Journal of Environmental Science, Ecology & Chemistry

JESC, 1(2), 63-70, 2025
https://doi.org/10.58985/jesec.2025.v01i02.06
eISSN: 0000-0000

Research Article

Evaluating indigenous knowledge of non-native mangrove palm (*Nypa fruticans Van Wurmb)* in the Douala-Edea national park, Cameroon

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Article Information
Received: 29 December 2024
Revised: 10 February 2025
Accepted: 14 February 2025
Published: 13 March 2025

Academic Editor
Prof. Dr. Giuseppe Oliveto

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Keywords
Invasion, local perceptions, mangrove, *Nypa, fruticans*, palm.

Abstract

Nypa fruticans Van Wurmb, commonly known as 'Natte De Mami Water' or 'Na Jahjah,' is a versatile palm that serves various purposes, including roof thatching, partitioning, food sources, medicinal applications, and fuel wood. Its rhizomes are particularly important for fishing and enhance the buoyancy of nets on the water's surface. Additionally, *Nypa fruticans* plays a crucial role in soil stabilization, erosion protection, and mitigating the impacts of cyclones and high sea waves in coastal areas. This study aimed to investigate the indigenous knowledge, perceptions, and utilization of the non-native mangrove palm, *Nypa fruticans Van Wurmb*. Methodologically, data were collected using Participatory Rural Appraisal (PRA) tools, which included semi-structured interviews with local residents, primarily fishermen, living near the mangroves. Field observations complemented the interviews. A purposive sampling approach was employed to administer questionnaires that gathered public opinions. Primary data on the utilization of Nypa were obtained through direct interviews with community members using detailed household questionnaires designed to capture both quantitative and qualitative insights. The findings reveal that the palm is significantly undervalued by local inhabitants, who primarily acquire it through self-exploitation, with limited commercial activity and insufficient adaptation and management strategies regarding its use. To address these challenges, this study proposes recommendations for sustainable management practices aimed at enhancing the value and utilization of *Nypa fruticans* within the community.

1. Introduction

Nypa palms usually thrive well in sediments deposited by an accreting process by the sea, creating a clayish type of soil, with brackish water that promotes an anaerobic system [1]. This Nypa *fructicans* is native to Singapore and was introduced in Nigeria in 1906 to control erosion has been reported to have spread across extensive areas replacing native mangroves [2]. *Nypa fruticans* is an important component of the East Asian mangrove vegetation. It is one of the oldest living palms [3]. In Bangladesh, the natural distribution of the Nypa Palm is restricted to the 'Sundarbans', the largest single continuous tract of

mangrove forest in the world [4]. It was introduced into West Africa in the early 1900s, specifically, Oron (4.8°N, 8.2°E, Nigeria) in 1906 and Calabar (Nigeria) in 1912. Today, it has colonized large areas along the coastline of the Bight of Biafra, particularly in brackish and sheltered tidal areas such as river delta areas where dicotyledonous mangrove species are more commonly found. The species has now established itself as far south as the Wouri Estuary near Douala, Cameroon [5].

It grows along coastlines and estuarine habitats in the Indian and Pacific Oceans and in Africa as an exotic species. It is a stem-less palm with tall erect fronds and underground rhizomatous stem [6] possessing an extensive root system, well suited to resist swift running water [7]. *Nypa fruticans* is adapted to muddy soils in rivers and estuaries. It forms extensive stands along brackish to tidal freshwater creeks and rivers. It can thrive in freshwater environments as well as brackish conditions, demonstrating its wide ecological tolerance. It may also be found inland, as far as the tide can deposit floating seeds. It is the only palm species found in mangrove forests [8]. This species is found in the upstream estuarine zone in the low, mid, and high intertidal regions. It forms extensive belts along brackish to tidal freshwater creeks and rivers. It grows rapidly, especially in freshwater, and is a competitive species. In regions where mangrove coverage is sparse and the soil is exposed, Nypa can swiftly establish itself, outcompeting native mangrove species and leading to their permanent displacement [9,10].

The competitive Nypa palm replaces the indigenous mangrove species. The Nypa palm can grow as tall as 10 m, unlike other palms. It lacks an upright stem, instead it has thick, prostrate and rhizomatous stems that branch dichotomously underground [11]. Unfortunately, colonization has considerable ecological implications. It has been observed that Nypa is a highly opportunistic (invasive) species and its dense monospecific stands outcompete indigenous mangrove vegetation. This is exacerbated by the fact that much of the mangrove forest of Cameroon is being felled to provide fuel wood for smoking fish for commercial sale along with other anthropogenic activities, significantly weaken the resilience of mangrove ecosystems, and creating opportunities for Nypa palm to invade and establish itself in these vulnerable areas [12].

Nypa palms can ecologically disrupt the balance of the ecosystem due to their invasive nature in disturbed mangrove forest areas, on the other hand Nypa palms have ecological and economic functions. Nypa is able to stabilize soil in coastal areas, protect against soil erosion due to waves and wind, as well as reduce the strength of cyclones and high sea waves in coastal zones [13]. Parts of the Nypa plant organs have been used by people living around the ATPF, including the leaves, stems and fruit, as well as earthworms associated with palm trees [14]. In several places in the world, various organs of Nypa have been used to make various products, such as fuel, medicine, food, clothing accessories, and so on. The Nypa palm is often undervalued compared to other species within the mangrove ecosystem due to limited understanding and fewer studies on its ecological uses of the Nypa palm; however, local people harvest several metric tonnes of Nypa per annum for various traditional uses. Although very little has been documented on its ecological benefits, it possesses several economic benefits. The dye from the fruits is used to dye fishing nets, which apparently makes them less conspicuous and thus improves catch rates, and the seeds are used for making jewelry and hair clips. In Southeast Asian countries, Nypa leaves are used as roofing mats and for hat making [15].

In Bangladesh and India, *Nypa fruticans* commonly known as 'golpata' is used mainly for roof thatching, food, fuel, fence-making, medicine, cigarette wrapping, molasses, wine and fishing.The kernels of immature fruits are used as food sources. The juice is used to make molasses, locally called Gur, and alcohol. Newly developed shoots have been reported to be used as vermicides. Ash from the palm is used as an analgesic against tooth pain and headaches, and for treating herpes [15]. Dry leaves, petioles, stem wood and fruit residues are used as fuel and the sap is also used for fattening livestock [8]. The Nypa palm has great economic value in other parts of the world, but its importance is usually under-emphasized. There are also limited strategies to aid different stakeholders in finding adequate planning for better management

https://doi.org/10.58985/jesec.2025.v01i02.06

and utilization of Nypa. Limited experimental scientific data exist and the Nypa palm is undervalued, hence this research is therefore intended to contribute scientifically in this regard.

2. Materials and methods

2.1. Study area

The Douala-Edéa National Park is situated at latitude (3° 14′ 3°50′N) and longitude (9°34′10°03′ E) (Fig. 1). It is located at 75 km southwest of Douala in the Districts of Mouanko and Manoka in the Littoral Region within the Douala-Kribi basin of the coastal Atlantic Ocean which stretches for 100 km along the Cameroon coastline [13].

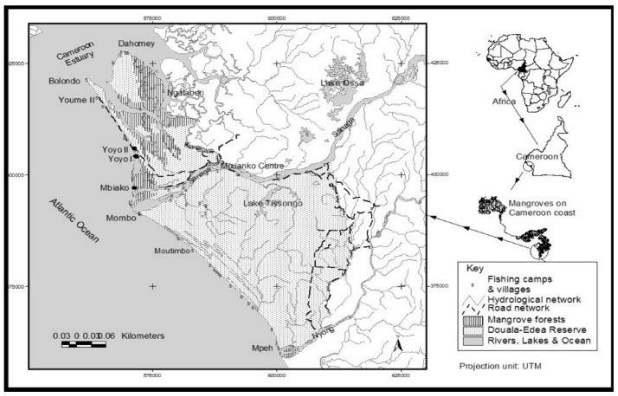

Figure 1. Location of the mangroves of the Douala–Edea National Park Cameroon [23].

Located in the coastal plain, it extends from the Atlantic coast to a maximum distance of 35 km, with its eastern limit following the Dipombe River. The park is made up of two unequal parts: the largest, in the south, is between the mouths of Sanaga to the North and Nyong to the South; the other extends along the northern coast of Sanaga to Souelaba Point and is bounded on the east by Kwa Kwa Creek. Mouanko is a town and community in the Sanaga maritime area, lying on the north bank of the Sanaga River in the Littoral Region of Cameroon. The Division (Sanaga Maritime) covers an area of 9,311 km² and as of 2001 had a total population of 167,661 [16].

The population includes Nigerian, Beninois and Ghanaian immigrant fishermen; who are often seen along the Atlantic coast. Along the rivers that create the park's natural boundaries, particularly the Sanaga, lie significant villages that have long been established and are inhabited by the Bakoko and Malimba ethnic groups. The inhabitants of these new villages belong to the Bakoko ethnic group and other groups that have installed like Bassa (from Edéa) and Ewondo coming from even further to ballast. Hunters from Douala and Edéa enter the park along the road between Dizangue and the fishing villages of Yoyo. Penetration can also be made from the Abé locality on the Edéa-Kribi axis [17].

2.2. Sampling method

A public survey was conducted through the administration of questionnaires and collection of general public opinion from respondents. Primary data on Nypa utilization were obtained through direct interviews with local people using detailed household questionnaires. Purposive sampling was employed and 60 (40%) questionnaires were administered in the Yoyo I community, 59 (39.3%) were administered in Mbiako and 31 (20.7%) were administered in the Yoyo II community making a total of 150 completed questionnaires in the three sampled communities. Selection was based on population density and availability of Nypa palms in the community (Fig. 2).

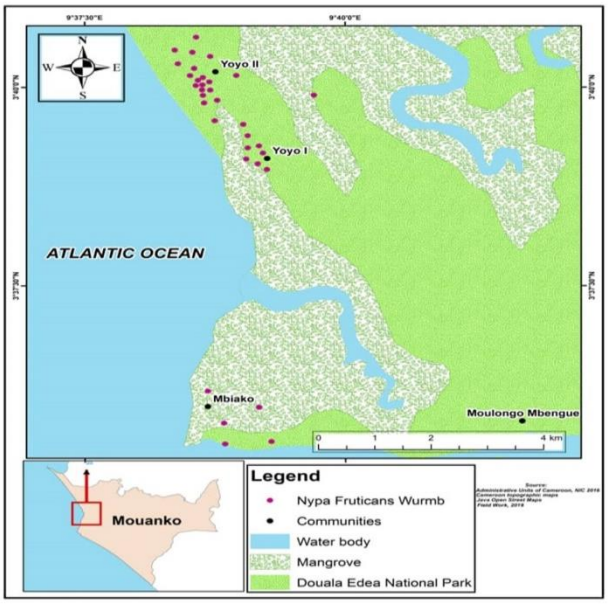

Figure 2. Map showing distribution of Nypa palm in Yoyo I, Yoyo II and Mbiako Cameroon.

The data were generated by conducting semi-structured interviews with local residents (mostly fishermen living in the immediate vicinity of

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mangroves) and our field-based observations. From March 20, 2019, to May 1, 2019, semi-structured questionnaires were utilized to explore the different clans within the three sampled localities: Yoyo I, Yoyo II, and Mbiako communities, with the number of respondents being 60, 30, and 60, respectively. Most interviews were conducted in Pidgin English, English and French, except in a few cases where a local language called 'Malimba' was used with the help of a translator. Household visits were carried out at the end of the day after the locals returned from their occupation/fishing activities. Households were sampled opportunistically (*i.e.*, respondents encountered in the houses were interviewed, and people away from their homes were questioned where possible). The direct observation method was also used.

To avoid recurrent information, only one person (> 20 years of age) per household was questioned. Preference was given to elderly people who had lived on the site for more than a generation and could therefore relate changes that occurred in adjacent mangroves to certain events or conditions. A catalogue showing *Nypa fruticans* leaves, fruits and flowers was used to assess the level of each respondent's knowledge of the species and data on local people's demography (*e.g.*, age, gender, etc.) along with plant vernacular names and usages, were gathered from the household interviews. The questionnaire consisted of sections on respondent identification, awareness and utilization of Nypa palm, its cultural significance, external exploitation, changes in coverage over time, wildlife presence, and management opinions regarding invasive Nypa palm. The interviewees were asked whether the surrounding Nypa forest had increased, decreased, or remained unchanged in cover. Likewise, an attempt was made to distinguish whether local informants perceived mangrove forests as less or more degraded over time as a result of *Nypa fruticans* spread. They were urged to provide the causes of the reported changes along with their consequences on their livelihood. Local inhabitants were also asked questions about any observed disturbances in the mangrove ecosystem caused *Nypa fruticans*.

2.3. Data analysis

Data were collected on scale and categorical variables (e.g. occupation, marital status, age,) and were explored using frequency tables. Open-ended questions were analyzed through thematic analysis, where responses were grouped into major themes and quotations were provided to describe these themes.

Quantitative data were entered into a pre-designed SPSS 23.0 (IBM, 2016) spreadsheet database, which has in-built consistency and validation checks were used to enter the data. Data range and validation checks were performed to identify invalid codes. Microsoft Office Excel Version 10.0 was used to plot charts and statistical tables were designed using Microsoft Office Word Version 10.0. Data are presented using maps, frequency tables, graphs and charts.

3. Results

3.1. Demographic information

The age range was divided into six categories: 18-20 years, 21-35 years, 36-45 years, and individuals over 50. Based on the data collected, most respondents (41.3%) were in the 36-45 age range, followed by those aged 21-35 at 30.0%. Respondents over 50 years of age accounted for 15.3%, while those in the 18-20 range make up the smallest group at 13.3%. Thus, most of the population is within the working age group.

Regarding educational attainment, respondents were categorized as having no formal education, primary, secondary, or university education. Among all respondents, 92 (61.3%) reported having no education, 52 (34.7%) completed primary school, 6 (4%) achieved secondary education, and none (0%) attended university or higher level institutions.

The occupations considered in this study were farming, fishing, business, civil service, and hunting. A significant portion of respondents, 73 (48.7%), identified as businesspeople, while 38 (25.3%) were involved in fishing. Farmers comprised 13 (8.7%), hunters accounted for 7 (4.7%), and 19 (12.7%) respondents reported having no specific occupation.

3.2. Local knowledge and value of the palm

Table 1 shows the local awareness of Nypa palm existence by respondents in the three sampled communities. A total of 137 (91.3%) of the respondents knew about Nypa palm and had little knowledge about its existence while 13 (8.7%) had no idea of

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Table 1. Awareness on the existence of the palm by respondents.

Knowledge About the Palm	Frequency	Percentage (%)
No	13	8.7
Yes	137	91.3
Total	150	100.0

Nypa palm (Table 1).

The majority of respondents (70%) had no idea or did not attach any significant importance to the mangrove palm in the area, compared to (30%) who viewed the palm as an important plant species. Furthermore, of the 30% who reported that the palm could be important, only 25.3% acknowledged having actually used the palm in one way or another, while a majority of 74.7% had no use of Nypa palm (Fig. 3).

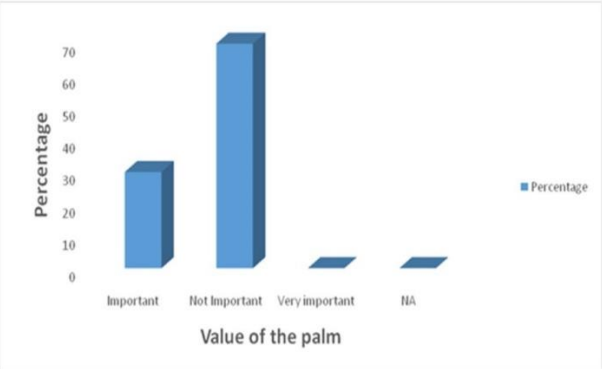

Figure 3. Value of Nypa palm in the sample area.

3.3. Local uses of Nypa palm in the study area

The significance of the mangrove palm in the area primarily lies in its use for local construction, as a substitute fuel source, and for decoration. Specifically, 14% of respondents reported using Nypa for small-scale construction and fuel, while 4.7% acknowledged using it solely for fuel. Additionally, 4.7% of the responded used the palm for decorative purposes, and 2% used it exclusively for small-scale local construction. Notably, a substantial majority (74.7%) of the responded indicated that they had no use for Nypa palms.

It is important to highlight that 100% of the respondents stated that the palm is not consumed and serves no consumption purpose. Furthermore, all respondents reported that the Nypa palm holds no cultural significance for the community. The frequency of palm usage was reported as inconsistent, varying by individual and over time, as residents do not heavily depend on or value the palm trees. Respondents typically acquire Nypa through self-exploitation as needed, with no commercial utilization was reported. Local opinions on the use of Nypa palm across the three sampled communities were consistent, with inhabitants utilizing the palm in similar ways (Fig. 4).

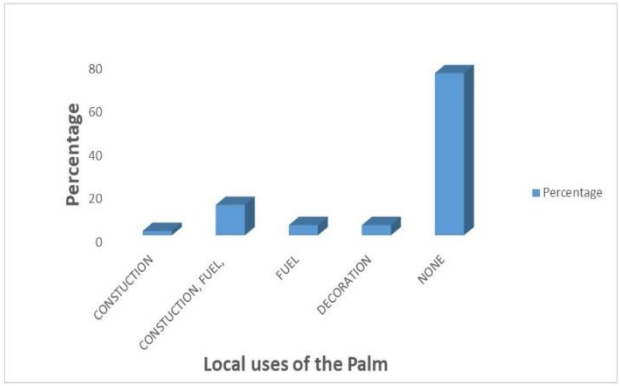

Figure 4. Uses of Nypa palm in the study area.

3.4. Respondents' knowledge on the impact of Nypa palm spread on the ecosystem

A significant 55.3% of respondents indicated that the spread of invasive Nypa palms led to the destruction of native mangrove species, resulting in a substantial decline in the native mangrove population. Additionally, 25.3% reported that the proliferation of Nypa palms adversely affects fishing in the creek, as dense clumps of Nypa provide hiding spots for fish, making it more difficult to catch them. This issue parallels the impact on hunting activities, with 4.3% of respondents noting similar challenges. Furthermore, the spread of the Nypa palm has reduced the available land for other activities, such as farming, as reported by 9.3% of respondents. Additionally, 5.3% highlighted the negative environmental impact of pollution caused by the palm's spread, noting that its seeds litter the beach and ocean (Fig. 5).

3.5. Major coping or adaptation strategies to handle the spread of the palm

The implications of the spread of Nypa palm are well recognized by the local community, as it disrupts their way of life and appears to be spreading throughout their neighborhoods.

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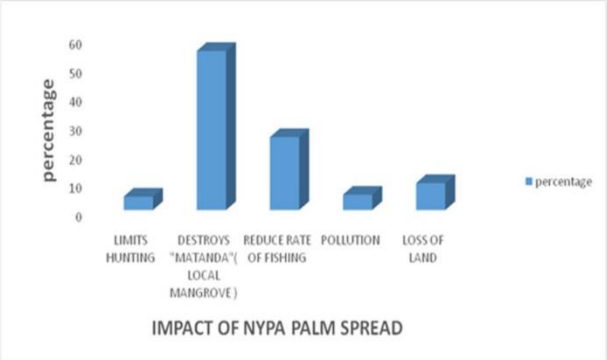

Figure 5. Impact of Nypa Palm spread on the ecosystem.

To combat this issue, several adaptation strategies have been implemented, including the cutting and destruction of Nypa palm stands, as well as regeneration projects for native mangroves. A significant 83.3% of respondents advocated for the enforcement of eradication schemes, while 13.3% suggested implementing research and training programs to help locals understand the potential benefits of the palm. Meanwhile, 3.4% remained neutral, expressing a desire to let nature take its course (Fig. 6).

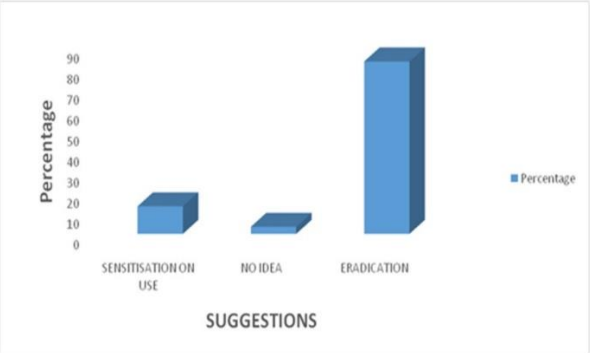

Figure 6. Proposed strategies by local population to counter Nypa palm spread.

4. Discussion

The results, showed that the respondents had limited knowledge and underutilization of the palm compared to the findings of Nha [18] in TraVinh province generally and Chau Thanh district showed high values generated mainly from Nypa leaves (7.67 million VND/ha/year or 500USD/ha/year), trunks (only 432 thousand VND/ha/year or 30USD/ha/year). Moreover, in terms of providing fish, farmers earn about 3.2 million VND/ha/year or about 220USD/ha/year) [18].

It was reported that the frequency in which the palm was required was not stable and varies with period and on each individual since inhabitants in the area don't depend and attach so much value to the palm. Respondents acquired the palm through self-exploitation when needed and there is no commercial activity concerning the Nypa palm in the area. This is contrary to other studies [19, 20]. from an economic viewpoint, even though tapping of Nypa saps could be labor-intensive, it could create a considerable number of jobs and help generate sustainable livelihoods for coastal communities [19, 20].

The importance of mangrove palms in the area is mainly for local construction, as a substitute source of fuel and for decoration. In Bangladesh and India, *Nypa fruticans* is used mainly for roof thatching, food, fuel, fence-making, medicine, cigarette wrapping, molasses, wine and fishing. The kernels of immature fruits are used as food and also used for making molasses, locally called Gur, and alcohol. Newly developed shoots are reported to be used as vermicides, ash from the palm is used as an analgesic against tooth pain and headache, and for treating herpes, dry leaves, petiole, stem wood, and fruit residues are used as fuel [8]. The rhizomes of the palm are extensively used in fishing, facilitating the fishing net to float over the water surface. Farmers also reported that Nypa in rivers or the sea attracts deep-water fish. The sap is also used for fattening livestock [8]. [21, 22]. In Nigeria, dye from the fruits is used to dye fishing nets, which apparently make them less conspicuous and thus improve catch rates. In some villages in Nigeria, the seeds are used to make jewelry and hair clips. Leaves are also used as roofing mats and for hat making [15].

The results revealed that the spread of invasive Nypa palms has led to the destruction of native mangrove species and greatly reducing the native mangrove population and causing negative environmental impacts, such as pollution caused by the spread of the palm seeds all over the beach and ocean. This is similar to other research findings that stated that, *Nypa fruticans* displaces native mangrove vegetation throughout the Niger Delta and in Cameroon and forms dense monospecific stands that outcompete native species [9]. Particularly in areas where native

https://doi.org/10.58985/jesec.2025.v01i02.06

red and white mangroves (Rhizophora sp.) are felled for fuel wood and sale, the resulting exposed mudflats are readily colonised by opportunistic *Nypa fruticans*. In such areas where Nypa is dominant, there is often a low incidence of encrusting tree fauna and little or no evidence of burrowing crabs due to the dense stand structure of the palm [22, 5]. Its dense structure also chokes mangrove vegetation, in which fish breed, and thus may contribute to the decline of fish populations in the area [5].

It was also revealed that floating masses of Nypa palm can destroy nets and cages set by fisherman, potentially having economic impacts. This is similar to findings where the displacement of native mangrove species also deprives fishermen of fuel wood for smoke-drying fish and constructing huts [22]. The adaptation strategies put in place included, cutting and destruction of Nypa palm stands and regeneration projects of native mangroves to help combat the spread of the palm and respondents proposed the enforcement of beneficial eradication schemes, which is similar to Nha T. [18]. People in Chau Thanh district started extracting Nypa palms, and the Nypa area has been reduced sharply from 0.94 ha/household to 0.56 ha/household. Nypa palms in Tra Vinh province generally and Chau Thanh district in particular, are endangered by local people' activities. In this case, Nypa is the main income source of many households and farmers cut Nypa leaves almost every day without any consideration about the resource's rehabilitation for the future [18].

5. Conclusions

The results indicate that *Nypa fruticans* palms are significantly undervalued by local communities. The data reveal that respondents primarily obtain this palm through self-exploitation, with minimal involvement in commercial activities. Furthermore, there appears to be a lack of effective adaptation and management strategies regarding the utilization of the Nypa palm, highlighting a critical gap in sustainable practices within the communities around the Park. To enhance the sustainable use of *Nypa fruticans*, it is essential to implement community-based management strategies that promote awareness of its ecological and economic value. Training programs focusing on sustainable harvesting techniques and developing value-added products could empower local inhabitants and improve their livelihoods. Additionally, integrating indigenous knowledge with scientific research could foster more effective conservation and utilization strategies for this valuable palm species.

Disclaimer (artificial intelligence)

Author(s) hereby state that no generative AI tools such as Large Language Models (ChatGPT, Copilot, etc.) and text-to-image generators were utilized in the preparation or editing of this manuscript.

Authors' contributions

Conceptualization and research design, G.N.N.T., A.F.N., K.P.; Data collection and analysis, G.N.N.T., P.B., D.C.M., N.N., L.R.L.; Supervision and drafted the manuscript, G.N.N.T.

Acknowledgements

The authors would like to express their heartfelt gratitude to the community members, field assistants, staff of the Douala-Edea National Park, and COSUDEAG for their invaluable contributions to the successful completion of this study. We also extend our thanks to the Department of Environmental Science, Faculty of Science, University of Buea, for their support, which made this research possible.

Funding

This research received no external funding.

Availability of data and materials

The data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of interest

The authors declare that there are no conflict interests.

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