AJMB
Avicenna Journal of Medical Biochemistry
Avicenna J Med Biochem, 2023; 11(2):102-110. doi:10.34172/ajmb.2417
http://ajmb.umsha.ac.ir

Original Article

Ethnobotanical Survey of Medicinal Plants Used for Wound Healing in Uzo-Uwani Local Government Area Enugu State Nigeria

Cletus Anes Ukwubile[1*], Simon Paul[2], Babagana Modu[3]

[1]Department of Pharmacognosy, Faculty of Pharmacy, University of Maiduguri, Maiduguri, Nigeria
[2]Department of Biological Sciences, Faculty of Science, Federal University of Health Sciences, Otukpo, Nigeria
[3]Department of Biochemistry, Faculty of Science, University of Maiduguri, Maiduguri, Nigeria

Article history:
Received: January 21, 2023
Revised: June 15, 2023
Accepted: June 19, 2023
ePublished: August 15, 2023

***Corresponding author:**
Cletus Anes Ukwubile,
Emails: doccletus@yahoo.com, caukwubile@unimaid.edu.ng

Abstract

Background: Due to numerous advantages derived from the use of plants, at least 70% of the indigenes of the Uzo-Uwani Local Government Area (LGA) depend on plants.

Objectives: The present study was performed to survey medicinal plants used for wound healing by the indigenes of communities in Uzo-Uwani LGA, Nigeria.

Methods: A survey was conducted from February to September 2022 to find out plants that are employed for wound healing by the indigenes. Information was gathered through oral interviews, including semi-structured questionnaires, with traditional medicine practitioners in each community, herbalists, and elderly villagers.

Results: Overall, 33 plants belonging to 26 families were identified consisting of trees (51.51%), herbs (33.33%), and shrubs (15.15%), and 15.15%, 36.36%, and 48.48% were endangered, threatened, and neither threatened nor endangered, respectively. From the findings, 51.51%, 24.24%, and 24.24% were collected wild, wild plus cultivated, and cultivated, respectively. Fabaceae (21.21%) and Asteraceae (9.10%) families were the highest used species for wound healing, respectively, followed by Liliaceae (6.10%) and Rubiaceae (6.10%) families. Leaves (36.36%) were the most frequently used part, followed by the stembarks (27.27%), whole plant (12.12%), and roots (9.10%), seeds (9.10%), as well as shoot, fruits/pods, and aerial parts (3.03% each). Decoction (72.72%) and infusion (27.27%) were the prominent methods of use. *Pycnanthus angolensis* had the highest use value (1.04%), fidelity level (100%), informants' consensus factor (0.66 %), and Rahman's similarity index (RSI) (84.06%) but low citation.

Conclusion: Our findings documented medicinal plants used as ethnomedicinal prescriptions for wound healing by the indigenes with the view to providing alternate drug sources.

Keywords: Medicinal plants, Wound healing, Decoction, Traditional medicine

Please cite this article as follows: Ukwubile CA, Paul S, Modu B. Ethnobotanical survey of medicinal plants used for wound healing in Uzo-Uwani Local Government Area Enugu State Nigeria. Avicenna J Med Biochem. 2023; 11(2):102-110. doi:10.34172/ajmb.2417

Background

Medicinal plants have been playing a crucial role in the human healthcare system in developed and developing countries of the world for many years because of their numerous applications and treatments of diseases such as inflammation, cancers, diabetes, fevers, hypertension, ulcers, infertility, infections, and convulsion (1-3). This ethnobotanical importance of plants was due to the presence of many phytochemicals such as flavonoids, alkaloids, phenols, terpenoids, carotenoids, and saponins, among others, with many biological activities in humans (3). In African traditional medicine, the culture and herbal knowledge of the indigenous people have immensely contributed to obtaining adequate raw materials used for developing drugs by pharmaceutical industries on larger scales (4). Traditional medicine in Nigeria has played a critical role in the daily healthcare needs of the people and has been a huge source of income, especially those in rural and less urbanized communities where more than 80% of the population depends on medicinal plants (1,5,6). Despite the advantages derived from medicinal plants, these plants face many challenges; for instance, many of the plants are threatened by rapid forces of urbanization, adulteration of medicinal plant products by marketers, and growing trends of deforestation (6,7).

The use of herbal medicine by the indigenes of Uzo-Uwani Local Government Area (LGA), Enugu State, Nigeria, has been on the increase since the late 1970s due to the lack of adequate healthcare facilities in most rural communities in the area, inherent lack of trust on

conventional drugs by the people, high cost of orthodox medicines, low cost of herbal medicines, and easy access to them. Considering that 80% of the indigenes of the local government area practice farming as their major occupation, the area is called the major agricultural zone of the state and one of the top ten local government areas out of 774 in Nigeria (8). The farming activities often resulted in injuries which are sustained during bush clearing and weeding using native cutlasses or matchet. Most of these injuries further developed into different forms of wounds if not quickly treated. Apart from agricultural activities in the area, other factors can be attributed to causing wounds, including social vices such as fighting and various crimes, which are readily noticed in most communities in the area due to a lack of employment and adequate Western education (8).

Wounds are defined as damage to the appearance of body tissues such as mucous membranes, skin, and organs by various factors, including traumas (9,10). Medically, wounds are classified into open and closed types. Wounds that are exposed to the underlying tissues or organs and open to the outside environment are called open wounds (e.g., penetrating wounds such as abrasion, burns, punctures, avulsion, and laceration), while those without underlying tissues or organs are called closed wounds (10).

In addition, some pathological changes which often start from the external or internal of affected organs or tissues may cause wounds. Wounds may occur intentionally or accidentally or as a cumulative effect of a disease pathological process (11,12). Some immunological responses such as bleeding, coagulation of the blood vessel, activation of complement, and inflammation stimulus are often noticed in wound conditions (11). In most rural communities' wounds remained one of the commonly occurring ailments usually associated with intense pain and high treatment costs. Nowadays, wound management methods involve proteolytic enzymes, debridement, tissue grafts antibiotics, and irrigation. These methods have many setbacks such as high costs and invasiveness (13).

The wound healing process refers to all the stages the skin undergoes to repair damages sustained from wounds. These stages include primary, secondary, and tertiary wound healing depending on the type and severity of wounds (10,14). Many plants have been reported to facilitate the wound-healing process and have been successively used to treat various types of wounds in traditional medicine. This is because these plants show wound healing activities using various mechanisms such as reducing bacterial loads, increasing the deposition of collagen, fibroblasts, and fibrocytes, and modulating wound healing (15,16).

The present study sought to survey and document medicinal plants employed by the indigenous rural communities in Uzo-Uwani LGA of Enugu State, Nigeria for wound healing. This study will be relevant also in ecological management, the preservation of traditional knowledge for future generations in rural communities, and the preservation of threatened and endangered species of medicinal plants.

Materials and Methods

Study Area and Sampling

This study was performed in all seventeen rural communities in Uzo-Uwani LGA Enugu State, Nigeria. These communities included Adaba, Abbi, Nrobo, Ugbene, Nkpologu, Akpugu, Ogurugu, Asabaa, Nkume, Ukpata, Umulokpa, Ojor, Igga, Adani, Ovuru, Nimbo, Umulokpa, and Okpanda. The local government headquarters is Umulokpa. It is located at latitude 6°45'N and longitude 7°12'E, with 28 °C average temperature and 10 km/h (6.2 mph) average wind speed (16). The major occupation is farming food crops such as rice, yam, cocoyam, maize, millet, guinea corn, and the like, and practicing traditional medicine. The indigenes speak the Igbo language as the major dialect, as well as Igala (strictly by communities bordering Kogi State) and English languages. Their main religion is Christianity mostly Catholics. It borders in the east with Nsukka, Igbo-Etiti, Udi, and Ezeagu LGAs, as well as west and north with Anambra and Kogi States, respectively (Figure 1). The land mass area is 855 km^2, and it has a population of 124480 (17) and postal code area of 411. There are variations in flora distribution among various communities, although the convergence of plant species exists in these communities. For instance, densely populated tropical rainforest is found in communities that border Kogi State in the north, and these communities have the largest distribution of tree species.

Ethnobotanical Survey

A field trip was conducted between March and September 2022. The major respondents used in the current study were highly knowledgeable traditional medicine practitioners, herb sellers, herbalists, and community elders randomly selected from each of the rural communities in the Uzo-Uwani LGA (18). Personal information collected from each respondent included name, age, gender, rural community, years of experience in the use of medicinal plants, and education level (Table 1). The consents of informants were voluntarily sort for responses, and they were assured that collected data would be strictly applied for academic purposes and acknowledgment in the end. Having satisfied the basic requirements for the study in the rural communities, several data were gathered, including medicinal plants used for wound healing, local name, mode of collection, conservation or accessibility of plants, applied parts, methods of preparation, and modes of administration. The data were collected by means of oral interviews and 200 semi-structured questionnaires (19,20). The plants were identified by Mr. C.A. Ukwubile (a taxonomist) assisted by PlantSnap application software (updated 2022). Medicinal plant names were validated to ensure the correct families, genera, species, and authorities from plant data archives (http://www.ipni.org/) and the Royal Botanic Garden Kew (http://www.theplantlist.org/).

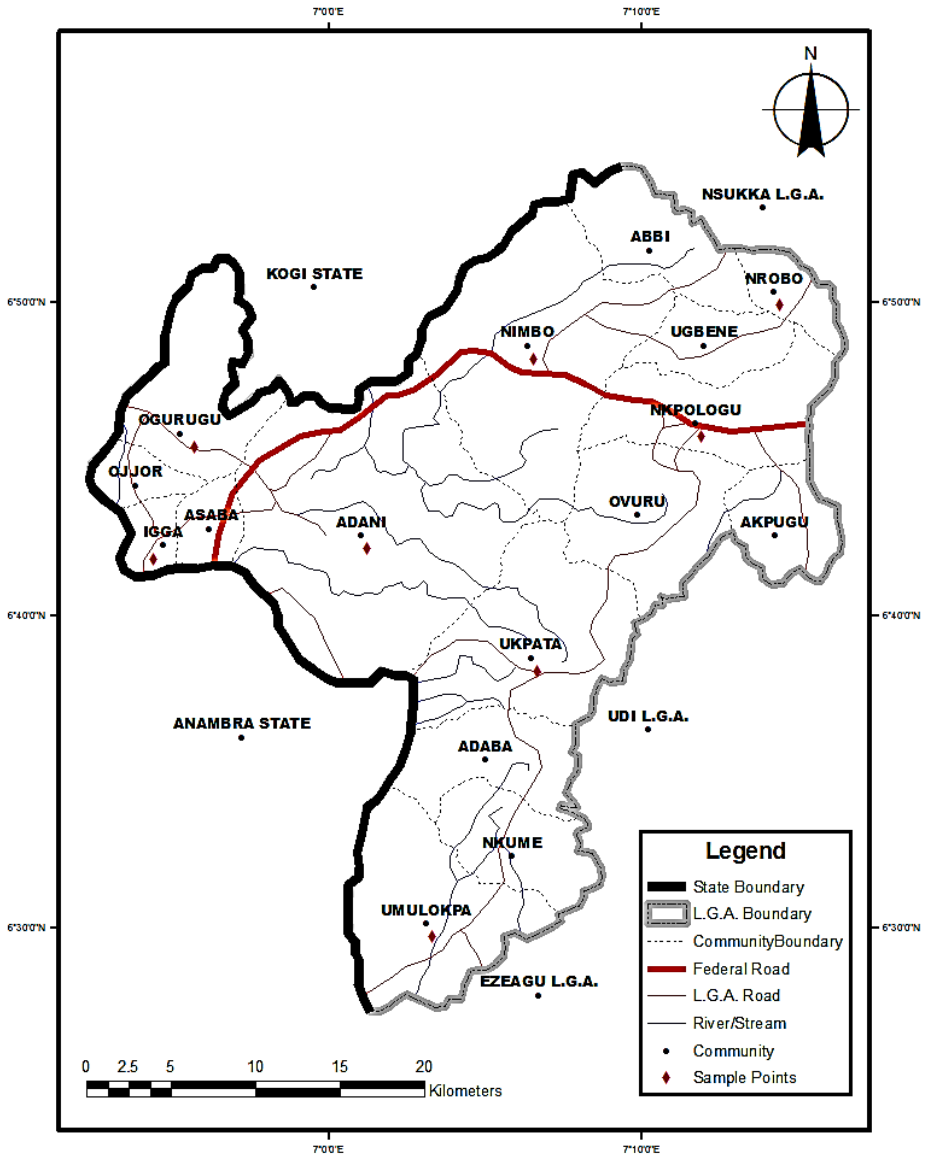

Figure 1. Map of Uzo-Uwani LGA. *Source*. Ali and Asogwa (16)

Table 1. Questionnaire Used for the Ethnobotanical Survey

Parameter	Information/Question
Informant's biodata:	Name: Gender: Age: Education: Occupation: Community:
Survey questions:	(1) How many years have you been practicing traditional medicine? (2) Where did you learn it from? (3) Which plant/Igbo name do you use for wound healing? (4) How do you collect the plant? (Wild, domesticated, and wild/cultivated) (5) Which part(s) of the plant(s) do you use? (6) How do you prepare them before use? (Decoction, infusion, concoction, powder, ointment, tea, and the like) (7) How long does it take to heal a wound?

The voucher specimens of the plants were compared with those of the herbarium of forest guides in rural communities.

Quantitative Data Analysis

The surveyed medicinal plants used for wound healing in this study were arranged in alphabetical order according to their families and tabulated under the headings, including families, scientific names, local (Igbo) names, applied parts, modes of preparations, identification codes, and references. The obtained results were further analyzed using some ethnobotanical quantitative data parameters such as percentage use value (UV), fidelity level (FL), informant consensus factor (ICF), Rahman's similarity

index (RSI), and relative frequency citation (RFC) (21,22).

Percentage Use Value

This is the percentage of respondents that have knowledge about medicinal plant use for wound healing. The high UV indicates the relative importance of the species (21). It was calculated from the following formula:

$$UV = \frac{\text{Number of respondents that mentioned the use of the plant}}{\text{Total number of interviewed respondents}} \times 100 \quad (1)$$

Fidelity Level

The percentage of respondents that mention the use of a particular medicinal plant for wound healing is called the FL. The parameter demonstrated the choice of a respondent for a particular medicinal plant for wound healing over another plant. It represents how important a species is over the other for a particular use (22-24). It is determined using the following formula:

$$\% FL = (Np/N)\ 100 \quad (2)$$

where *Np* denotes the number of respondents who indicated the use of a specific medicinal plant for wound healing, and *N* is the overall number of cited the plant for the disease.

Informant Consensus Factor

This is a factor employed to show the cultural importance of a medicinal plant and the agreement for its use (25). It is calculated to test the levels of uniformity or consistency of the respondent's knowledge of the remedy for a disease, and its value is usually from zero to one. A high value represented that there was agreement among informants in the use of the plants. The formula is as follows:

$$ICF = \frac{\text{NoUR -Nto}}{\text{NoUR}} - 1 \quad (3)$$

where *NoUR* denotes the number of useful reports in each rural community, while *Nto* indicates the total number of medicinal plants used for wound healing in each rural community.

Rahman's Similarity Index

This index was utilized to determine the similarities and differences among rural communities regarding the knowledge of traditional medicine (26-28). It demonstrates the similarities in culture between rural communities in the study areas by calculating particular medicinal plants applied for wound healing. The percentage of similar plants used between rural communities was computed using the formula:

$$RSI = (D / A + B + C\text{-}D)\ 100, \quad (4)$$

where *A* and *B* represent the number of medicinal plants specific to a community and the number of medicinal plants specific to other communities, respectively. Moreover, *C* and *D* denote species found in all communities and common plants used for wound healing in all communities, respectively.

Relative Frequency Citation

It indicates the importance of each medicinal plant within a locality or area, as shown by its frequency of citations (29,30). The RFC index is calculated by applying the following formula:

$$RFC = Fc / N \quad (5)$$

where *Fc* is the number of respondents citing the medicinal plants for use in wound healing, while *N* denotes the total number of respondents in the surveyed areas without citing the plants.

Results

Demographic Information

Out of the total 32 informants interviewed in the rural communities, 18 (56.25%) cases were males, while 14 (43.75%) of them were females. In addition, those with one or more categories of education were 37.5%, and uneducated ones were 62.5% (Table 2). Information on the use of these medicinal plants was acquired by the respondents from their parents, oral history, and experienced traditional medicine practitioners. Age demography of respondents showed that those above 50 years were more with 46.88%, followed by those ages 40-49 (37.5%). The survey also represented that 75% of the respondents were married, while 25% were either unmarried, separated, or widowed.

Medicinal Plants Species Surveyed in the Study

From the current study, a total of 26 families and 33 species, including trees 17 (51.51%), shrubs 5 (15.15%), and herbs 11 (33.33%), were reported to be used for wound healing in the rural communities. The results also demonstrated that 5 (15.15%) and 12 (36.36%) were endangered and threatened, respectively, and 16 (48.48%) were neither endangered nor threatened. Among the communities in the study areas, Ogurugu had the high distribution of 22 species (66.67%), followed by Adani with 12 species (35.36%), while Nkpologu had the lowest

Table 2. Demographic Information of Informants (n = 32)

Parameter	Group	Count	Percent
Gender	Male	18	56.25
	Female	14	43.75
Age	30-39	5	15.63
	40-49	12	37.51
	>50	15	46.88
Education	Yes	12	37.5
	None	20	62.5
Marital status	Married	24	75
	Others	8	25

number of species with 6 (18.18%). The family Fabaceae 7 (21.21%) was the most abundant, followed by Asteraceae 3 (9.10%) (Figures 2 and 3). According to our study, wild collection (W) was the most common method used for collecting the plants with 51.51% (17), while the other methods of collection, including wild plus cultivation (WC) at 24.24% (8) and cultivated (C) 24.24 % (8), were the least (Figure 4). The study further revealed that the leaves (36.36%) were the most applied part, followed by stembarks (27.27%), whole plant (12.12%), seeds (9.01%), and roots (9.10%), while the other parts had 3.03% usage (Figure 5). Decoctions 18.81(57 %) were the most used mode of preparation, followed by infusions 6.93 (21 %) and ointments 3.3 (10 %) (Figure 6).

Ethnobotanical Indices of Surveyed Medicinal Plants

The quantitative indices from the field study are presented in Table 3, representing the most used or cited plants for wound healing among other data. The data were analyzed in terms of UV, FL, informant's consensus factor (ICF), RSI, and RFC. The UVs of the 15 most commonly used medicinal plants in various communities were from 0.20 to 1.04%, while the FL ranged from 60% to 100%, 0.32% to 0.66% for ICF, 12.14% to 84.06% for RSI, and 0.24% to 0.80% for RFC. Of all the 33 surveyed plant species, fifteen medicinal plants were identified to have shown high FL values, and *Pycnanthus angolensis* (100%), *Aspilia africana* (88%), and *Abrus precatorius* (86%) had the highest values. Based on data in Table 4, *P. angolensis, A. Africana*, and *A. precatorius* were reported by most informants which affected RFC values. These fifteen plants were mentioned by most of the informants in all the communities in the study area.

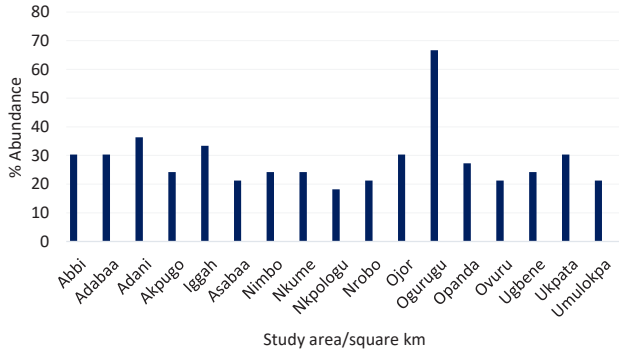

Figure 2. Medicinal Plants Abundance According to Rural Communities

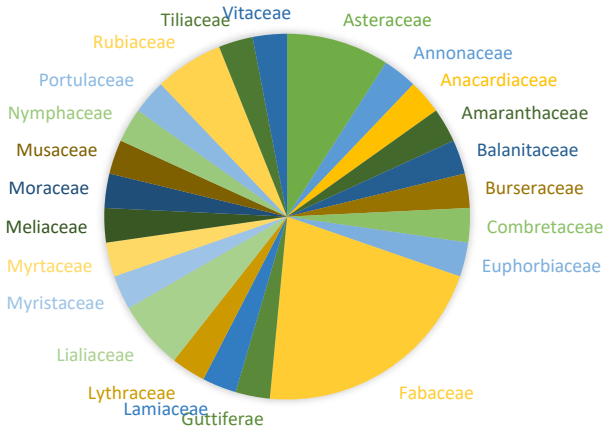

Figure 3. Distribution of Medicinal Plants According to Their Families

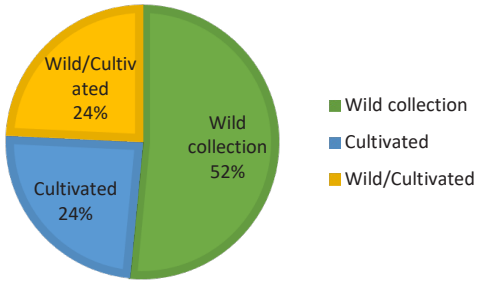

Figure 4. Methods of Collection for the Surveyed Medicinal Plants

Discussion

The use of medicinal plants among rural communities in Uzo-Uwani LGA had increased in recent times due to the lack of adequate hospitals in about 80% of the rural communities. In the study areas, traditional medicine is often practiced by males and females (old and young) who gained their knowledge from their grandparents majorly (25,28). The transfer of this knowledge was handed over from generation to generation because access to the modern healthcare system has continued to be out of reach to most people in areas where they are mainly low-income

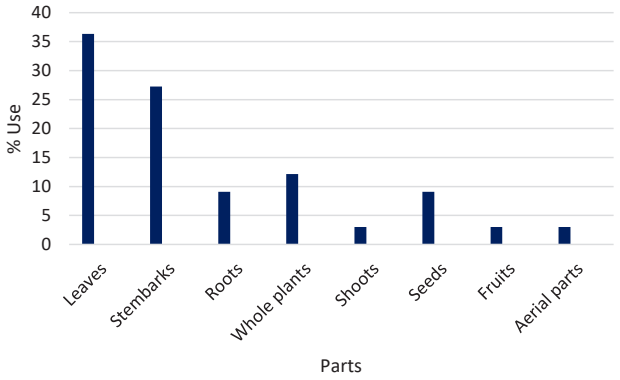

Figure 5. Uses of Plants' Parts for Wound Healing in Study Areas

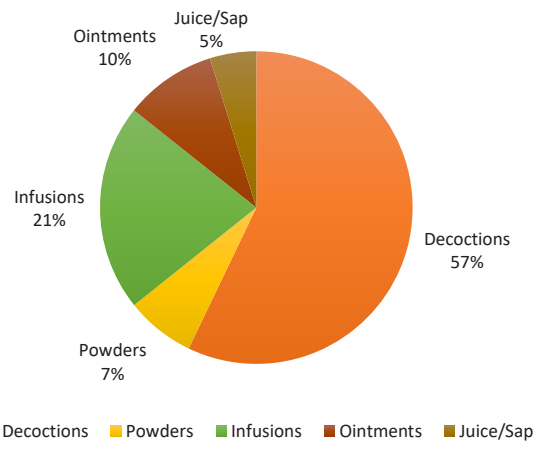

Figure 6. Modes of Preparation of Plants Before Use

Table 3. Medicinal Used for Wound Healing in Uzo-Uwani LGA Enugu State Nigeria

Family	Plant	Voucher #	Igbo Name	Part Used
Amaranthaceae	*Amaranthus spinosus* L.[a]	FR001	Nnuno-uku	Whole plant
Anacardiaceae	*Mangifera indica* L.[a]	FR014	Mangoo	Stembark
Annonaceae	*Xylopia aethiopica* A. Rich [a]	FR014	Uda	Fruits
Asteraceae	*Ageratum conyzoides* L.[a] *Aspilia africana* C.D. Adam[a]	FR074 FR055	Ula-ujula Uranjila	Whole plant Leaf
Balantaceae	*Balanites aegyptiaca* Del.[a]	FR006	Ogu-enyi	Young shoot
Burseraceae	*Boswellia dalzielii* Hutch.[b]	FR089	Nwanyi-ocha	Root
Combretaceae	*Anogeissus leiocarpus* G/P.[a]	FR234	Atara	Bark
Euphorbiaceae	*Jatropha curcas* L.[a]	FR010	Ugbolu	Leaf
Fabaceae	*Abrus precatorius* L.[a] *Detarium microcarpum* G/P.[b] *Entada africana* G/P.[a] *Gliricidia sepium* Walp.[a]	FR097 FR048 FR052 FR205	Anya-nnunu Ofo Egbu Ekommili	Seed Leaf Bark Bark
Guttiferae	*Indigofera hirsuta* L.[b] *Parkia biglobosa* R.B/G.D.[a] *Senna occidentalis* L. [a] *Garcinia kola* Heckel [a]	FR008 FR037 FR066 FR016	Uli Ogili Akidi-nmuo Aku-ilu	Whole plant Stembark Leaf Seed
Lamiaceae	*Leonotis nepetifolia* R.Br. [a]	FR088	Ekunu	Leaf
Liliaceae	*Aloe vera* Burm.f. [a] *Asparagus africanus* Lam. [b]	FR300 FR084	Alo Egbu	Leaf Leaf
Lythraceae	*Woodfordia uniflora* Koe.[b]	FR234	Ododo	Root
Meliaceae	*Carapa procera* DC. [a]	FR515	Mpaoku	Seed/Bark
Moraceae	*Ficus thonningii* Blume [a]	FR022	Opoto	Stembark
Musaceae	*Musa paradisiaca* L.[a]	FR003	Ijioko	Leaf
Myristaceae	*Pycnanthus angolensis* Wa.[a] *Eucalyptus globulus* Labill. [a]	FR125 FR250	Akwa-mmili Nkwu-ishi	Stembark Leaf
Nymphaeaceae	*Nymphaea lotus* L. [b]	FR301	Mkpiri	Leaf
Portulaceae	*Portulaca oleracea* L. [a]	FR076	Nti-oke	Whole plant
Rubiaceae	*Borreria verticillata* G.M. [b]s *Mitracarpus villosus* DC. [a]	FR044 FR623	Ube-oyibo Ogwu-ngwa	Root Aerial part
Tiliaceae	*Grewia bicolor* Juss. [b]	FR233	Osisi-akwa	Stembark
Vitaceae	*Cissus quadrangularis* L.[a]	FR802	Gbolodi-ohia	Leaf

Note. N = 26 and n = 33, where N and n represent the total number of families and the total number of species, respectively. In addition, [a] denotes plants whose wound-healing activities have been determined, and [b] implies plants whose wound-healing activities have not been determined.

Table 4. The Most Commonly Used Medicinal Plants for Wound Healing in Study Areas (n = 15)

Plant Species	% UV	% FL	ICF	% RSI	RFC	References
Abrus precatorius L.	0.40	86	0.56	25.01	0.54	(31)
Aspilia africana C.D.Adam	0.44	88	0.42	34.11	0.58	(31-35)
Borreria verticillata G.M.	0.20	60	0.33	28.12	0.26	ND
Boswellia dalzielii Hutch.	0.24	66	0.34	44.00	0.28	ND
Carapa procera DC.	0.28	68	0.38	52.02	0.30	(36)
Cissus quadrangularis L.	0.36	78	0.48	64.88	0.42	(37-40)
Detarium microcarpum G/P.	0.25	65	0.32	22.02	0.25	ND
Garcinia kola Heckel.	0.20	60	0.33	72.10	0.26	(41-43)
Indigofera hirsuta L	0.38	80	0.52	16.00	0.50	ND
Jatropha curcas L.	0.34	76	0.43	12.14	0.30	(44-49)
Leonotis nepetifolia R.Br.	0.26	65	0.32	54.12	0.24	(50-52)
Mitracarpus villosus DC.	0.20	60	0.33	32.24	0.25	(53)
Portulaca oleracea L.	0.35	77	0.44	30.44	0.40	(54-57)
Pycnanthus angolensis Wa.	1.04	100	0.66	84.06	0.80	(58)
Xylopia aethiopica A. Rich.	0.28	80	0.52	76.66	0.50	ND

Note. UV: Use value; FL: Fidelity level; ICF Informant consensus factor; RSI: Rahman's similarity index; RFC: Relative frequency citation; ND: Not determined.

earners, uneducated, peasant farmers, and artisans.

The variations in the geographical distribution of these plants among rural communities could be attributed to climatic conditions such as rainfall, as well as edaphic factors, including soil and mineral elements present in the soil (59). In this study, there is an abundance of medicinal plant species utilized for wound healing in the Ogurugu (66.67%) and Adani (35.36%) communities when compared to other communities (Figures 1 and 2, Table 2). For instance, the presence of forest reserves and rivers in the Ogurugu and Adani communities may have also contributed to the abundance of these plants in the areas. The least number of medicinal plants applied for wound healing in rural communities such as Nkpologu (18.18%) may be due to the presence of mountains and the rocky nature of the soil which do not support plants' abundant growth (59). The abundance of these plants in the forests of the surveyed areas has resulted in the wild as the mostly used method of collection for these plants in the surveyed areas (Figure 4). Wild collection of plants has been described as the simplest and commonest method in traditional medicine (1,5). Similarly, the findings demonstrated that the leaves and stembarks are the most employed parts for wound healing in the areas, respectively (Figure 5). The decoctions of these parts are the most applied mode of preparation in the areas (Figure 5). These results are consistent with reports by other researchers on ethnomedicinal surveys (7,60).

In the current study, Fabaceae, Asteraceae, and Rubiaceae families were dominantly used for wound healing (Table 2, Figure 3). These medicinal plants consist of trees (51.31%), herbs (33.33%), and shrubs (15.15%). These families have previously been reported by other researchers to be applied in wound healing (60,61). These plant families have shown numerous taxonomic and biological importance. For instance, the Fabaceae family is unarguably one of the largest families of angiosperms with several economic and biological importance. This family was previously called Leguminosae or Papilionaceae because it was a member of the pea or legume family with over 20 000 medicinal plant species distributed worldwide. Many of the members are capable of fixing nitrogen in the soil, anticancer, antiulcer, wound healing, antimalaria, and antidiabetic agents, as well as ornamental in function. The highest percentage in the use of the Fabaceae family (21.21%) for wound healing in this present study further confirms the ethnomedicinal relevance of the family. Similarly, members of the Asteraceae family have been reported to possess anticancer and wound healing activities in both *in vitro* and *in vivo* experiments (62,63). The families of these plants have the presence of phytochemical constituents such as alkaloids, terpenes, sesquiterpenes, flavonoids, tannins, and phytosterols that are responsible for their biological activities (62-64).

From the study findings, *P. angolensis* had a UV of 1.04%, FL of 100%, ICF value of 0.66, and RSI of 84.06% and ranked the highest in the treatment of wounds in most communities. The medicinal value of *P. angolensis* has been documented by other researchers (60,65). The plants have been employed as anti-inflammatory, anticancer, antiulcer, antioxidant, and antidiabetic agents in traditional medicine in Africa, especially in southeast Nigeria. The high values of these indices (Table 4) for the plant showed the cultural beliefs in the use of this plant and others in the study areas. Despite the preferred use of the plant (*P. angolensis*) for wound healing, its frequency of citation on wound healing is low. Based on the results, the fact that these plants were mostly collected from the wild does not endanger them since there are cultural laws regarding the use of plants. According to the informants, plants are carefully collected to allow for the fresh growth of new ones. The study further confirmed that in most communities in the study areas, the surveyed plants are not mixed with other plants for wound healing. Healing of wounds no matter the type of wound takes a maximum of four weeks, and the findings have confirmed this issue based on the analyzed indices from the fifteen most prominently used medicinal plants in the areas. Although some of these plants have been cited, some were not evaluated biologically for wound-healing activities (Tables 3 and 4). Finally, the indigenous people of Uzo-Uwani LGA typically used medicinal plants for the treatment and management of various human diseases. They have preserved and conserved the ethnobotanical cultural knowledge passed to generations by grandparents.

Conclusion

Our study findings demonstrated that most of these plants used for wound healing are collected from the wild. This trend combined with the rapid force of urbanization may threaten the existence of these plants, especially in communities such as Ogurugu, Adani, Umulokpa, Nkpologu, and Ukpabi in the future if neglecting the cultural laws. The results further revealed that medicinal plants with high UV, FL, RSI, and ICF values can be evaluated further for their wound healing activities so as to validate the acclaimed ethnobotanical use, resulting in the isolation of novel compounds with wound healing potentials. Lastly, previous reports by other researchers on the wound-healing activities of most of the surveyed plants in this study further justify the use of these medicinal plants for wound healing in Uzo-Uwani LGA. Moreover, the use of these 22 plant families to effectively manage and treat all types of wounds in these areas has been judged to be satisfactory by the indigenes of the areas because permanent healing was achieved in most cases. It is suggested, therefore, that medicinal plants from this study, which have not been evaluated for wound-healing activities, should be screened to validate these claims.

Acknowledgements

We are thankful to the community leaders of all the rural communities in Uzo-Uwani LGA and all the informants for their immense assistance in this surveyed study.

Authors' Contribution

Conceptualization: Cletus Anes Ukwubile.
Data curation: Cletus Anes Ukwubile and Simon Paul.
Formal analysis: Cletus Anes Ukwubile and Babagana Modu.
Funding acquisition: Cletus Anes Ukwubile, Simon Paul, Babagana Paul.
Investigation: Cletus Anes Ukwubile and Simon Paul.
Methodology: Cletus Anes Ukwubile, Simon Paul, Babagana Modu.
Project administration: Cletus Anes Ukwubile.
Resources: Simon Paul.
Software: Cletus Anes Ukwubile.
Supervision: Cletus Anes Ukwubile, Simon Paul.
Validation: Cletus Anes Ukwubile, Simon Paul.
Visualization: Cletus Anes Ukwubile, Simon Paul, Babagana Modu.
Writing–original draft: Cletus Anes Ukwubile.
Writing–review & editing: Cletus Anes Ukwubile, Simon Paul, Babagana Modu.

Competing Interests

We have none to declare.

Ethical Approval

The ethical approval for this study was approved by the Medicinal Plants Research Ethical Committee of Ogurugu Forest Guard with approval number: OFG/ENU/0205.

References

1. Iwu MM. Handbook of African Medicinal Plants. 2nd ed. Boca Raton: CRS Press; 2013. p. 506. doi: 10.1201/b16292.
2. Naderifar M, Goli H, Ghaljaie F. Snowball sampling: a purposeful method of sampling in qualitative research. Stride Dev Med Educ. 2017;14(3):e67670. doi: 10.5812/sdme.67670.
3. Chen JT. Phytochemical omics in medicinal plants. Biomolecules. 2020;10(6):936. doi: 10.3390/biom10060936.
4. Josephine Ozioma EO, Nwamaka Chinwe OA. Herbal medicines in African traditional medicine. In: Builders PF, ed. Herbal Medicine. London: IntechOpen; 2019. p. 191-214. doi: 10.5772/intechopen.80348.
5. Sofowora A. Medicinal Plants and Traditional Medicine in Africa. Ibadan: Spectrum Books Ltd; 2006. p. 289.
6. Abdullahi AA. Trends and challenges of traditional medicine in Africa. Afr J Tradit Complement Altern Med. 2011;8(5S):115-23. doi: 10.4314/ajtcam.v8i5S.5.
7. Ukwubile CA, Malgwi TS, Angyu AE, Otalu O, Bingari MS. Review of antiviral medicinal plants used in Taraba state Nigeria: a possible source for COVID-19 drug discovery. J Sci Res Med Biol Sci. 2020;1(2):1-23. doi: 10.47631/jsrmbs.v1i2.50.
8. Ojima SS. Traditional medicine, cultural significance and agricultural practices in Uzo-Uwani local government area of Enugu State, Nigeria [thesis]. CSS Odeke; 2021.
9. Herman TF, Bordoni B. Wound classification. In: StatPearls [Internet]. Treasure Island, FL: StatPearls Publishing; 2023. Available from: https://www.ncbi.nlm.nih.gov/books/NBK554456/. Updated April 28, 2022.
10. Onyekwelu I, Yakkanti R, Protzer L, Pinkston CM, Tucker C, Seligson D. Surgical wound classification and surgical site infections in the orthopaedic patient. J Am Acad Orthop Surg Glob Res Rev. 2017;1(3):e022. doi: 10.5435/JAAOSGlobal-D-17-00022 .
11. Flanagan M. The physiology of wound healing. J Wound Care. 2000;9(6):299-300. doi: 10.12968/jowc.2000.9.6.25994.
12. Son YJ, Tse JW, Zhou Y, Mao W, Yim EKF, Yoo HS. Biomaterials and controlled release strategy for epithelial wound healing. Biomater Sci. 2019;7(11):4444-71. doi: 10.1039/c9bm00456d.
13. Tekleyes B, Huluka SA, Wondu K, Wondmkun YT. Wound healing activity of 80% methanol leaf extract of *Zehneria scabra* (L.f) Sond (Cucurbitaceae) in mice. J Exp Pharmacol. 2021;13:537-44. doi: 10.2147/jep.s303808.
14. Abdel Hamid AA, Soliman MF. Effect of topical aloe vera on the process of healing of full-thickness skin burn: a histological and immunohistochemical study. J Histol Histopathol. 2015;2(1):3. doi: 10.7243/2055-091x-2-3.
15. Farahpour MR. Medicinal plants in wound healing. In: Dogan KH, ed. Wound Healing - Current Perspectives. IntechOpen; 2019. doi: 10.5772/intechopen.80215.
16. Ali AN, Asogwa SO. Road transportation network constraints on food crop production in Uzo-uwani local government area of Enugu state, Nigeria. Afro Asian J Soc Sci. 2017;8(4):1-21.
17. National Population Commission (NPC). Nigeria Population Head Counts. NPC; 2006.
18. Burkill HM. The Useful Plants of West Tropical Africa. Vol 2. London: Royal Botanic Garden, Kew; 2000.
19. Cunningham AB. Applied Ethnobotany: People, Wild Plant Use and Conservation. Earthscan; 2001. p. 320.
20. Maroyi A. An ethnobotanical survey of medicinal plants used by the people in Nhema communal area, Zimbabwe. J Ethnopharmacol. 2011;136(2):347-54. doi: 10.1016/j.jep.2011.05.003.
21. Ugulu I. Fidelity level and knowledge of medicinal plants used to make therapeutic Turkish baths. Stud Ethno-Med. 2012;6(1):1-9. doi: 10.1080/09735070.2012.11886413.
22. Umair M, Altaf M, Abbasi AM. An ethnobotanical survey of indigenous medicinal plants in Hafizabad district, Punjab-Pakistan. PLoS One. 2017;12(6):e0177912. doi: 10.1371/journal.pone.0177912.
23. Heinrich M. Ethnobotany and its role in drug development. Phytother Res. 2000;14(7):479-88. doi: 10.1002/1099-1573(200011)14:7<479::aid-ptr958>3.0.co;2-2.
24. Tsioutsiou EE, Giordani P, Hanlidou E, Biagi M, De Feo V, Cornara L. Ethnobotanical study of medicinal plants used in Central Macedonia, Greece. Evid Based Complement Alternat Med. 2019;2019:4513792. doi: 10.1155/2019/4513792.
25. Abe R, Ohtani K. An ethnobotanical study of medicinal plants and traditional therapies on Batan Island, the Philippines. J Ethnopharmacol. 2013;145(2):554-65. doi: 10.1016/j.jep.2012.11.029.
26. Rahman IU, Afzal A, Iqbal Z, Abd Allah EF, Alqarawi AA, Calixto ES, et al. Role of multivariate approaches in floristic diversity of Manoor Valley (Himalayan Region), Pakistan. Appl Ecol Environ Res. 2019;17(2):1475-98. doi: 10.15666/aeer/1702_14751498.
27. Tefera T, Yihune M. Ethnobotanical study on medicinal plants used by indigenous people in Tenta district, South Wollo, Ethiopia. J Med Plants Res. 2019;13(2):47-54. doi: 10.5897/jmpr2018.6599.
28. Asiimwe S, Namukobe J, Byamukama R, Imalingat B. Ethnobotanical survey of medicinal plant species used by communities around Mabira and Mpanga Central Forest Reserves, Uganda. Trop Med Health. 2021;49(1):52. doi: 10.1186/s41182-021-00341-z.
29. Vijayakumar S, Morvin Yabesh JE, Prabhu S, Manikandan R, Muralidharan B. Quantitative ethnomedicinal study of plants used in the Nelliyampathy hills of Kerala, India. J Ethnopharmacol. 2015;161:238-54. doi: 10.1016/j.jep.2014.12.006.
30. Naceiri Mrabti H, Bouyahya A, Naceiri Mrabti N, Jaradat N, Doudach L, Faouzi MEA. Ethnobotanical survey of medicinal plants used by traditional healers to treat diabetes in the Taza region of Morocco. Evid Based Complement Alternat Med. 2021;2021:5515634. doi: 10.1155/2021/5515634.
31. Sudaroli M, Chatterjee TK. Evaluation of wound healing activity of red and white seed varieties of *Abrus precatorius* Linn. extracts on rats. Pharmacologyonline. 2009;3:175-92.

32. Okoli CO, Akah PA, Okoli AS. Potentials of leaves of *Aspilia africana* (Compositae) in wound care: an experimental evaluation. BMC Complement Altern Med. 2007;7:24. doi: 10.1186/1472-6882-7-24.
33. Attama AA, Uzor PF, Nnadi CO, Okafor CG. Evaluation of the wound healing activity of gel formulations of leaf extract of *Aspila africana* Fam. Compositae. J Chem Pharm Res. 2011;3(3):718-24.
34. Osunwoke EA, Otakore O, Lelei S. Wound healing effects of the leaves extract of *Aspilia africana* on Wistar rats (*Rattus norvegicus*). Vedic Research International Phytomedicine. 2014;2(1):1-5. doi: 10.14259/pm.v2i1.59.
35. Komakech R, Matsabisa MG, Kang Y. The wound healing potential of *Aspilia africana* (Pers.) C. D. Adams (Asteraceae). Evid Based Complement Alternat Med. 2019;2019:7957860. doi: 10.1155/2019/7957860.
36. Udoumoh AF, Eze CA, Chah KF, Etuk EU. Antibacterial and surgical wound healing properties of ethanolic leaf extracts of *Swietenia mahogoni* and *Carapa procera*. Asian J Tradit Med. 2011;6(6):272-7.
37. Mohanty A, Sahu P, Das C. Wound healing activities of methanolic extract of *Cissus quadrangularis* on albino rat: a research. Int J Drug Formul Res. 2010;1(2):176-84.
38. Bharti M, Borane K, Singhasiya A. Evaluation of wound healing activity of *Cissus quadrangularis*. World J Pharm Pharm Sci. 2014;3(6):822-34.
39. Marume A, Matope G, Katsande S, Khoza S, Mutingwende I, Mduluza T, et al. Wound healing properties of selected plants used in ethnoveterinary medicine. Front Pharmacol. 2017;8:544. doi: 10.3389/fphar.2017.00544.
40. Ramachandran S, Fadhil L, Gopi C, Amala M, Dhanaraju MD. Evaluation of bone healing activity of *Cissus quadrangularis* (Linn), *Cryptolepis buchanani*, and *Sardinella longiceps* in Wistar rats. Beni Suef Univ J Basic Appl Sci. 2021;10(1):30. doi: 10.1186/s43088-021-00120-z.
41. Eze CA, Nwaogu I, Idoko EN. Assessment of the wound healing activity of methanolic and n-hexane extracts of *Garcinia kola* seed in albino rats. Pharm Biol. 2012;50(5):605.
42. Nwaehujor CO, Nwinyi FC, Igile GO. The wound healing activities of *Garcinia* hydroxybiflavanonol (GB1) from *Garcinia kola* in streptozotocin-induced diabetic rats. Int J Biochem. 2013;114:173-80.
43. Roy A, Bhoumik D, Sahu RK, Dwivedi J. Medicinal plants used in liver protection-a review. Pharm Biosci J. 2014;2(1):23-33. doi: 10.20510/ukjpb/2/i1/91143.
44. Shetty S, Udupa SL, Udupa AL, Vollala VR. Wound healing activities of bark extract of *Jatropha curcas* Linn in albino rats. Saudi Med J. 2006;27(10):1473-6.
45. Esimone CO, Nworu CS, Jackson CL. Cutaneous wound healing activity of a herbal ointment containing the leaf extract of *Jatropha curcas* L. (Euphorbiaceae). Int J Appl Res Nat Prod. 2008;1(4):1-4.
46. Nwala CO, Akaninwor JO, Monanu MO. Phytochemical screening and wound healing activities of extracts of *Jatropha curcas* leaf formulated in a simple ointment base. Int J Eng Sci Invention. 2013;2(6):72-5.
47. Sachdeva K, Garg P, Singhal M, Srivastava B. Wound healing potential of extract of *Jatropha curcas* L. (stem bark) in rats. Pharmacogn J. 2011;3(25):67-72. doi: 10.5530/pj.2011.25.12.
48. Alzomor AK, Sallam NM, Al-Fotaihy SA, Al-Moliki B, Al-Zohairy BA. Antibacterial and wound healing activities of topical gel of *Jatropha variegata* Vahl extract in rats. Pharm Biomed Res. 2020;6(4):287-96. doi: 10.18502/pbr.v6i4.5115.
49. Salim MN, Masyitha D. The activity of *Jatropha curcas* cream on day 5 of skin wound healing in mice infected with *Staphylococcus aureus*. In: 2nd International Conference on Veterinary, Animal, and Environmental Sciences (ICVAES 2020). Atlantis Press; 2021. p. 165-9. doi: 10.2991/absr.k.210420.035.
50. Nithya V, Brinda P, Anand KV. Wound Healing activity of *Leonotis nepetaefolia* R.Br., in Wistar albino rats. Asian J Pharm Clin Res. 2011;4(2):23-6.
51. Williams A, Clement Y, Nayak S, Rao A. *Leonotis nepetifolia* protects against acetaminophen-induced hepatotoxicity: histological studies and the role of antioxidant enzymes. Nat Prod Chem Res. 2016;4(3):222. doi: 10.4172/2329-6836.1000222.
52. Powder-George Y. Secondary metabolites from the leaves and stems of *Leonotis nepetifolia* (Lamiaceae). Trop J Nat Prod Res. 2018;2(6):293-6. doi: 10.26538/tjnpr/v2i6.7.
53. Jato JA, Inalegwu B, Onyezili FN. Antioxidant enzymes in assessment of wound healing efficacy of *Mitracarpus villosus* ointment in diabetic state. Chron Dis J. 2021;9(1):7-13. doi: 10.22122/cdj.v9i1.581.
54. Rashed AN, Afifi FU, Disi AM. Simple evaluation of the wound healing activity of a crude extract of *Portulaca oleracea* L. (growing in Jordan) in *Mus musculus* JVI-1. J Ethnopharmacol. 2003;88(2-3):131-6. doi: 10.1016/s0378-8741(03)00194-6.
55. Eldeighdye SM, Abdel-Khalek T, Allam TM. The therapeutic effect of purslane (*Portulaca oleracea*) extract on wound healing in diabetic albino rats. World J Pharm Pharm Sci. 2016;5(11):1454-69.
56. Setyowati H. Potential use of purslane (*Portulaca oleracea* L.) as alternative wound healing therapy. Cermin Dunia Kedokteran. 2017;44(11):818-20. doi: 10.55175/cdk.v44i11.707.
57. Guo J, Peng J, Han J, Wang K, Si R, Shan H, et al. Extracts of *Portulaca oleracea* promote wound healing by enhancing angiology regeneration and inhibiting iron accumulation in mice. Chin Herb Med. 2022;14(2):263-72. doi: 10.1016/j.chmed.2021.09.014.
58. Agyare C, Asase A, Lechtenberg M, Niehues M, Deters A, Hensel A. An ethnopharmacological survey and in vitro confirmation of ethnopharmacological use of medicinal plants used for wound healing in Bosomtwi-Atwima-Kwanwoma area, Ghana. J Ethnopharmacol. 2009;125(3):393-403. doi: 10.1016/j.jep.2009.07.024.
59. John R, Dalling JW, Harms KE, Yavitt JB, Stallard RF, Mirabello M, et al. Soil nutrients influence spatial distributions of tropical tree species. Proc Natl Acad Sci U S A. 2007;104(3):864-9. doi: 10.1073/pnas.0604666104.
60. Ilodigwe EE, Ndunagu LU, Ajaghaku DL, Utoh-Nedosa UA. Evaluation of the wound healing activity of a polyherbal remedy. Ann Biol Res. 2012;3(11):5393-8.
61. Medical News Today. https://www.medicalnewstoday.com/articles/types-of-wound-healing.
62. Tang T, Yin L, Yang J, Shan G. Emodin, an anthraquinone derivative from *Rheum officinale* Baill, enhances cutaneous wound healing in rats. Eur J Pharmacol. 2007;567(3):177-85. doi: 10.1016/j.ejphar.2007.02.033.
63. Suguna L, Singh S, Sivakumar P, Sampath P, Chandrakasan G. Influence of *Terminalia chebula* on dermal wound healing in rats. Phytother Res. 2002;16(3):227-31. doi: 10.1002/ptr.827.
64. Warriner R, Burrell R. Infection and the chronic wound: a focus on silver. Adv Skin Wound Care. 2005;18 Suppl 1:2-12. doi: 10.1097/00129334-200510001-00001.
65. Kumar B, Vijayakumar M, Govindarajan R, Pushpangadan P. Ethnopharmacological approaches to wound healing--exploring medicinal plants of India. J Ethnopharmacol. 2007;114(2):103-113. doi:10.1016/j.jep.2007.08.010.