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Ethnomedicinal Knowledge of plants used in Alternative Medicine to treat Acnes in Lubumbashi (Democratic Republic of Congo)

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Abstract

Traditional medicine is a primary healthcare option for many Congolese, particularly in Lubumbashi, yet remains under-documented and underutilized. This study aims to systematically document medicinal plant use in acne management among Lubumbashi residents. Data were gathered via direct interviews with households (n=368), herbalists (n=8), and traditional healers (n=14), totaling 390 informants (sex ratio M/F = 0.6; mean age = 43.6 ± 5 years; mean experience = 14 ± 7 years). Respondents identified 27 medicinal plant species, predominantly trees (48%), spanning 38 botanical families, with Fabaceae as the most represented (20%). Diabetes (8 species) emerged as the most frequently reported condition aside from acne. A total of 39 traditional anti-acne formulations were recorded, primarily using leaves (>44%) and prepared as poultices (>41%). For the first time, this study reports the ethnobotanical use of 20 plant species for acne treatment, including *Afzelia quanzensis* (CRF = 0.17), *Byrsonima verbascifolia* (CRF = 0.11), and *Uapaca sansibarica* (CRF = 0.11), which had the highest citation frequencies. *Afzelia quanzensis* (UVp = 0.18) and *Uapaca nitida* (UVp = 0.18) exhibited the highest usual values (UVp). The therapeutic applications documented here serve as a foundational database for future research. Further studies should validate traditional acne treatments through pharmacological analyses while promoting conservation of these valuable species in the Congolese flora.

Keywords: *Afzelia quanzensis; Byrsonima verbascifolia; Phragmanthera capitata; Uapaca sansibarica*; Acnes; Katangese traditional medicine (KTM).

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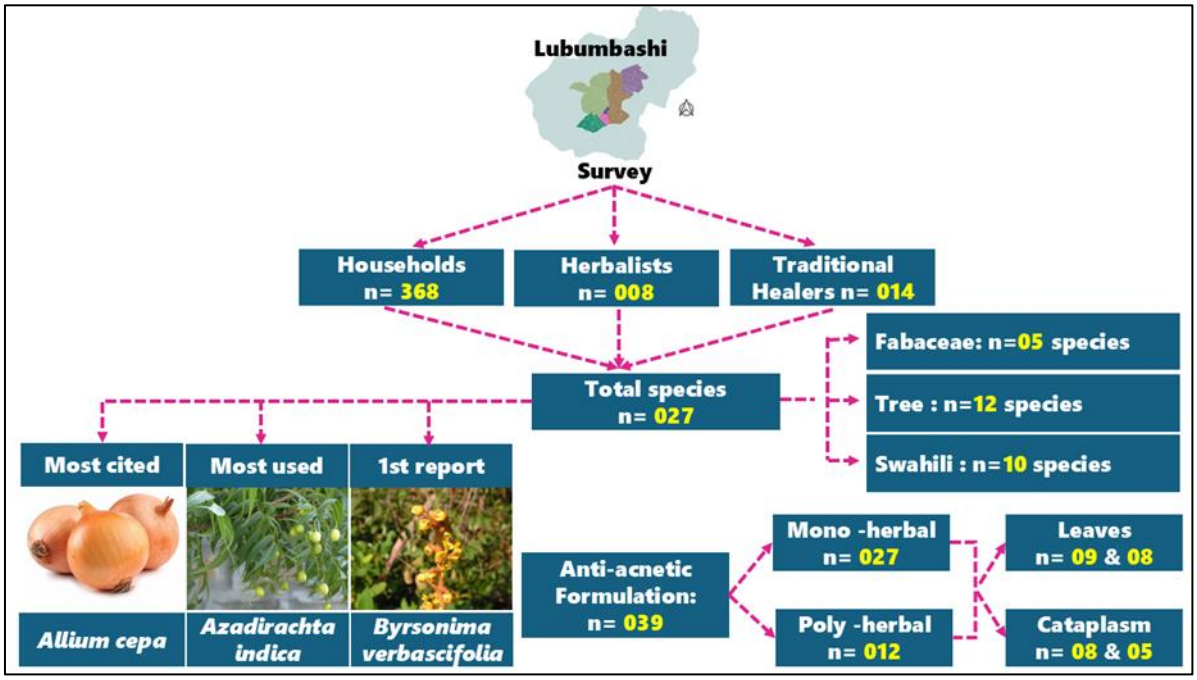
Graphical Abstract



1. Introduction

Acne vulgaris is a chronic inflammatory dermatological condition predominantly affecting adolescents, though it can persist into adulthood [1,2]. Its pathogenesis is multifactorial, involving hormonal fluctuations, genetic predisposition, and environmental influences. The disease primarily manifests in regions rich in sebaceous glands, such as the face, chest, and back, with clinical presentations ranging from mild to severe [3–5]. Lesions include comedones, papules, pustules, nodules, and cysts, which may lead to long-term scarring [1,6]. Beyond its physical manifestations, acne can profoundly impact psychological well-being, contributing to anxiety, depression, and social withdrawal, particularly among young individuals [7,8].

Epidemiologically, acne is one of the most prevalent dermatological conditions, affecting 85-90% of adolescents worldwide [9,10]. Estimates from 2019 report 117.4 million incident cases and 231.2 million prevalent cases globally [11]. African populations exhibit similar prevalence rates, though variations in genetic factors, and environmental influences, such as climate and dietary habits, may modulate disease severity. In the Democratic Republic of Congo, available data remain scarce. However, studies conducted in Kinshasa among schoolchildren aged 10 to 19 years reported a prevalence ranging from 15-58%, with a notable female predominance [12,13]. These findings highlight the need for further epidemiological investigations to refine treatment strategies, and preventive measures.

The therapeutic approach to acne vulgaris integrates topical and systemic pharmacological treatments alongside dermatological interventions to optimize outcomes [14,15]. Retinoids, benzoyl peroxide, and topical antibiotics are preferred for mild to moderate cases, while isotretinoin remains the gold standard for severe presentations due to its ability to regulate sebaceous gland activity and keratinization [3,16]. Hormonal therapies may be considered for select patients, particularly those exhibiting endocrinological imbalances [17]. Emerging modalities, including phototherapy [18], and anti-inflammatory medicinal plants [19,20], are increasingly explored for their adjunctive potential.

Despite the availability of biomedical treatments, access to primary healthcare remains limited in developing countries, restricting the management of common dermatological conditions such as acne. In response, populations increasingly rely on traditional medicine as a complementary approach, a trend particularly evident in intertropical Africa, including the Democratic Republic of Congo (DRC) and especially in Lubumbashi. However, despite its widespread use, traditional practices remain inadequately documented, limiting their integration into contemporary therapeutic frameworks.

Although ethnobotanical studies in various regions of the Democratic Republic of Congo—including Kinshasa [21], Central Kongo [22], and Rutshuru [23]—have indirectly referenced the use of medicinal plants in acne treatment, no comprehensive research has specifically examined the traditional knowledge associated with these remedies. In Haut-Katanga, particularly in Lubumbashi, several plant species, such as *Aloe vera* L [24,25] *Anisophyllea pomifera* Engl. & Brehmer [26], and *Albizia adianthifolia* (Schumach.) W. Wight [27], have been reported for their ethnobotanical applications in acne management within broader ethnomedical surveys. However, their traditional usage, and preparation methods remain poorly documented in scientific literature. This study aims to systematically explore local traditional knowledge, critically assess its relevance in acne treatment, and contribute to the integration of indigenous practices into dermatological research.

2. 2. Material and Methods

2.1. Experimental framework.

The study was conducted in the seven communes of the city of Lubumbashi: Annexe, Kampemba, Katuba, Kamalondo, Kenya, Lubumbashi, and Rwashi, in the province of Haut-Katanga in the Democratic Republic of Congo (Figure 1).

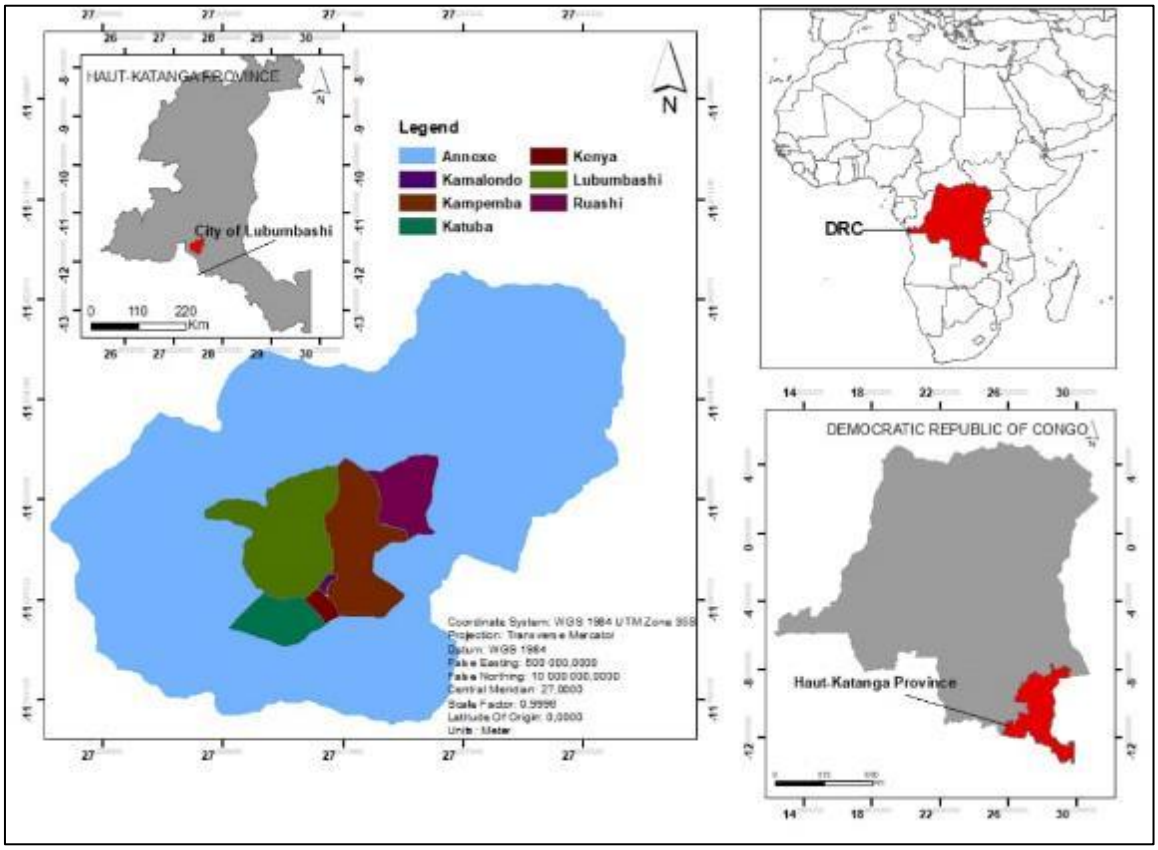


Figure 1 Lubumbashi, Haut-Katanga province (Democratic Republic of Congo).

Lubumbashi is geographically positioned between 11°26', and 11°55' north latitude and 27°15' and 27°40' east longitude, at an elevation of approximately 1,230 meters above sea level. The region is characterized by a tropical climate, with an average annual temperature of 22.4°C, and a mean yearly precipitation of 512.7 mm[3]. The local climate exhibits a distinct bimodal seasonal pattern, comprising a relatively brief rainy season extending from November to April, followed by a prolonged dry season. The predominant vegetation type within the study area is the Miombo clear forest, a semi-deciduous woodland ecosystem adapted to periodic drought conditions. [24].

2.2. Ethnobotanical data Collection.

This cross-sectional descriptive ethnobotanical study was conducted between September 2021, and August 2022 through semi-structured interviews based on an earlier survey [28]. The interview focused on the knowledge of plants

used in the management of acnes. Three groups have been interviewed: household, herbalists and traditional healers (TH) in Lubumbashi.

Household informants were interviewed in the 7 communes of the city of Lubumbashi: Annexe, Kamalondo, Kampemba, Katuba, Kenya, Lubumbashi and Ruashi, between 8 a.m. and 6 p.m.. The representative sample was determined by the Schwartz formula, (since the town hall approached for information on the general population did not have the exact data):

$n = \frac{z^2 * p * (1-p)}{e^2}$ (1) (https://goodcalculators.com/sample-size-calculator/)

Where: z = 1.96 for a confidence level (α) of 95%, p = population proportion (expressed as a decimal) using plant in the managing of acnes: 65%, e = margin of error: 5%.

The minimum required sample size was calculated to be 350. However, during fieldwork, 368 individuals were interviewed and subsequently recontacted at their households, which enhanced the accuracy of the study findings.

The herbalists consulted in this study were drawn from six prominent markets in Lubumbashi—Mzee, Kenya, Zambia, Kamalondo, Kalala Banza, and Moise—all recognized as key hubs of traditional medicine. These markets serve as vital sources of ethnobotanical knowledge, offering valuable insights into regional medicinal practices. A total of 36 herbalists were interviewed, among whom only 8 (22%) reported having specific formulations for the treatment of acne.

Traditional healers included in this study were initially selected from a pre-established list of 50 practitioners compiled during a previous survey [24]. This process resulted in the identification of 21 traditional healers, of whom only 10 reported treating acne. To enhance the sample size, snowball sampling was subsequently employed, leading to the inclusion of four additional healers, three of whom had already appeared on the initial list.

2.3. Data processing and analysis.

The names of the plant species were given by the respondents in the local language during the interviews. The plants were collected in the company of the interviewees. On this occasion, photographs were taken, and herbarium specimens were prepared and deposited at the Kipopo Herbarium, where the plants were formally identified and given scientific names by the herbarium botanists. The names were updated by comparison with the following databases: Plants of the World Online (https://powo.science.kew.org/) , The World Flora Online (http://www.worldfloraonline) or the African Plant Database (https://africanplantdatabase.ch/).

Given the current controversy surrounding ethnobotanical indexes [29], we have used only Two ethnobotanical indexes to assess the significant species: the usual value (UV) and the Relative Citation Frequency (RCF). However Apart from these two ethnobotanical indexes, we have expressed the results as percentages (%).

The formula determined the usual value (UV):

$UV = \frac{\sum Ui}{Ni}$ (2)

where Ui is the number of uses mentioned by an informant for a plant (organ), Ni = number of informants who said the plant.

The Relative citation frequency on the plant (organ) (IC) was calculated by the formula:

$RCF = \frac{Np}{N}$ (3)

where Np is the number of people who cited the plant (organ) and N is the number of informants consulted in the study. This index also represents the consensus factor for the use of the plant in the treatment of acne, making it a particularly relevant tool, as the study is targeted.

In this study, UV: makes it possible to evaluate the medicinal importance of a plant in the study area; The relative citation frequency (RCF) indicates the popularity of a plant in the treatment of acne. This also implies a consensus on the use of a plant by the informants in the treatment of acne, given that we are in the presence of a targeted ethnomedicinal study.

2.4. Ethics approval consent to participate Research and Availability of the study

The research proposal and ethical framework were rigorously evaluated and formally approved by the Department of Pharmacology, Faculty of Pharmaceutical Sciences, University of Lubumbashi (FSPUNILU-DP-BD-062026). In adherence to the ethical, and moral principles upheld by the University of Lubumbashi, informed verbal consent was obtained voluntarily from all study participants (n=390) prior to the commencement of data collection. Participants who did not provide explicit informed verbal consent or who lacked prior experience utilizing plants for acne treatment were systematically excluded from the study. Additionally, all respondents were duly informed that the data collection was conducted exclusively for academic purposes, and that the obtained information would remain confidential, with no disclosure to third parties.

3. Results

3.1. Ethnobotanical profile of inventoried plants.

Depending on the type of informant consulted (households, traditional healers and herbalists), the plants inventoried in this study can be divided into 7 classes, dominated by the only traditional healer class with 8 plants (class ξ). This is followed by the class common to all three informants group, class ϑ, with 5 plants. (Figure 2).

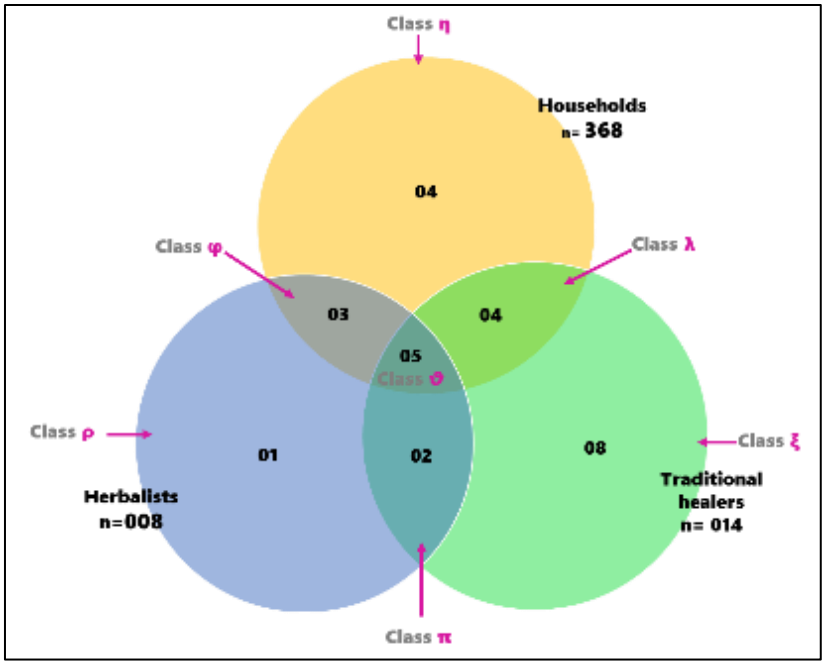


Figure 2 Number of species by class of the informant.

Ethnobotanic studies conducted during this study identified 27 plant species used by Lubumbashi people for acne treatment. Each of these plants was mentioned at least three times by informants, and the five most frequently mentioned species are *Allium cepa* (CRF: 0.18), *Afzelia quanzensis* (CRF: 0.17), *Azadirachta indica* (CRF: 0.15), *Tetradenia riparia* (CRF: 0.15), with a relative frequency of more than 0.15. Similarly, each of the plants reported in this study has at least three medicinal uses among the informants: *Azadirachta indica* (UV: 0.26), *Allium cepa* (UV: 0.23), *Afzelia quanzensis* (UV: 0.18), and *Uapaca nitida* (UV: 0.18) are the most commonly used plants (Table 1).

Table 1 General characteristics of plants surveyed

Plant species [Category] **(Herbarium code)**	**Family**	**Local name** [ethnicity, MT, GT]	**N° Recipe**	**Local Medical Uses** [UP,PM]	**No. Citations (RCF: n=390)**	**No. Uses (UV: n=39)**
Afzelia quanzensis Welw [a,b] (KIP000011020)	Fabaceae	Mbambakofi [d,n,o]	R01	Acne [u,δ]	65(0.17)	7(0.18)
		Mukonge		Bilharzia		
				Chest pains		
				Eye problems		
				Gonorrhea		
				Kidney problems		
				Snakebites		
Allium cepa L [a,b,c]	Amaryllidaceae	Litungulu sumu [d,l,p]	R02	Acnes [y,μ]	71(0.18)	9(0.23)
				Constipation		
				Diabetes		
				Fever		
				Gastrointestinal disorders		
				Helminth		
				Hypertension		
				Sores		
				Spasms		
Aloe vera (L.) Burm.f. [a,b,c] (KIP000011021)	Asphodelaceae	Cizimya muliro [i,k,p]	R03	Acne [y,δ]	47(0.12)	3(0.08)
				Diabetes		
				Wounds		
Annona senegalensis Pers.[b]	Annonaceae	Mulolo [f,n,t]	R04	Acne [x,μ]	21(0.05)	5(0.13)
(KIP000011022)				Diabetes		
				Jaundice		
				Sickle cell anemia		
				Wounds		
Azadirachta indica A.Juss [a,b,c]	Meliaceae	Nfwama [g,n,o]	R05	Acne [y,μ]	59(15)	10 (0.26)
				Amoeba		
				Ascariasis		
				Diabetes		
				Fever		
				Gastrointestinal disorders		

Plant species [Category] **(Herbarium code)**	**Family**	**Local name** [ethnicity, MT, GT]	**N° Recipe**	**Local Medical Uses** [UP,PM]	**No. Citations (RCF: n=390)**	**No. Uses (UV: n=39)**
				Malaria		
				Tooth decay		
				Ulcers		
				Wounds		
Byrsonima verbascifolia (L.) DC. [b] (KIP000011023)	Malpighiaceae	Kalayi [e,m,p]	R06	Acne [x,γ]	41(0.11)	3(0.08)
				Diabetes		
				Wounds		
Chenopodium album L [a] (KIP000011024)	Amaranthaceae	Lufuluabo [e,l,r]	R07	Acne [y,μ]	3(0.08)	4(0.10)
				Diarrhea		
				Helminthes		
				Hepatitis		
Milicia excelsa (Welw.) C.C.Berg [a,b,c] (KIP000011025)	Moraceae	Molundu [h,n,o]	R08	Acne [y,μ]	10(0.03)	4(0.10)
				Asthenias		
				Cough		
				High blood pressure		
Citrus × limon (L.) Osbeck [a,b] (KIP000011026)	Rutaceae	Ndimu kali [d,n,o]	R09	Acne [w,μ]	51(0.13)	3(0.08)
				Coughs		
				Gastrointestinal disorders		
Colocasia esculenta (L.) Schott [b] (KIP000011027)	Araceae	Kabobo [e,l,p]	R10	Acne [z,γ]	12(0.03)	3(0.08)
				Constipation		
				Liver diseases		
Erigeron floribundus (Kunth) Sch.Bip [a,b]	Asteraceae	Tukituki [g,l,p]	R11	Acne [y,μ]	38 (0.10)	3(0.08)
(KIP000011028)				Gastrointestinal disorders		
				Malaria		
Malus domestica (Suckow) Borkh. [b]	Rosaceae	Tufaha [d,n,p]	R12	Acne [w,ε]	4(0.01)	4(0.10)
(KIP000011029)				Asthma		
				Diabetes		
				High blood pressure		

Plant species [Category] **(Herbarium code)**	**Family**	**Local name** [ethnicity, MT, GT]	**N° Recipe**	**Local Medical Uses** [UP,PM]	**No. Citations (RCF: n=390)**	**No. Uses (UV: n=39)**
Markhamia lutea (Benth.) K.Schum[a,c]	Bignoniaceae	Kelebelebe [g,n,o]	R13	Acne [y,ε]	21(0.05)	3(0.08)
(KIP000011030)				Fever		
				Headache		
Markhamia obtusifolia (Baker) Sprague [a]	Bignoniaceae	Kalebelebe [g,n,o]	R14	Acne [x,θ]	21(0.05)	3(0.08)
(KIP000011031)				Convulsion		
				Stomach gas		
Melaleuca alternifolia (Maiden & Betche) Cheel [b] (KIP000011032)	Myrtaceae	Mti wa cahi [d,n,p]	R15	Acne [y,γ]	5(0.01)	3(0.08)
				Jaundice		
				Wounds		
Milicia excelsa (Welw.) C.C.Berg [c] (KIP000011033)	Moraceae	Molundu [h,n,o]	R16	Acne [y,μ]	21(0.05)	4(0.10)
				Coughs		
				Gastrointestinal disorders		
				High blood pressure		
Phragmanthera capitata (Spreng.) Balle [a,c]	Loranthaceae	Kwapata [d,j,o]	R17	Acne [x,α]	40(0.10)	3(0.08)
(KIP000011034)				Fever		
				Gastrointestinal disorders		
Psidium guajava L [a,c]	Myrtaceae	Lipera [d,n,p]	R18	Acne [w,δ]	27(0.07)	6(0.15)
(KIP000011035)				Diabetes		
				Diarrhea		
				Dysentery		
				Gastroenteritis		
				High blood pressure		
Pterocarpus rotundifolius (Sond.) Druce [b]	Fabaceae	Kiswahu [e,m, q]	R19	Acne [z,δ]	5(0.01)	5(0.13)
(KIP000011036)				Coughs		
				Diarrhea		
				Gonorrhea		
				Mouth ulcers		
Schotia brachypetala Sond [b,c](KIP000011037)	Fabaceae	Kifulumi [d,m,o]	R20	Acne [z,β]	21(0.05)	3(0.08)

Plant species Category **(Herbarium code)**	**Family**	**Local name** ethnicity, MT, GT	**N° Recipe**	**Local Medical Uses** UP,PM	**No. Citations (RCF: n=390)**	**No. Uses (UV: n=39)**
				Fever		
				Headache		
Senegalia polyacantha (Willd.) Seigler & Ebinger [a,b,c]	Fabaceae	Munga [f,n,q]	R21	Acne [v,μ]	38(0.10)	4(0.10)
(KIP000011038)				Fever		
				Headache		
				Malaria		
Senna petersiana (Bolle) Lock [b,c] (KIP000011039)	Fabaceae	Kafungumbele [f,m,q]	R22	Acne [z,β]	3(0.01)	4(0.10)
				Diabetes		
				Fever		
				Malaria		
Solanum lycopersicum L [b](KIP000011040)	Solanaceae	Njiwa [d,l,p]	R23	Acne [w,μ]	41(0.11)	4(0.10)
				Cancers		
				Diabetes		
				High blood pressure		
Tetradenia riparia (Hochst.) Codd [a,b,c] (KIP000011041)	Lamiaceae	Mutuzo [d,m,o]	R24	Acne [y,μ]	58(0.15)	5(0.13)
				Coughs		
				Diarrhea		
				Malaria		
				Ulcers		
Uapaca nitida M¨ull. Arg [a,b](KIP000011042)	Phyllanthaceae	Musonkolobe [e,n,o]	R25	Acne [y,μ]	12(0.03)	7(0.18)
				Diabetes		
				Fever		
				Gonorrhea		
				Pain		
				Sexual dysfunction		
				Wound		
Uapaca sansibarica Müll.Arg.[a](KIP000011043)	Phyllanthaceae	Mutankola [e,k,s]	R26	Acne [v,ε]	41(0.11)	4(0.10)
				Fever		
				Sexual dysfunction		
				Wounds		

Plant species Category **(Herbarium code)**	**Family**	**Local name** ethnicity, MT, GT	**N° Recipe**	**Local Medical Uses** UP,PM	**No. Citations (RCF: n=390)**	**No. Uses (UV: n=39)**
Urtica dioica L [b]	Urticacee	Netele [d,k,p]	R27	Acne [y,ε]	6(0.01)	4(0.10)
(KIP000011044)				Arthritis		
				Rheumatism		
				Urinary infections		

Legend – *Informants* - a: Households; b: Traditional healers; c: Herbalists – *Local plant naming languages* – d: Swahili, e: Bemba, f: Luba-Kat, g: Zela, h: Kongo; i: Shi – *Morphological type* – j: Hemiparasite, k: Perianal gras, l: annual gras, m: shrub; n: Tree – *Geographical type* – o: TA (Tropical Africa), p: Non Africa, q: SA-TA (SA: South Africa),r : NA-TA(NA: North Africa), s: NA, t: Madagascar(MA)-SA-TA , - Used part – u: Seed, v: Root bark, w: Fruit, x: Stem bark, y: Leaves, z: Root; - *Preparation method* – θ: Decoction, α: Infusion, β: dry fumigation (Dry fumigation: the plant or plants are burnt over hot coals), γ: Liniment (Liniment: a composition of oil (palm or olive) and plant powder in the proportions 5 and 2. It is applied to the affected areas.), ε: ointment (Ointment: preparation obtained from pork fat with a paste of the plant in parts 3÷1.), δ: Wet fumigation (Wet fumigation: the plants are boiled in water to produce an aromatic vapor), μ: Cataplasm (Cataplasm: the plant is applied directly to the skin if it is fine enough. Otherwise, they can be heated in water to soften them and then gently crushed to extract the active ingredients); Duration of application: 2 weeks for each anti-acne formula that uses a single plant.

The plants inventoried during this survey belong to 19 families, dominated by the Fabaceae (%RCF: 18.5 %), followed by the Bigoniaceae , Moraceae , Myrtaceae and Phyllanthaceae with a RCF of 0.7 each (Figure 3).

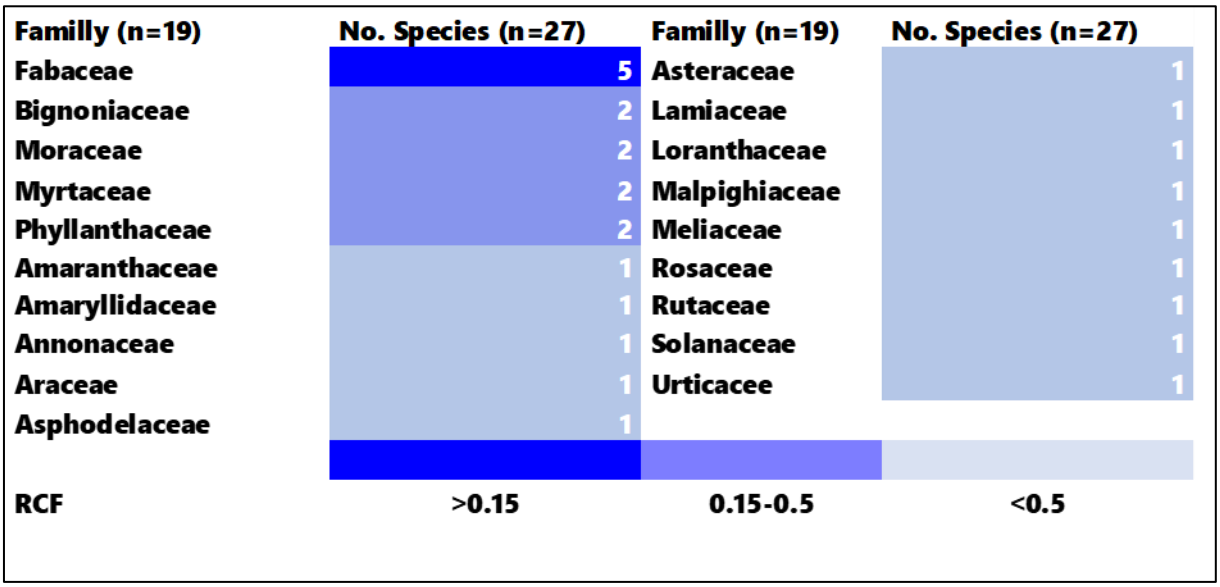


Figure 3 Botanical families.

These plant species are mostly trees (%RCF: 48%) or shrubs (%RCF: 24%) endemic to tropical Africain most cases: %CRF: 44% (Figure 4a-b). They were collected by 3 categories of informants, with a predominance of the category of traditional healers: 18 plants, 69 citations (c and d). These plants were found in the 7 communes of the city of Lubumbashi, with a predominance of the Annex commune: 21 plants, 79 citations, followed by the Ruashi commune. In last place is the commune of Kamalondo (Figure 4).

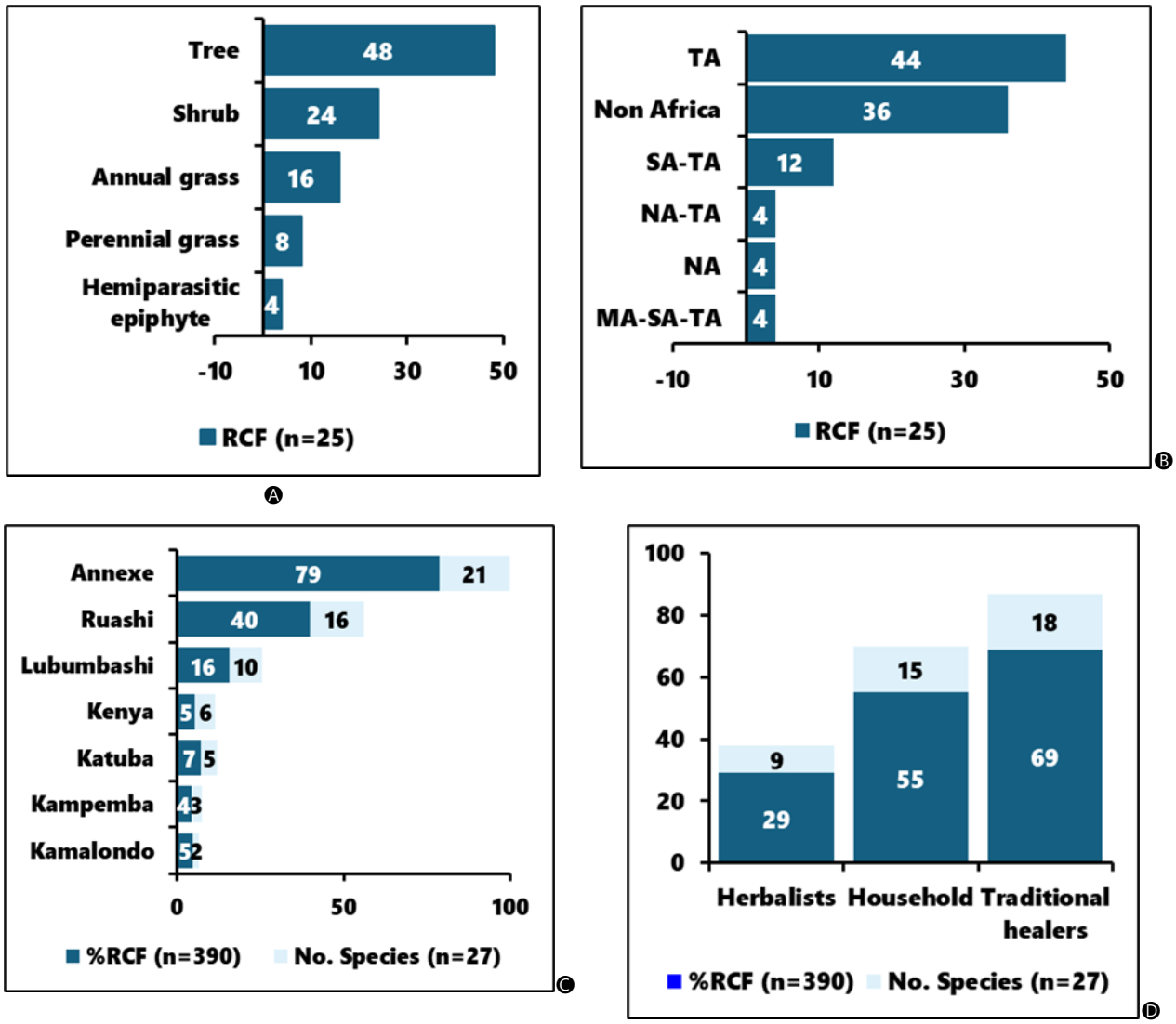


Figure 4 Morphological (a) and geographical (b) type of plants, category of informants (c), and situation of the plant with the literature.

Legend: NA: North Africa; CA: Central Africa; TA: tropical Africa; SA: southern Africa; MA: Madagascar.

Each of these plants is named in one of the 6 Congolese ethnic groups reported in this study, of which Swahili (52%) and Bemba (21%) occupy the first two places (Figure 5).

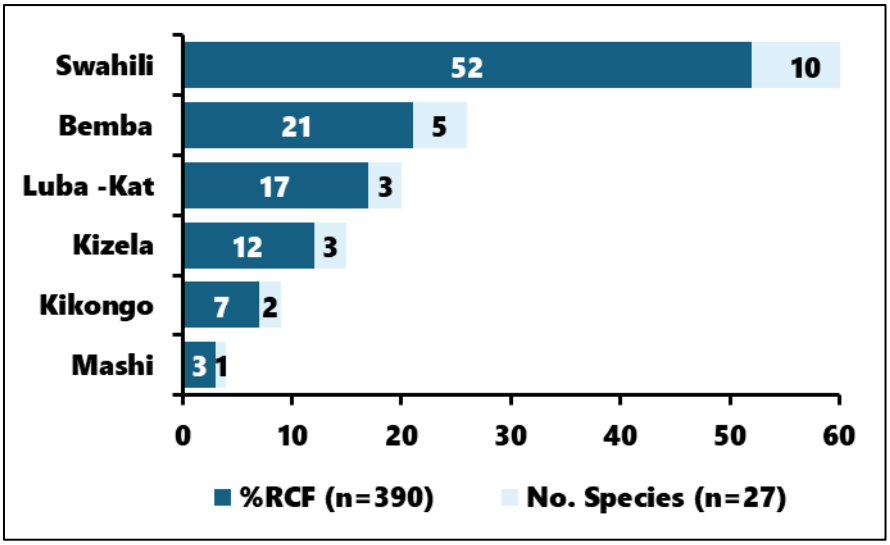


Figure 5 Distribution of species according to their local naming languages.

3.2. Anti-acnetic formulation from inventoried plants.

The twenty-seven plants inventoried in this study are used in 39 traditional anti-acnetic formulations, of which 27 traditional anti-acnetic formulations are mono-herbal and 12 are polyherbal (Tables 1 and 2).

The relative citation frequency (RCF) of the anti-acne recipes identified in this study ranged from 0.01 to 0.18. The highest values were observed for recipe R02, based on *Allium cepa* root (bulb), and R39, based on a mixture of *Annona senegalensis* stem bark and *Allium sativum* root (bulb);

The leaf is the most used organ (9 and 8 recipes), and the cataplasm is the most predominant method of preparation (8 and 5 recipes) for the two types of recipes (mono-herbal and polyherbal) (Figure 6).

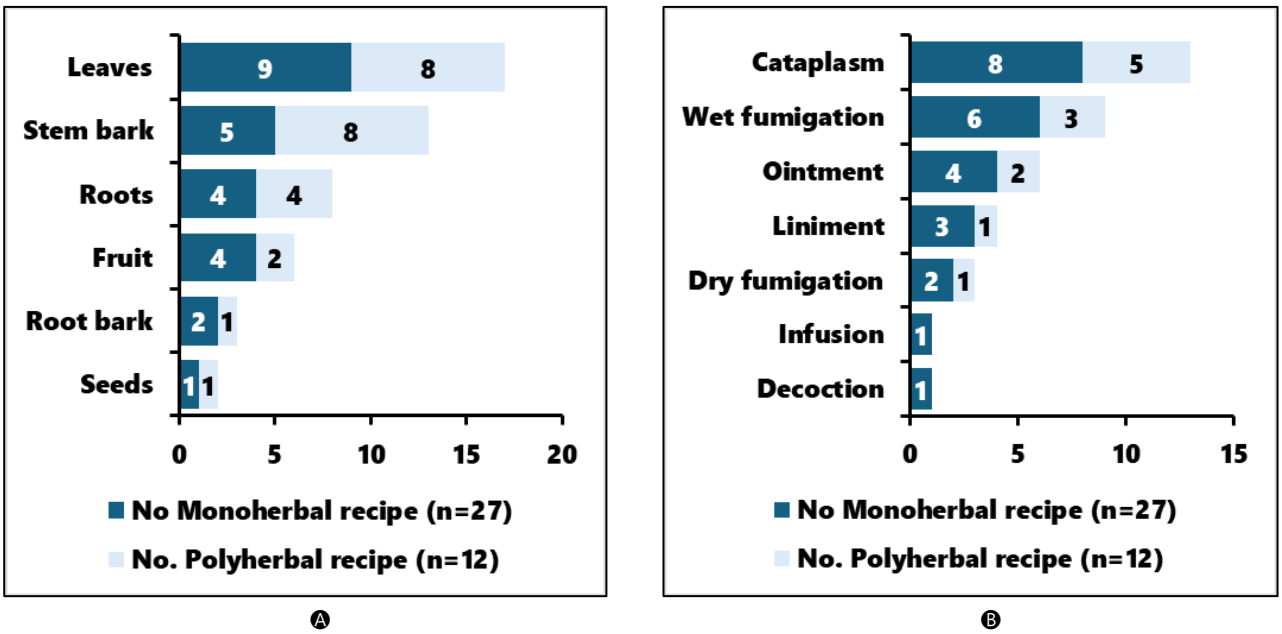


Figure 6 Parts used (A) and mode of preparation of traditional anti-acnetic formulations (B).

In the traditional anti-acnetic formulations where two plants are combined, only 13 of the 27 plants are involved. In these traditional anti-acnetic formulations (R28-R39) we can observe the following associations: Leaves-root, Leaves-fruit, Leaves-seed, Stem-bark-fruits, Stem-bark-roots and Leaves-stem-bark, which represent 33% of these associations. For these traditional formulations of plants in association, the duration of treatment varies between 4 and 14 days. The

combination (R39) *Annona senegalensis* (stem bark), and *Allium sativum* (roots) with an RCF of 0.17 is the most cited (Table 2).

Table 2 Traditional Anti-acnetic polyherbal formulations

N°	Specie 1	Specie 2	N° TAF	UP – (Ratio)	Preparation	TD (D)	Ni (RCF, n=390)
1	*Afzelia quanzensis*	*Aloe vera*	R28	Sd-Lv (2÷1)	Cataplasm	5	10(0.03)
2	*Annona senegalensis*	*Byrsonima verbascifolia*	R29	Lv-Sb (1÷2)	Cataplasm	6	12(0.03)
3	*Chenopodium album*	*Colocasia esculenta*	R30	Lv-R (2÷3)	Cataplasm	14	15(0.04)
4	*Erigeron floribundus*	*Markhamia obtusifolia*	R31	Lv-Sb (1÷1)	Wet fumigation	12	18(0.05)
5	*Senna petersiana*	*Annona senegalensis*	R32	Rb- Sb (3÷1)	Cataplasm	7	22(0.06)
6	*Tetradenia riparia*	*Uapaca nitida*	R33	Lv-Fr (2÷1)	Ointment	7	27(0.07)
7	*Uapaca nitida*	*Annona senegalensis*	R34	Lv-Sb (2÷1)	Cataplasm	7	30(0.08)
8	*Senna petersiana*	*Colocasia esculenta*	R35	R-Sb (2÷1)	Ointment	10	18(0.05)
9	*Erigeron floribundus*	*Annona senegalensis*	R36	Lv-Sb (2÷1)	Wet fumigation	9	35(0.09)
10	*Allium sativum*	*Azadirachta indica*	R37	R-Lv (2÷1)	Liniment	7	31(0.08)
11	*Annona senegalensis*	*Azadirachta indica*	R38	Sb-Fr (2÷3)	Wet fumigation	7	18(0.05)
12	*Annona senegalensis*	*Allium sativum*	R39	Sb-R(3÷2)	Dry fumigation	7	68(0.17)

Legend - PU-Ratio: Part used and proportion of the mixture; Lv: leaf; R: root; Rb: Root bark; Sb: Stem bark; Fr: fruit; Sd: Seed; DT: duration of treatment; D: Day; the F_{CR} is expressed in %, n= 390; N° Recipe. = anti-acnetic recipe.

3.3. Other diseases treated by inventoried species

The 27 plant recorded in the surveys treat 34 other conditions, with 12 of these being treated by at least two plants, diabetes being the most common (10 plants, 20 mentions). This is followed by fever (9 plants, 20 citations), and wounds (7 plants, 17 citations): Figure 7.

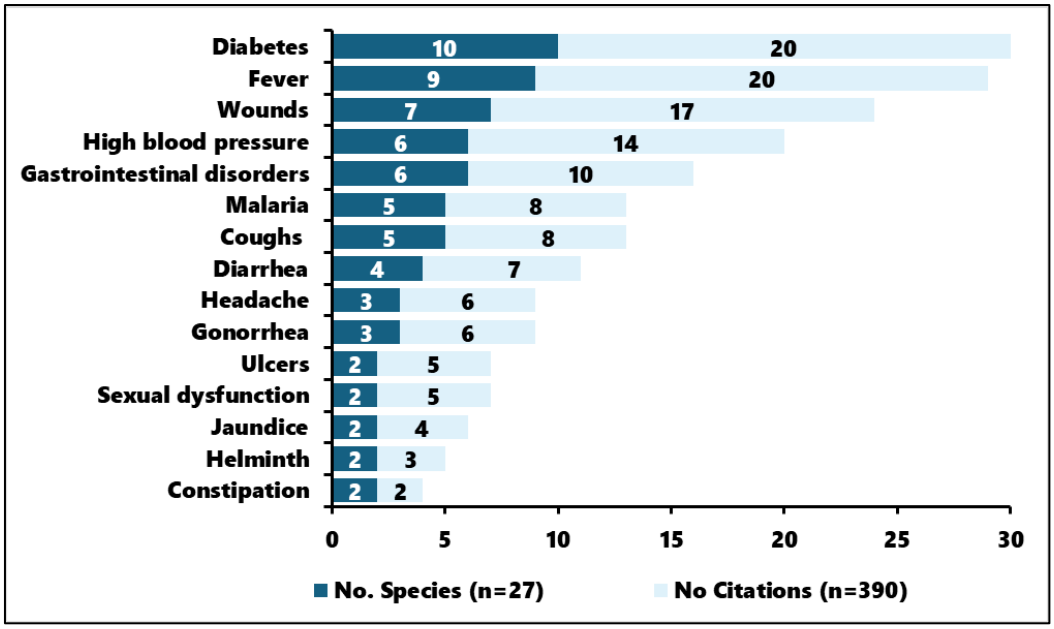


Figure 7 The ten most frequently cited diseases other than acnes.

3.4. Socio-demographic profile of informants.

The informants interviewed during this study are either household members (94.4%), herbalists (2.1%) or traditional healers (3.6%). They are mainly women (62.3%), and their average age is between 26 and 45 years, with extremes ranging from 15 to 78 years. They mainly live either in the municipality of Annexe (21.5%), and their average level of education is secondary (55.9%). They are mainly engaged in 6 types of work, the most representative of which is domestic work (51.5%). In most cases, they have more than 14 years of experience in the use of medicinal plants for the treatment of acne (Table 3).

Table 3 General characteristics of the informants.

Class	**Category**	**household (n=368)**		**Herbalists (n=8)**		**TH (n=14)**		**% All Informants (n=390)**
		n_i	%	n_i	%	n_i	%	%
Age	15-25	23	6.3	00	00.0	01	07.1	06.2
	26-35	121	32.9	01	12.5	03	21.4	32.1
	36-45	179	48.6	05	62.5	02	14.3	47.7
	46-55	35	09.5	01	12.5	02	14.3	09.7
	>55	10	02.7	01	12.5	06	42.9	04.3
Experience	1-5	20	05.4	00	00.0	01	07.1	05.4
(Year)	6-10	124	33.7	01	12.5	06	42.9	33.6
	11-15	170	46.2	04	50.0	03	21.4	45.4
	16-20	44	12.0	02	25.0	02	14.3	12.3
	21-25	10	02.7	01	12.5	02	14.3	03.3
Profession	Trade	20	05.4	00	00.0	00	00.0	05.1
	Public sector	59	16.1	00	00.0	00	00.0	15.1
	Liberal	88	23.9	00	00.0	00	00.0	22.6

Class	Category	household (n=368)		Herbalists (n=8)		TH (n=14)		% All Informants (n=390)
	Housework	201	54.6	00	00.0	00	00.0	51.5
	TH	00	00.0	00	00.0	14	100	03.6
	Herbalist	00	00.0	08	100	00	00.0	02.1
Gender	Female	231	87.2	05	62.5	10	71.4	63.1
	Male	137	12.8	03	37.5	04	28.6	36.9
Municipality of residence	Annexe	82	22.3	01	12.5	01	07.1	21.5
	Kamalondo	20	05.4	00	00.0	00	00.0	05.1
	Kampemba	61	16.6	02	25.0	02	14.3	16.7
	Katuba	54	14.7	02	25.0	04	28.6	15.4
	Kenya	55	14.9	02	25.0	01	07.1	14.9
	Lubumbashi	55	14.9	01	12.5	03	21.4	14.9
	Ruashi	41	11.1	00	00.0	03	21.4	11.3
Level of studies	None	44	11.9	00	00.0	00	00.0	11.3
	Primary	58	15.8	01	12.5	03	21.4	15.9
	Professional	41	11.1	03	37.5	01	07.1	11.5
	Secondary	207	56.3	03	37.5	08	57.1	55.9
	University	18	04.9	01	12.5	02	14.3	05.4

Legend **-** TH: Traditional healer.

4. Discussion

For generations, communities in Lubumbashi have harnessed the floristic wealth of the Miombo forest, extracting medicinal plants to address their primary healthcare needs. Among dermatological conditions, acne is a prevalent disorder for which local populations rely on the therapeutic potential of this ecosystem.

This study identified 27 plant taxa utilized by both the general population, and traditional medicine practitioners in the management of acne in Lubumbashi. A comprehensive review of scientific literature on the documented species led to their classification into two major categories, subdivided into six distinct groups: (i) Plants that have never been reported for anti-acne properties (20 species distributed across four groups: ♠,♣,♥,★). (ii) Plants already documented in existing literature as anti-acne agents (7 species classified into two groups: ♧,❀).

The first group (♠) comprises species for which no documented cosmetic or therapeutic application in acne treatment exists, either in the Democratic Republic of Congo (RDC) or globally. This category includes *Byrsonima verbascifolia*, *Melaleuca alternifolia*, *Milicia regia*, and *Phragmanthera capitata*, all recognized for their medicinal properties in various regions. Studies confirm that *B. verbascifolia* exhibits anti-inflammatory activity, notably employed in Brazil for inflammatory conditions [30]. Similarly, *M. alternifolia*, commonly known as tea tree, has been historically utilized by Australian Indigenous communities for wound healing, burns, and insect bites; its essential oil, obtained via steam distillation, is widely acknowledged for its therapeutic potential [31]. *M. regia* contributes to blood pressure stabilization in Sierra Leone [32], while in Ghana, it is applied in cancer management [33]. Meanwhile, *P. capitata*, recorded in Cameroon as a medicinal plant, exhibits extensive biological properties, including antioxidant, anti-inflammatory, hematopoietic, antibacterial, antifungal, gastroprotective, and spermatogenetic activities [34–36].

The second group (♣) consists of medicinal species endemic to the Democratic Republic of Congo (DRC), which, despite their well-established integration into traditional pharmacopoeias, have never been associated with acne treatment or cosmetic applications. This group includes *Markhamia lutea*, *Markhamia obtusifolia*, *Senegalia polyacantha*, *Senna petersiana*, *Uapaca nitida*, and *Uapaca sansibarica,* each recognized for its distinct therapeutic properties. *M. lutea* has

been documented in Lubumbashi for its role in wound management, with recent research highlighting its cicatrizing properties [25]. Similarly, *M. obtusifolia* is traditionally employed as an aphrodisiac, its use deeply embedded in local medicinal practices [37]. *S. polyacantha* demonstrates remarkable therapeutic versatility in Lubumbashi, being utilized not only in the treatment of sexual dysfunctions but also in the management of diabetes, diarrhea, and dysmenorrhea [38,39]. Moreover, *S. petersiana* is referenced for its beneficial effects on wound healing [25], and its role in diabetes management [40]. Lastly, *U. nitida* and *U. sansibarica*, also employed in Lubumbashi, are valued both for their ability to promote wound healing [25], and for their antimitotic properties, suggesting potential applications in oncology [41]. While their dermatological applications remain unexplored, these species represent a promising reservoir of bioactive compounds, warranting further investigation to uncover novel therapeutic potential.

The third group (♥) comprises species whose anti-acne properties have never been documented but are utilized in dermatological care for cosmetic purposes without being formally classified among the medicinal plants of the Democratic Republic of Congo (DRC). This group includes *Afzelia quanzensis*, *Malus domestica*, and *Pterocarpus rotundifolius*, each exhibiting diverse therapeutic applications. *Afzelia quanzensis* is employed in Zimbabwe and South Africa (RSA) for dermatological treatments [42] and is also used in managing conditions such as pneumonia, malaria, gonorrhea, chest pain, kidney disorders, bilharzia, ocular ailments, and snakebites [43,44]. *Malus domestica* is traditionally utilized in Asia for various skin conditions [45,46], and has been studied for its beneficial effects on oxidative stress, inflammation, cancer, cardiovascular diseases, and diabetes [47,48]. Meanwhile, *Pterocarpus rotundifolius* is recognized in RSA for its dermatological applications [49] and is additionally employed in treating inflammatory diseases, High blood pressure, gonorrhea, infections, coughs, mouth ulcers, boils, diarrhea, and pain management [50,51]. Although these species have not been specifically investigated for their effects on acne, their rich composition of bioactive compounds suggests promising avenues for future research in dermatology and cosmetology.

The fourth group (★) comprises medicinal species utilized in the treatment of various dermatological conditions and incorporated into the traditional pharmacopoeias of the Democratic Republic of Congo (DRC), although their specific anti-acne efficacy has not been documented. Available studies indicate that these species are widely employed in traditional medicine for the management of respiratory, ophthalmological, oncological, and dermatological disorders, including measles, eczema, ringworm, scabies, leprosy, and boils, both in the DRC and across other regions of the world. This group includes *Annona senegalensis* [22,25,28,52], *Citrus × limon* [53–55], *Colocasia esculenta* [56–58], *Erigeron floribundus* [25,59,60], *Milicia excelsa* [61–65], *Schotia brachypetala* [66,67], and *Urtica dioica* [68–70], all of which have well-established medicinal applications. These species thus represent a valuable resource for pharmaceutical, and dermatological research, potentially leading to the identification of novel therapeutic applications.

The fifth group (♧) comprises plant species traditionally employed in the treatment of acne, although their efficacy has yet to be validated through experimental studies. This group includes *Solanum lycopersicum* and *Tetradenia riparia*, both recognized for their dermatological and therapeutic applications. *Solanum lycopersicum,* despite its predominant role in nutrition [71], and its documented use in managing sexual dysfunctions [37], is frequently incorporated into cosmetic formulations, particularly for acne treatment [72,73]. Meanwhile, *Tetradenia riparia* has long been utilized in the management of various skin disorders [74,75], and is also employed in the treatment of candidiasis, cryptococcosis, malaria, wound healing, and respiratory infections [25,75,76]. Although these species have demonstrated empirical applications in dermatological care, their therapeutic potential necessitates rigorous scientific validation to elucidate their mechanisms of action and possible pharmacological applications.

Finally, the sixth group (❀) consists of plant species whose anti-acne activity has been scientifically validated, confirming their empirical use in traditional medicine. It includes *Allium cepa*, *Aloe vera*, *Azadirachta indica*, *Chenopodium album*, and *Psidium guajava*, all recognized for their dermatological properties. Research has demonstrated their effectiveness in acne management, supporting their inclusion in the traditional Congolese pharmacopoeia. *Allium cepa* has been studied for its anti-acne properties [68,77]. Similarly, *Aloe vera* is widely documented for its benefits in treating skin disorders, including acne, and is among the most frequently used medicinal plants [25,78–80]. *Azadirachta indica* is well known for its purifying, and antimicrobial properties, which account for its frequent application in acne treatment [81–84]. Additionally, *Chenopodium album* has been explored for its dermatological effects [37,85,86]. Lastly, *Psidium guajava* has been scientifically recognized for its positive impact on skin health, and acne reduction [87–89]. The validation of these species suggests the possibility that other plants cited in this study may also possess anti-acne properties, warranting further investigation into their therapeutic potential.

These 27 plant species are predominantly trees belonging to the Fabaceae family, endemic to tropical Africa, and primarily designated by their Swahili names (Table 1, Figure 3). The findings of this study align with existing literature. Indeed, various ethnobotanical investigations conducted in Lubumbashi [25,28,40,90] have highlighted the

predominance of Fabaceae in Lushois traditional medicine. This prevalence is also observed at the continental scale [91]. Our study thus falls within both local and broader African trends.

Figure 8 Important plant species identified as anti-acnetic plants in Lubumbashi**.**

Sources: Mikembo, and Kipopo INERA in Lubumbashi, Haut-Katanga, DRC.

Among the 39 anti-acne formulations analyzed, 17 (43.5%) incorporate leaves, while 14 (35.9%) are applied as poultices. Studies investigating the medicinal plants used for acne treatment [92–94] have identified leaves as the most frequently utilized plant organs, aligning with the trends observed in the present study. Using leaves as raw materials provides several benefits. Firstly, leaves are more accessible and abundant compared to roots or bark, which often

require damaging the plant for harvesting [95]. Secondly, they contain high concentrations of bioactive compounds, as they serve as primary sites for photosynthesis, and metabolic processes, leading to the accumulation of beneficial phytochemicals [28]. Additionally, leaves are easier to dry, and grind than other plant parts, making them more convenient for preparing extracts, and medicines [25]. Lastly, they offer a more sustainable option, as they can be harvested without harming the plant, ensuring continuous use, and conservation of plant species [95].

For the 20 plants reported for the first time by this study as anti-acnetics, the RCF vary between 0.01 and 0.17, *Afzelia quanzensis* (0.17), showing the highest values. Usual plant UVp values vary between 0.08 and 0.18; the highest values were observed in *Afzelia quanzensis*, and *Uapaca nitida* with an UVp = 0.18 each.

The most frequently cited plant in this study are *Allium cepa*, and *Afzelia quanzensis*, while the most widely used plant is *Azadirachta indica*. *Afzelia quanzensis*, *Byrsonima verbascifolia, Phragmanthera capitata*, and *Uapaca sansibarica* represent the most frequently cited plants reported for the first time as anti-acne plants. It is thus possible to consider these plant as those which have been singled out by this study (Figure 8).

A poultice offers several advantages for topical treatment. It allows direct application of medicinal herbs or other therapeutic substances onto the skin, ensuring localized relief. Since it retains moisture, it can help soften skin, and promote better absorption of active compounds. Poultices can reduce inflammation, ease pain, and draw out toxins or infections, making them useful for wounds, bruises, and skin conditions. Additionally, they are easy to prepare with natural ingredients, offering a simple and effective remedy without the need for complex formulations.

Concerning ethnobotanical indexes, it should be noted that for an ethnobotanical study targeted towards a specific pathology, the relative frequency of citations corresponds to the consensual citation index of the plant, which translates the consensus which is reached around a particular plant species on targeted use. For the 20 taxa not studied, there is a higher consensus on the use of *Afzelia quanzensis* seed (RCF = 0.17) as an anti-acnetic than any other species of the same category (Table 1).

Diabetes (RCF = 20%; 10 species), fever (RCF = 20%; 9 species), and wounds (RCF = 17%; 7 species) represent the three most commonly treated conditions, aside from acne, using the plant species documented in this study. Among these ailments, diabetes [96,97] and fever [98] are among the most prevalent organic disorders worldwide. Medicinal plants from Lubumbashi contribute to the local management of diseases with significant global epidemiological relevance.

The study indicates that the oldest traditional healers (THs) tend to be the most experienced, and greater experience correlates with a higher number of patients. This suggests that traditional medicine requires time to build patient trust, with individuals favoring practitioners who have accumulated extensive expertise. A similar pattern is observed in conventional medicine, where patients often seek reassurance in a doctor's experience before undergoing consultation, particularly for specialized conditions.

4.1. Limits of the study

The findings of this study should be considered in light of several limitations: (i) the absence of data regarding the pressure exerted by local demand on the potential decline of highly sought-after plant taxa; (ii) the lack of clinical validation for the information gathered during interviews concerning the plants and their mechanisms of action; (iii) the study's focus on ethnomedicinal knowledge related to the treatment of specific diseases, along with its limited geographical scope, means that it may not fully capture all uses of these plant taxa by the local population; (iv) key details on usage conditions, contraindications, dosage, and potential side effects of the medicinal plants documented were not collected during field surveys, highlighting the need for complementary research on each reported plant; and (v) insufficient documentation of herbal recipes and other traditional applications beyond acne treatment, warranting further investigation in future studies.

5. Conclusion

In Lubumbashi, households, herbalists, and traditional healers utilize a diverse range of plant species for the treatment of acne. Notably, taxa such as *Byrsonima verbascifolia*, *Phragmanthera capitata*, and *Uapaca sansibarica* are documented for the first time as possessing anti-acne properties. Among these, *Phragmanthera capitata* and *Uapaca sansibarica* are endemic to the Democratic Republic of Congo. Additionally, these plant species play a crucial role in the management of other prevalent conditions, including diabetes, fever, and wounds. This study establishes a foundation for further biological, and clinical research aimed at validating the reported medicinal applications, and potentially identifying the bioactive compounds responsible for their medicinal uses.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest concerning the data presented in this study.

Data available statement

The data used in this study are provided and include within the article.

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Authors' contribution

Design, formatting, and analysis of data: BCV, KMB, development of methods, and drafting of the first manuscript: BCV; study checks: ONP, Manuscript corrections: BCV, NP and LSJB.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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