

Effectiveness of Enriched Flour in the Recovery of Children Aged 6 to 59 Months with Moderate Acute Malnutrition

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Abstract

Introduction: In Chad, malnutrition is a silent emergency. Yet the use of local products in the fight against malnutrition is essential. The purpose of this study was to compare the efficacy of locally sourced enriched flour in the recovery of children 6 to 59 months of moderate acute malnourishment compared to Ready-to-Use Therapeutic Foods (Plumpy' Sup) in the city of Abéché-Chad. **Methodology:** This study took place from 1 October 2021 to 31 January 2022 in the city of Abéché, capital of the province of Ouaddaï. It was conducted in eight (8) urban health centers in the city of Abéché and concerned eighty (80) children with moderate acute malnutrition. It was based on a consumption assessment of two complementary foods by two groups of children. The assessment of nutritional status was made through anthropometric data such as weight, height and brachial perimeter. **Results:** All 80 children were tested for moderate acute malnutrition. Two complementary foods have been used which are locally produced flour and the Ready-to-Use Therapeutic Food. The study showed that the group 1 who consumed the locally produced flour had an average weight gain of 1100 g and the group 2 who consumed the Plumpy sup had an average weight gain of 400 g. **Conclusion:** The present study carried out in Abéché allowed us to compare the effectiveness of locally produced weaning flours with Ready-to-Use Therapeutic Foods on moderate malnourished child weight growth in the nutritional units of the town of Abéché.

Keywords

Moderate Acute Malnutrition, Local Food, Ready-to-Use Therapeutic Foods

(Plumpy' Sup)

1. Introduction

Malnutrition, a medical condition caused by the deficiency or excess of one or more nutrients in the body, remains a public health problem in developing countries [1]. The consequences of child malnutrition in the first 1000 days of life are disastrous, with high rates of mortality and morbidity, as well as immune deficiencies in children in developing countries [1].

By the age of 6 months, breast milk becomes qualitatively and quantitatively insufficient for infants with increasing nutritional needs [2]. Appropriate feeding practices in the critical period from birth to age 2 are essential to achieving growth and developmental potential throughout childhood and adequate nutritional status [3]. In many developing countries, infant and young child malnutrition, growth curve breakdowns, and child mortality are closely linked to often inappropriate supplemental feeding practices [2]. Infant and young child feeding is a critical area for improving child survival and promoting healthy growth and development [4]. Thus, many studies have shown a correlation between diet and nutritional status in children [5]. In Chad, malnutrition is a silent emergency. In 12 of the 23 provinces, the prevalence of moderate acute malnutrition exceeds the critical threshold of 15% set by the World Health Organization [6].

Various sectoral food and nutrition programs and projects have been implemented for decades at both the health and community level [7] [8]. Other solutions exist to fight malnutrition in Chad on a sustainable basis. One is to make supplementary infant flours available to as many people as possible after weaning.

With this in mind, this study was initiated to compare the effectiveness of locally produced flour with Plumpy' Sup (Ready-to-Use Therapeutic Foods) in the recovery of children 6 to 59 months of moderate acute malnourishment.

2. Equipment and Methods

2.1. Site and Study Period

The study took place in Abéché, which is the third city in Chad after the capital N'Djaména and Moundou. It is the capital of the Ouaddaï region. This study involved eight (8) urban health centers in the city of Abéché: Ahmed El Badawi (6th district), Islamic (4th district), Salamat, Djatinie (2nd district), Taiba, Kamina, Simaraldjanna (1st district) and Mabrouka (7th district). The study ran from October 1, 2021 to January 31, 2022. At each health center, support from health personnel was required for screening for moderate acute malnourished children, for taking parameters, for blood collection, and for sending samples to the laboratory for biological analysis. This study obtained a research authorization from the Ministry of Higher Education and the Ministry of Health.

2.2. Investigations

This research is a comparative study, with children aged 6 to 59 months screened for moderate malnourishment. The children were screened during the consultation in the nutrition management units. Moderate malnutrition was defined by a weight/height index. Children were randomized into two groups (G1 and G2), with 40 children per group of children. Mothers of children in the first group (G1) received flour from local resources, followed by a training session to properly prepare the porridge. Mothers of children in the second group (G2) received the Ready-to-Use Therapeutic Food (Plumpy' Sup). In this study, each child represents their own witness. For follow-up, children in both groups were assessed weekly at their respective recovery centers. In view of the fact that the children were being followed on an outpatient basis and the socio-economic, environmental and cultural conditions.

2.3. Recovery Feeds

For this study, we used only one type of enriched flour consisting of local ingredients that have been proven in infant feeding. These ingredients are: sorghum, peanut, soy, sugar and salt. The energy value was 400 kcal/100 g. For Kouassi [9] compound flours derived from sprouted or fermented corn, sorghum and soybeans meet the requirements of the Codex Alimentarius. With regard to food consumption, each child in G1 received a 250 g packet per day of sorghum flour enriched with peanut and soybean, plus sugar and salt, without taking into account the anthropometric parameters and sex of the child. As for Plumpy' Sup, it is a ready-to-use nutritional supplement (RUSF) also defined as Lipid-based Nutrient Supplement Large Quantity (LNS-LQ), which was designed for the treatment of moderate acute malnutrition from the age of 6 months, as part of nutritional supplementation programs. It consists of peanut paste, vegetable fats, soy protein isolates, whey, maltodextrins, sugar, cocoa and a range of micronutrients. Each G2 child received 100 g per day from Plumpy' sup.

2.4. Sampling and Inclusion

The sample size was calculated using the Lorentz formula while based on the prevalence of children aged 6 - 59 months with moderate acute malnourishment in the city of Abéché of the 2019 SMART survey [5].

$$N = t^2 \times P(1 - P) / m^2$$

n: Minimum sample size for meaningful results;

t: Confidence level (the standard value of the 95% confidence level will be 1.96);

p: Estimated proportion of children 6 - 59 months moderately malnourished in the city of Abéché according to the Z-score < -2 which is 7.3% according to the 2019 SMART survey

m: 5% margin of error (standard value 0.05)

N = 80

In each of the eight (8) urban health centers in the city of Abéché, 10 children were retained and monitored.

The criteria for inclusion of children for the study were:

- Be at least 6 months of age and 59 months of age;
- Permanently reside in the study area;
- Be screened for moderate malnourishment: -3 Z-Weight/Height score according to 2006 WHO standards [10].

2.5. Data Collection

Data were collected from anthropometric measurements of children, biological examinations of children, observations and weighing of children's food intakes, and a hedonic test with children. The weight measurement was done with a SECA electronic scale with a capacity of 150 kg and an accuracy of 100 g (0.1 kg). The weight growth assessment was done weekly (J1, J8, J15, J22, J29). The size was measured with a gauge. For children under 87 cm, the height measurement was done in the prone position. Children with a height greater than or equal to 87 cm were measured in a standing position. The MUAC (Middle - Upper Arm Circumference) was used to measure the Brachial Perimeter. The nutritional status of children was determined from the 2006 WHO Weight/Height table.

2.5.1. Collection Tools

The data is collected on a weekly basis through interviews using the pre-established interview guide.

2.5.2. Data Processing and Analysis

The collection sheets were entered and analyzed using SPSS 20, Word and Excel 2007. Anthropometric data were recorded with the ENA for SMART software, to obtain the z-scores of children's nutritional status indices. Descriptive statistics are used to determine the proportions of children by complement food consumption group, age groups, and sex.

3. Results and Discussion

Table 1 shows the proportions of groups of children by complement food consumption. It was found that the sample was evenly distributed randomly into two groups, 40 (50%) children per group of children. Each group of children consumed one supplement food. Group 1 had consumed flour made from sorghum, peanut, soy sugar and salt. Group 2 had consumed Plumpy' sup which is a ready-to-use therapeutic food. In a previous study [11], the authors distributed their sample into three groups, including group 1 (N = 20) where children with moderate acute malnutrition received millet flour-based porridge, flour from peanut meal enriched with Maringá powder, Group 2 (N = 12) where children with mild acute malnutrition received the same food as Group 1 and Group 3 (N = 12) where children with moderate acute malnutrition received CSB++.

Table 1. Distribution of children by complementary food consumption group.

Child group	Complementary feed	Actual	Frequency
Group_1	Fortified flour	40	50%
Group_2	Plumpy sup	40	50%
Total		80	100%

Table 2 shows the characteristics of children. Eighty (80) children participated in the study, of whom 36 were male (45%) and 44 (55%) were female (55%). Of the Group 1 workforce, 23 (57.5%) children were female and 17 (42.5%) were male. For Group 2, 21 (52.5%) children were female and 19 (47.5%) were male. These results are similar to the results of a study carried out in Guinea Conakry [12], which reported 56% of girls versus 44% of boys in 41 children with severe acute malnutrition undergoing nutritional recovery. On the other hand, in an evaluation of a nutrition program based on a ready-to-use therapeutic food in Chad, which involved 168 children, 60.7% of boys were reported compared to 39.2% of girls [13].

Table 3 shows the age group of children. It appears that children in the age group 6 to 23 months were the most represented with 91.3% with an average age of 13, 36 months. This observation was made during a study on the Assessment of the management of acute malnourished children from 6 to 59 months in the Centers of Learning and Nutritional Rehabilitation of the prefecture of Kouroussa in Guinea Conakry, which found that of the 322 moderate acute malnourished children, 63% were in the 6 - 17 month age group and 30% in the 18 - 29 month age group [14]. This situation could be explained by the fact that weaning occurs after 6 months, with inadequate dietary practices, such as the early or late introduction of supplement foods, often of little variety, of low nutritional quality.

Figure 1 shows that there was not a large difference in the average weight at admission of the two groups of children, 7.03 kg for Group 1 and 6, respectively. 84 kg for Group 2. In a trial of weaning flour in the nutritional rehabilitation of acute community malnutrition in Niger, which involved children aged 6 to 59 months, the authors obtained an average intake weight of 6.630 kg [11]. In addition, Amadou and collaborators [15] had tested the nutritional and sensory quality of infant flour enriched with soy and spirulina and nutritional recovery test in children aged 6 to 24 months in Niger. The results obtained in their study had meant an intake weight of between 3.00 and 7.60 Kg for the maize, soya, spirulina and sugar enriched flour group and between 3.40 kg and 9.00 kg for the plumpy nut group.

Figure 2 shows the change in Z-scores of the weight/height indices for both groups of children at J8 of the study. The mean Z-scores for the nutrition indices had increased from -2.42 to -1.98 for G1 and from -2.38 to -2.08 for G2.

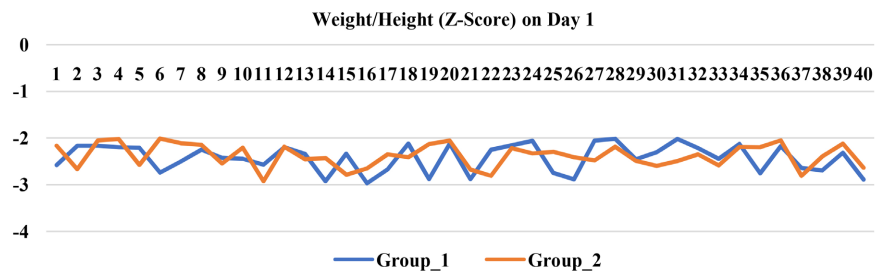


Figure 1. P/T weight status (z-Score) of children at admission.

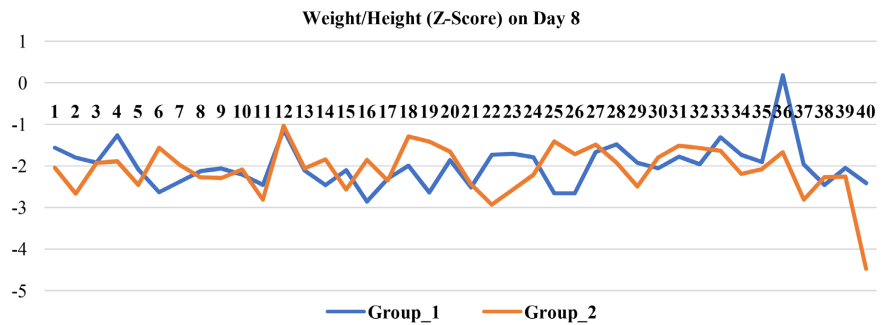


Figure 2. Weight evolution at P/T (Z-Score) of children on Day 8.

Table 2. Distribution of children by sex.

	Sex	Actual	Frequency
Group_1	F	23	57.5%
	M	17	42.5%
Group_2	F	21	52.5%
	M	19	47.5%
Total		80	100%

Table 3. Distribution of children by age group.

	Age range (months)	Actual	Frequency
Groupe_1	23 - 59	4	10.0%
	6 - 23	36	90.0%
Groupe_2	23 - 59	3	7.5%
	6 - 23	37	92.5%
Total		80	100%

Figure 3 shows the change in Z-scores of the weight/height indices for both groups of children at the J15 of the study. The mean Z-scores of the nutrition indices had increased from the mean Z-scores of the nutrition indices from -2.42 to -1.98 for G1 and from -2.38 to -2.08 for G2. Maman and collaborators [11] had tried the efficacy of millet flour enriched with moringa powder, peanut

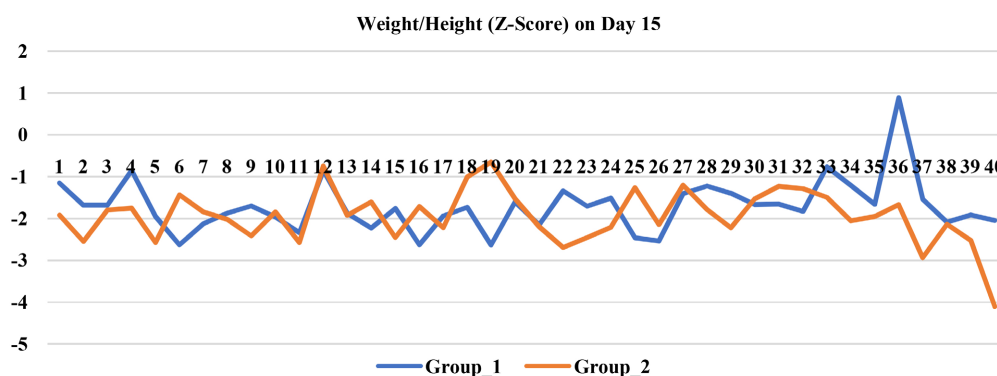


Figure 3. Weight evolution at P/T (Z-Score) of children on Day 15.

meal flour and sugar on moderate acute malnourished children aged 6 to 59 months for an average of 14 days. The results of their study showed that of the 20 moderately malnourished children admitted for management, 18 met discharge criteria and were properly discharged (a 90% treatment success rate). One in 20 malnourished children was referred to the CRENI (a reference rate of 05%) and only one in 20 malnourished children was considered non-response to treatment. The results of a study conducted by Amadou and collaborators [15], revealed that out of 15 malnourished children initially rehabilitated with enriched flour, 12 went out cured after two weeks of nutritional recovery, either an 80% cure rate and the other 3 untreated or 20% are due to certain medical complications. For those recovered with ATPE (plumpy-nut) on 15 children, 13 went out cured after two consultations and represent a cure rate of 87%.

Figure 4 shows the evolution of the Z-scores of the weight/height indices for both groups (G1 and G2) of children at the J22 of the study. The mean Z-scores for the nutrition indices were reduced from -1.70 to 1.41 for G1 and -1.94 to -1.82 for G2.

Figure 5 shows the change in Z-scores of the weight/height indices for both groups of children at J29 of the study. The mean Z-scores for the nutrition indices were reduced from -1.41 to -0.86 for G1 and from -1.82 to -1.67 for G2.

Figure 6 shows the average weight growth per week and per group of children throughout the study period. Children in both groups showed a significant improvement in their weight status. However, children in Group 1 had an average weight gain of 1100 g, which corresponds to an average daily gain per child of 37.93 g/day. For children in Group 2, the average weight gain was 490 g, which corresponds to an average daily gain per child of 16.89 g/day. In a study on the acceptability and efficacy of local supplemental foods proposed by NGOs in Niger [16], the authors obtained a weight gain ranging from 700 g to 1400 g during the four weeks of the study. The average weight obtained ranged from 9 to 19 g per child per day. WHO recommends a weight gain of 10 to 20 g/child per day. Of the 40 children in G1 with a Z-score below -2 , 38 children had a Z-score above -2 , 95% and the other 2 children remained non-responsive to the therapy, 5%. For children in G2, 29 children had a Z-score below -2 , 72.5%, and

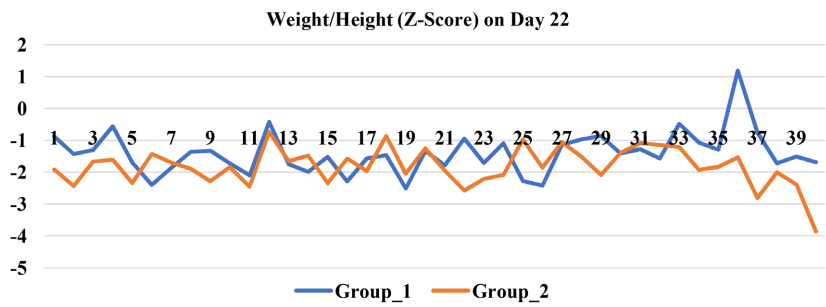


Figure 4. Weight evolution at P/T (Z-Score) of children on day 22.

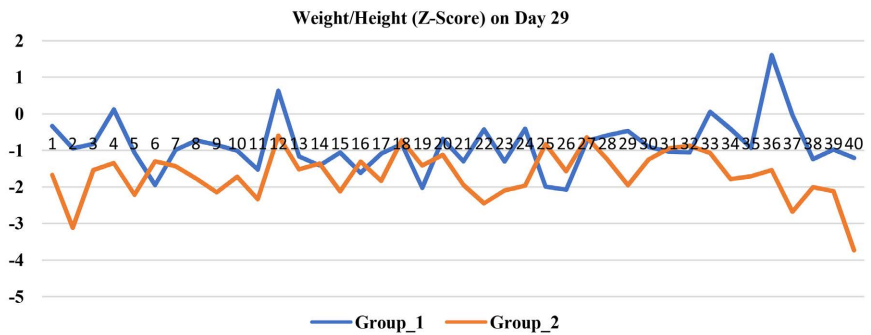


Figure 5. Weight evolution at P/T (Z-Score) of children on J29.

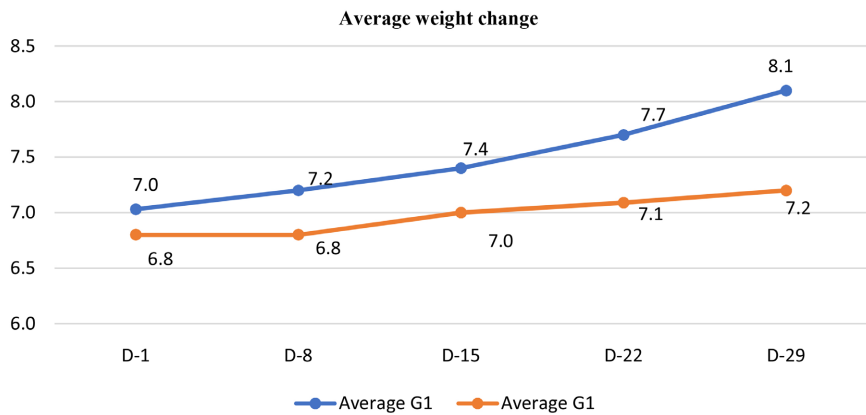


Figure 6. Evolution of the average weight of children from day 1 to day 29.

the remaining 11 did not achieve the minimum exit weight of 27.5%. Mory and collaborators [17] reported average weight gain in both groups (MAS Moringa group and plumpy nut group) respectively 12 and 14 g/kg w/day. The average length of stay was 42 days for the Plumpy nut group compared to 44 days for the MAS-moringa group.

Moreover, several research studies had evidenced that 10 g of moringa powder leaves introduced daily in the diet of malnourished children of the center of LISSÈZOUN allow to significantly improve the nutritional status of children of 6 - 59 months, both for wasting, underweight and stunting [18] [19] [20]. These results also indicated that at the end of the study, no children receiving PFMo suffered from any form of malnutrition [20]. Other authors had also shown that

new formulations of therapeutic foods based on local foods could rehabilitate 78% of children suffering from severe malnutrition in hospital settings [21].

4. Conclusions

At the end of this study two complementary foods for nutritional rehabilitation were evaluated. These complementary foods are locally produced flours and the Ready-to-Use Therapeutic Food (Plumpy' Sup). In this study, all 80 children were screened for moderate acute malnourishment based on the WHO reference curve, 2006 with the height weight index (P/T -3 and <-2 Z-score) and brachial perimeter (PB 115 and <125 mm).

This study in Abéché allowed us to assess the weight growth of two groups of children. G1 consumed locally produced enriched flour and G2 consumed Plumpy' Sup. At the end of the study, it was shown that the results obtained with locally produced flours are superior to those achieved with Plumpy' Sup. The G1 had an average weight gain of 1100 g. The average weight gain for children in Group 2 was 490 g. This means that locally produced enriched flour is more effective than Plumpy' sup in recovering children 6 to 59 months with moderate acute malnutrition. Overall, the study found that the two supplemental foods assessed improved the weight status of children for wasting and reduced the prevalence of moderate acute malnutrition among children aged 6 to 59 months in the city of Abéché. The composition of flours from local resources can be an alternative to ATPE in the management of moderate acute malnutrition. However, it seems important to value local products for the design of supplement or supplement flours, support communities in the formulation of complementary flour based on local products and train women in improved techniques for processing and preserving local products.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this article.

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