Open Access Library Journal
2026, Volume 13, e14855
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Empirical Evaluation of the Durability of *Eremospatha spp*. (Kekele) Lianas in the Vernacular Architecture of Kisangani, DR Congo: An Ethnoscientific and Observational Approach

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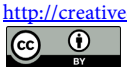
How to cite this paper: Biambala, P.B. (2026) Empirical Evaluation of the Durability of *Eremospatha spp*. (Kekele) Lianas in the Vernacular Architecture of Kisangani, DR Congo: An Ethnoscientific and Observational Approach. *Open Access Library Journal*, **13**: e14855.
https://doi.org/10.4236/oalib.1114855

Received: January 8, 2026
Accepted: February 6, 2026
Published: February 9, 2026



Abstract

Empirical Evaluation of the Durability of *Eremospatha spp*. (Kekele) Lianas in the Vernacular Architecture of Kisangani, DR Congo: An Ethnoscientific and Observational Approach. The vines of the genus Eremospatha, locally known as "Kekele", are ubiquitous construction materials in the vernacular structures of Kisangani, in the Democratic Republic of Congo. This study aims to empirically evaluate their durability through an approach that combines direct observation, ethnoscientific analysis of local knowledge, and systematic visual inspection. Without resorting to laboratory mechanical tests, this research is based on semi-structured interviews with artisans and users, as well as the observation of 50 constructions to document traditional harvesting, processing, and implementation practices. The results indicate that *Kekele lianas*, when properly selected and prepared, offer adequate durability for non-structural and lashing applications, with a functional lifespan of up to 8 years under optimal conditions. Protection against humidity and direct contact with the soil are identified as the most critical factors influencing their longevity. This study highlights the richness and validity of vernacular knowledge and underlines the potential of local bio-sourced materials for sustainable and economically accessible construction in an equatorial context.

Subject Areas

Civil Engineering

Keywords

Eremospatha, Kekele, Liana, Vernacular Architecture, Kisangani, Durability, Bio-Based Materials, Ethnobotany, Local Knowledge

1. Introduction

Vernacular architecture in Central Africa, and more specifically in the Congo Basin, reflects an ingenious adaptation to local environmental and socio-economic constraints. It relies on the use of natural, renewable, and accessible materials, among which Non-Timber Forest Products (NTFPs) play a predominant role [1]. In the Kisangani region, located in the heart of the equatorial forest of the Democratic Republic of Congo (DRC), lianas of the genus Eremospatha (family Arecaceae), locally called "Kekele", are an essential component of traditional construction techniques. These robust and flexible lianas are primarily used as binding ties to assemble the wooden frames of dwellings, to secure structural elements, and in the manufacture of various handicrafts [2].

Despite their ancestral use and vital importance to local communities, *Kekele lianas* have been the subject of very few formal scientific studies regarding their mechanical properties and durability under real-world conditions. This gap in the scientific literature contrasts sharply with the wealth of empirical knowledge held by local artisans and builders. Population pressure, deforestation, and socio-economic changes threaten both the resource and the transmission of this traditional knowledge [3]. Furthermore, the promotion of modern, often imported and expensive building materials tends to marginalize these local solutions, which are potentially more sustainable and environmentally friendly.

In this context, the present study aims to fill part of this gap by proposing an empirical assessment of the durability of *Eremospatha lianas* in vernacular buildings in the Kisangani region. Adopting an ethnoscientific and observational approach, this research aims to document and analyze local knowledge related to the use of this material, evaluate its in situ performance, and identify the factors that influence its longevity. The objective is not to replace standardized mechanical tests, but to demonstrate the value of an alternative approach, rooted in the local context, for characterizing an unconventional building material. This approach is part of a broader movement recognizing vernacular architecture as a source of inspiration for the development of sustainable building solutions adapted to the challenges of the 21st century [4].

The study is structured around three specific objectives:

1) document traditional practices of selection, harvesting, preparation and implementation of *Kekele lianas*;

2) visually assess the state of degradation of the vines in a sample of buildings of varying ages;

3) identify, through the discourse of local actors and field observations, the

main factors (environmental, biological, technical) that affect the durability of this material.

Ultimately, this article aims to provide a solid scientific knowledge base on *Eremospatha lianas* as a building material, to value endogenous knowledge and to contribute to the reflection on the future of bio-based materials in housing in tropical Africa.

2. Study Context and Literature Review

2.1. The Geographic and Climatic Context of Kisangani

Kisangani, the capital of Tshopo province, is an emblematic city of the Congo Basin. Its geographical location, almost exactly on the equator, subjects it to an equatorial climate of type Af according to the Köppen-Geiger classification. This climate is characterized by constant heat and very high humidity throughout the year. Local meteorological records indicate average temperatures ranging between 23˚C and 31˚C and annual rainfall frequently exceeding 1800 mm, distributed across all months. The average relative humidity is around 80% - 85%. This hyper-humid and hot environment creates particularly aggressive conditions for building materials, promoting the development of biological degradation agents such as fungi, molds, and wood-boring insects [5]. It is in this demanding context that local building materials, and in particular *Eremospatha lianas*, must prove their effectiveness and durability.

2.2. Eremospatha Vines: A Strategic Non-Timber Forest Product

Lianas of the genus Eremospatha belong to the subfamily Calamoideae, which also includes rattans. These climbing palms are a major structural and functional component of tropical African forest ecosystems [6]. In the DRC, and particularly in the Kisangani region, several species of this genus are exploited by local populations. Sunderland (2004) documented the use of *Eremospatha cabrae* and *Eremospatha haullevilleana* for rope making and construction [2]. These lianas are classified as Non-Timber Forest Products (NTFPs), which are defined as "all biological materials, other than wood, that are extracted from forests for human use" [7]. NTFPs are fundamental to the livelihood strategies of millions of people in rural areas, providing food, medicine, and contributing significantly to local economies [8]. The exploitation of *Kekele lianas* fits fully into this dynamic, representing a vital resource for low-cost housing.

2.3. Vernacular Knowledge and Sustainable Architecture

Vernacular architecture is increasingly recognized as a source of solutions for sustainable construction. It is the product of a long tradition of experimentation and adaptation, optimizing the use of local resources to meet climatic and cultural constraints [4]. The study of traditional building practices in Africa highlights a deep knowledge of the properties of local materials and techniques for maximizing their durability. These buildings often incorporate passive bioclimatic design

principles, such as natural ventilation, solar protection, and effective humidity management [9].

However, bio-based materials such as lianas present inherent challenges. Their organic nature makes them vulnerable to degradation. Natural fibers, composed primarily of cellulose, hemicellulose, and lignin, are hydrophilic. Moisture absorption can lead to fiber swelling, loss of mechanical properties, and degradation of the interface with other materials, thus compromising the structural integrity of the assembly [10]. Research on natural fiber composites has extensively documented these phenomena, highlighting that exposure to moisture can reduce tensile strength by nearly 40% [11]. Although our study does not involve polymer composites, the fundamental water-related degradation mechanisms remain relevant.

The ethnoscientific approach, which involves studying the knowledge systems specific to a culture, is particularly well-suited to documenting and analyzing the performance of non-standardized materials like Kekele. Ethnobotanical studies conducted in the DRC have already demonstrated the richness of local knowledge, particularly in the medicinal field [5]. Applying a similar approach to the art of building allows us to capture valuable technical expertise, passed down through generations, and integrate it into a rigorous scientific evaluation.

3. Methodology

In the absence of laboratory data and with a desire to value local knowledge, this study adopts a decidedly qualitative approach, combining methods from ethnography, ethnobotany, and scientific field observation. The methodology was designed to capture the complexity of the use of *Kekele lianas* in their real-world context, focusing on the practices and perceptions of local stakeholders.

3.1. Study Area and Sampling

The study was conducted in several peri-urban communes of the city of Kisangani, including Tshopo, Makiso, and Kabondo. These areas were chosen for their high prevalence of vernacular architecture using local materials. Sampling was carried out using a purposive, rather than probabilistic, approach, aiming to maximize the diversity of the cases studied.

3.2. Data Collection

Data collection took place over a three-month period and relied on the triangulation of three main techniques: 1. semi-structured interviews: A total of 25 individuals, including 15 experienced artisans and 10 homeowners, were interviewed. An interview guide was developed to address the following themes in a flexible manner: the selection criteria for lianas in the forest (species, maturity, appearance); harvesting and post-harvest techniques (drying, storage); preparation methods before use (soaking, softening); knotting and tensioning techniques; the estimated

lifespan of lianas according to their exposure (protected, exposed to rain, in contact with the ground); recognized signs of degradation; and maintenance and replacement practices.

1) Semi-structured interviews: An interview guide was developed to address the following themes in a flexible manner: the selection criteria for lianas in the forest (species, maturity, appearance); harvesting and post-harvest techniques (drying, storage); preparation methods before use (soaking, softening); knotting and tensioning techniques; the estimated lifespan of lianas according to their exposure (protected, exposed to rain, in contact with the ground); recognized signs of degradation; and maintenance and replacement practices.

2) Direct and Participant Observation: Direct observation was conducted on the 50 structures in the sample. For some of them, participant observation was possible, particularly during construction or repair work, allowing for the documentation of technical skills and know-how in action.

3) Systematic Visual Analysis: For each structure, a detailed visual inspection of the vine ties was performed. An evaluation grid was used to standardize observations, based on the following criteria:

Mechanical integrity: Intact, frayed, cracked, broken.

Surface appearance: Smooth, rough, presence of micro-cracks.

Biological attacks: Absence, presence of mold (color, extent), traces of insect galleries.

Colour: Natural colour (light brown), darkened, blackened (sign of prolonged humidity).

Residual flexibility: Tested manually (carefully) to assess whether the vine is still flexible or has become brittle.

3.3. Data Analysis

The results of the visual analysis were synthesized to establish correlations between the age of the structures, exposure conditions, and the observed state of degradation of the vines. Of the 50 structures inspected, 80% (40 structures) showed some form of degradation on lianas exposed to the elements, with mold being the most common defect (60% of cases), followed by cracking (35%) and insect galleries (15%).

3.4. Limitations of the Methodology

The authors acknowledge the inherent limitations of this approach. The lack of laboratory mechanical measurements (tensile strength, modulus of elasticity) prevents precise quantification of the lianas' performance loss. Visual assessment involves a degree of subjectivity, even though the evaluation grid was designed to minimize it. Finally, estimating the age of the structures relies on the inhabitants' memories and may contain a margin of error. Nevertheless, the triangulation of sources and methods provides sufficient robustness to the results to achieve the study's objectives.

4. Results

The cross-analysis of interviews, field observations and visual inspection of constructions has yielded a set of consistent results concerning the use and sustainability of *Eremospatha* (Kekele) *lianas* in Kisangani.

4.1. Ethnobotanical Knowledge and Selection Practices

Interviews with the artisans revealed a detailed and shared knowledge of the lianas. Two main types of Kekele are distinguished locally, based on morphological criteria and perceived properties:

"Kekele ya Mobali" (the male Kekele): Described by artisans as stiffer, thicker, and more difficult to work with. It is perceived as more resistant and is preferentially used for critical ligation points in the main structure.

"Kekele ya Mwasi" (the female Kekele): Described by artisans as thinner, more flexible and easier to handle. It is used for secondary bindings, fixing infill elements (such as mud-brick partitions) and for crafts.

In the forest, the selection process focuses on lianas that have reached an optimal level of maturity—neither too young (brittle) nor too old (rigid and fibrous). The artisans look for stems of a consistent diameter, free from visible damage or signs of insect infestation. The harvest period is also considered important, with most artisans agreeing that lianas harvested during the dry season are of higher quality.

4.2. Preparation and Implementation Techniques

Once harvested, the vines undergo a systematic preparation process. They are first left to dry in the shade for one to two weeks to reduce their initial moisture content. Just before use, they are re-moistened by soaking them in water for several hours, which restores the flexibility needed to be knotted and stretched. This step is considered crucial by all artisans to ensure effective tightening, which will be further strengthened during the final drying process in situ.

Observation of knot-tying techniques has allowed the identification of several types of complex knots, adapted to different assembly configurations (corner knots, crossover knots, etc.). Tensioning is done manually with considerable force, ensuring a tight, play-free assembly of the wooden pieces.

4.3. In-Situ Sustainability Assessment

Visual analysis of the 50 structures provided empirical data on the longevity of the vines as a function of their exposure. The results are summarized in Table 1.

It is clear from these observations that the durability of Kekele vines is directly correlated to their protection against moisture. The most durable structures, with a lifespan of up to 8 years, systematically integrate protective architectural features. These included wide roof overhangs (averaging 60 - 80 cm) that protect the walls from rain, and raised foundations (at least 30 cm above the ground) preventing direct contact of the lianas with soil moisture.

Table 1. State of degradation of Kekele vines according to age and exposure.

Type of exposure	State observed	Estimated functional lifespan
Protected location (interior, under the roof)	Mechanical integrity intact, natural color, flexibility preserved.	Over 8 years.
Exposure to the elements (fences, exterior walls)	Blackening, mold (black/grey), radial cracks, loss of flexibility.	2 to 3 years (requires frequent replacement).
Direct contact with the ground	Rapid rotting, presence of termite galleries, and breakdown of fiber cohesion.	Very short (most critical factor in degradation).

4.4. Maintenance Practices

The analysis of the interviews made it possible to document an implicit maintenance schedule, summarized in Table 2.

Table 2. Recommended maintenance schedule for Kekele ligatures.

Location of the ligature	Maintenance/Replacement Frequency	Recommended technique
Exterior fencing elements	Every 2 to 3 years	Systematic replacement after detection of mold or cracks
Internal framework and ties (protected)	Inspection every 5 years; replacement after 8 years and more	Preventive replacement if signs of drying out (becoming brittle) appear

The interviews confirmed that users have a good understanding of these phenomena and incorporate regular maintenance practices. Preventive replacement of the most exposed ties is a common practice, often carried out every 2 to 3 years for fence elements or the lower parts of walls. This proactive maintenance is a key element of the overall durability of the vernacular building system.

5. Discussion

The results of this empirical study, while qualitative, offer substantial insights into the performance of *Eremospatha* (Kekele) *lianas* as a vernacular building material. They allow us to compare traditional knowledge with established scientific concepts in materials science and ecology, and to position this material within the broader context of sustainable construction.

5.1. Validation of Ethnobotanical Knowledge

The local distinction between “Kekele ya Mobali” and “Kekele ya Mwasi” is a fas-

cinating example of ethnobotanical classification. While it does not necessarily correspond to a formal botanical distinction between species (it could reflect stages of maturity or phenotypic variations within a single species), it reflects a nuanced empirical understanding of the mechanical properties of lianas. The more rigid and resistant "male Kekele" is logically reserved for the most demanding applications, corresponding to an intuitive optimization of material use. This practice echoes similar knowledge documented in other cultures that depend on forest products [5]. The rigorous selection of stems in the forest and adherence to seasonal harvesting are also practices aimed at ensuring maximum quality and durability, principles that are central to sustainable resource management [7].

5.2. Humidity: A Key Factor in Durability

The most striking result of this study is the predominant role of moisture as a degrading agent in *Kekele lianas*. The observations (**Table 1**) dramatically confirm the findings of research on natural fibers and bio-based materials: contact with water and high ambient humidity are the main enemies of their durability [11]. The blackening, loss of flexibility, and the appearance of mold observed on exposed lianas are classic indicators of fungal degradation of lignocellulose. Rapid rotting upon contact with the soil is due to the combined action of stagnant moisture and a maximum biological load (soil microorganisms, termites).

Conversely, the remarkable longevity of the vines in a protected environment (over 8 years of functional lifespan) is crucial information. It demonstrates that the material itself possesses very respectable intrinsic durability. The key to its performance, therefore, lies not in absolute resistance to degradation, but in intelligent implementation that protects it from environmental stresses. Vernacular design principles, such as the use of stone or masonry foundations to isolate the timber structure from the ground, and wide roof overhangs to protect the walls from rain, appear not as architectural details, but as fundamental and deliberate sustainability strategies.

5.3. Comparison with Other Natural Materials

The observed durability of Kekele can be compared to that of other natural building materials. For example, bamboo, another material widely used in tropical regions, presents similar durability challenges related to humidity and insect infestations. Without treatment, bamboo's lifespan outdoors is often limited to a few years. Traditional knowledge has also developed treatment techniques (soaking, smoking) to improve its longevity. Kekele's performance, particularly its flexibility and tensile strength for bindings, positions it as a complementary rather than competitive material to wood or bamboo. Its role is that of a natural "nail" or "screw", a flexible and resilient connector.

5.4. Implications for Sustainable Construction

This study has important implications for the promotion of sustainable construc-

tion in the DRC and in similar contexts.

First, it scientifically validates the effectiveness of a local, abundant, and renewable material. The use of Kekele reduces dependence on imported manufactured products (nails, wire, synthetic ropes), which have a much higher economic cost and environmental impact (carbon footprint, non-biodegradable waste).

Secondly, it highlights that durability is not merely an intrinsic property of the material, but an emergent quality of the entire construction system, including architectural design, implementation techniques, and maintenance practices. Promoting construction using local materials therefore requires valuing and transmitting the associated knowledge.

Thirdly, it opens up interesting avenues for research. Further studies could aim to botanically identify the different varieties of Kekele, quantify their mechanical properties before and after aging, and analyze the effectiveness of simple and environmentally friendly preservation treatments (e.g., lime treatment, salt treatment, smoking) to improve their durability under exposed conditions. A comparative life cycle analysis between a Kekele binding and a metal assembly could precisely quantify the environmental benefits.

6. Conclusions

This study provided an initial empirical assessment of the durability of *Eremospatha spp*. (Kekele) lianas, a fundamental building material in the vernacular architecture of Kisangani. Using a qualitative methodology that places local knowledge at the heart of the analysis, the research demonstrated that Kekele, when selected, prepared, and implemented according to traditional practices, constitutes a reliable and durable binding solution, particularly for applications protected from the elements. Its functional lifespan, which can exceed eight years under optimal conditions, attests to the performance of this bio-based material.

Discussion on Botanical Correlations: The distinction between "male" and "female" Kekele, as perceived by the artisans, likely corresponds to different species or variations in the maturity of the lianas. For instance, the "male" Kekele could correspond to Eremospatha cabrae, known for its robustness, while the "female" Kekele might be Eremospatha haullevilleana, which is generally more flexible. Further botanical and mechanical studies are needed to confirm these hypotheses.

The main findings of this study are as follows:

1) **Validation of indigenous knowledge**: The practices of local artisans (distinguishing between types of lianas, preparation techniques, maintenance strategies) are not anecdotal but constitute a coherent and effective body of technical knowledge, validated by centuries of experimentation. The ethnoscientific approach has proven relevant in revealing the logic and rationality underlying these practices.

2) **The crucial importance of design**: The durability of the Kekele is less an absolute intrinsic property than a systemic characteristic. It is the intelligent architectural design (foundations, roof overhangs) that, by protecting the vine from

moisture, guarantees its longevity. This underscores that the promotion of local materials is inseparable from the promotion of bioclimatic design principles adapted to them.

3) **Potential for sustainable construction**: In a context of seeking low-environmental-impact and economically accessible construction solutions, Kekele represents a credible alternative to industrial bonding materials. Its renewable nature, local availability, low embodied energy, and biodegradability at the end of its life are major advantages.

This research paves the way for future investigations. Quantitative studies on the mechanical properties of different Kekele varieties, as well as research on simple and environmentally friendly preservation methods, would be valuable additions. It would also be relevant to conduct an economic and life-cycle analysis to quantify the advantages of this local sector compared to imported alternatives.

In conclusion, far from being a relic of the past, the use of Kekele vines in construction in Kisangani is a lesson in sustainability and resilience. Valuing and supporting this type of know-how is not only an act of cultural preservation, but also a relevant strategy for building a more sustainable future rooted in local realities.

Conflicts of Interest

The author declares no conflicts of interest.

References

[1] Chamberlain, J., Small, C. and Baumflek, M. (2019) Sustainable Forest Management for Nontimber Products. *Sustainability*, **11**, Article 2670. https://doi.org/10.3390/su11092670

[2] Sunderland, T.C.H. (2004) Indigenous Nomenclature, Classification, and Utilization of African Rattans. *Advances in Economics Botany*, **15**, 175-213.

[3] Muhwezi, O., Cunningham, A.B. and Bukenya-Ziraba, R. (2009) Lianas and Livelihoods: The Role of Fibrous Forest Plants in Food Security and Society around Bwindi Impenetrable National Park, Uganda. *Economic Botany*, **63**, 340-352. https://doi.org/10.1007/s12231-009-9096-1

[4] Awoussi, M.Y., Domtse, E.K.A., Gake, D.K., Genovese, P.V. and Dziwonou, Y. (2025) Analysis of the Sustainability Elements of Vernacular Architecture in Northern Togo: The Case of the Kara Region. *Sustainability*, **17**, Article 2450. https://doi.org/10.3390/su17062450

[5] Muhesi, E.K., Betti, J.L., Din, N., Kapiri, M.M., Afiong, H.N.N. and Fils, P.B. (2023) Ethnobotanical Knowledge of Prunus Africana (Hook. F.) Kalkman (Rosaceae) by People Living in Community Forests in North Kivu, Eastern Democratic Republic of Congo. *Ethnobotany Research and Applications*, **26**, 1-28. https://doi.org/10.32859/era.26.12.1-28

[6] Wang, S., Wang, W., Gu, J., Li, Z., Wang, Y. and Yang, L. (2023) Lianas Have a Faster Resource Acquisition Strategy than Trees: Below-Ground Evidence from Root Traits, Phylogeny and the Root Economics Space. *Journal of Ecology*, **111**, 436-448. https://doi.org/10.1111/1365-2745.14035

[7] Belcher, B., Ruíz-Pérez, M. and Achdiawan, R. (2005) Global Patterns and Trends in

the Use and Management of Commercial NTFPs: Implications for Livelihoods and Conservation. *World Development*, **33**, 1435-1452. https://doi.org/10.1016/j.worlddev.2004.10.007

[8] Dalu, M.T.B., Gunter, A.W., Makatu, M., Dowo, G.M., Dondofema, F. and Dalu, T. (2021) Contribution of Natural Forest Products to Rural Livelihoods at Mavunde and Sambandou Villages, Vhembe Biosphere Reserve, South Africa. *Sustainability*, **13**, Article 4252. https://doi.org/10.3390/su13084252

[9] United Nations Environment Programme (2024) 2023 Global Status Report for Buildings and Construction: Beyond foundations—Mainstreaming Sustainable Solutions to Cut Emissions from the Buildings Sector. United Nations Environment Programme.

[10] Elfaleh, I., Abbassi, F., Habibi, M., Ahmad, F., Guedri, M., Nasri, M., *et al.* (2023) A Comprehensive Review of Natural Fibers and Their Composites: An Eco-Friendly Alternative to Conventional Materials. *Results in Engineering*, **19**, Article 101271. https://doi.org/10.1016/j.rineng.2023.101271

[11] Pavlovic, A., Valzania, L. and Minak, G. (2025) Effects of Moisture Absorption on the Mechanical and Fatigue Properties of Natural Fiber Composites: A Review. *Polymers*, **17**, Article 1996. https://doi.org/10.3390/polym17141996