

[Domicile](#) / Équipe éditoriale

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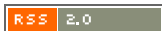
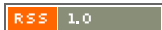
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Numéro actuel



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[Faire une soumission](#)

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[Home](#) / [Archives](#) / Vol. 21 (2021)

Vol. 21 (2021)

Published: 2021-06-23

Editorial

Intellectualist premise of folk names support their restoration in formal taxonomy

F. Merlin Franco

1-3



Research

A preliminary study on the ethno-traditional medicinal plant usage in tehsil “Karnah” of District Kupwara (Jammu and Kashmir) India

Mohammad Asif, Shiekh Marifatul Haq, Umer Yaqoob, Musheerul Hassan, Hammad Ahmad Jan

1-14



Ethnobotanical knowledge of Kewrat community of Morang district, eastern Nepal

Bishnu Dev Das, Niroj Paudel, Meghraj Paudel, Madan Kumar Khadka, Sajita Dhakal, Amrit KC

1-11



Uses, availability and endogenous conservation strategies of *Canarium schweinfurthii* (Engl.) (Burseraceae) in the Cascades region (Burkina Faso)

Lassina Traoré, Mipro Hien, Issaka Ouédraogo

1-17



Diversity and uses by farmers of cashew (*Anacardium occidentale* L.) orchards weeds in Côte d'Ivoire

Mory Latif Konate, Doudjo Noufou Ouattara, François N'Guessan Kouamé, Adama Bakayoko

1-14



PDF

Ethnobotanical study of *Pistacia lentiscus* L. in El Tarf region (Northeastern Algeria)

Moncef Beldi, Hayette Merzougui, Amel Lazli

1-18



PDF

Gender differences in plant use knowledge within a traditional fishing community in northeastern Brazil

David Y P Tng, Deborah Mattos Guimaraes Apgaua, Marisa M. D. Lisboa, Charbel N El-Hani

1-36



PDF

Chiuri (*Diploknema butyracea* (Roxb.) H.J.Lam): An Economic tree for Improving Livelihood of Chepang Communities in Makwanpur, Nepal

Roshan Chikanbanjar, Umed Pun, Bhola Bhattarai, Ripu Mardan Kunwar

1-11



PDF

Ethnobotany of Weeds in Kanchanpur District, Far-Western Nepal

Man Dev Bhatt, Yagya Prasad Adhikari, Ripu Kunwar

1-19



PDF

Wild and semi-wild edible plants used by the communities of Acholi sub-region, Northern Uganda

Alfred Nyero, Innocent Achaye, Walter Odongo, Godwin Anywar, Geoffrey Maxwell Malinga

1-12



PDF

Ethnobotanical investigation of herbal food additives of Morocco used as natural dyes

Aziz Drioiche, Nadia Benhlma, Amale Kchibale, Salima Boutahiri, Atika Ailli, Fatima El Hilali, Brahim Moukaid, Touriya Zair

1-43



PDF

The trade of wild medicinal plants in the andean district of Lircay, Huancavelica, Perú: A comparative study

Roxana Castañeda, Harol Gutiérrez, Héctor Aponte, Ivette Z. Ocampo, Rainer W. Bussmann, Narel Y. Paniagua-Zambrana

1-32



PDF

Traditional knowledge and uses of *Argemone mexicana* L. (Papaveraceae) in southern Benin

Gbodja Houéhanou François Gbesso, Florence Koussi Gbesso, Ruddy Chancelle Fleur Adoukonou, Ghislain Comlan Akabassi, Elie Antoine Padonou, Agossou Brice Hugues Tente

1-11



PDF

Medicinal uses of plants by traditional birth attendants to facilitate childbirth among Djimini women in Dabakala (Center-North of Côte d'Ivoire)

Silvère Romuald Koman, Wokapeu Blaise Kpan, Konan Yao, Djakalia Outtara

1-12



PDF

Mixtec taxonomy: plant classification, nomenclature, and identification in Oaxaca, Mexico

Juan Carlos Aparicio, Robert Voeks, Ligia Funch

1-13



PDF

Ethnobotanical survey on plants used by traditional healers to fight against COVID-19 in Fez city, Northern Morocco

Nesrine Benkhaira, Saad Ibensouda Koraichi, Kawtar Fikri-Benbrahim

1-18



PDF

Ethnoveterinary and fodder plants used among transhumant communities around Georgia-Turkey border, in the Western Lesser Caucasus

Ceren Kazancı, Soner Oruç, Marine Mosulishvili

1-26



PDF

Traditional management of Cactaceae: *Cereus jamacaru* DC as the native cactus most managed by rural communities in areas of Caatinga in Brazil

Ailza Maria de Lima-Nascimento, José Severino Bento da Silva, Alejandro Casas, Camilla Marques de Lucena, Reinaldo Farias Paiva de Lucena

1-12



PDF

Assessing human pressure on wild food and forage tree species for designing effective conservation actions in West Africa Sahel region

Bossila Séraphin Hien, Loyapin Bondé, Sié Sylvestre Da, Fidèle Bognounou, Issaka Joseph Boussim, Oumarou Ouédraogo

1-11



Potential uses of lycophytes and ferns in Sri Lanka: an ethnopteridological perspective

Rajapaksha Haddockata Gedara Ranil, Rainer W Bussmann

1-11



Ethnomedicinal use of some plant species by Gujjar and Bakerwal community in Gulmarg Mountainous Region of Kashmir Himalaya

Muatasim Jan, Tawseef Ahmad Mir, Aijaz Hassan Ganie, Rakesh Kumar Khare

1-23



Ethnobotanical profile of medicinal plants used by people of North-eastern Morocco: Cross-cultural and Historical approach (Part I)

Ilyass Alami Merrouni, Loubna Kharchoufa, Nouredine Bencheikh, Mostafa Elachouri

1-45



Ethnobotanical study of medicinal plants in northern Morocco (Taounate): case of Mernissa

Mohamed Jeddi, Zineb Benziane Ouaritini, Kawtar Fikri-Benbrahim

1-23



Knowledge, attitudes and practices (KAP) of rural women in the dry zone of Sri Lanka on underutilized vegetable crops

Ruwan Chamara, Madhavi Wijerathna, Ishani Herath, Ranil Rajapaksha

1-25



Assessments of medicinal plant usage for the traditional treatment of skin diseases in Akinyele Local Government Area, Ibadan, Oyo State, Nigeria

Oluyinka Christopher Ariyo, Bello Mohammed Usman, Olusegun David Adelani, Oluyemisi Mary Ariyo

1-18



Use and management practices of medicinal plants in and around mixed woodland vegetation, Tigray Regional State, Northern Ethiopia

Mehari Girmay Gebru, Ermias Lulekal, Tamrat Bekele, Sebsebe Demissew

1-26



Gendered plants and plant categorization by gender: classificatory and “storied” knowledge in Trás-os-Montes, Portugal

Amélia Frazão-Moreira, Ana Maria Carvalho

1-20



Medicinal plants used to boost immunity and decrease the intensity of infection caused by SARS-COV-2 in Morocco

Souad Belhaj, Lahcen Zidane

1-17



Documentation of veterinary practices from Gujjar and Bakarwal tribes of District Poonch, Jammu & Kashmir: A boon for animals from our ancestors

Abhishek Dutta, Kanwaljeet Singh, Bikarma Singh, Yash Pal Sharma, Rainer W Bussmann

1-18



Ethnomedicinal knowledge on the precise use of herbal medicine - An interview-based study on traditional healers from Jaunsar-Bawar region of Uttarakhand

Deepak Kumar Semwal, Ankit Kumar, Ashutosh Chauhan, Ruchi Badoni Semwal, Ravindra Semwal, Sunil Kumar Joshi

1-17



Utilization of herbs with abortifacient potentials to prevent Malaria in pregnant women in Southwestern Nigeria: A random survey

Ayodele Samuel Babalola, Olufunmilayo Ajoke Idowu, Kehinde Olutoyin Ademolu

1-11



Diversity and knowledge of plants used in the treatment of snake bite envenomation in Benin

Ayékotchami Jacques Dossou, Adandé Belarmain Fandohan, Agossou Bruno Djossa, Achille Ephrem Assogbadjo

1-20



PDF

Descriptive study of plant resources in context of the ethnomedicinal relevance of indigenous flora; a case study from Rajouri-Poonch region of Himalaya

Zishan Ahmad Wani, Shreekar Pant, Bikarma Singh

1-22



PDF

Ethnobotanical Utilization of Forest Resources in Sindh Forest of Kashmir Himalaya, India

Dr Nazir A. Pala, Muneesa Banday, M. A. Islam, Megna Rashid, Zubair A Malik, Rainer W Bussmann

1-18



PDF

Reviews

Achillea eriophora: an ethnobotanical and pharmacological review

Toktam Mohammadi, Atefeh Pirani, Hamid Moazzeni, Jamil Vaezi

1-19



PDF

Ethnobotany of the genus *Elatostema* J.R. Forster & G. Forster

Ashutosh Kumar Upadhyay, Rajib Gogoi, Prashanta Kumar Mitra

1-24



PDF

Andean Mesas and Cosmologies

Douglas Sharon

1-41



PDF

Reflections on the use of hypotheses in ethnobotany: A response to Leonti et al. (2020)

Washington Soares Ferreira Júnior, Ulysses Paulino Albuquerque, Patrícia Muniz Medeiros

1-5



pdf

Culinary herbs and spices in Nepal: A review of their traditional uses, chemical constituents, and pharmacological activities

Asmita Khanal, Hari Prasad Devkota, Sammodavardhana Kaundinnyayana, Prakash Gyawali, Ravindra Ananda, Rameshwar Adhikari

1-18



PDF

Baccharis genistelloides (Lam.) Pers. "carqueja": a review of uses in traditional medicine, phytochemical composition and pharmacological studies

Alejandrina María Llaure-Mora, Mayar Luis Ganoza-Yupanqui, Luz Angélica Suárez-Rebaza, Rainer W. Bussmann
1-37



PDF

Databases and Inventories

Rainer Willi Bussmann's scholarly impact: A scientometric review

Basharat Ahmad Malik, Zubair A. Malik
1-19



PDF

An Ethnobotanical Study on Native Plants of Bargarh District of Western Odisha, India in Relieving Urogenital Ailments

Alok Ranjan Sahu, Maninee Sahu, Ain Raal
1-11



PDF

Ethnobotanical profile of some useful plants and fungi of District Dir Upper, Tehsil Darora, Khyber Pakhtunkhwa, Pakistan

Murad Muhammad, Lal Badshah, Adnan Ali Shah, Muhammad Ali Shah, Abdullah Abdullah, Rainer W Bussmann, Abdul Basit
1-15



PDF

Diversity and Ethnobotany of genus Garcinia L. (Clusiaceae) in Assam, Eastern Himalaya

Sanjib Baruah, Pranjan Barman, Sanswring Basumatary, Birina Bhuyan
1-14



PDF

Notes on Ethnobotany

Socio-economic value and ethnobotanical study of Moroccan wild plant: Leopoldia comosa L. bulbs.

Mohamed Boulfia, Fatima Lamchouri, Nacima Lachkar, Abdelmajid Khabbach, Abdelouahab Zalaghi, Hamid Toufik
1-17



PDF

Ethnobotany and varietal characterization of *Jatropha curcas* L. in the Sudanese savannas of North-Cameroon

Benjamine Anguessin, Pierre Marie Mapongmetsem

1-11



PDF

Factors influencing the effectiveness of galactogenic recipes in Borgou cows reared in a real environment in Benin

Zénabou Agani Agani, Cyrille K. Boko, Adam Dourossimi Adenile, Guénolé C Akouedegni, Guy Appolinaire Mensah, Joseph Dossou, Séverin Babatounde

1-18



PDF

Repatriation of ethnobotanical studies

Mesas y Cosmologías Andinas

Douglas Sharon

1-43



PDF

Book Reviews

Ethnobotany of the Caucasus: A Book Review

Zubair A. Malik

1-2



PDF

The Nuauulu World of Plants: Ethnobotanical cognition, knowledge and practice among a people of Seram, eastern Indonesia: A Book Review

Rainer W Bussmann

1-2

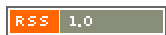


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Current Issue

ATOM 1.0

RSS 2.0



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Traditional knowledge and uses of *Argemone mexicana* L. (Papaveraceae) in southern Benin

Gbodja Houéhanou François Gbesso, Florence Koussi Gbesso, Ruddy Chancelle Fleur Adoukonou, Ghislain Comlan Akabassi, Elie Antoine Padonou, Agossou Brice and Hugues Tente

Research

Abstract

Background: *Argemone mexicana* is an important medicinal plant species used by local people to treat several diseases. Despite its importance, the species faces serious conservation problem. This study was conducted in southern Benin to assess the traditional knowledge and uses of *A. mexicana* within four socio-cultural groups.

Methods: Ethnobotanical surveys were conducted in local communities with 130 informants randomly selected among four socio-cultural groups namely Fon, Adja, Mahi, and Nago/Yorouba. The interview was performed in local language. Ethnobotanic parameters were calculated to assess the knowledge and use of the species. Hierarchical Cluster Analysis followed by Correspondence Analysis (CA) were used to show the relation between the surveyed populations, diseases treated and the involved organs.

Results: Local community members of the four socio-cultural groups used the different parts of *A. mexicana* for 12 treatments. The leaves of the species were the most organ used followed by the whole plant. The socio-cultural group Fon had better knowledge of the uses of the species compared with others. The old men/women tradi-practitioner had the best knowledge on the species. *A. mexicana* was only present in agroforestry systems. The deforestation was the main threat of the conservation of the species.

Conclusion: This study demonstrates the use of *A. Mexicana* in Southern Benin. The result could be

used to develop specific sustainable utilization and conservation strategies of *A. Mexicana* within local communities of Benin.

Keywords: *Argemone mexicana*, ethnobotany, conservation, Benin

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21:20 (2021)

Background

In Africa, traditional medicine is seen as the primary means of treating illnesses (Lougbeignon *et al.*, 2011). The use of plants is often associated with local beliefs, strongly anchored in the founding myths of local communities and giving an important place to spirits, ancestors and some living beings. These medico-magical or magico-religious beliefs play a very essential role in healing in Africa (Lougbeignon *et al.*, 2011). The plant is being capable of both good and evil which provides a link between the individual and his ancestors (Savadogo and Thiombiano, 2010; Savadogo *et al.*, 2010). The vocation of the plant is therefore to support the life of living beings, in particular human beings. In view of the role that the plant plays in the life and cultures of traditional African societies, it is imperative to protect them by involving all user communities.

Recent estimates have indicated that by the end of the 21st century, more than 33,000 species are threatened with extinction. Among the 53,000 to 72,000 species of medicinal plants recorded throughout the world, 15,000 are threatened with extinction (UICN, 2019), and the most threatened are those leaves, roots, seeds and fruits are used in traditional medicine (Nzuki, 2016). Among the latter are *Argemone Mexicana* L. (<http://www.cabicompendium.org/cpc/home.asp>)

A. mexicana, species belonging to Papaveraceae plant family is native to Mexico and the West Indies (Photo 1). *A. mexicana* becomes pantropical after accidental introduction or introduction as an ornamental. It is naturalized in most African countries, from Cape Verde east to Somalia, and south to South Africa. *A. mexicana* is medicinal and ornamental plant species very used by local communities to treat many diseases. Stem bark, leaves, fruits and seeds of the species are used in traditional medicine against many tropical diseases such as Malaria, cough, oedema, inflammation, muscle pain, ulcers, wound and yaws etc. In the medico-magic field, it is also used during the rituals of implantation of the deities. In Nigeria, the seed oil is used to protect wood from termite attack, whereas in India, Mexico and the West Indies the seed oil is sometimes used to make soap, for greasing and for illumination. The seed oil of *A. mexicana*, called is sometimes added to mustard oil in India to increase the pungency (Chang *et al.*, 2003). Larger amounts are sometimes used to adulterate mustard oil or sesame oil, which may lead to oedema and glaucoma in people who consume the oil. In Cameroon the latex extracted from the leaves is applied to treat lumbago. It is also placed in a carious tooth to relieve toothache or to help to loosen the tooth and render extraction easier. *A. mexicana* contains many isoquinoline alkaloids of the

protoberberine type and related types, including sanguinarine. The alkaloid 6-acetonyldihydrochelerythrine has recently been isolated from whole plant extracts and was found to have significant anti-HIV activity (Chang *et al.*, 2003)

Despite its medicinal and ornamental importance, there is very few studies on the species conservation. There is no policy and regulation available guiding the sustainable management of *A. mexicana*. According to the Nagoya Protocol (CDB, 2010), on access to genetic resources, the fair and equitable sharing of benefits, investigating in the traditional knowledge of indigenous peoples should be the first step for an effective and participatory conservation program. The existing works on *A. mexicana* concern more with the toxicity and biochemical studies (Diallo *et al.*, 2005). In Benin no study has been carried out on the species. However, botanical inventory studies record the plant among the species most used by local communities in the treatment of bodily and spiritual diseases (Kouchadé *et al.*, 2017). In the perspective to contribute to the conservation and valorization of this species, this paper aims at assessing the knowledge and uses of *A. mexicana* in local communities in southern Benin with the following research questions: (1) What ethnobotanic knowledge do local communities have on the use of *A. mexicana*? (2) What is the conservation status of *A. mexicana* in southern Benin history, threats to plant diversity and use, geomorphology, landscape and terrain) of these regions are dealt in detail.

Each chapter of *Part II* describes either a particular species of a family (e.g. *Abies nordmanniana* of Pinaceae and *Agasyllis latifolia* of Apiaceae) or a few species of the same genus of a particular family (e.g. four species of genus *Alcea* i.e. *Alcea hyrcana* A. *lenkoranica*, *A. rugosa*, *A. tabrisiana* of Malvaceae) and rarely two different genera of the same family (e.g. *Danae* and *Ruscus* of Asparagaceae) are described together (P 253). The chapters (total 129 in number) describing plant profiles feature a modern overview on taxonomy, local names, and information on the ecology and distribution of all species, local medicinal/food/handicraft and other uses. The ethnobotanical information provides both an overview on historic uses, as well as data from the recent scientific studies of plant use in the region and contains the up-to-date literature sources. The plant species described are arranged in an alphabetic order, irrespective of the family to which they belong.

Detailed phytochemistry of the described species is skipped. Discussion of phytochemistry is essential especially while discussing the medicinal properties/uses of plants. The botanical description of plants is excellent wherein minute details of

morphological characters and major events of the life cycle (flowering & fruiting) in different regions (Armenia, Azerbaijan, Georgia) are given. This along with high-quality photographs (over 300 in number), taken by the editor and/or contributors, makes the books an ideal and reliable pictorial field guide that would help the students/researchers in identifying and locating these plants. Although most of the photographs are of high quality, a few of them are not so clear, as for example that of *Amaranthus retroflexus* (P 108) *Berberis vulgaris* (139), *Falcaria vulgaris* (301), *Gleditsia caspica* (320) etc.

The different details (like local names, ethnobotany etc.) of described plant species are not compared with other far flung/distant regions as is done in the volumes of *Ethnobotany of the Mountain Regions* (<https://link.springer.com/bookseries/15885>).

Despite some above-mentioned minor lacunae, it is hoped that this book will provide an opportunity to both interested laypeople as well as professionals to

learn about the fascinating biodiversity and plant use culture of the Caucasus and will develop interest in its further documentation, sustainable use, and conservation.

Material and methods

Study area

This study was carried out in the plateau of Abomey in Benin. The plateau of Abomey has six districts (Abomey, Bohicon, Zapkota, Agbangnizoun, Djidja, Zogbodomey) (Fig. 1). All these communes were located in Guineo-Congolian climatic region of Benin, located between 6°25' and 7°30'. Mean annual rainfall is 1200 mm with relative humidity between 69% and 97%. Daily temperature ranges from 25° C to 29° C. The soils are either deep ferrallitic or rich in clay and humus. The vegetation consists of dense semi-deciduous forests and Guinean savannas. This area is dominated by Fon Ethnic group.

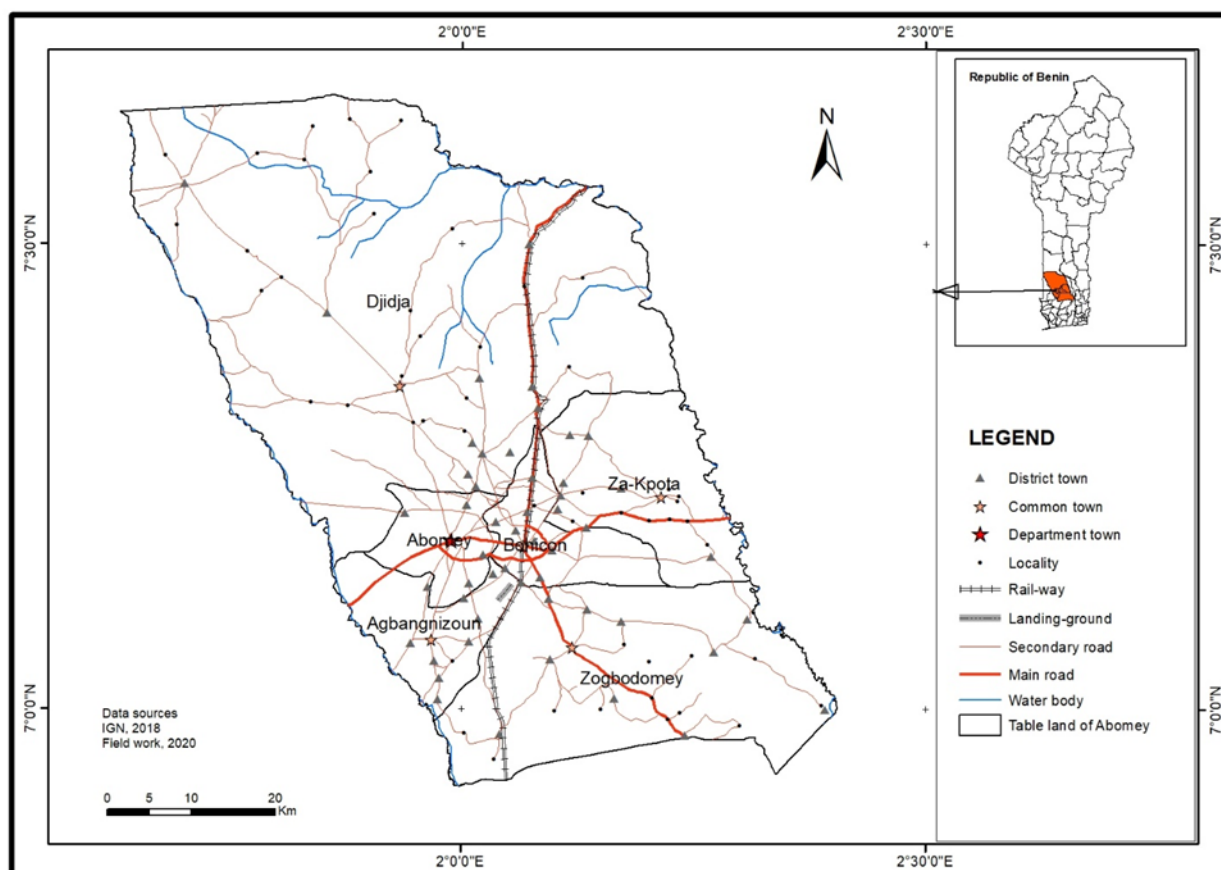


Figure 1. Geographical location of the study area

Research design and Sampling

Based on the preliminary surveys among 75 individuals randomly interviewed after obtaining oral prior informed consent within four ethnic groups (Fon, Adja, Mahi, and Nagot/Yorouba) on the use of

the species. It was found that 32% of the respondents had knowledge on at least one use of the species. This information was used to calculate the sample size following the formula of Dagnelie (1998):

$$n = U_{1-\alpha/2}^2 \times \frac{p(1-p)}{d^2} \quad (\text{Eq. 1})$$

With n the size of the sample, p the proportion of people using the species ($p = 0.32$; from the preliminary survey), $U_{1-\alpha/2} = 1.96$ is the value of the normal random variable at probability value of $\alpha = 0.05$ and d is the margin error of the estimation of any parameter to be computed from the survey. A value of 8% was considered. Under these assumptions, 130 people were sampled during the survey.

Data collection

Data were collected from households selected at random; however, households with traditional practitioners and sellers of medicinal plants were systematically selected. Individual interviews were conducted in the local language using a questionnaire. The main local languages interviewed were Fon, Adja, Mahi and Nagot/Yorouba. The participants aged 18 and over were considered regardless of education level, ethnicity and gender (Akabassi *et al.*, 2020). Focus group discussion was performed to cross-check the data collected during the individual interviews. Three categories of participants were considered: the young ($18 \leq \text{age} \leq 30$), the adult ($31 \leq \text{age} \leq 49$) and the old ($\text{age} \geq 50$). The information collected concerned the biodata (name, sex, age, ethnic group, main activity, religion and matrimonial situation), the endogenous practices related to the use and the forms of use of the species (mutilated organs, aims of mutilations and use frequency) as well as the habitat of the species and its abundance at three-time scale levels (0-5 years, 5-10 years and + 10 years). The discussion with the informants ended with direct observations in the field.

Data analysis

The importance of *A. mexicana* (Fig. 2) for the surveyed local communities was determined by the calculation of the use frequency of the plant (FUP).

$$FUP = \frac{IYo + IAd + IOl}{Ni} \times 100 \quad (\text{Eq. 2})$$

Ni is the total number of interviewees; IYo , IAd and IOl are the number of young, adult and old age group interviewees respectively. The use was considered as 'credible' in case FUP is above 50% (Akabassi *et al.*, 2020; Camou-Guerrero *et al.*, 2008).

The most used plant organ was identified through the computation of the index value related to useful organs (IVO).

$$IVO = \frac{Nvo}{Ni} \times 100 \quad (\text{Eq. 3})$$

Nvo , the number of uses in the organ; Ni , the total number of identified uses.

The importance of plant uses according to different ethnic groups was determined through the computation of the use frequency for each ethnic group (UFP).

$$UFP = \frac{Rge}{Ni} \times 100 \quad (\text{Eq. 4})$$

Rge being the number of uses identified in the targeted ethnic group.

The index of global knowledge possession (IGKPA) on *A. mexicana* was computed

$$IGKPA = \frac{Vm}{Ni} \times 100 \quad (\text{Eq. 5})$$

Where Vm is the sum of the mean value of old, adult and young users of *A. mexicana*.

The IGKPA indicates the global level of knowledge on *A. mexicana* according to ethnic groups: $IGKPA < 10\%$: mediocre level of knowledge, $10 \leq IGKPA < 20\%$: fair level of knowledge, $20 \leq IGKPA < 30\%$: medium level of knowledge, $30 \leq IGKPA < 40\%$: good level of knowledge, $40 \leq IGKPA < 50\%$: very good level of knowledge and $50 \leq IGKPA$: excellent level of knowledge.

The uses of the species were grouped into two fields of traditional application, namely: medicine and medico-magic. A use was considered medicinal when results from the use of one part of the species associated or not with other plants or ingredients of animal without any ritual, prayers or incantations. A use was considered medico-magic when it associates the medicinal use with ritual, prayers or incantations (Akabassi *et al.*, 2020).

Hierarchical Cluster Analysis on the bio data of the surveyed population followed with Correspondence Analysis (CA) were used to show the relation between the surveyed populations, use categories, treated diseases and involved organs.

Ethical considerations

Ethical approval was not sought for this study. The study is deemed by the researchers to be low risk, as it did not record any identifying information of participants; it was not an interventional or clinical-based study. However, a consent has been received from community leaders and participants, which was used for data collection and analysis.

Results

Knowledge and use of *A. mexicana*

A total of 12 uses of the organs of *A. mexicana* (Fig. 2) including whole plant, roots, leaves, flower and seeds were cited (Table 1). One use was related to the seeds, two related to the root and the flowers, six

related to the whole plant and ten related to the leaves. The three first uses that had highest use frequency were malaria (19.23), bellyache (14.62) and luck (10). The leaves were the most important organ used in the study area (83.33%). The socio-cultural group Fon granted more importance and had the best knowledge on *A. mexicana* than the other groups (Table 2).

The Hierarchical Cluster Analysis revealed five distinct groups with a coefficient of determination R^2 which equal to 0.54 (Table 3). The group 1 was characterized by adult traditional healers from Fon ethnic group and traditional religion, married with primary level of education. The group 2 was characterized by adult trader female from Fon ethnic group and Christian religion, married with primary level of education. The group 3 was characterized by adult trader female from Fon ethnic group and traditional religion widow with primary level of education. The group 4 was characterized by handicraft male from Fon ethnic group and Christian religion married with secondary level of education.

The group 5 was characterized by adult trader male from Nagot/Yoruba ethnic group and traditional religion with primary level of education.

The Correspondence Analysis (CA) revealed that group 1 used the plants roots and flowers to treat malaria and bellyaches; group 2 used the leaves and the whole plant for infection diseases; group 3 used the plant for luck, menses dirty, diabetes and woman bleeding; group 4 used the seeds for headache, fever and haemorrhage; and group 5 used the plant for bosom cancer (Figure 3). The first two axes of the CA counted for 72.05% of the initial variance.

Use forms of *A. mexicana*

Two use forms (medicinal and medico-magic) were known for *A. mexicana*. The medico-magic use was slightly known by the four socio-cultural groups (Figure 4). Most of informant who cited *A. mexicana* for medico-magic use was old tradi-practitioner (76,15%).



Figure 2 *A. mexicana* in bloom.

Table 1. Use frequency of *A. mexicana* in South Benin

Organ	Uses	FUP (%)	IVO (%)
Whole plant	Heart diseases	0.77	
	Malaria	10	
	Bellyaches	5.4	50
	Diabetes	0.77	
	Bosom cancer	0.77	
	Heart diseases	0.77	
Root	Diabetes	0.77	16.67
	Menses dirty	0.77	
Leaves	Malaria	19.23	
	Bellyaches	14.62	
	Infection diseases	0.77	83.33
	Headaches	1.54	
	Luck	10	
	Fevers	1.54	
	Woman bleeding	0.77	
	Witchcraft	1.54	
	Diabetes	0.77	
	Hemorrhage	0.77	
Flowers	Headaches	0.77	16.67
	Luck	0.77	
Seeds	Luck	0.77	8.33

Table 2. Mean value of uses (Vm) and index of global knowledge (IGKPE) of *A. mexicana* for each socio-cultural group.

Sociocultural groups	UFP	Vm	IGKPE(%)
Fon	8.46	0.92	0.71
Adja	2.30	0.25	0.19
Mahi			
Nagot/Yorouba	0.76	0.08	0.06
	2.30	0.25	0.19

Table 3. Characteristics of the groups

	Group 1		Group 2		Group 3		Group 4		Group 5	
Variables	m	s	m	s	m	s	m	s	m	s
Age	50.35	11.46	40.95	6.06	57.13	11.50	50.57	15.03	48.40	3.51
Sex	0.98	0.14	0.00	0.00	0.41	0.50	0.93	0.27	0.00	0.00
Marital Situation	1.10	0.31	1.07	0.26	3.09	0.43	1.07	0.27	4.00	0.00
Ethnic	1.08	0.45	1.33	0.57	1.05	0.21	1.07	0.27	4.00	0.00
Religion	0.98	0.14	1.72	0.45	1.41	0.50	2.00	0.00	3.00	0.00
Instruction Level	1.08	0.65	1.00	0.72	0.55	0.60	1.86	0.53	0.80	0.45
Profession	5.96	0.20	4.16	1.31	4.96	1.33	4.00	1.66	5.00	0.00

m: mean; s: standard deviation

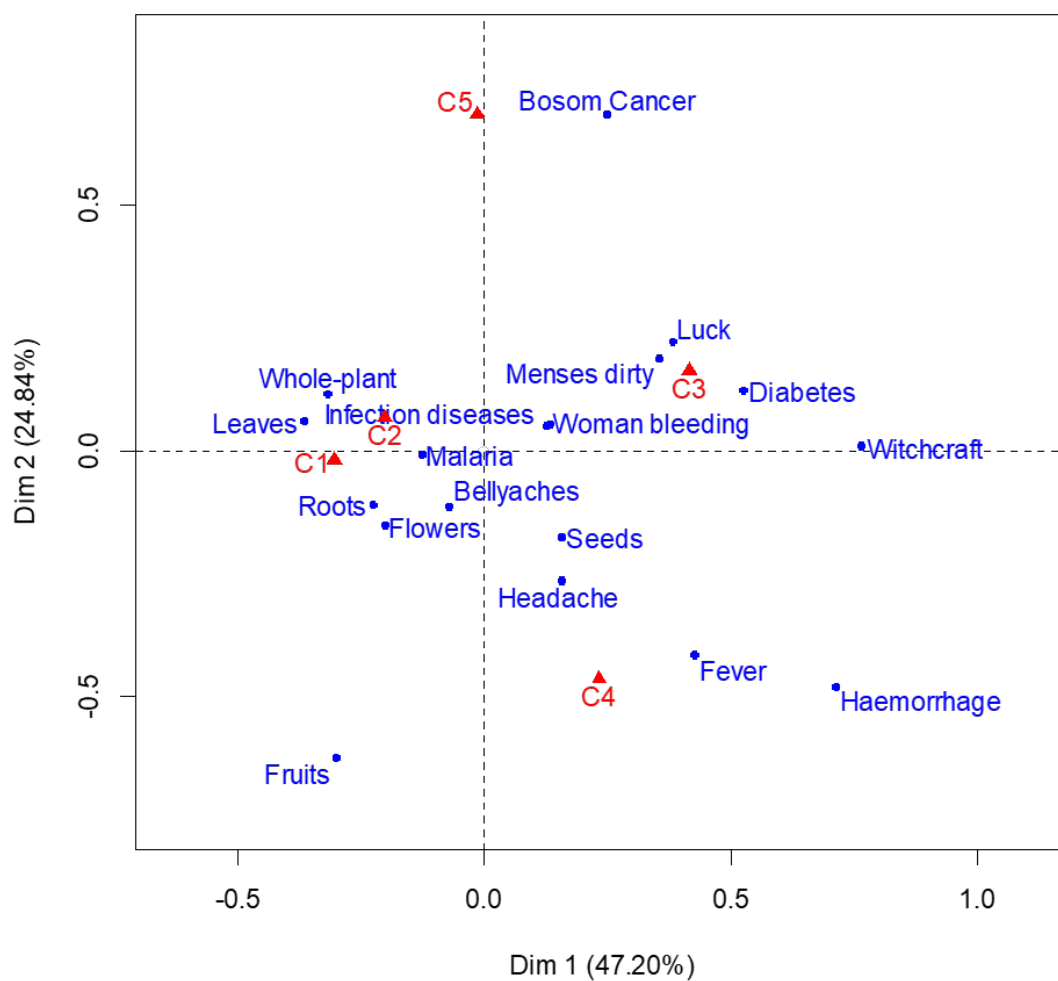


Figure 3. Projection of informant groups (Ci), the uses and organs of *A. mexicana* on Correspondence Analysis axes 1 and 2.

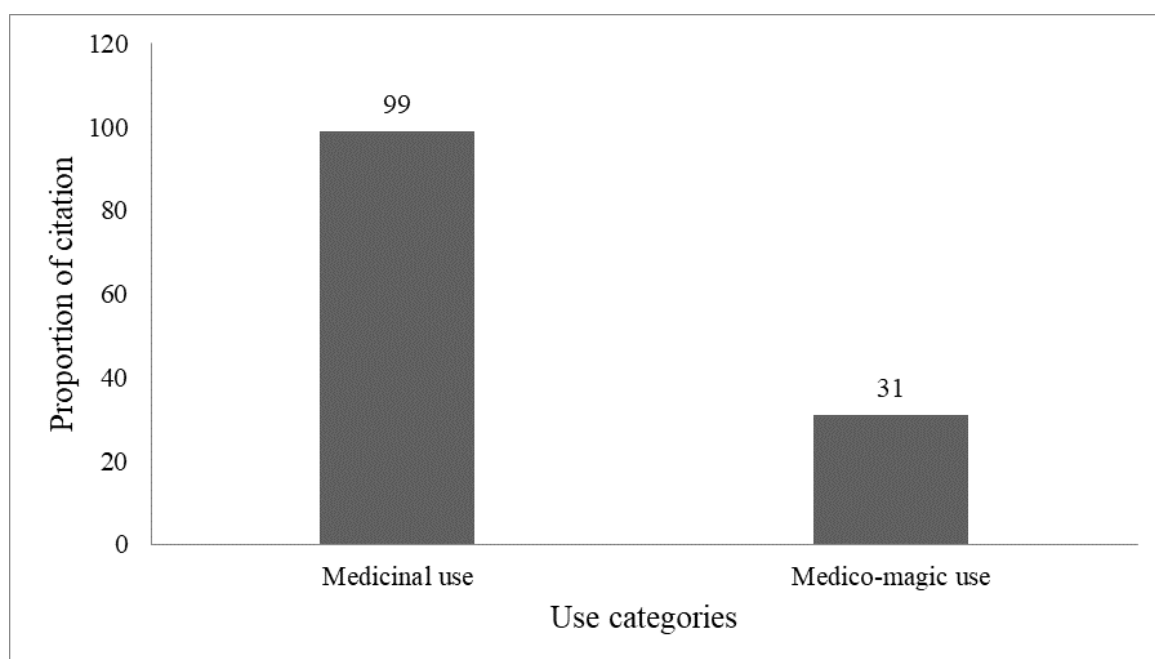


Figure 4. Forms of use of *A. mexicana*

A. mexicana was found mainly in agroforestry systems with more availability in the rainy season (Figure 4). In a future of 5 years old, *A. mexicana* would be very rare and extinct if nothing is done. On the other hand, the majority of respondents think that with the protection measures, the species would be very abundant between 5-10 years and +10 years (Figure 5).

All the populations surveyed mentioned that there were so far no endogenous conservation strategies for *A. mexicana*. The main threats to the species's conservation were deforestation, urbanization and agriculture (Figure 6).

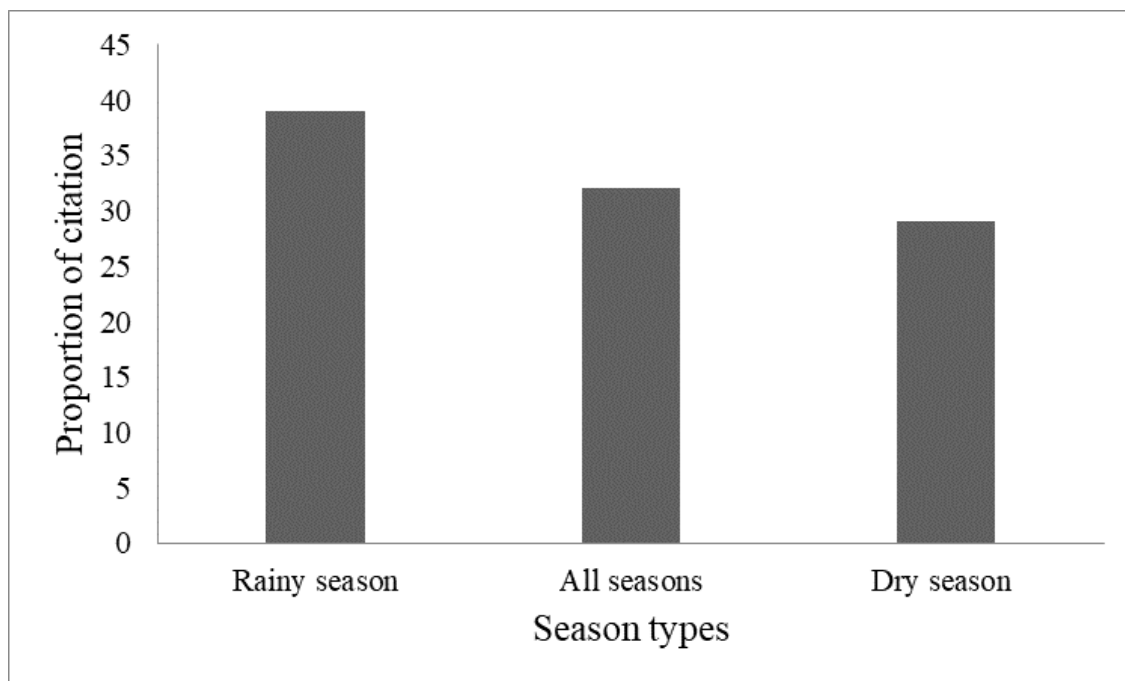


Figure 5. Availability of *A. mexicana* following the seasons

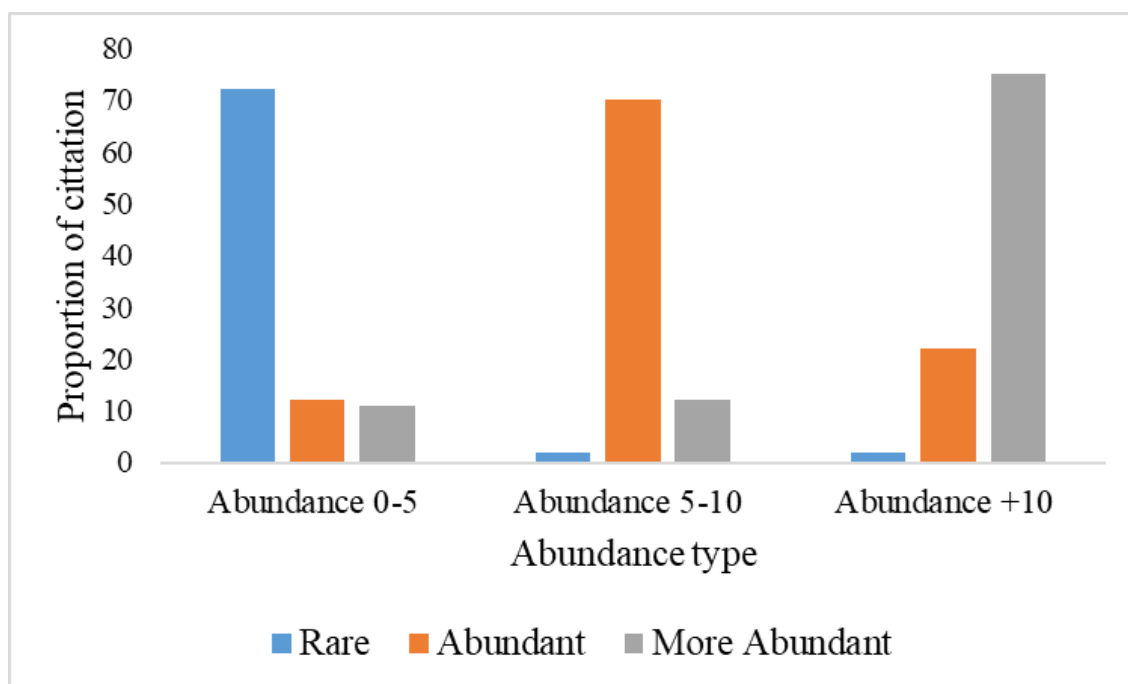


Figure 6. Perception of local populations on the future (0-5 years, 5-10 years and +10 years) abundance of *A. mexicana*

Discussion

A. mexicana is used in southern Benin for 12 uses with malaria, bellyaches and luck as the mains uses recorded. Among the four sociocultural groups investigated, Fon had the best knowledge on *A. mexicana* than the others. This low number of uses identified showed the poor knowledge of local populations regarding the species. This could be due to lack of importance and scientific studies granted to the species. Only the elderly tradi- practitioner have better knowledge on the species and use it mainly in spiritual field. The use of the species as antimalarial plant species confirmed the works of Diallo *et al.* (2005) who showed that the decoction of *A. mexicana* is clinically effective in falciparum malaria. Moreover, Papaveraceae plant family is rich in plant species used as source for drugs in both traditional and conventional medicines. The

medicinal activity of these plants was due to the presence of isoquinoline alkaloids of the protoberberine type and related types, including sanguinarine. Papaveraceae plant species are used to treat gastrointestinal ailments, malaria, pain and diabetes, including skin and ecto-parasitic diseases (Shahidul & Rasheda, 2019).

The leaves are peripheral organs are richer in secondary metabolites and constitute the basic materials. Its use was less harmful to the plant than the roots and bark. However, its overuse is very dangerous for the growth of the plant because it can create a total decrease in photosynthesis and carbon fixation of trees (Martin *et al.*, 2015). The use of the whole plant is a great threat to the sustainability of the species (Fig. 7). It is therefore urgent to establish a strategy for the conservation and sustainable use of *A. mexicana*.

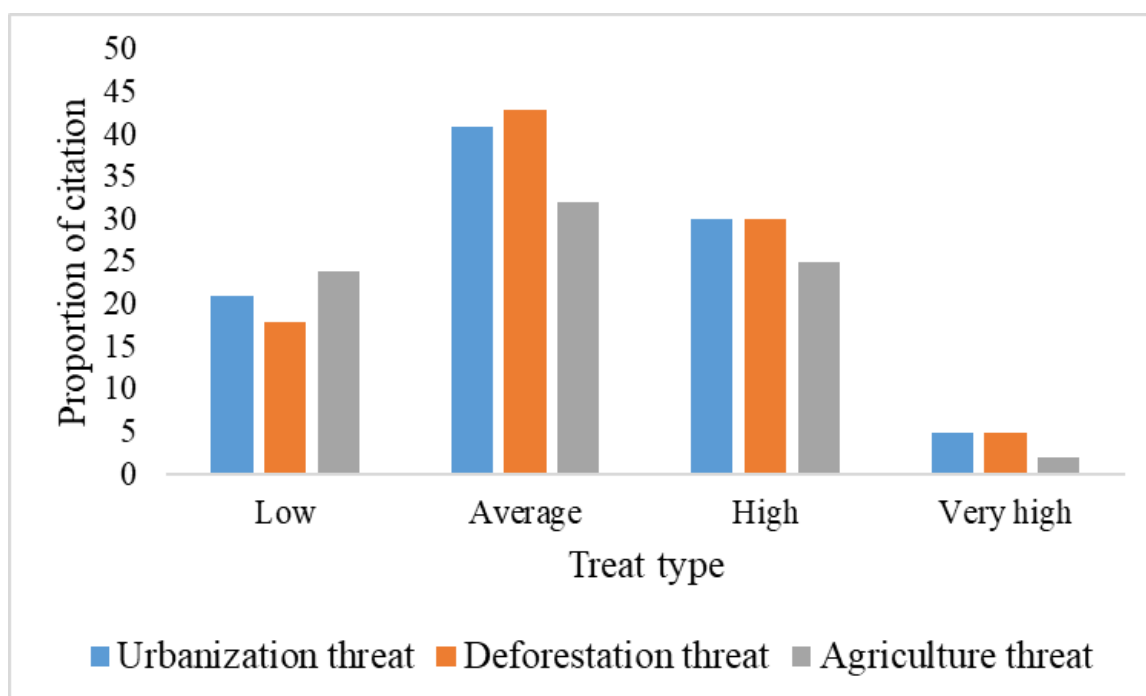


Figure 7. Main threats to the conservation of *A. mexicana*

The medicinal uses of the species varied according to the age and socio-cultural groups. While the medico-magic use was specifically reserve to the adult and old people. This result confirms the idea that certain knowledge, especially spiritual or magical, remains the property of the initiates and the elderly. This knowledge is difficult to bequeath to young people who do not yet have a high wisdom degree. The use of medicinal plants in the medico-magic field in black Africa is characterized by a set of local beliefs, strongly anchored in the founding myths of local communities and giving an important place to spirits, incantations and ancestors. These magico-religious beliefs are most often reserved for initiates and the elderly with a high wisdom degree

because the results deriving from incantatory words are often irreversible (Savadogo *et al.*, 2018).

Deforestation and expansion of cultivable land for the benefit of agriculture significantly contribute to the loss of biodiversity and was the main threat of *A. mexicana* conservation. This result corroborated with those of Shanley & Luz (2003) who showed that forest degradation has diminished the availability of some widely used medicinal plant species and many of these medicinal plants have no botanical substitute, and pharmaceuticals do not yet exist for some of the diseases for which they are used.

Despite the threat factors to the populations of *A. mexicana*, socio-cultural groups Fon, Adja, Mahi and Nagot/Yorouba did not have endogenous measures to preserve the species. Only the presence of the species in the places of worship of the deities constitutes the conservation forms. It is therefore urgent to set up a conservation program of *A. mexicana* through agroforestry systems.

Conclusions

The study evaluated the medicinal importance of *A. mexicana* within local population in Benin. It was obtained that different parts of the species were used for 12 treatments. Both use categories recorded identified were medicinal use and medico-magic use. In medicinal field, *A. mexicana* was essentially used as plant anti-microbial, antidiabetic, anti-inflammatory, anti-asthmatic, anti-ulcerous, anti-diarrheal and wound healing etc. In medico-magic field, *A. mexicana* is used by old men/women traditional practitioner to treat the spiritual diseases. Despite its importance for local peoples, deforestation was the main threat of *A. mexicana* conservation.

Declarations

List of abbreviations: CA: Correspondence Analysis; UFP: Use Frequency for each ethnic group; IGKPA: Index of Global Knowledge possession on *A. mexicana*.

Ethics approval and consent to participate: The research team explained to the elders and the local community members the purpose of the study before data collection. Ethical approval was not sought for this study. The study is deemed by the researchers to be low risk, as it did not record any identifying information of participants; was not an interventional or clinical-based study.

Consent for publication: Not applicable.

Availability of data and materials: The data was not deposited in public repositories.

Competing interests: The authors declare no competing interests.

Funding: Not applicable.

Authors' contributions: GHFG configured the research project and carried out fieldwork. FKG carried out fieldwork. RCFA carried out fieldwork. GCA analyzed the data and drafted the manuscript. EAP analyzed the data and improved the manuscript. ABHT: Supervised the work and improved the manuscript. All authors read, reviewed and approved the final version of the manuscript.

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