

Research Article

Perception of Mothers on the Nutritional Benefits of *Moringa oleifera* Lam Leaf Powder in the Diet of Their Malnourished Children in N'Djamena, Chad

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Abstract

This study aims to explore the perception and uses of *Moringa oleifera* (Mo) in infant complementary feeding in N'Djamena, Chad. She focused on the mothers of malnourished children hospitalized in N'Djamena. The study was carried out between March-May 2024. Two methods were crossed: documentary research and a survey of mothers of malnourished children hospitalized in two Therapeutic Nutrition Units (TNU) in the city of N'Djamena, Chad. For this purpose, a face-to-face questionnaire was used for data collection. 151 mothers participated in the study. The results obtained show that 91.39% of the mothers surveyed know Mo with a gap between their levels of perception of its benefits. Among them, 41.72% affirm that feeding Mo leaves ensures good growth for malnourished children. On the other hand, 58.28% of mothers prefer to give their children foods that they like but they are not opposed to adding Mo leaf powder as a nutritional supplement to the diet. In addition, this study reveals that 76.82% of respondents perceive Mo as a food (leaf vegetable) rather than a medicine. It would be possible to contribute to the fight against child malnutrition in the commune of N'Djamena by incorporating Mo leaf powder as a food supplement with educational programs adapted to each target area. Nutritional and sensory properties will be analyzed in order to consolidate consumers' knowledge on the contributions of Mo in the diet.

Keywords

Perception of Mothers, Food Supplement, Child Malnutrition, *Moringa Oleifera*, Chad

1. Introduction

In Chad, chronic malnutrition is one of the main public health problems with irreversible effects on children in terms of physical growth, cognitive development and productivity in adulthood [1, 2]. According to the 2021 SMART survey in Chad, one in eight children dies before reaching the age of 5. The persistence of poor practices in Infant and Young Child

Feeding (IYCF) and poorly diversified complementary feeding are the main causes of this form of malnutrition. However, the populations have unsuspected forest food resources, including leafy vegetables, which can help solve the problems of child malnutrition.

Indeed, green leafy vegetables are now emerging as a

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means of combating “hidden hunger” [3], thanks to their richness in micronutrients [4] essential for the good nutritional status of children. [5] have shown that most complementary foods, particularly porridges given to infants in Africa, are of low nutritional quality. They do not cover children’s needs in terms of proteins, lipids and micronutrients (vitamins, minerals). This is why studies have been carried out to improve the quality of these porridges by incorporating, for example, *Moringa oleifera* Lam leaf powder.

Moringa oleifera is a plant of great importance due to its wide range of uses and adaptability to almost all climatic conditions [6, 7]. However, it is one of the neglected leafy vegetables [7]. However, rich in both protein and micronutrients, its leaves are among the most promoted leafy vegetables to ensure food and nutrition security of mothers and infants in developing countries [7]. Due to the nutritional quality of its leaves, this plant has given rise to a significant number of initiatives in Africa, Europe and the United States, in the fields of nutrition and dietetics. Studies by [8, 9] have shown that incorporating *Moringa oleifera* leaf powder into infant porridges results in satisfactory results in the nutritional recovery of malnourished children. However, few research studies in Chad have focused on assessing or verifying the general knowledge of households about *Moringa oleifera* and its uses in infant nutrition.

From a general knowledge point of view, *Moringa oleifera* is quite commonly used in food and folk medicine in African and Asian societies [5]. In Senegal, the leaves are eaten cooked or in the form of a sauce called Mbuun, accompanying couscous made from cereals composed of millet, corn or rice. Mbeulekh é is a dish made from rice and sauce enriched with 30 g of *Moringa oleifera* leaf powder [5-10]. It can be a cheap, year-round and high-quality food for humans. In Burkina Faso, *Moringa oleifera* leaves are used to prepare sauce for basic dishes (couscous, rice sauce, etc.) [5]. According to [11] young green pods of *Moringa oleifera* are very tasty and can be eaten boiled like beans. In India, almost all parts are consumed either as food or medicine [12]. However, a few rare studies [12-14] have focused on the state of general knowledge and uses of *Moringa oleifera* by households, with satisfactory results. Indeed, apart from the food consumption of its leaves, almost all the organs of this plant are used in traditional pharmacopoeia, thanks to the presence of compounds with multiple therapeutic properties [15]. The leaves traditionally consumed are now requisitioned in certain programs to combat malnutrition in certain African countries and in India.

In Chad, *Moringa oleifera* is known by several ethnic groups in the southern provinces and some northern regions, who consume it as a leaf vegetable [16]. *Moringa oleifera* leaf

powder has been used in maternal and child protection centers (MCP) opened in Koumra and N'Djamena by the Betsaleel Chad association, with a view to improving maternal and child nutrition. Indeed, *Moringa oleifera* is an effective remedy against malnutrition. According to [17], the plant organs (leaves, pods and seeds) are very rich in essential nutrients. And according to [18], *Moringa oleifera* leaves could contain 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk, 9 times more protein than yogurt, 15 times more potassium than bananas and 25 times more iron than spinach [17].

However, many mothers in some localities of the country, particularly those in the capital N'Djamena, seem to be unaware of this plant and its benefits in improving the nutritional status of infants and young children. According to [12], acquiring new knowledge can have an impact on eating habits and lead to behavioral changes. Moreover, [18] have proven that action aimed at combating malnutrition requires a prior analysis of the uses and habits of the target populations [19]. The perception and uses of *Moringa oleifera* by mothers in the complementary feeding of infants and young children consequently constitute issues to be explored. It is with this in mind that this study is conducted. It aims to assess the state of knowledge of *Moringa oleifera* by mothers and its incorporation into the complementary diet of children in N'Djamena (Chad).

2. Materials and Methods

2.1. Location of the Study Site

The study took place at two sites in N'Djamena: the Therapeutic Nutrition Unit (TNU) of the University Hospital Center for Mothers and Children (UHCMC) located in the Gardol é district, in the 3rd arrondissement, and the Therapeutic Nutrition Unit (UNT) of the Our Lady of the Apostles Hospital (OLAH) located in the Chagoua district, in the 7th arrondissement.

2.2. Study Material

The leaves of *Moringa oleifera*, the subject of the study, are transformed into powder and incorporated into infant flours. The aim was to assess the perception of mothers of malnourished children on the importance of this practice. For this purpose, a questionnaire was sent to them and filled out face to face by an investigator.

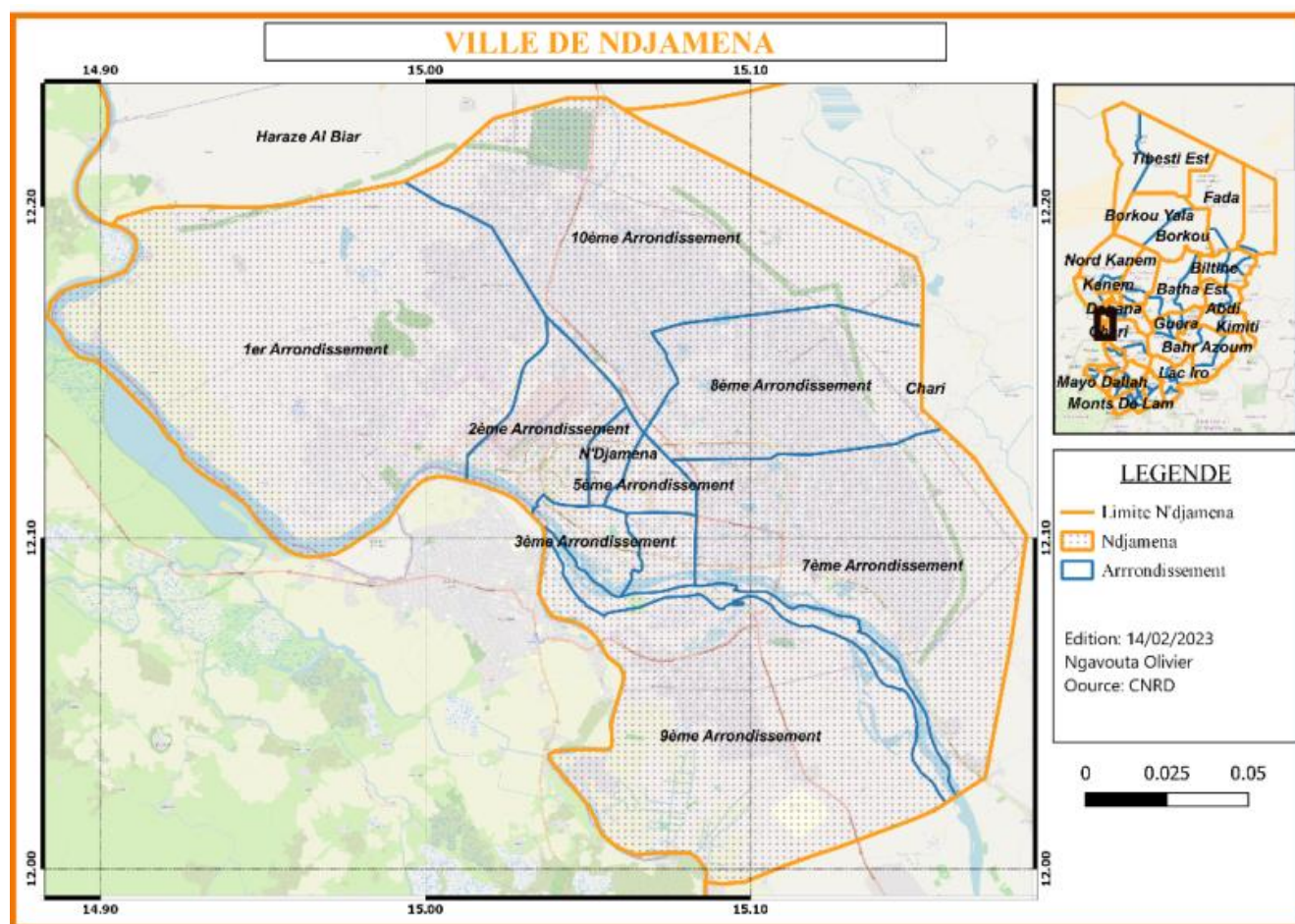


Figure 1. Map of the commune of N'Djamena, Chad.



Figure 2. Moringa oleifera plant.



Figure 3. Powder of the leaves of Moringa oleifera.

2.3. Methods

The method used is a field survey. According to [20], the field survey refers to a rather qualitative data collection method for which the researcher must go to the field and conduct his research in the daily context of the subject studied. It allows to collect useful informative data that must help the investigator to answer his problem and verify his hypotheses. This survey was conducted among the mothers of malnour-

ished children hospitalized in the therapeutic nutritional units of the University Hospital Center for Mothers and Children and at the Our Lady of the Apostles Hospital in N'Djamena. The study used a quantitative study technique called the questionnaire. This technique makes it possible to obtain other additional information that is useful for understanding the phenomenon studied [20].

Sample size

The survey used a random sample whose selection criteria are:

1. being a mother of a child of at least 6 months malnourished and hospitalized in one of the TNU during the survey period;
2. freely agree to participate in the survey.

The determination of the sample size of the survey took into account the prevalence of global acute malnutrition (GAM) of children aged 6-59 months for the province of N'Djamena, according to the results of the 2022 SMART survey in Chad. It is given by the formula of [21].

$$N = N = \frac{z^2 \cdot p \cdot q}{d^2}$$

Where:

z is a constant equal to 1.96;

p represents the prevalence of GAM in children aged 6 to 59 months in N'Djamena;

q = 1-p; d is the standard margin of error taken as 5%.

This calculation led to a sample of 147 mothers. However, 151 mothers of malnourished children aged 6 months and over were surveyed at will, by answering the questionnaire developed for this purpose.

Conduct of the survey

Verbal informed consent was requested from each mother of a child. They were informed of the voluntary, free and unpaid nature of the study. Data were collected from the mothers during a face-to-face interview. The information was recorded in a questionnaire, the completion of which began as soon as the respondent gave her opinion.

Data processing and statistical analysis

After collection, data processing was carried out using the Excel 2019 spreadsheet for data entry and correction. These data were transferred to the general statistics software, XLSTAT 2023 for variance analysis. After the ANOVA, the Student-Newman-Keuls test was used to compare means at the 5% threshold. SPSS statistic 27 software was used for the analysis and analysis of survey data.

3. Results

The variables studied were: knowledge of *Moringa oleifera*, its use in children's diet, appreciation of foods based on *Moringa oleifera* leaves, appreciation of children's diet with *Moringa oleifera* leaves and other uses of *Moringa oleifera*.

After processing the collected data, the results were recorded in the following tables and figures.

Table 1. Distribution of mothers according to general knowledge of *Moringa oleifera*.

Modalities	Number	Frequency by (%) 95% CI
No	13,000	8,609 (4,135 - 13,083)
Yes	138,000	91,391 (86,917 - 95,965)
Total	151	100

The results prove that the majority of mothers in the study (91.39%) are very familiar with *Moringa oleifera* ("haloum" in local Arabic, "kag n'dongue" in the Gambaye language). However, some mothers claim to have never seen this plant, despite the images and samples shown to facilitate the survey.

Table 2. Distribution of mothers according to their consumption of *Moringa oleifera* leaves.

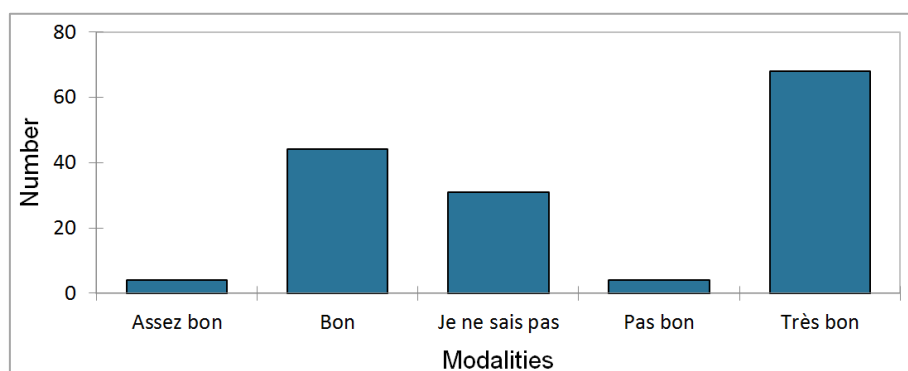
Modalities	Number	Frequency (%) 95% CI
No	38,000	25,166 (18,244 - 32,087)
Yes	113,000	74,834 (67,913 - 81,756)
Total	151	100

Table 3. Preparation of children's food with *Moringa oleifera* leaf powder.

Modalities	Number	Frequency (%) 95% CI
No	102,000	67,550 (60,082 - 75,017)
Yes	49,000	32,450 (24,983 - 39,918)
Total	151	100

Table 3 shows that the majority of mothers (67.55%) have not yet added *Moringa oleifera* leaves to their infant diet. Those who say they have done so (32.45%) are mothers who share the family meal with infants and young children.

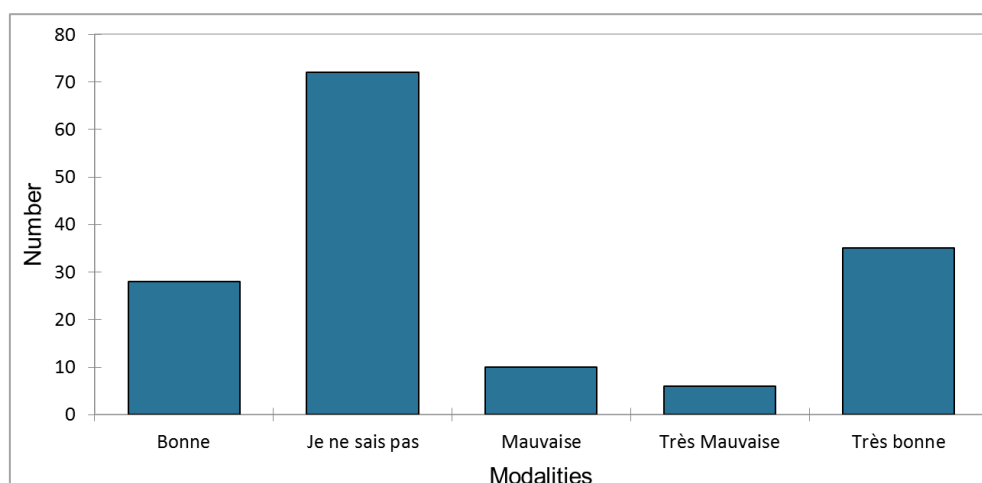
When assessing the food incorporating *Moringa oleifera* leaves, the results vary from "very good" to "not good" as shown in Figure 4. They reveal that 74.17% of mothers appreciate the preparations (sauces) with *Moringa oleifera* leaves; while 20.53% of mothers did not comment on this aspect. This implies that they are unaware of this food.



Note: Assez bon: quite good; bon: good; Je ne sais pas: I don't know; Pas bon: not good; Très bon: very good

Figure 4. Appreciation of food prepared with *Moringa oleifera* leaves by mothers.

Regarding the impact of feeding *Moringa oleifera* leaf powder, the results of the assessment by the mothers are recorded in Figure 5 below.



Note: Assez bon: quite good; bon: good; Je ne sais pas: I don't know; Pas bon: not good; Très bon: very good

Figure 5. Assessment of the impact of feeding *Moringa oleifera* leaves on infant growth.

The majority of respondents (47.68%) do not feel the impact of incorporating *Moringa oleifera* leaves into the diet of infants and young children. Furthermore, 41.72% of mothers believe that it is a good diet for children's growth. This assessment varies between "very good" (23.18%) and "good" (18.54%).

Table 4. Knowledge of other uses of *Moringa oleifera*.

Modalities	Number	Frequency (%) 95% CI
No	116.00	76.821 (70.091 - 83.552)
Yes	35.000	23.179 (16.448 - 29.909)
Total	151	100

These results show that the majority of mothers (76.82%) are unaware of other uses of *Moringa oleifera*. The rest (23.18%) use it to treat blood pressure, diabetes or as tea, according to the opinions collected.

4. Discussion

There is a link between the level of knowledge of mothers about nutritional needs and the quality of the diet provided to children [12]. Indeed, mothers are primarily responsible for the food consumed by their children [12-22]. They are considered the nutritional guardians of the family [12] because they are the ones who often control the household's food purchases and consumption. However, several studies have highlighted the factors limiting mothers to fulfill this function; among others, the low level of education of mothers which influences the choice of foods given to children [23] as well as

the lack of knowledge about healthy eating which is added to low purchasing power. Consequently, they become responsible for inappropriate feeding practices leading to malnutrition in children from 6 months, the age of food diversification according to the World Health Organization (WHO). In order to improve the dietary practices of mothers using *Moringa oleifera* leaves, it is essential to first inquire about their level of knowledge and uses of this leafy vegetable.

Regarding knowledge of *Moringa oleifera*, the survey results (Table 1) reveal that this plant is known by households. Indeed, the majority of mothers surveyed (91.39%) know *Moringa oleifera*. These results corroborate those obtained by [13] (95%) in a study on the uses of *Moringa oleifera* in Maroua, Cameroon. In addition, they are comparable to those of [18], who revealed that 100% of households surveyed in Cameroon know *Moringa oleifera*. Knowledge of this plant by mothers could help combat malnutrition because, very rich in micronutrients, this leafy vegetable is increasingly recommended for populations suffering from malnutrition [24]. Indeed, several studies have shown that its leaves, consumed in almost all of West Africa, are particularly rich in provitamin A, vitamins B and C, minerals (especially iron) and amino acids [8-10]; which gives *Moringa oleifera* a particular interest in the fight against malnutrition linked to nutrient deficiencies in Sahelian Africa [10-24].

Regarding the consumption of *Moringa oleifera* leaves, the results of the study (Table 2) show that 74.83% of the mothers surveyed consume its leaves. These results are lower than those of [13] (93.4%). They also corroborate those of [14] which show that 89.29% of the respondents know the use of *Moringa oleifera* in human food. Furthermore, the non-consumption of *Moringa oleifera* leaves by a portion of the respondents (25.17%) could be explained by ignorance and lack of knowledge of the plant, as well as the very young age of some respondents.

As for the preparation of *Moringa oleifera* leaves, 32.45% of mothers surveyed in N'Djamena know the dietary use of *Moringa oleifera* in their households (Table 3). This result differs significantly from that of [18] which is 99.3% of urban households. However, the results of the study reveal that 67.55% of respondents have never prepared *Moringa oleifera* leaves in their households. This high frequency in N'Djamena could be justified by the fact that this leafy vegetable is not yet part of the eating habits of most households in the city of N'Djamena. The information collected in the field highlighted the lack of knowledge of the plant and its human food use: questions about where to get some were asked by some mothers, after seeing the image of the plant. However, this plant is well known in southern Chad where its leaves are used in the preparation of sauces and promoted in actions to combat malnutrition among mothers and children [16].

In the assessment of food prepared with *Moringa oleifera* leaves, the results vary between "Very good" and "Not good" (Figure 4). In short, a large proportion of mothers (74.17% resulting from the combination of the values of "Very good"

and "Good") greatly appreciate foods prepared with *Moringa oleifera* leaves. The satiating power of *Moringa oleifera* leaf sauces and their sensory qualities justified the assessments of these respondents. However, a significant percentage of respondents (20.53%) did not comment on the issue. This attitude could be explained by the fact that they do not know the dietary use of the leaves of this vegetable.

Regarding the impact of incorporating *Moringa oleifera* leaf powder into complementary foods on children's growth, the assessment varies from "Very good" to "I don't know". Figure 5 shows that a large proportion of the mothers surveyed (47.68%) have no idea about the impact of incorporating *Moringa oleifera* leaves into children's diets on their growth. This could be explained by the lack of information on this subject. However, several studies have proven the nutritional quality of *Moringa oleifera* [8-26] and its effectiveness in the nutritional recovery of malnourished children aged 6 to 59 months [3-9] and in malnourished HIV-positive and HIV-negative subjects [27]. To overcome this problem, an information and awareness policy for mothers, particularly on the use of *Moringa oleifera* leaves in the complementary feeding of children, would be welcome in order to curb the fight against malnutrition in infants and young children in N'Djamena.

Regarding knowledge of other uses of *Moringa oleifera*, several studies have reported food and medicinal uses [12-28]. However, the results of the study (Table 4) show that a small proportion of respondents (23.18%) know other uses of *Moringa oleifera*. This result is very different from those of the study by [13], in Maroua, which revealed that 60.64% of respondents use *Moringa oleifera* roots and less than 2% use the seeds as medicine in traditional pharmacopoeia. It is also much lower than that obtained in a study in Niamey [28], where 84% of respondents claim to have knowledge of the nutritional and/or therapeutic values of *Moringa oleifera*. The medicinal indications most reported by respondents are malaria, high blood pressure and diabetes. These same results were collected by [28]. Furthermore, a significant difference is noted compared to the result (12%) obtained by [14] during a study on the uses of *Moringa oleifera* in Togo. Indeed, the work of [6-15] has highlighted the various substances extracted from different organs of *Moringa oleifera*, which have varied therapeutic properties. These include antitumor, antiulcer, antispasmodic, diuretic, antihypertensive, cholesterol-reducing, antioxidant, antihypertensive, and antidiabetic properties. Unfortunately, the therapeutic use of the organs of the *Moringa oleifera* plant is less known by the majority of respondents (76.82%) in the city of N'Djamena. Furthermore, this study complements that of [12] who highlighted significant differences between African and Indian respondents in terms of *Moringa oleifera* consumption habits. It emerges that the majority of African respondents (80.6%) consume much more leaves than other parts of the plant, and most often in the form of tea (26%); while Indians consume almost all parts in different forms (soups, sauce, salad). In addition, [16] in their study, state that extracts from the leaves of *Moringa oleifera*

are used to potentially increase lactation in nursing mothers. This suggests that Africans in general, and Chadians in particular, are called upon to further explore *Moringa oleifera* in order to increase its added value.

5. Conclusion

Moringa oleifera is a plant known in N'Djamena by a majority of mothers. Its leaves are available, fresh and/or dried, in all the markets of N'Djamena. However, its food use in general and its incorporation into infant diet in particular, remain unknown by mothers whose children suffer from malnutrition. This study showed that *Moringa oleifera* is less anchored in the eating habits of most urban and peri-urban households in the commune of N'Djamena, compared to other cities in Africa. Furthermore, the lack of knowledge of mothers on the nutritional interest of leafy vegetables with high nutritional potential such as *Moringa oleifera*, is a determining factor in the malnutrition of mothers and their children. It is therefore essential to undertake appropriate actions to popularize the mothers on the introduction of *Moringa oleifera* in infant complementary foods in order to prevent all forms of malnutrition linked to nutritional deficiencies. Thus, an analysis of the nutritional and sensory properties should be considered in order to consolidate consumers' knowledge on the contributions of *Moringa oleifera* in the diet. From this analysis will come the formulation of complementary foods enriched with *Moringa oleifera* leaf powder, adapted to the nutritional recovery of moderately malnourished children aged 6 to 59 months.

Abbreviations

ANOVA	Analysis of Variance
CI	Confidence Interval
GAM	Global Acute Malnutrition
HIV	Human Immunodeficiency Virus
IYCF	Infant and Young Child Feeding
MCP	Maternal and Child Protection
Mo	<i>Moringa oleifera</i>
OLAH	Our Lady of the Apostles Hospital
SMART	Standardized Monitoring and Assessment of Relief and Transition
TNU	Therapeutic Nutrition Unit
UHCMC	University Hospital Center for Mothers and Children
WHO	World Health Organization
XLSTAT	Logiciel Statistique pour Excel / Statistical software for Excel

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Author Contributions

Kaziri Adeline: Conceptualization, field survey, writing, financing

Epolyte Adjeffa: Conceptualization, reading, correction, validation

Djekota Christophe Ngarmari: Conceptualization, reading, formal analysis, documentation, guidance counseling and validation

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Informed Consent Statement

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Data Availability Statement

The data are contained in the article.

Conflicts of Interest

The authors declare no conflicts of interest.

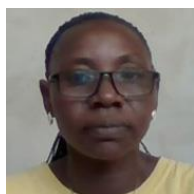
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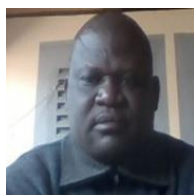
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Biography



Kaziri Adeline is a doctoral student at the Doctoral School of Sciences, Technology and Environment (ED-STE) of the University of N'Djamena in Chad. She holds a degree in Agri-Food Sciences from the SAAD AL-HALEB University of Blida in Algeria in 2005. Currently, she is a research

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Epolyste Adjeffa, Assistant Professor/CAMES, Lecturer-Researcher at the Higher Normal School of N'Djamena in Chad. Holder of a single thesis of Doctorate in Sciences and Technologies of Water, Energy and the Environment, option: Water, defended in 2015 at the International Insti-

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Djekota Christophe is a lecturer-researcher at the University of N'Djamena and the National Higher Institute of Agronomic Sciences and Agro-Food Technologies of Laï (INSATAL), in Chad, Department of Biology. An Agro-forestry engineer, he obtained his PhD in Knowledge, Conservation and

Valorization of Biodiversity at the Cheikh Anta Diop University of Dakar/Senegal in 2014, and his Advanced Studies Diploma (DEA) in Botany and Biodiversity in 2008 at the same institution. He has participated in several research projects including the National Program for Adaptation to Climate Change, Valorization of mycorrhizal fungi in corn production with the UNDP. Lecturer/CAMES since 2015, he is currently Director General of INSATAL.

Research Field

Kaziri Adeline: Nutrition and Food Sciences.

Epolyste Adjeffa: Agro-Pedology, Rural Planning, Water and Environment, Sustainable Land Management, Quality, Hygiene and Safety.

Djekota Christoph: Ethnobotanical research and characterization of flora, Knowledge and conservation of biodiversity, Food and non-food valorization of local agricultural products.