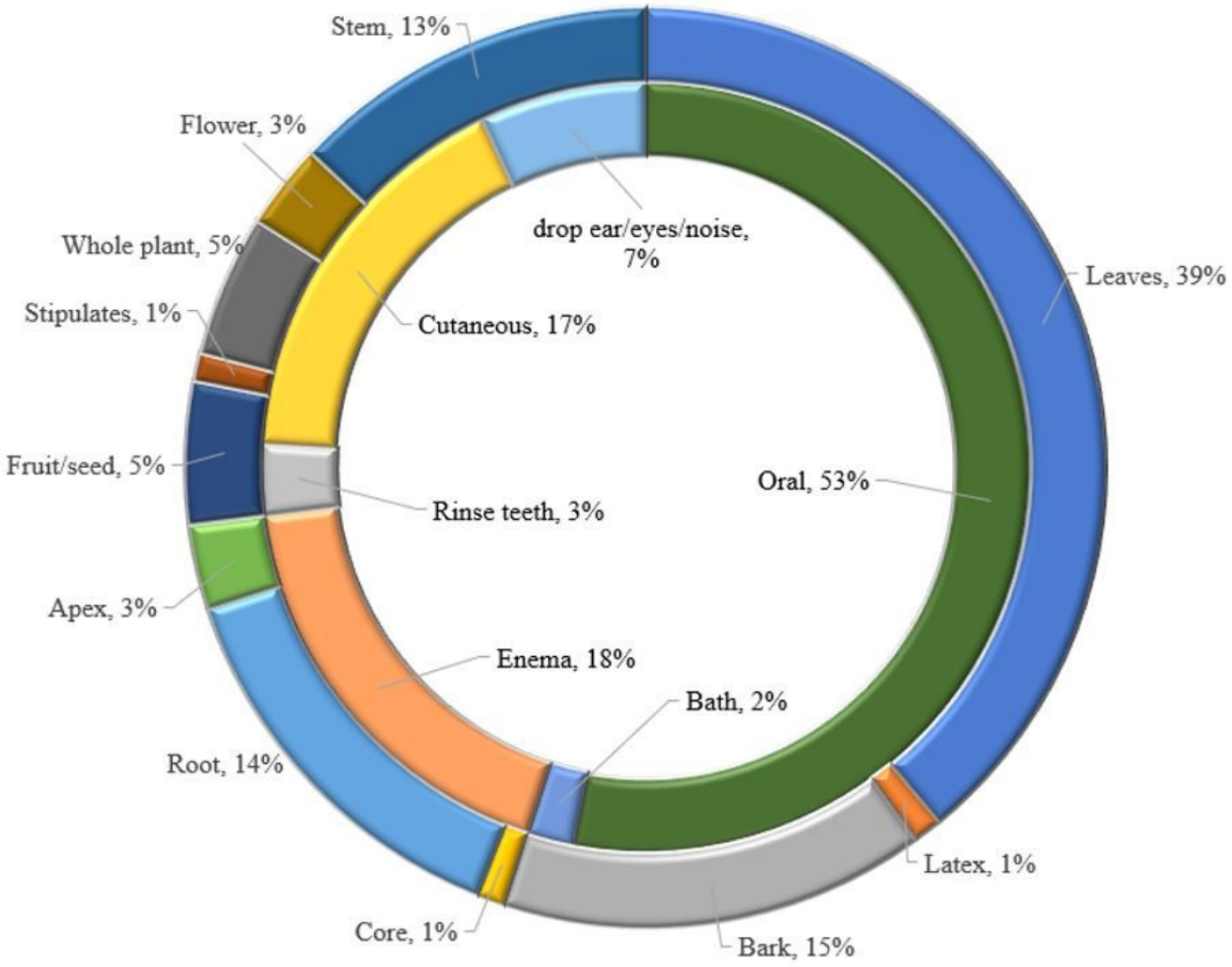

Figure 4

Frequencies of used Parts (outer circles) and administration modes (inner circles)

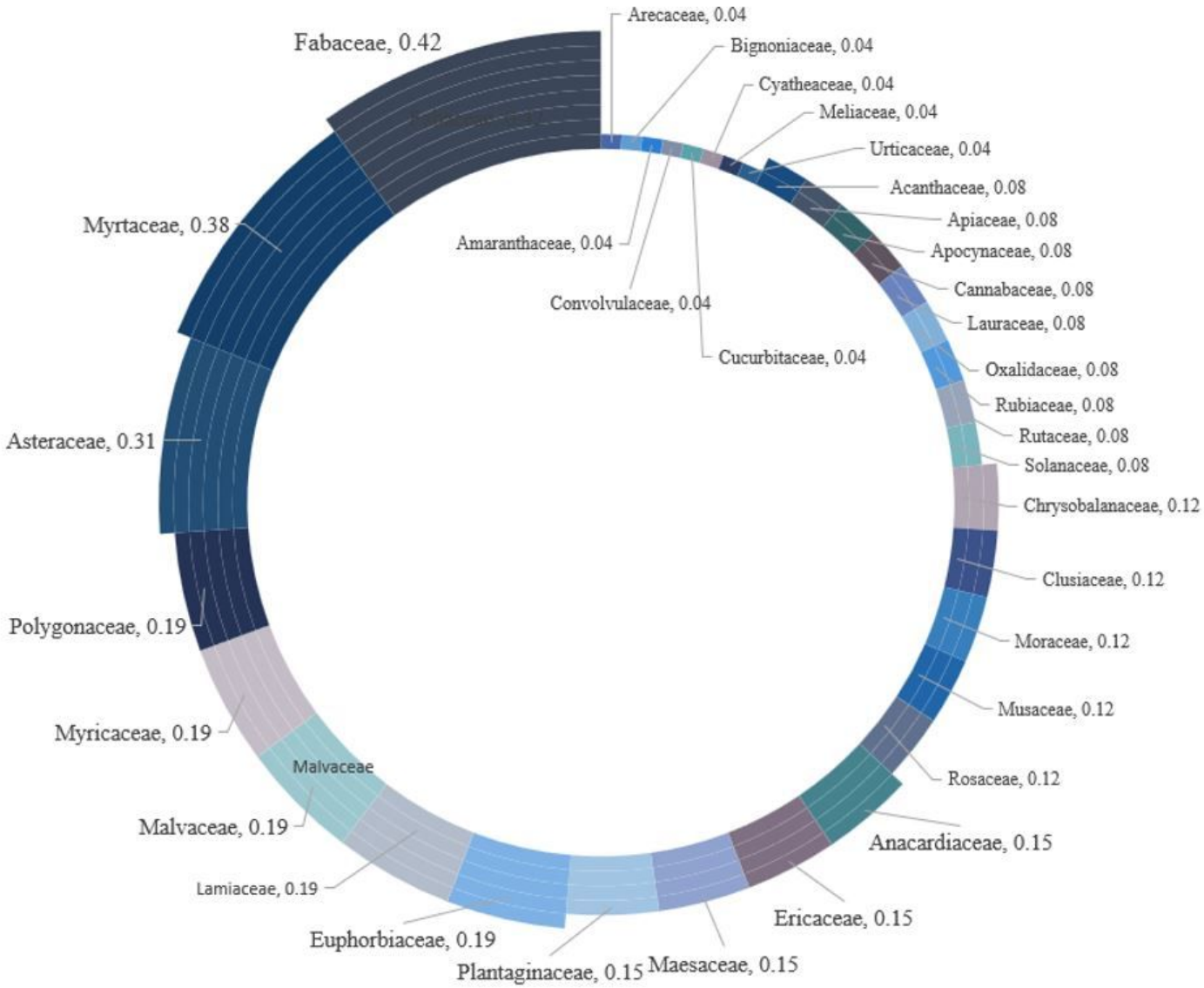

Figure 5

Family importance value (FIV)