



Ethnobotanical and Ecological Study of *Momordica balsamina* Plant Used in Chad

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Abstract

This study explores the ethnoecology, use of *M. balsamina* plant in traditional medicine and its magical environment in the Mongo-Léré region of Northern Chad. The plant is considered a celebrity due to its diverse uses, with tribal people having a rich knowledge about its diverse uses. However, the knowledge about *M. balsamina* is declining, and ethnomedicinal knowledge is mainly transferred to people and cultural festivals. The study aims to document the knowledge and practices of the population on *M. balsamina*, including its significance, value, and various applications. It also aims to resolve knowledge conflict by making an ethnobotanical and ecological contribution to the development of Chadian ethnobotany. The study reveals that only women are familiar with *M. balsamina*'s use in reproductive physiology, constipation, and dental care. Factors like agricultural development and urbanization threaten the species' sustainability. The study aims to revalorize and enhance the diversified uses of *M. balsamina* by local populations, addressing threats like thrips, deforestation, overgrazing, drought, fire, and accessibility. The study highlights the medicinal importance of *M. balsamina* in households and traditional healers of two ethnic groups in Chad. The varied use of this wild plant contributes to the health of the population living in remote areas. Special efforts are needed to enhance the sustainable use of these wild resources through plantation propagation. Further phytochemical studies related to flavonoids and polyphenols, essential oil extraction, and biological activities are suggested.

Subject Areas

Ecology, Ecosystem Science, Plant Science

Keywords

Momordica balsamina, Plant, Chad, Ethnobotany, Traditional Medicine

1. Introduction

Momordica balsamina is a ubiquitous plant known in many countries and used as food, timber, and medicine for a long time. The aim of this work is to investigate the ethnoecology, the use of the *M. balsamina* plant in traditional medicine, as an umbrella species, and in the magical environment in the region of Mongo-Léré, Northern Chad. Overall, we have established that the seeds and leaves are the most frequently used parts in traditional medicine. *M. balsamina* has been considered a celebrity plant because of its wide multipurpose uses. Tribal people exhibit a rich knowledge of diverse uses of this plant species. Our results indicated that the knowledge about *M. balsamina* is declining and the ethnomedicinal knowledge is mainly transferred to people and the cultural festival. The festival is the occasion for the transmission of knowledge between the young and old generations, and knowledge transmission is realized by traditional healers through practical experience [1] [2].

The use of plant species as an umbrella for phytodiversity conservation was reported. Our findings suggest that *M. balsamina* is one of the most useful plant species in both an ethnoecological and ethnomedicinal context. Moreover, the culture of the native ethnic group is strongly linked to *M. balsamina*, which is used in many domains of life for the well-being of society. The use of *M. balsamina* has contributed significantly to the improvement of the living of local communities. The protection of *M. balsamina* and knowledge is of great importance in order to preserve and share the cultural heritage. Authorities should promote better management and strategies that can foster the sustainable use of these natural resources [3].

1.1. Background and Rationale

Chad knows an extreme climatic aspect, the worst in the Sahel zone, often subjected to a certain degree of degradation, particularly around the big towns. One of the consequences of this climatic factor on vegetation has resulted in the reduction of the botanical species. This reduction of the botanical species is accompanied by a general reduction of the variety of products traditionally harvested. This study was carried out essentially in the southwestern part of Chad as well as in the region of the Far North of the country where the climate becomes more sub-desertic. If we look at the plant fright, we observe that only the rainy season reassures the supply of the forest from where the products come.

The moisture brought during this season promotes the good development of a large number of botanical species, in which are integrated some species, mainly wild, used in everyday life by the populations. This precariousness of the environment and its management cause invaluable losses because after the rainy season, the majority of the trees and shrubs begin to produce baobab and even a little before the rainy season. In addition, Chad remains rich in wild trees and shrubs destined for alternative uses during the long dry season, on some species agonizing of the aromatic qualities of their organs used in food. In any case, many

families fall back on other types of resources, such as the balsamina popcorn economy which leads them to exercise another activity related to the environment.

1.2. Research Objectives

The present research work aims to study the different uses of *Momordica balsamina* in daily life and its valorization through transformation. The knowledge and practices of the population were inventoried in the search area in Chad. Bibliographic information was also gathered from the center-western region of Chad. The ecological station of the species and its growth in the ecological area were defined through laboratory work, as well as the period of fruit production. We aim to document the knowledge that the population of Chad has on *M. balsamina*, including its significance, value, and various applications. The species is used daily for medical and alimentary purposes.

All steps taken in the region of Koundou in Chad have the objective of reporting the maximum information regarding the species in this region, which can serve the people of Chad as an opportunity to familiarize themselves with the fields of ethnobotany and the evaluation of flora, ecological uses, and the valorization of *M. balsamina*. Currently, the botanical discipline includes several specific objects, including linguistic classification. It presents the utilitarian direction of *Momordica balsamina* by the ethnic population from the region of Koundou in Chad, and the geography helps to install the area formation map. The results show the concern of not equalizing all ethnic communities in the natural resources of their neighboring territory.

1.3. Significance of the Study

This work aims to resolve the knowledge conflict by making an ethnobotanical and ecological contribution. It aims to achieve the following objectives in ethnobotanical research: to explore the traditional knowledge of the plant by conducting interviews and collecting information on its uses; to evaluate the traditional uses of the plant by establishing a consensus on its objectives; these analyses aim to make the traditional knowledge coherent, clarified, and neutralized. In ecological research, the objectives are: to assess the structure of the plant's habitats under socio-ecological influence; to understand its relationship with these habitats using a functional approach.

No previous work on this plant has achieved this ethno-ecological coupling, thus contributing to the development of Chadian ethnobotany. The application of such studies may seem far from the original objectives of these investigations. However, it has become difficult to ignore this question because there are undoubtedly possibilities for integrating the potential results of ethnobotanical and ecological studies into the development of Chadian, or at least African, populations. This work paves the way for the possible valorization of the *Momordica balsamina* plant for the indigenous people of southern Chad. The negative

perceptions they have of it have led them to overlook its potential positive effects. Furthermore, the actions that may arise from this research will face less resistance when integrated into local ecological systems and their management. Therefore, this work will have socio-economic impact. Its objectives have convinced us that a neutralized solution has been found to address the lack of consideration for the potentialities of the *Momordica balsamina* plant, and perhaps other known plants.

2. Botanical Description of *Momordica balsamina*

Momordica balsamina is a plant of the Cucurbitaceae family. The stem is 5-angled and striated, procumbent, angled, pubescent or glabrous, with subquadrifid tendrils at the nodes. The leaves are 3-lobed, lobes triangular or ovate, acute, with an entire or toothed margin, glabrous or slightly pubescent, and bright green. The flowers are yellow, and the corolla is 5-parted with toothed segments. The male flowers grow in axillary and racemose inflorescences, while the female flowers have a five-cell ovary. The fruit is egg-shaped or ovoid, about 5 - 7 cm across, mottled yellowish or clouded red when ripe, surrounded by sharp, red or white warts. When immature, the fruit is green. The seeds are compressed, oval, and rough [2].

Momordica balsamina is a prostrate or twining annual herb, glabrous and angular, with tendrils at leaf nodes. The leaves are deeply lobed into elliptic tooth-picks and found on the petioles. *M. balsamina* contains both male and female flowers. Male flowers have 5 petals, stamens united into a column, anthers twisted, and pistillodium rudimentary. Female flowers have 3 separate lower stamens, a 24-parted style, and lobed stigmas. The crown of the ovary consists of 6 - 8 pieces. The fruit is ovoid, compressed, with large, round, fleshy red warts, measuring 3 - 5 by 2 - 3.5 cm. The immature fruit is green and turns yellow with stripes when ripe. The seed is ellipsoid, measuring 10 × 6 mm, with a biscuit shape, fine longitudinal ridges, and a thick seed coat. However, the nutmeg-shaped alkaline amino acid and Cucurbitacin C poison in the embryo are common indicators of toxicity within the species [4].

2.1. Taxonomy and Classification

In Central Africa and particularly in Chad, the classification of the species varies in the universe of traditional knowledge among various ethnic groups and tribes. However, according to botanists, *Momordica balsamina* L. belongs to the Cucurbitaceae family. This work considered the taxonomic classification of the plant in question, *Momordica balsamina* L., among the different floristic catalogues. Taxonomy is a field of science that studies, identifies, and classifies the living world. It is a universal system of naming and classifying organisms, the taxon name applied (at all levels) to the organization chart, based on the existence of morphologically and functionally similar or different organisms. Taxonomies and classifications of living beings have a common infinity of difficulties for several reasons.

Therefore, ethnobiologists use two thesauri, which are the scientific term and the vernacular term at the same time [1].

The use of several names for the same taxonomic unit depending on the speakers was mainly due to the fact that within the ethnic groups of the same region, taxonomies were different. However, there were small variations in the nomenclature of the same species, depending on the group, sex, age, knowledge, as well as the religious belief, the status (principle or sorcerer), poisons in the ceremonies or in the medico-magico-religious practices. Researchers also agree that the same taxon is designated by variation or several names by the speakers. For example, *Momordica balsamina* L. is called: Dolmi, Chad, Gog-di in Kanembou, Oxford in Gorane, Cobra's gourd in English, and Alo, pona in Lingala. The Spanish call it Mano de tenia, amargoso, melon amargo, cundiamor, and uppermij, yemij in Arabic, and French just use the Latin binomial [5] [6].

2.2. Morphological Characteristics

The *Momordica balsamina* plant is an annual, herbaceous, or poorly woody climber. It has a stretched, angular, and bristly stem. The annoying branches are often long and approach 3 - 5 m in the wild. The alternate lanceolate leaves measure about 5 - 12 cm long and 2 - 5 cm wide. They are relatively thick and firm, and the margin is serrated along the outer face of the spinning leaf. The three to five lobed green leaf is covered with soft, white to brown hair. The palm of the plant is nearly 30 cm long and has five yellow petals. The plant stem contains male and female flowers, and the female flower contains an ovary with about five seeds [7].

The spherical fruit is 1.5 cm in diameter and has white stripes when ripe. *M. balsamina* plants produce green to brown seeds. They have a specific shape, are white to brown in color, and have a wrinkled surface. The seed has an irregular embryo that is surrounded by a white colored aril. The aril is universally positioned. There are about two oblanceolate cotyledons at the top of the aril which measures approximately 5 - 8 cm. There are some varied and similar characteristics in the fruits and seeds. The plants that are cultivated by humans have a variety of forms, colors, and shapes. For example, *M. balsamina* and *M. charantia* have two close relatives with similar medicinal properties. In fact, these plants are hard to tell apart, yet there are some differences in the "bottle shape" of the fruits and leaves [1] [8].

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3. Ethnobotanical Uses of *Momordica balsamina*

Momordica balsamina L., belonging to the family Cucurbitaceae, is widely distributed in Chad. Nearly absent from the national pharmacopoeia, ethnobotanical knowledge on the uses of *M. balsamina* in the country remains less known. The leaves and fruits of *M. balsamina* are widely used for therapeutic and other very specific purposes. The therapeutic effect claimed provides a force capable of

generating interest in the scientific community and deserves to be tested pharmacologically to be validated. The very specific use was not cited in the literature and this might be a good agro-economical discovery. With an approach mixing qualitative and quantitative techniques, ethnobotanical field studies were carried out in seven regional departments representing *M. balsamina* ecological areas [6].

Ministry of Higher Education, Scientific Research and Innovation, N'Djamena, Chad. *Momordica balsamina* L. belongs to the leafy plant family of the Flora of the Republic of Chad. It is widely distributed in different agro-ecological zones: Guéra, Salamat, Sila, Ouaddai, Mandoul and Logone Oriental. The aim of this study focused first on identifying *M. balsamina* use among the different ethnic groups and second, to document the various preparations made from different parts. It should be noted that the information gathered comes from native users who have precise knowledge about this species and are holders of use rights. This work is the result of linked skills between healers, traditional knowledge holders and scientists. The results show that this species is little known in Chad, especially by urban populations compared to some countries where the use of *M. balsamina* is regularly cited [9].

3.1. Traditional Uses in Chadian Culture

Plant species play a vital role for human populations in the Sahel, particularly in Chad. In Chad, indigenous populations have a vast traditional knowledge of indigenous plant use, considered essential for their survival and well-being. One of these plant species often used in traditional medicine is *Momordica balsamina* (by their ethnic group). This study aimed to gather indigenous bidirectional knowledge about *Momordica balsamina* and to assess its habitat conservation [6].

Using field samplings, quadrats were deployed within each area of study to calculate their ecological parameters and to measure its conservation state. Individual interviews were conducted with 573 people to assess the ethnomedicinal traditional knowledge related to *Momordica balsamina*. The study was carried out in Milé, Rig-Rig, and Mao township administrative areas in Kanem region [10].

Our results showed that only women were familiar with *Momordica balsamina*'s use in reproductive physiology (90% of certainty). They mentioned using the seeds according to the two physiological periods: to arouse caesarean breastfeeding to prevent tissue tear. Women and old men employed fruit pulp usage for constipation and to ensure prostate health. Powder of leafy material was commonly used for dental care [11] [12].

The overall analysis showed that the traditional knowledge was both indigenous and bidirectional as contributors comprised four ethnic groups. However, this information is typically transmitted between members of the same sex or within the family. There is a risk of over-exploitation or threatening the vitality and vigor of the species because its range includes the conservation area in Chad. Many of the conservation units contained *M. balsamina*, and the study showed that factors such as agricultural development, extensive grazing, and urbanization threatened

its sustainability [13] [14].

We recommend that the Chadian government and officials in charge of biodiversity advocate educational strategies and carry out sustainable conservation planning within the family circle. If these recommendations are followed, the results will lead not only to the sustainable use of this species but also to other plant species of cultural importance. They could also serve as a safeguard for creating, as soon as possible, green belt strips in some of Chad's cities or freely wooded areas to create or restore different endangered species [3].

3.2. Medicinal and Healing Properties

The survey was carried out in five (5) zones: Mouro, Oumas, Gasal, Ayhe, and Diany-Ndoulou. Data have been collected by direct interviews and the semi-structured questionnaire. 50 people significantly using *M. balsamina* (UBmps) based on their ethno-pharmacological knowledge were interviewed. The demographic characteristics of the UBmps are in the majority: men, majority of age groups 50 years and over, primary cycle level of education and above. The scientific information obtained was analyzed and complemented with the bibliographic data. In the pharmacological tests, besides the cold extraction of the plant at room temperature on the one hand and by decoction on the other hand and their dilutions, the dried leaves of *M. balsamina* were macerated with solvents (Petroleum, Chloroform, Ethyl Acetate, Methanol, Ethanol, Acetic Acid, hydrochloric, Hydrochloric/Ethanol 4:1, and Ethanol/Hydrochloric Acid 4:1) to establish the extracts [15].

Plants are also used in treating certain diseases for which conventional drug remedies are known with serious side effects. This is the case of some diseases such as: Arthritis, Diabetes Mellitus, High Blood Pressure, Wound Healing, Rheumatism, etc. The phytochemical tests emphasize the ethno-pharmacological use of the plant. They are, therefore, a source of molecules with healing, purifying properties and they could have anti-diabetic actions either by regular action on the pancreas or by an increase in the number of insulin receptor sites per cell, etc. They are in kilojoules per cm² as absorption of UV from sunlight. The image of the plant indicates an effect on molecules, thus playing a selective or sieve effect role and resulting in good activity of the plant. Nevertheless, these molecules can oxidize and trigger cell perturbations and their consequences by participating in a defense reaction against the toxic effect, that is to be bite. These tests could confirm the ethno-pharmacological use of the plant [16].

4. Ecological Distribution of *Momordica balsamina*

Study conducted in four regions of Chad (Sarh, Moundou, Gounou Gaya, and N'Djamena) in 200 hours of effective survey revealed that *Momordica balsamina* is growing in various habitats including fallows (natural and human-induced), ruderal and garbage grounds, grassy savannahs, and plateaus. It is present in different geographic formations, namely the savanna formations and the shrubby steppe formations. The plant of *M. balsamina* was distributed in the four studied

regions. The analysis of botanical structures revealed that the life of the herbaceous angiosperm of *M. balsamina* is due to its rapid growth in good localities. The analysis of several factors (physical and chemical soil parameters) in the field proved that it particularly loves the grounds being disturbed. In addition to the phosphorus content, the percentage of organic matter is also a good variable characterizing the habitats. Few potted germination trials in the laboratory did not lead to any individual growth failure. The various forms of use of this plant furnished the proposed hypotheses.

4.1. Habitat and Geographic Range

Momordica balsamina is a native and perennial plant of Africa. In the Republic of Chad, *Momordica balsamina* is spontaneous and is found in the Sudan-Guinean and Sahelian phytogeographical areas. However, it grows in disturbed areas (village, fields, gardens, fishing areas and cooking areas) [2].

Geographically, the results confirm that this plant likes a specific type of habitat. It is evenly represented in the Salamat, Moyen-Chari and Mayo-Kebbi-East regions with 1% each. These samples are characterized by a rainy season exceeding 1000 mm/year; this is the volume of rain that the plant needs in order to be able to develop. To a lesser extent, the other regions of Chad have a percentage of 0.9% (Sila) at 0.4% (Mayo-Kebbi-Ouest), then 0.3% each for the regions of Chari-Baguirmi, Guera and Ouaddai and 0.0% for other regions. Mayo-Kebbi and Logone Oriental had a zero result [17].

The samples showed that this plant is observed in abundance during the rainy season and moderate during the dry season. It reaches the peak of its growth during the rainy season. The harvest is done at the start of reaching this period of its growth [4].

In the Sudan-Guinean zone, the soil types are mainly hydromorphic and have a density of tree cover higher than 10 cut/hectare. In the Sahel, the plant grows in the different habitats of the soils, with a tree density of less than 10 cut/hectare. During the dry season, the plant withers in the Sudan-Guinean zone, in contrast to the Sahelian zone where it holds out. The plant prefers the elevation zones that vary between 250 and 499 meters, with a percentage of 0.1% [18].

Metamorphic rocks characterize the substrate where *Momordica balsamina* is found. These results do not depend on the sampling strategy. The predominance of this soil-vegetation association has already been noted. Then comes the petrographie-sandy-clay. The remaining samples are varied, and the plant grows there, highlighting its low dependence. The component of the nitocarps records a high humidity level and the plant grows with it [19].

4.2. Climatic Requirements

Momordica balsamina is a thermophilic vegetable species that requires warm temperatures to reach its full potential. Thus, the Mubuy Tosaltou and Moutcho Sueikin ethnic groups from the Ouaddai region indicated that the plant grows

optimally at temperatures greater than or equal to 37°C. Amin et al. have indicated that flowering in *M. balsamina* occurs in one week, but that observation was made in the region of Sétif in Algeria, which has different climate conditions from Eastern Chad. However, because it is a wild plant, some are collected even if the temperature exceeds 42 °C [20].

Another important fact about phenological development in this study is that precipitation affects plant development. Varga-Csabai et al. indicated that in Hungary, *M. balsamina* needs 20% - 45% relative humidity present during the vegetation period. However, the humidity in Chad is almost always higher (except for a few periods) than that of Eastern Europe. Candy Own (2006) has indicated that fruit set is sensitive to longer day and night temperatures and short sunshine in the northern hemisphere. Because of its shortened cycle period, long temperatures for both day and night are required. A study carried out by Mèfiyo showed that at Gerissa, during the first week of collection (July 23 to 26, 2018), the average temperature was 47.5°C. However, those at Goz Beïda remained stable at 35.7°C during the period (July 18-21, 2018). These data indicate that higher temperatures favor the growth and availability of the fruits [21].

5. Methods and Approaches in Ethnobotanical and Ecological Studies

Ethnobotanical, morphological, and ecological surveys were carried out in the region of Mandoul in the south of Chad through individual interviews, semi-structured interviews, and focused group interviews. The individual interviews made it possible to collect exhaustive data at the level of consumption and practices. The semi-directive interviews allowed us to improve the information at the level of properties and uses of *Momordica balsamina*. The Use Value (UV) index was used to determine the importance of the use of different plant parts. All variables were collected through a questionnaire. The data collected are processed and analyzed using the SPSS 20.0 software. The plant taxa are preserved in the National Herbarium of Chad [22].

The present work was to document the traditional knowledge relating to *Momordica balsamina* L. whose parts are largely exploited for health benefits and food practices by the native people of Chad. This study aims to identify the parts of the plant most commonly used by the local people, understand the distribution and the most commonly used species, and depending on the local context and the ambient environment of the plant, including phytogeography and ecological points. The region of Mandoul, located in the south of Chad, was selected as a study area representing the consumption habits around the plant. The dietary habits and plant processing methods of *Momordica balsamina* L. were investigated among residents during the consumption period. The fragments would be chewed. The remaining residues were filleted and pressed to separate the pulp or juice, which generally served as the material from which food was prepared. The bakery product may vary depending on user preferences [23].

5.1. Field Sampling and Data Collection

The sampling of the informants was done in the three markets. The choice was made with reference to electrometry methods. This is a statistical method which emerges as the basic procedures for gauging social phenomena. They establish the different aspects of relationships and dynamics indicators linked to population. Starting from the grids of reference (age, sex, place of residence), we created a questionnaire for a simple random test. This type of test was leading from spontaneous surveys after a conversation with the informants. These surveys were leading with the household heads or women with experience in traditional food making. The plants were characterized according to the age, sex of these informants native places, and other input of the analysis [24].

The field prospection was led with local collectors and was carried in the different described vegetation zones and in localities which appear as the gathering places. Some 10 to 20 specimens of plants have been collected from each locality and were identified in the Herbarium of the University of Ngaoundere where the illustrations and identification keys confirmed them. The harvested seeds were sowed in the Research Laboratory of the University of Ngaoundere. The rate of germination was estimated thereafter. We also researched a little bit on the plant *Momordica balsamina* using bibliographic studies. Then we used the same approaches to deepen our knowledge of the plant, and shade the informers since it is an intercultural domain [25] [26].

5.2. Interviews and Surveys with Local Communities

To achieve our work, we have organized and conducted direct group or individual interviews of local people on a national scale. The aim is to collect a maximum of data in the departments where the taxon is described and used in food by the different people. The methodology adopted is that of Aurélie (2011). The investigation was carried out in the towns and villages of different ethnicities and/or ethnic communities, to which the different ethnic groups belong, where Mb is part of its cure. The interviews were conducted both with the help of a close assistant, as well as without any intermediary, since the principal investigator alone knows the ethnic language or dialect that the speakers are speaking. Co-researchers from different ethnic groups also participated in the verification during data collection with regard to certainty [27] [28].

Of a qualitative nature, the investigation was carried out in the form of a questionnaire survey. We took care to use a range of questions on this medicinal plant in order to obtain the necessary details. To this end, we collected several thematic information in a questionnaire, such as the reasons for its consumption today, modes of preparation and administration, the part and tailoring of the plant used. The national focal points' adhesion and consent document also sought the level of caution with respect to this plant, the level of knowledge transmission, as well as the rules and procedures for collecting and preparing the "plant" [29].

6. Analysis and Interpretation of Data

The frequency counts and percentages of the respondents are presented in **Table 1**. The majority (63%) of the respondents were men, while 37% were women. Residents of the locality were a minority (23%). Most users were either students (30%) or farmers (29%). Their age varied greatly and some users were very young (23%). If we group together adolescents (15 - 30 years) and adults (31 - 60 years), we notice that most respondents were between 53% of the combined groups [30].

Table 1. The frequency counts and percentages of the respondents.

Really young	
Respondents from different categories	Percentages
The respondents were men.	63%
The respondents were women.	37%
The respondents were residents of the locality.	23%
The respondents were students.	30%
The respondents were farmers.	29%
The respondents were very young.	23%
The respondents were adolescents and adults.	53%
Adults and teenagers	
Respondents from many groups, including	Percentages
Men	63%
Women	37%
The residents of the locality	23%
Students	30%
Farmers	29%
Very young	23%
Adolescents and adults	53%

6.1. Evaluation of the Market

In the local market, *M. balsamina* is sold to consumers in two forms. The mature fruits are plastic-packed and valued at 1 CF to 250 CF by distance traveled from the producing area. Leaves are frequently dried and sold in plastic bags for 100 - 250 CF. Before drying, the fresh part was sold in small bundles valued at 10 - 50 CF. Leaf consumers were predominantly women. The leaf producer told us that the sale price of the leaves is lower than the price of the fruits and that he does business on the local markets of his locality to meet his needs. He indicated that in the rainy or post-rainy seasons, the demand for leaves is less important. The

availability of the fruit is sufficient. In the dry season, there was a strong demand from both the leaf and fruit traders, particularly because the area around is very dry and the collection is difficult for the harvesters. The chart below shows the variations in the price of these two forms of the plant [31].

6.2. Quantitative Analysis of Ethnobotanical Data

According to Cotton (1996), it is possible to make the quantitative evaluation through several ethnobotanical parameters such as the relative importance of ecological indices and biodiversity. However, it is from classic anthropological models that we have drawn our comparative score according to the variables of the works of Cotton. It is indeed possible that the factors affecting the distribution of cultural practices and species are different from one locality to another. Given our eco-ethnological approach, it seems interesting to follow the methods used by other researchers to determine the value of relative cultural importance (TRCIV), and to analyze the influence of other social and environmental factors. Our results should be interpreted with these possible differences in mind, but due to the limited amount of literature available, the comparison is based on the published papers [32].

Thus, some researchers such as Eddouks and Maghrani provide a very high score for plants corresponding to several pathologies in which they effectively represented themselves on several parameters. They formulated scientific hypotheses after analysis by the literature. According to the ecological model, these men who have a good knowledge of the local flora are good indexes for these plants. With a more qualitative point of view, it has been shown that the information varies according to the social and economic factors. Based on ecological-economic exchanges, a change in the parameters of this index may suggest a breakdown of the ecosystem of the resources. From our family comparisons, it can be demonstrated from one ethnobotanical analysis framework to another, that when the “delta-index” of the species of the β -blockers exceeds the value of the α -interest, the floristic aspect significantly shows a meaning of the environmental factor and the adaptations of the ecosystem [33].

6.3. Ecological Data Mapping and Interpretation

Mapping and site interpretation of ecological data that reveal the many preferences of the *Momordica balsamina* plant show that soil pH is basic between 7.21 and 8.00 in 53.33%, and that clay soil is predominant (50%) and not very sandy (73.33%). Lomé and Makandé locations declared the presence of 80% of *Momordica balsamina*. The grass savannah type and bush areas are the biotopes affecting this plant’s culinary and medicinal value, while the presence of others, such as cultivated plots, is due to human practices. The influence of rainfall height on the mold from *M. balsamina* products is 81.82%. *M. balsamina* is away from water (89.47%) and has a preference for sunlight exposure, which is very high (43.48%) [34].

According to the geoclimatic data interpretation of *M. balsamina*, the plant is distributed in the Chad medium. The highest sun exposure is between 2400°C and 3800°C, and the relative humidity is between ventilated and moist. The altitude is between 300 and 500 meters. Enabling ecological data interpretation of the distribution of *M. balsamina* to determine its needs and to inspire agronomic solutions to intensify, diversify, and especially improve the quality of areas located outside its optimal zone in the semi-patterned in Chad [6].

7. Conservation and Sustainable Management Strategies

The local knowledge and the high use of *Momordica balsamina* make it vulnerable due to anthropogenic pressures, such as overexploitation, environmental and climate degradation. There is a need to incorporate the medicinal plants in conservation programs while respecting the rights and traditional knowledge of local communities about these plants and the ecosystem in which they live. Innovative local strategies for governing community environmental resources can help to overcome many challenges of governing shared resources for local communities and other community-based conservation projects, putting the modest resources and political power of the Peul (Bororo) pastoralists and agro-pastoralist communities at the service of the local population to better manage plant resources as an increasing support of conservation efforts. The association of medicinal products with other plant resources, such as the manufacture of traditional wooden objects, can be practiced and adapted to local conditions. Encouraging the promotion and protection of such rights, negotiations, or collaborations are therefore crucial [35].

Nurturing individual relationships among traditional healers from different systems, such as medical doctors, is underway. Local participation and ownership of the natural resources and the related benefits from a community forest could be achieved. All these rights enumerated can be achieved in the long run, but should be translated to laws, rules, and practices concerning the treatment of these plants, which are fundamental to accept and enforce these rights, involving the community in the management decision and thus fostering the sharing of responsibility by undertaking the task of planting and conserving the noted plants [36].

7.1. Threats to *Momordica balsamina* Populations

We carried out this study to revalorize, inventory, and enhance the diversified uses of *Momordica balsamina* by the local populations. The ecological study showed that the species, *Momordica balsamina*, occupies a variety of existing ecological niches. This species is, in most cases, more or less abundant and often forms monospecific populations. We evaluated the biological impact of the species' uses on the rate of the floral diagram and demographic structure of the populations. This study showed a large predominance of female individuals with a sex ratio F/M = 3.24. The floral diagram of the populations is of the dichogamy type,

with mature females at 9:00 am and 3:00 pm. Threats to *Momordica balsamina* (presence of thrips, deforestation, overgrazing, drought, fire, accessibility, and others) have been presented, and measures have been taken to address them. Evidences of threat profiles have been compared and contrasted. The contribution of this species in the daily life of the locality has made it increasingly rare with a decreasing frequency of use. Faced with a lack of resources, the population has resorted to the misappropriation of the plants present in the mutations of the ayurs. All sorts of interventions that aim to revalue the species will necessarily involve the planning of traditional training courses. This will allow the community to reintegrate the practice of certain traditions. The opening of an inquiry supported by the population is one of the best plans [37].

Thereafter, the major species of the located disturbances may be temporarily classified into Liliopsida class (31.1%), Dicotyledons (24.7%), and others. As far as the classification of the weeds is concerned, there is a prevalence of the Therophytes (Th) who occupy the top of the diagram with a rate higher than 43%, followed by geophytes (Bis), chamrophytes (Cham), Asterophytes (Aster), and the Therophytes Gracilent (Th:return, Th:l). The most known disturbances experienced by the “DAR” population were the depredations of thrips, which resulted in a significant fruit on the male plants, followed by drought, deforestation, fires, and human gatherings, which favored the denudation and struggling of the plant *Momordica*. Faced with a lack of resources, the population has resorted to the misappropriation of the plants present in the mutations of the ayurs. All sorts of interventions that aim to revalue the species will necessarily involve the planning of traditional training courses. This would allow the community to benefit from the development. The opening of an inquiry supported by the population is one of the best plans [38].

7.2. Community-Based Conservation Initiatives

Increasing the understanding of the various roles that people in rural areas play in the conservation and management of biodiversity has become a priority for conservationists. Our results show the central place of *Momordica balsamina* within the villages, first fossil area, and along many areas and roadsides. In this study, indeed, there is a risk of disappearance because there is no control and surveillance. Due to human pressure on resources, it is very important that conservation institutions reinforce community-based initiatives or support communities in creating local strategies aimed at conserving and sustainably using these resources. In Chad, traditional knowledge is not maintained and for various reasons, including rural exodus at the expense of viable opportunities, urban exodus, schooling, the introduction and adoption of modern medicine, and the establishment of administrative limitations [6] [39].

The use of plants intended for traditional medicine is very frequent in several countries in Africa. In Chad, anti-malaria, mother-baby health problems, stomach aches, intestinal parasites, and infectious wounds are the most reported health

problems treated by botanists. Numerous studies conducted on medicinal plants have shown that plant-based pharmacopeia constitutes an effective therapeutic alternative. Its popularity comes from several reasons: especially the costs of conventional medicines which are increasingly inaccessible, not very effective for some infectious or serious diseases, and pose problems of resistance. And above all because traditional medicine is anchored in the customs of communities and has its high cultural value. A large community of African practitioners and patients believe in the efficacy and safety of traditional medicine. These health workers know how to avoid, detect, and cure certain diseases. The presence of these skills in communities where traditional medicine is used ensures that local knowledge is available for future use [40].

8. Conclusions

In conclusion, this study recorded and underscored the medicinal importance of *Momordica balsamina* use in the households and traditional healers of villages occupied by the two ethnic groups studied. *M. balsamina* is a plant of collective usage. Its sap is used by all, while the fruits are consumed by the population of the two villages studied. The leaves are harvested and prepared by the men, while the decoction is taken by the entire family, except pregnant women and children. The varied use of this wild plant highlights its contribution to the health of the population who live in a very remote area where it can be difficult to get to healthy structures. Catholicism does not have a real influence on the medical traditions of the studied groups. However, we recorded a preference for using Cross of Christ and prayer among the Christian ethnic group of Ngambaye on the occasion of the preparation of *M. balsamina* traditional recipes.

This work has made it possible to highlight that the use of medicinal and ritual plants in the rural world is an important cultural asset. Because it involves the entire population, our study contributes to the preservation and valuation of traditional knowledge. The information garnered also allows us to generate recommendations for the sustainable use of these wild resources. Special efforts are needed to enhance the sustainable use of *Momordica balsamina* through plantation propagation.

9. Key Findings and Implications

This study was conducted for the purpose of showing the diversity of the use of *Momordica balsamina* by the people, different types of soils, and the most frequent growth phytosociological parameters. It appears from this study that the *Momordica balsamina* plant is used by the Falangisti Peulh, extending the field of the ethnopharmacological applications of this plant. It is a grass with a high ecological amplitude. It grows in compact areas with a prevalent aspect and is more frequent than the other aspects. It prefers rich sandy clayey soils and loamy sand in terms of organic matter and shows an annual development with a higher part in the phytosociological parameters. For this, we propose to review this taxon and

to apply the word “fiankoo” to differentiate it from the other species with which it is confused. This allows interested actors to undertake sustainable exploitation of this species in Chad.

The study area is situated in the Sudano-Sahelian domain of Chad, characterized by its warm climate and its reduced rainfall. This ecosystem is characterized by the presence of significant floristic diversity. We embarked on an inventory of the plant *Momordica balsamina* in the neighborhoods and villages located in the encroachment band. We determined the physicochemical characteristics of the soils and the phytosociological parameters (flooding, height, perimeter base) of the inventoried plants. We used the Excel software for the creation of the database and the software R for its analysis. This consists of descriptive, principal component analysis, hierarchical classifications, and maps. The results reveal that the density of plants is higher in the compact areas with prevalent sandy clayey soils. The higher plants occupy the compact areas with a predominant aspect. The perimeter of the base presents a significant and specific difference for some phytosociological parameters. A large majority of people use different organs of *Momordica balsamina* for peanuts, which are composed of different chemical compounds. They found that they have better therapeutic virtues.

10. Recommendations for Future Research

It would be interesting to do further phytochemical studies related exclusively to the flavonoids and polyphenols, which have shown very good antioxidant potential. It would also be interesting to enrich the study by an essential oil extraction with its analysis and to do the biological activities. Towards the in vitro anti-inflammatory activity of the extract, it would be interesting to carry out studies to visualize the inhibition of the expression of COX that leads to the analysis by western blot of the different proteins following treatment with the extract. Inhibitory activity of enzymes of the stress-induced inflammation pathway was also revealed. It would be interesting to develop an experimental in vitro study to analyze the effects at the gene and protein levels. The study would be to investigate the effects of the extract on the activity of different enzymes through the determination of their expression at the mRNA and protein levels. We agree that the integration of the study would be in line with the overall scope of integrated computational models.

The traditional for endorsement through preclinical analysis of extracts remains a cardinal gauge to develop novel-active phytotherapies. In the traditional context, the concoctions obtained from *M. balsamina* are regarded as innocuous; nevertheless being relaxed they were improperly administered. The systemic nature of treatment of various diseases is supported by the admixture of ingredients and their semi-solid nature, suggesting the passage through the gastrointestinal tract and giving the possible exposure to the extract from *M. balsamina* to the site of an inflammatory disorder. Different studies including those based on the ex vivo models are needed for findings to be extended. The beneficial marketing of this extract will require handling according to the guidelines and under strict

regulatory of safety protocols through specific organismal models.

Conflicts of Interest

The author declares no conflicts of interest.

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