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Local Food Resources to Fight Children Malnutrition and Infectious Diseases in Mozambique

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Abstract

Objective: To develop sustainable recipes, using local food resources, as a possible solution to manage children malnutrition and nutritional lack in Mozambique, thus preventing infectious diseases.

Methods: Our work was based on the Dietary Reference Intake (DRI) reports for children aged 4-8 years old. After having listed more than 60 commonly consumed local foods in Mozambique, we developed some recipes, indicating composition, energy and nutrients values. Information on nutrients concentrations was taken from the National Nutrient Database for Standard References, the Food Composition Tables for Mozambique and the Research Center for Aliments and Nutrition. In the recipes, the traditional way of listing ingredients was reported, which were then turned into international, standardized values.

Results: We elaborated some different local food recipes, easy to prepare, at low cost and useful in a systematic approach in order to fight malnutrition in Sofala Province, Mozambique. Each recipe included functions and daily Recommended Dietary Allowance (RDA) of: water, proteins, lipids, carbohydrates, fibers, sodium, potassium, iron, calcium, phosphorus and vitamins. We suggested recipes richer in vitamins and micro/macro nutrients for breakfast, while those providing high caloric intake were more indicated for the main meal. The resulting recipes have been made understandable, for both local and international population, thanks to the coexistence of traditional and international description of ingredients.

Conclusion: Local recipes approach is a possible promising tool among the most cost-effective/high impact interventions against child malnutrition and mortality from infectious diseases in Mozambique.

Keywords: Malnutrition; Infectious diseases; Children; Local food resources; Mozambique; Doctors with Africa

Introduction and Objective

Pediatric malnutrition is defined by the Academy of Nutrition and Dietetics and the American Society for Parenteral and Enteral Nutrition as "an imbalance between nutrient requirements and intake that results in cumulative deficits of energy, protein or micronutrients that may negatively affect growth, development and other relevant outcomes" [1]. It represents a serious public health issue linked to an increased mortality and morbidity risk and children under 5 years old have a higher risk due to growth speed and brain development [2].

The World Health Organization (WHO) reports that the annual infant mortality rate is about 6.3 million and 42% of these takes place in the African region. Just six causes are considered responsible of 73% of deaths in children under the age of five: respiratory infections (19%), diarrhea (18%), malaria (8%), pneumonia and neonatal sepsis (10%), pre-term birth (10%) and birth asphyxia (8%) [3-5]. Malnutrition is obviously an additional risk for all of these conditions, worsening the course of the infectious diseases and slowing the healing, and it is considered the underlying cause of 53% of pediatric deaths up to 5 years [6]. In fact, an inadequate diet leads to weight loss, decrease of the immune response and damage of the mucosa, allowing invasion of pathogens, which finally worsens the overall nutritional status. In addition, these conditions lead to decreased efficacy of vaccines and increased exposure to infectious agents [7,8].

An important role in child health and development is also played by the nutritional and educational status of the mother [9,10].

In developing countries about 200 million children - one in three - between 0 and 5 years suffer from some form of malnutrition and those with a severe form have a nine times greater risk of death compared to well-fed children [11,12].

In Mozambique, children constitute 52% of the national population and malnutrition in childhood is a serious concern: 16.9% of babies are born with low birth-weight; 5.9% children under 5 years suffer from acute malnutrition (moderate or severe) and 42.6% are chronically malnourished [13-15]. The problem is particularly heavy in rural areas, where the quality of the diet is extremely low and the consumption of food and dietary diversification are inadequate in more than 31% of households, in spite of

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a general improvement in food production and availability of food [16]. Different and various strategies have been adopted to fight the malnutrition problem and the food-based approach in prevention and control of micronutrient deficiencies as well as nutrition, is fully recognized by the Food and Agriculture Organization of the United Nations [10,17].

There are also a wide range of specialized foods ranging from Fortified Blended Foods (FBFs) and micronutrient powders to Ready-to-Use Foods and High-Energy Biscuits (HEBs) such as Plumpy'Net, with which it is possible to obtain good results [18,19].

In Mozambique, Government programs concerning malnutrition, child care and health education are active, including: nutritional supplementation interventions, school health programs and agriculture, community preventions campaigns, nutrition and food security plans [20].

Nevertheless, there is a gap of knowledge on the use of local food resources as a possible, simple, low cost solution to fight malnutrition and prevent infectious diseases in Mozambique. In fact, even if many Authors suggest that malnutrition and diseases are strongly related [7,21], worsening the prognosis of infectious diseases like tuberculosis, HIV and malaria, no study have yet been published concerning the power and the potential good effect of local food resources on these aspects. A major issue in countries with limited resources is the sustainability of the program itself.

Thus, this study seeks to illustrate some sustainable recipes, made with local food resources, as a possible solution to fight child malnutrition and reduce the risk of infectious diseases (mainly tuberculosis, HIV and malaria), in Mozambique.

Methods

In this study project, we adopted the Dietary Reference Intake (DRI) for children aged 4-8 years old from the DRI reports [22] and the function and the Recommended Dietary Allowance (RDA) of main nutrients were considered. Moreover, we obtained a list of local food resources in order to select and propose local recipes as a possible, innovative, simple and rapid approach to fight children malnutrition and infectious diseases in a low-income country as Mozambique [7,21,23,24]. The research was made in cooperation with the Provincial Health Department of Sofala and the local association "Grupo das Mães Kuplumussana".

Dietary reference intake

The DRI represents the most current scientific knowledge on nutrient needs of healthy populations. We adopted the DRI for children aged 4-8 years old from the DRI reports [22]. Main nutrients were listed and for each one the function and the RDA were indicated. RDA is used as a goal for individual intake and in this study was set to meet the needs of almost all (97 to 98 percent) individuals in the mentioned age group.

Food list

The list of foods commonly consumed in Mozambique, in particularly in the Province of Sofala, was made consulting the Food Composition Tables for Mozambique [25], the Health Provincial Direction (DPS) of Sofala and searching in local markets, shops and supermarkets.

Information on nutrient concentrations in foods was taken from the USDA National Nutrient Database for Standard References [26], the Food Composition Tables for Mozambique [25] and the Research Center for Aliments and Nutrition [27].

Recipes elaboration

The recipes were developed by the joint work of the DPS, the non-governmental organization "Doctors with Africa" and a local association named "Grupo das Mães Kuplumussana", taking also cue from the manual "Oficina culinarias praticas de Mocambique".

The recipes have been firstly collected reporting traditional way of listing ingredients and then, based on the DRI and the food list, turned into international, standardized values.

Results

The DRI for 4-8 years old children is reported in Table 1, where functions and daily RDA are listed in term of: water, proteins, lipids, carbohydrates, fibers, sodium (Na), potassium (K), iron (Fe), calcium (Ca), phosphorus (P) and vitamins (thiamin or vitamin B1, riboflavin or vitamin B2, niacin or vitamin B3, vitamin A, vitamin C and vitamin E).

In Table 2 we reported sixty foods commonly used in Mozambique, indicating for each one the composition and the energetic value.

Nutrient	Function	RDA/die
Water	Maintains homeostasis in the body, allows for transport of nutrients to cells and removal and excretion of waste products of metabolism	1.7 L
Protein	Are the major structural component of the body. Are made by amino acids, nine of the amino acids must be provided in the diet; these are termed indispensable amino acids	19 g
Lipid	They are a source of energy. Its presence in the diet increases absorption of fat soluble vitamins and precursors such as vitamin A and pro-vitamin A carotenoids	No
Carbohydrate	Primary energy source for the brain; AMDR based on its role as a source of kilocalories to maintain body weight	130 g
Fiber	Improves laxation, assists in maintaining normal blood glucose levels	25 g
Na	Maintains fluid volume outside of cells and keep normal cell function	1.2 g
K	Maintains fluid volume inside/outside of cells and keep the normal cell function	3.8 g
Fe	Component of hemoglobin and numerous enzymes	10 mg
Ca	Essential role in muscle contraction, nerve transmission, and bone and tooth formation	1000 mg
P	Maintenance of pH, storage and transfer of energy by ATP-phosphorylation and nucleotide synthesis	500 mg
Thiamin (Vit. B1)	Coenzyme in the metabolism of carbohydrates	0.6 mg
Riboflavin (Vit. B2)	Coenzyme in numerous redox reactions	0.6 mg
Niacin (Vit. B3)	Coenzyme in numerous redox reactions	8 mg
Vit. A	Required for normal vision, reproduction, embryonic development and immune function	400 µg
Vit C	Cofactor for numerous reactions and as protective antioxidant	25 mg
Vit E	Cofactor in numerous antioxidant reactions	7 mg

Legend: Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin)

Table 1: Dietary Reference Intakes (DRIs) for 4-8 years old children.

FOOD	E.P.	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	%	G	g	G	G	g	G	g	Kcal	KJ	mg	mg	Mg	mg	mg	mg	mg	mg	µg	mg	mg
Rice flour	100	12.34	7.30	0.57	87.00	79.10	0.00	1.00	360.00	1506.24	4.04	104.00	0.40	7.00	90.10	0.05	0.04	1.40	0.00	0.00	0.11
Corn flour	100	12.50	8.71	2.70	80.80	72.10	1.50	3.10	362.00	1515.34	1.04	130.04	1.80	6.00	99.00	0.35	0.10	1.90	11.02	0.00	0.42
Rye flour	100	10.20	11.73	2.38	75.09	73.48	1.10	14.30	311.00	1302.02	2.00	374.00	2.54	24.00	225.00	0.28	0.11	1.72	0.00	0.00	1.43
Wheat flour	100	13.43	11.90	1.96	67.80	59.70	2.10	8.40	319.00	1334.24	3.00	337.20	3.00	28.00	300.04	0.40	0.16	5.00	0.00	0.00	0.85
Millet flour	100	12.60	11.01	4.20	74.10	62.90	4.90	3.10	360.00	1505.24	1.00	174.00	3.50	17.00	300.10	0.41	0.07	6.02	tr	0.00	0.11
Potato	83	78.50	2.10	1.04	17.90	15.90	0.40	1.60	85.00	355.64	7.06	570.40	0.60	10.00	54.00	0.10	0.04	2.50	3.50	15.00	65.00
Sweet potato	100	86.81	2.49	0.51	8.82	2.40	12.80	5.30	65.00	271.96	1.10	350.00	0.80	7.00	28.00	0.06	0.06	0.70	45.06	16.05	0.00
Cassava	100	59.68	1.36	0.28	38.06	36.24	1.7	1.8	160.00	669.44	14.00	271.04	0.27	16.00	27.00	0.08	0.04	0.85	1.00	20.6	0.19
Bananas	65	76.80	1.20	0.30	15.40	2.40	12.80	1.80	65.00	271.96	1.22	350.25	0.83	7.05	28.44	0.06	0.06	0.70	45.45	16.69	0.10
Egg	94	80.30	12.50	9.51	0.72	N.A.	0.37	0.00	143.00	598.31	142.00	138.42	1.75	56.00	198.00	0.04	0.45	0.07	160.00	0.00	1.05
Cow milk	100	87.50	3.30	3.64	4.70	0.00	4.70	0.00	63.00	263.59	43.00	149.45	0.20	160.04	95.09	0.04	0.18	0.08	50.08	1.78	0.07
Yogurt	100	87.00	3.89	3.90	4.30	0.00	4.30	0.00	66.00	276.14	48.95	170.64	0.10	125.09	105.33	0.04	0.19	0.11	38.90	1.55	0.08
Beef	100	72.90	20.31	16.70	3.74	N.A.	0.70	0.09	233.00	974.87	723.75	116.00	2.06	15.73	118.18	0.18	0.15	4.70	2.38	0.20	N.A.
Chicken	62	76.10	19.40	3.60	1.47	N.A.	N.A.	0.00	110.00	460.24	70.48	307.99	6.25	8.01	200.68	0.10	1.19	5.80	4374.00	18.41	N.A.
Cuttlefish	50	81.50	14.09	1.50	0.70	N.A.	N.A.	0.00	72.00	302.24	372.00	353.34	6.02	90.0	387.00	tr	0.91	1.21	113.00	5.30	N.A.
Squid	65	80.00	12.60	1.70	3.08	N.A.	0.00	0.00	68.00	284.51	44.00	246.00	0.68	32.00	221.00	0.02	0.41	2.17	10.00	4.70	1.20
Crab	75	79.20	18.13	0.90	0.04	N.A.	N.A.	0.00	81.00	338.90	293.00	329.00	0.74	89.00	229.00	0.08	0.04	2.70	2.00	3.00	N.A.
Shrimp	85	83.01	13.61	1.01	0.91	N.A.	0.00	0.00	71.00	297.06	566.41	113.47	0.21	54.37	244.14	0.02	0.01	1.77	54.25	0.00	1.32
Termite	92	71.30	54.69	2.90	36.71	N.A.	N.A.	2.09	121.00	506.26	58.80	N.A.	N.A.	44.35	N.A.	N.A.	N.A.	N.A.	2.43	0.74	N.A.
Peanut	65	6.5	29.06	50.09	16.13	N.A.	4.72	10.90	598.00	2502.03	18.00	680.47	4.58	92.00	376.00	0.64	0.13	12.06	0.00	0.00	8.33
Cashew nut	70	5.2	15.01	46.07	33.00	N.A.	5.91	3.02	598.00	2502.03	12.00	660.00	6.06	37.00	590.56	0.42	0.05	1.06	0.00	0.50	0.90
Soy	100	9.50	36.99	19.10	23.27	11.1	11.0	11.94	407.00	1702.89	14.45	1740.77	6.93	257.77	491.78	0.58	1.16	4.31	6.00	0.00	1.95
Peas	31	79.42	5.52	0.66	16.56	12.25	4.09	6.34	52.00	217.56	5.00	243.87	1.47	25.79	97.66	0.21	0.13	2.63	38.00	32.77	0.13
Beans	100	10.57	23.63	2.07	47.57	40.04	3.57	17.59	291.00	1217.54	4.47	1445.67	8.00	137.05	438.00	0.46	0.17	2.37	3.01	3.83	N.A.
Pumpkin seed	84	4.58	18.55	19.43	53.75	N.A.	N.A.	18.43	446.00	1866.06	18.45	919.47	3.31	55.49	92.10	0.03	0.05	0.28	3.65	0.37	0.00
Watermelon seed dried	N.A.	5.05	28.33	47.37	15.31	N.A.	N.A.	N.A.	557.00	2330.49	99.94	648.10	7.28	54.04	755.98	0.19	0.14	3.55	0.00	0.00	N.A.
Sweet potato leave	100	86.81	2.49	0.51	8.82	N.A.	N.A.	5.37	42.00	175.72	6.76	508.08	0.97	78.16	81.14	0.15	0.34	1.13	189.65	11.07	N.A.
Pumpkin leave	100	92.88	3.15	0.43	2.33	N.A.	N.A.	4.71	19.00	79.49	11.19	104.07	2.22	39.22	104.66	0.09	0.12	0.92	97.09	11.76	N.A.
Cassava leave	100	91.37	7.36	1.01	18.36	N.A.	N.A.	4.09	91.00	380.74	N.A.	0.026	7.66	303.71	119.45	0.25	0.06	2.44	11.77	8.76	N.A.
Moringa leave	100	78.66	9.43	1.41	8.28	N.A.	N.A.	2.03	65.00	271.96	9.00	337.46	4.17	185.85	112.22	0.25	0.66	2.22	378.45	51.70	tr
Cabbage	93	92.25	2.14	0.17	2.59	0	2.56	2.6	19.00	79.49	23.76	260.07	1.16	60.78	29.43	0.06	0.04	0.60	19.77	47.71	0.15
Eggplant	93	92.23	2.15	0.19	5.88	N.A.	2.57	2.61	19.00	79.49	2.31	260.06	0.23	9.14	29.77	0.04	0.04	0.61	1.15	2.72	0.30
Pumpkin	81	94.62	1.12	0.18	6.56	4.24	2.76	0.50	18.00	75.31	1.00	340.00	0.96	20.11	40.56	0.03	0.11	0.53	429.98	9.88	1.06
Cucumber	77	96.55	0.78	0.11	3.63	N.A.	1.81	0.87	14.00	58.57	2.00	140.0	0.32	16.92	17.47	0.02	0.03	0.09	5.00	2.47	0.03
Green bean	95	90.50	2.10	0.12	6.42	N.A.	3.49	2.96	18.00	75.31	5.99	210.07	0.98	35.45	38.14	0.07	0.15	0.81	41.45	12.86	0.41
Broad bean	95	10.98	26.12	1.53	58.29	N.A.	5.72	25.02	341.00	1426.74	13.07	421.11	6.72	103.38	421.36	0.55	0.33	2.83	3.64	1.48	0.05
Garlic	95	58.85	6.36	0.54	33.06	N.A.	1.00	2.10	149.00	623.41	17.09	401.09	1.70	181.00	153.11	0.29	0.11	0.77	tr	31.27	0.08
Onion	95	89.11	1.19	0.16	9.34	N.A.	4.24	1.77	40.00	167.36	4.77	146.14	0.21	23.12	29.68	0.04	0.02	0.11	tr	7.47	0.02
Tomato	100	94.23	1.24	0.26	5.85	0.00	3.83	1.01	17.00	71.12	3.09	290.19	0.46	11.61	26.11	0.03	0.03	0.70	42.97	21.11	0.38
Carrot	95	91.61	1.17	0.23	8.69	N.A.	5.67	3.19	35.00	146.44	95.49	220.16	0.74	44.43	37.01	0.04	0.04	0.70	835.00	5.74	0.66
Mango	73	82.89	1.06	0.21	12.69	N.A.	12.61	1.69	53.00	221.75	1.10	250.07	0.58	7.14	11.98	0.02	0.04	0.65	53.67	36.57	0.90
Papaya	70	89.39	0.45	0.27	9.94	N.A.	6.93	1.32	38.00	158.99	7.19	140.03	0.25	28.65	10.15	0.02	0.03	0.36	47.14	60.44	0.30
Pineapple	57	86.42	0.51	0.12	13.03	N.A.	9.85	1.46	40.00	167.36	1.09	109.07	0.29	13.36	8.01	0.07	0.03	0.50	3.01	47.74	0.02
Apple	79	82.51	0.33	0.16	13.71	N.A.	10.79	2.04	53.00	221.75	1.00	107.00	0.18	6.21	10.99	0.01	0.02	0.09	3.08	4.45	0.18
Lemon	64	89.53	0.67	0.20	10.35	N.A.	1.39	2.99	11.00	46.02	2.17	104.07	0.61	32.97	18.42	0.04	0.02	0.21	2.00	35.33	0.22
Orange	80	87.28	1.71	0.27	25.88	N.A.	N.A.	10.60	97.00	405.84	3.09	210.04	0.87	161.41	22.09	0.12	0.09	0.90	21.00	136.0	0.25
Tangerine	80	81.43	0.95	0.33	17.66	N.A.	10.59	1.76	72.00	301.24	2.00	170.37	0.26	32.63	19.42	0.08	0.04	0.35	34.11	29.87	0.20
Baobab seed	84	80.25	33.76	30.61	78.08	N.A.	N.A.	N.A.	430.00	1799.12	6.06	280.67	6.34	58.93	6.01	N.A.	N.A.	N.A.	5.26	6.71	N.A.
Sugar	100	1.51	0.09	0.00	98.89	N.A.	97.02	0.00	392.00	1640.13	28.02	133.02	0.71	83.06	4.00	0.00	0.00	0.11	0.00	0.00	0.00
Honey	100	18.05	0.34	0.00	82.34	0.00	81.36	0.02	304.00	1271.94	4.07	51.07	0.54	5.41	6.44	tr	0.04	0.121	tr	0.5	tr
Peanut oil	100	Tr	0.00	100.00	0.00	N.A.	0.00	0.00	899.00	3761.42	tr	Tr	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.17
Cashew nuts oil	100	Tr	0.00	99.99	0.00	0.00	0.00	0.00	780	3263.52	tr	Tr	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.59
Corn oil	100	Tr	0.00	99.95	0.00	0.00	0.00	0.00	899.00	3761.42	tr	Tr	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	34.59
Soybean oil	100	Tr	0	99.90	0	0	0	0	899.00	3761.42	tr	Tr	0.13	0	0	0	0	0	0	0	18.54
Butter	100	14.10	0.81	83.44	1.16	N.A.	1.14	0.00	758.00	3171.47	7.7	15.37	0.00	25.15	16.55	tr	0.03	0.04	684	0.00	2.32
Margarine	100	13.01	0.54	84.05	0.41	N.A.	0.00	0.00	760.00	3179.84	800.19	15.07	0.06	3.00	5.00	0.01	0.03	0.02	819	0.2	9.00
Animal fat (lard)	100	0.00	0.00	100.00	0.00	0.00	0.00	0.00	892.00	3732.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.70
Coconut	52	50.96	3.57	35.02	15.43	N.A.	9.49	9.01	364.00	1522.98	23.75	256.09	1.76	13.98	95.83	0.05	0.02	0.50	0.00	3.48	0.24
Coconut milk	100	64.99	2.29	23.84	5.54	N.A.	3.34	2.20	230	962.32	15.19	263.00	1.64	16.00	100.00	0.02	0.00	0.76	0.00	2.8	0.15
Sesame	100	4.69	17.73	49.67	23.45	N.A.	0.31	11.84	573.00	2397.43	11.09	468.11	14.55	975.36	629.97	0.79	0.24	4.51	tr	0.00	0.25

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); N.A. (data not available); tr (traces).

Table 2: List of foods commonly consumed in Mozambique.

From all the collected recipes we chose six of them, two characterized by the presence of vitamins and micro/macro nutrients, therefore more indicated for breakfast, and four with high caloric intake, suggested for the main meal. Here we report the recipes described by the amount of traditional ingredients.

1. Mush of Baobab seeds: a cup of Baobab seeds, half tablespoon of corn flour, four tablespoon of sugar, a cup of milk;
2. Pap of Moringa leaves: four tablespoons of corn flour, four tablespoons of sesame, two tablespoons of beans, a tablespoon of peanuts, a handful of Moringa leaves;
3. Curry of Mandioca leaves: two coffee cups of cashews, a bunch of Mandioca leaves, half cup of shrimps, a cup of coconut milk, a onion, two tomatoes, rice flour;
4. Curry of peanuts with pumpkin leaves: a tea cup of chopped peanuts, four bunch of pumpkin leaves, two tomatoes, an onion, corn flour;
5. Curry of beans: two cups of beans, two tomatoes, three tablespoons of chopped onion, two garlic cloves, a tablespoon of corn oil, a cup of corn flour;
6. Curry of peanuts with cabbage: a cup of coffee of peanuts, a cabbage, two bunches of cabbage leaves, two tomatoes, half onion, a cup of rice flour.

The selected recipes are reported in Tables 3-8, with the ingredients in international, standardized values, and for each ingredient the nutritional content, energy intake and RDA are described.

The sustainability of these recipes, easy and simple to prepare with common local food resources in a low-income country such as Mozambique, suggested thus the potential main outcome of improving the nutritional status in children, allowing to obtain a reduction of incidence and a better prognosis of endemic infectious disease (tuberculosis, HIV and malaria). This results in a possible solution of one of the main public health issue, that is child manutrition and consequent diseases.

Discussion

To eradicate extreme poverty and hunger, reduce child mortality, improve maternal health and combat HIV/AIDS, malaria and other diseases, are some of the Millennium Development Goals [28] which may be undermined by malnutrition. In fact, malnutrition is a risk factor for health and wellness and worsens diseases prognosis,

Food	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	G	g	G	G	G	g	g	Kcal	KJ	Mg	mg	mg	mg	Mg	mg	Mg	mg	µg	mg	mg
Baobab seeds (250 g)	0	84.25	76.5	195.33	0	0	0	1075	4507.5	15.38	700.68	15.85	147.25	15.86	0	0	0	13.15	16.77	0
Corn flour (5 g)	0.62	3.48	1.08	32.32	28.84	0.65	1.24	144.8	606.51	0.4	52	0.72	2.47	39.65	0.14	0.04	0.76	26.83	0	tr
Sugar (20 g)	0.1	0	0	20.9	0	20.9	tr	78.4	328.87	0.2	0.4	0.06	0.27	Tr	0	0	0	0	0	0
Milk (250 g)	218.75	8.25	9	11.75	0	11.75	0	157.5	662.50	0	375.7	0.5	300.24	237.5	0.1	Tr	tr	125.35	2.5	0.17
Total (RDA%)	**219.47 (12.8)**	**95.94 (500.04)**	**86.58 (N.A.)**	**259.97 (199.97)**	**28.84 (N.A.)**	**33.25 (N.A.)**	**1.24 (4.96)**	**1455 (132.3)**	**6087.72 (132.3)**	**15.6 (1.3)**	**1127.4 (29.68)**	**17.13 (171.3)**	**449.85 (44.98)**	**292.1 (58.42)**	**0.24 (40)**	**0.04 (6.66)**	**0.76 (9.5)**	**164.95 (41.23)**	**19.27 (77.08)**	**0.17 (2.42)**

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); tr (traces); N.A. (data not available).

Table 3: Mush of Baobab seeds.

Food	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	g	g	G	G	g	g	G	Kcal	KJ	mg	mg	mg	mg	mg	Mg	mg	mg	µg	mg	mg
Corn flour (40 g)	5.08	3.48	1.08	32.32	28.84	0.6	1.24	144.85	606.09	0.48	52.38	0.72	2.48	39.67	0.14	0.04	0.76	26.87	0	tr
Sesame (40 g)	1.87	7.09	19.87	9.38	0	0.12	4.72	229.2	958.97	4.4	187.2	5.82	390.67	251.6	0.31	0.09	1.8	tr	0	0.18
Beans (40 g)	2.19	5.22	0.3	11.65	0	1.14	5.09	68.24	285.34	2.65	84.23	1.34	20.67	84.29	0.11	0.06	0.56	0.68	0.28	0.01
Peanuts (40 g)	0.23	2.9	5.05	0.85	0.49	0.31	1.09	59.88	250.27	0.64	68.25	0.35	6.46	28.37	0.01	tr	1.48	0	0	tr
Meringue leaves (30 g)	23.83	2.84	0.42	2.5	tr	tr	0.6	19.39	81.14	2.72	102.12	1.21	56.06	33.93	0.07	0.26	0.67	114.54	15.66	tr
Total (RDA%)	**33.13 (2.25)**	**21.54 (113.36)**	**26.67 (N.A.)**	**56.71 (43.62)**	**29.33 (N.A.)**	**2.17 (N.A.)**	**12.65 (50.6)**	**521.39 (47.39)**	**2181.66 (47.39)**	**10.72 (0.89)**	**493.52 (12.98)**	**9.44 (94.4)**	**475.46 (47.54)**	**437.63 (87.52)**	**0.66 (110)**	**0.41 (68.33)**	**5.20 (65)**	**141.94 (35.48)**	**15.94 (63.76)**	**0.11 (1.57)**

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); tr (traces); N.A. (data not available).

Table 4: Pap of Moringa leaves.

Food	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	G	g	G	G	g	g	g	Kcal	KJ	mg	mg	mg	mg	mg	mg	mg	Mg	µg	mg	mg
Cashew (120 g)	2.76	34.84	60.21	10.25	5.88	3.72	13.08	717.62	3002.45	7.25	816.02	4.22	76.86	339.65	0.19	0.09	16.84	0	0	0
Mandioca (50 g)	6.34	0.36	0.13	47.45	43.15	tr	0	180	753.54	2.22	10.07	0.54	6.08	6	0	0.05	0	0	0	0
Shrimp (125 g)	103.76	17.01	1.26	1.13	0.35	0	0	88.75	371.32	707.54	141.25	0.26	67.56	305.08	0.02	0.01	2.21	67.59	0	1.65
Coconut milk (250 g)	237.47	1.87	0.54	9.27	tr	6.52	2.75	47.54	198.72	262.59	625.09	0.72	60.07	50.28	0.07	0.14	0.29	0	6.07	0
Onion (70 g)	63.65	0.78	0.07	6.67	0	3.02	1.21	28.57	119.54	2.85	104.28	0.15	16.42	20.71	0.03	0.01	0.08	tr	5.28	0.01
Tomato (320 g)	301.44	3.84	0.64	8.96	0	8.96	3.2	54.41	230.47	9.64	928.08	1.28	35.29	83.24	0.09	0.09	2.24	134.44	67.27	0
Rice flour (150 g)	18.45	10.95	0.75	130.55	118.65	0	1.57	540.09	2259.78	6.09	156.07	0.64	10.54	135	0.07	0.06	2.17	0	0	0
Total (RDA%)	**733.83 (43.41)**	**69.48 (365.08)**	**63.32 (N.A.)**	**214.19 (164.76)**	**167.68 (N.A.)**	**22.23 (N.A.)**	**21.74 (86.96)**	**1656.82 (150.62)**	**6934.89 (150.62)**	**997.65 (83.13)**	**2780.53 (73.17)**	**7.71 (77.17)**	**272.42 (27.24)**	**939.51 (187.9)**	**0.49 (82.64)**	**0.48 (80.42)**	**23.63 (295.44)**	**201.97 (50.47)**	**78.48 (313.94)**	**1.66 (23.77)**

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); tr (traces); N.A. (data not available).

Table 5: Curry of Mandioca leaves.

Food	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	g	g	G	G	g	g	G	Kcal	KJ	mg	mg	mg	mg	mg	mg	mg	mg	µg	mg	Mg
Peanuts (150 g)	3.45	43.5	75	12.75	7.35	4.65	16.35	897	3753	9	1020	5.25	96	424.5	0.24	0.12	21	0	0	0
Pumpkin leaves (300 g)	278.64	9.45	1.2	6.99	N.A.	N.A.	14.1	57	238.47	33	312	6.66	117	312	0.28	0.38	2.76	291	33	0
Tomato (320 g)	301.44	3.84	0.64	8.96	0	8.96	3.2	54.4	230.4	9.6	928	1.28	35.2	83.2	0.09	0.09	2.24	134.4	67.2	0
Onion (70 g)	63.65	0.78	0.07	6.67	0	3.02	1.21	28.57	119.54	2.85	104.28	0.15	16.42	20.71	0.03	0.01	0.08	tr	5.28	0.01
Corn flour (150 g)	18.75	13.05	4.05	121.2	108.15	2.25	4.65	543	2272.5	1.5	195	2.7	9	148.5	0.52	0.15	2.85	100.5	0	0
Total (RDA%)	**665.93 (39.11)**	**70.62 (371.64)**	**80.96 (N.A.)**	**156.57 (120.43)**	**115.50 (N.A.)**	**18.88 (N.A.)**	**39.51 (158.04)**	**1579.97 (143.63)**	**6613.91 (143.63)**	**55.95 (4.66)**	**2559.28 (67.34)**	**16.04 (160.4)**	**273.62 (27.36)**	**988.91 (197.78)**	**1.17 (195)**	**0.76 (126.66)**	**28.93 (361.62)**	**525.9 (131.47)**	**105.48 (421.92)**	**0.01 (0.14)**

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); tr (traces); N.A. (data not available).

Table 6: Curry of peanuts with pumpkin leaves.

Food	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	G	g	G	G	g	g	g	Kcal	KJ	mg	mg	mg	mg	mg	mg	Mg	mg	µg	mg	mg
Beans (450 g)	47.25	106.2	9	213.75	180	15.75	78.75	1309.5	5472	18	6502.5	36	607.5	2025	1.8	0.45	10.35	13.5	13.5	0
Tomato (320 g)	301.44	3.84	0.64	8.96	0	8.96	3.2	54.4	230.4	9.6	928	1.28	35.2	83.2	0.09	0.09	2.24	134.4	67.2	0
Onion (40 gr)	35.64	0.44	0.04	3.73	0	1.69	0.68	16	66.9	1.6	58.4	0.08	9.2	11.6	0.01	0.01	0.04	tr	2.96	tr
garlic (6 g)	3.54	0.38	0.03	1.99	0	0.06	0.12	8.97	37.53	1.02	24.15	0.1	10.9	9.21	0.01	Tr	0.04	tr	1.87	tr
Corn oil (10ml)	Tr	0	9.99	0	0	0	0	89.9	376.2	Tr	Tr	0.01	0	0	0	0	0	0	0	3.45
Corn flour (150 g)	18.75	13.05	4.05	121.2	108.15	2.25	4.65	543	2272.5	1.5	195	2.7	9	148.5	0.52	0.15	2.85	100.5	0	0
Total (RDA%)	**406.62 (23.84)**	**123.91 (652.15)**	**23.75 (N.A.)**	**349.63 (268.94)**	**288.15 (N.A.)**	**28.71 (N.A.)**	**87.4 (349.65)**	**2021.77 (183.79)**	**8455.57 (183.79)**	**31.72 (2.64)**	**7708.05 (202.84)**	**40.17 (401.7)**	**671.8 (67.18)**	**2277.51 (455.5)**	**2.45 (408.5)**	**0.71 (118.33)**	**15.52 (194)**	**248.4 (62.1)**	**85.53 (342.12)**	**3.45 (48.3)**

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); tr (traces); N.A. (data not available).

Table 7: Curry of beans.

Food	H_2O	Pro	Lip	Car	Sta	S.S.	Fib	Energy		Na	K	Fe	Ca	P	Vit. B1	Vit. B2	Vit. B3	Vit. A	Vit. C	Vit. E
	G	g	g	g	g	g	g	Kcal	KJ	mg	mg	mg	mg	mg	mg	mg	Mg	µg	mg	mg
Peanuts (150 g)	3.45	43.56	75	12.75	7.35	4.65	16.35	897.03	3753	9	1020.07	5.25	96.14	424.53	0.24	0.12	21.07	0	0	0
Cabba ge (400 g)	368.84	8.44	0.45	10.04	0	10.18	10.49	76	312	92.09	1040.09	4.44	240.09	116.09	0.24	0.16	2.44	76.09	188.09	N.A.
Onion (40 g)	35.64	0.44	0.04	3.73	0	1.69	0.68	16	66.94	1.64	58.44	0.08	9.28	11.61	0.01	0.01	0.04	N.A.	2.96	0
garlic (6 g)	3.54	0.38	0.03	1.99	0	0.06	0.12	8.97	37.53	1.02	24.15	0.1	10.9	9.21	0.01	tr	0.04	tr	1.87	tr
Corn oil (10 g)	Tr	0	9.99	0	0	0	0	89.93	376.2	tr	tr	0.01	0	0	0	0	0	0	0	3.45
Corn flour (150 g)	18.75	13.05	4.05	121.26	108.15	2.25	4.65	543.07	2272.5	1.56	195.36	2.71	9.08	148.54	0.52	0.15	2.85	100.54	0	0
Total (RDA%)	**430.18 (25.33)**	**65.77 (346.15)**	**89.51 (N.A.)**	**149.67 (115.13)**	**115.54 (N.A.)**	**18.65 (N.A.)**	**32.2 (128.84)**	**1630.87 (148.26)**	**6818.17 (148.26)**	**105.12 (8.76)**	**2337.55 (61.51)**	**12.54 (125.4)**	**365.1 (36.51)**	**709.81 (141.96)**	**1.03 (171.66)**	**0.44 (73.33)**	**26.33 (329.12)**	**176.5 (44.12)**	**192.83 (771.32)**	**3.45 (49.28)**

Legend: H_2O (Water); Pro (Proteins); Lip (Lipids); Car (Carbohydrates); Sta (Starch); S.S. (Soluble sugars); Fib (Fibers); Na (Sodium); K (Potassium); Fe (Iron); Ca (Calcium); P (Phosphorus); Vit (Vitamin); N.A. (data not available); tr (traces).

Table 8: Curry of peanuts with cabbage.

particularly of infectious diseases [6,8]. It is a major challenge especially in Mozambique, where almost half of the children are living in extreme poverty conditions and are suffering from chronic malnutrition [29].

Some Authors have studied the correlation between malnutrition and diseases in children [7,21] while other Authors have considered the possible impact of the use of local resources to fight malnutrition in other low-income countries, such as Madagascar, however focusing on a survey and a consumer test [24].

Dietary diversification of local foods is considered a strategy to reduce chronic malnutrition, although this approach is under investigated and is lacking scientific evidence about its effectiveness. Thus in our study we focused on this particular aspect.

In this study, first of all, we have calculated the DRI for children aged 4-8 years old and listed the most common foods of Sofala Province. For each food, we indicated energy and nutritional values in order to develop recipes, based on traditional dishes, providing an adequate intake to children.

To make a more scientifically standardized work than other previous ones, we converted traditional values of ingredients in international ones, maintaining nevertheless quality and taste.

Certainly, this is not the first paper that considers local food as a weapon against malnutrition, however, to our knowledge, this is the first with a systematic and standardized approach proposing also a qualitative cost effectiveness assessment.

In this paper we present only few recipes, easy to prepare, suitable for malnourished children, that could be prepared daily in nutritional rehabilitation centers, at low cost. Considering the local products variety and the high energetic and nutrients intake of many of them, it could be a real attempt to both overcome micronutrients deficiencies and reduce levels of chronic undernutrition.

Knowledge of specific energetic and nutritional values of each food, allows us to create different recipes and food combinations in order to provide adequate feeding and, if necessary, increase a particular nutrient. Moreover, by balancing the amount of different foods it is possible to draw different recipes for different meals: for example, among the recipes we proposed, the "Mush of Baobab seeds" and the "Pap of Moringa leaves" are rich in proteins and nutrients and thus

most suitable for breakfast, while the others, much more energetic, are the right choice for the main meal.

However, it is not enough to propose good recipes without a health care assistance and adequate follow-up of targeted children, but it is crucial to monitor regularly the intervention. In fact, only a systematic approach made by well trained people, will allow not only to fight malnutrition, but also to follow up children, assessing health status and thus the effectiveness of intervention. Moreover, it can become a teaching method for mothers assisting the culinary demonstration, who in turn can then prepare these energy meals for their children at home. Even more interesting, from a socio-economic point of view, this approach ensures environmental development and sustainability, another Millennium Development Goal, and increases accessibility, supporting local economy.

Finally, although we were able to develop standardized recipes from local food resources as a possible solution to fight malnutrition and infectious diseases in Mozambique, the main limit of our study is that to quantitatively demonstrate the positive effects of this approach, a focused research project should be made, supported by the evidence in the Literature of the importance of nutrition on health status and healing. The results of our study can be considered a first step in trying to precisely standardize and define the potential effect of local food resources on malnutrition and on the outcome of endemic infectious diseases in low-income countries, such as Mozambique.

Conclusion

In conclusion, although more studies and evidence are needed, local recipes approach has the advantage to be among the most cost-effective/high impact interventions against child mortality in Mozambique, simultaneously helping to reduce chronic malnutrition and the risk of developing infectious diseases, paying attention to the local development.

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