Fighting malnutrition with Moringa oleifera leaves: an untapped resource

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The Moringa oleifera tree, native to India, now grows all over the tropics, especially in Africa where scientists, entrepreneurs and NGOs share a growing interest in this tree. The nutritional value of its leaves, rich in vitamins, minerals and proteins, has inspired numerous nutrition and health-food initiatives in Africa, Europe and the United States.

1. In preventing malnutrition, the medicinal use of Moringa is weakly regulated

Certain programs fighting malnutrition in Senegal, India, Benin and Zimbabwe are now using Moringa leaves, traditionally eaten in countries such as Niger, Nigeria, Senegal and Ethiopia.

For these programs, the leaves are generally dried and ground into powder, facilitating conservation and consumption. This transformation also lessens cooking time, thus preserving vitamins.

The empirical results (Senegal) as well as medical research (India) prove the leaf powder to be effective in reducing nutritional deficiency (notably vitamin A and protein deficiency).

None the less, **this usage is weakly regulated and just becoming an object of official authorisation**. The parties involved in distributing the Moringa leaf powder to health and sanitary structures are often small NGOs operating relatively informally, who have established trusting relationships with the medical personnel in their zone of action.

Others distribute the Moringa leaf powder through networks of traditional practitioners or clinics using phyto-medicine as well as conventional medicine. In this case, contact is usually established with the authorities of the Ministry of Health, but formal authorisation is not always obtained.

Yet, if the example of Senegal is taken, the commercialisation of food, food supplements and medicine is regulated by official texts.

- For products intended for human consumption, an authorisation must be obtained from the Ministry of Trade
- For food supplements considered as medicine (fortifiers, vitamin complexes…) pharmaceutical approval must be obtained prior to commercialisation from the Ministry of Health.
- Furthermore, a ministerial order establishes the conditions for the commercialisation of maternal milk substitutes and baby food.

For the time being, the parties involved do not seem worried by the authorities, most likely because they do not have a commercial structure even if they do sell the Moringa leaf powder through their association. Other parties, more involved in the formal economic aspect of the matter, such as businesses or clinics, have filed their product with the authorities (Heath Security Agency, Ministry of Health) and respect the country's standards.

The very least that needs to be accomplished prior to distributing the Moringa leaf powder to sanitary and social structures is to have the national **food safety authority certify** a sample of the product, guaranteeing the absence of pathogenic germs.

An **analysis** of the powder, giving a precise **percentage** of the proteins and if possible the predominant vitamins and minerals, should also become standard practice for products destined for nutritional use. If these analyses are not possible, NGOs can use the **average values** calculated by Moringanews based on over fifteen published reports. The **labels** on the product should include these percentages.

The use of Moringa leaf powder in medical structures also implies specific standards for production, processing and packaging that are not always respected.

For example the use of chemical treatments should be strictly controlled, all that much more as leaf harvest is rather frequent (every two or three weeks). The drying of the leaves should be done in the shade, meaning that the leaves must be monitored and turned over as often as necessary to avoid mould. The grinding of the leaves should not involve higher temperatures. The powder should be stored in opaque, or at least tinted containers as light exposure decreases its vitamin content.

All these conditions can be respected if a quality control is applied and respected, even in rural settings. Groups of women produce excellent quality powder in small-scale productions in Benin and Togo for example.

2. Producing Moringa leaf powder as a wage-earning activity

Projects that attempted to have Moringa leaves produced within health organisations gave up when faced with the inefficiency of this method. In Senegal, the project opted for an intensive, centralized production and in Benin, on the other hand, they opted for a small-scale production approach in a rural setting. For the small-scale production option, the organizing structure oversees quality control, implying additional transportation costs for this as well as for the purchase of the product.

The question of production costs for Moringa leaf powder had not been discussed up until recently as most of the organizations distributing the product did so for free.

In 2005, we have completed the first evaluation of production costs for Moringa leaf powder in Benin and Togo. The figures were compiled by the NGOs who manage the field projects, with a framework provided by Moringanews. Generally these figures do not imply heavy investment-neither a mill for grinding, nor a specific building.

We have also taken into consideration a completely different system used in the north of Senegal- a large-scale production of Moringa powder, using drip irrigation, fertilizer and insecticide as well as a more elaborate processing system (mill, processing workshop etc.).

Example of Senegal

Without taking into account certain investments such as the mill, the motorised pump, drip irrigation system and the building, the cost of production for one kilo of Moringa powder in this system is 4. The annual production reaches 5 tons of powder per hectare per year.

This system was established in order to supply large amounts of powder to a development project piloted by the Church World Service. A part of the production was also intended for nutritional value research, meaning one unique source of the powder, with a consistent and controlled quality. Unfortunately this American NGO is no longer working in Senegal and the manufacturing farm was confronted with a serious economic reality- its overhead was far too costly.

Furthermore, a contract to supply the World Food Program in Mauritania with several tons of powder was cancelled by the WFP Executive Board in Rome. The WFP did not want to take the risk of distributing a little-known product via its programs fighting malnutrition. The existing clinical and toxicological studies were not enough to dispel their concerns.

Example of Benin

In Benin, a small project led by a local NGO with the help of volunteers from the American Peace Corps obtained rather good results collaborating with the local health officials. The powder is produced by groups of women or by individuals, who grow and then process the Moringa leaves.

The women sell the powder 1000 FCFA/kg to the NGO GARPE who in turn resells it to sanitary structures without making a profit. These sanitary structures sell the powder in 100g packages to their patients at a price ranging from 1000 to 1500 FCFA/kg.

A three-week treatment requires 525 grams of powder costing between 525 FCFA (0.80) and 787.5 FCFA (1.20) . This price is acceptable for the patients.

In the city of Parakou, the powder is sold to individuals for 3000-4000 FCFA/kg.

The system used for this project is that of agro-forestry without irrigation. Productivity is obviously lower than in Senegal, as is overhead, production costs being around 2 /kg of powder. In fact these production costs are lower still but have been calculated here to include the family's wages.

Sale of the powder at 1500 FCFA/kg generates 170 FCFA/kg in profits. For a hectare, profits are 21, 866 FCFA/year (33.33 /year), without counting other productions associated with Moringa. This seems low, but more and more farmers (both men and women) are becoming involved in this sector. This can most likely be explained by the fact that the sale of the product pays for family labour. The sale's gross profit (without subtracting the cost of labour) is 200 /ha/year at a selling price of 1000 FCFA/kg, and 300 /ha/year at a selling price of 1500 FCFA/kg.

Example of Togo

In Togo, the association PROPAGE (structure existing prior to Moringanews) led a project in collaboration with a group of producers APPEF-TOGO, in the south-east of the country. A monocrop plantation, the trees are planted at 1m x 1m intervals and harvested eight times a year. A hectare yields, on average, 6 tons per year, with certain plots producing 15 tons/ha/year. Processing is manual, with a mortar and pestle or mechanic, using a mill.

The cost of production for a kilo of powder is between 1 and 1.83, depending on the plot yields and the means of processing. 95% of these costs are labour costs and the majority of it being family labour. Sale of the powder is a decent way to generate family labour income.

With the sale at 1500 FCFA/kg, average profits are 641 FCFA/kg, or almost 1 /kg. Profits per hectare are 214 /ha/year at a sale price of 1000 FCFA/kg and 970 /ha/year at 1500 FCFA/kg.

The production of Moringa leaf powder is thus an activity that can be financially lucrative for farmers (both men and women).

The processing of the leaves into powder increases the value of the product, requiring extra labour that is neither difficult nor time consuming.

The product must also be inexpensive enough to be easily sold in hospitals or clinics.

In the examples of Benin and Togo, it would appear that the price range suits both producers and consumers.

It is now necessary for producers to establish a system to independently control the quality and the sale of their product without the aid of an overseeing association. The producers, both men and women, in Togo and Benin are headed in this direction.

3. Using Moringa leaf powder to enrich baby cereals

In Africa, more often than not, the porridges given to babies are of poor nutritional value- usually cereal flour with sugar added, sometimes small fish and rarely (when the mothers have the means) powdered milk. These baby cereals do not cover children's protein, lipid and micronutrient (vitamins and minerals) needs.

That is why Melanie Broin, of the Moringanews association completed in 2005 an initial study on the introduction of Moringa leaf powder in infant cereal to increase its protein, vitamin and mineral content.

To calculate the formulation of infant cereal, we took into consideration the needs of children between the ages of six months and two years whose diet is mixed (baby cereals and mother's milk). These requirements were defined by the WHO. We also took into consideration the nutritional value of ingredients widely available in Africa used for infant cereal.

The formulation of the various mixtures was made possible by an application developed by the Tropical Nutrition Laboratory of the Institute for Research and Development (IRD) in Montpellier, France. Two work sessions with the IRD nutrition researcher Dr. Serge Trèche, specialised in developing countries' infant cereals allowed us to learn how to use this application as well as benefit from his valuable suggestions for the elaboration of this project.

A series of formulas were defined for testing on mother-child target groups. These formulas ensure a balanced daily intake of calories, covering children's needs in proteins, lipids, carbohydrates, as well as a maximum amount of vitamins and minerals.

Formula	**1**	**2**	**3**	**4**	**5**
Ingredients	100g	100g	100g	100g	100g
Millet	20	20	20	20	25
Sorghum	20	20	20	25	25
Corn	25	25	30	30	30
Soy	5	10	10	10	10
Moringa	20	15	10	5	0
Sugar	10	10	10	10	10
Salt	0,6	0,6	0,6	0,6	0,6

Sensory Tests

An agreement was reached with the University of Lome's nutrition laboratory, in Togo, in order to design sensory testing that would evaluate the different flours at well as determine the maximal level of incorporation of Moringa.

A certain number of preliminary steps were made in order to obtain the required authorisation and to establish contact with the persons and institutes involved. We were able to obtain authorisation from the Ministry of Heath to do the testing, and we designated two places for the testing- the Health Care and Social Welfare Centre of Casablanca (Lome) and the Paediatrics Service of the Tokin University Hospital (Lome). Mothers with their children consult these two centres regularly.

The tests were done on 53 children ages ranging from 6 to 30 months using the five flour mixtures. The test results were very encouraging- all the mothers accepted all of the flour mixtures, all of the children accepted the cereal with a 10% Moringa content, 3 of the 53 children refused to eat the cereal with a 15% Moringa content and 5 of the 53 children refused the cereal with a 20% Moringa content.

Afterwards, we distributed the quantity of flour mixture at 15% Moringa content necessary to nourish a child for one week to the mothers having participated in the tests. We asked them to come back and inform us of their results. 25 children ate the flour at 15% Moringa content for one week. Only the 25 mothers, whose children had eaten the flour at 15% Moringa for one week came back the following week. Of the 25 participants, no child showed signs of digestive problems during the test week. The results were conclusive.

The Tropical Nutrition Laboratory of IRD in Ouagadougou (Burkina Faso) generously offered us the opportunity to do the same testing in Burkina Faso using the structure the laboratory had already designed for other testing.

Nutrition researcher Dr. Claire Mouquet, compared, using sensory tests, plain cereal (no Moringa content) with cereals of 5 and 10% Moringa content (in g/100g of flour). The cereal was composed of corn, soy and peanuts. The tests, done with 30 women from Ouagadougou having a child old enough to eat cereals, consisted in classing the three mixtures (plain, Moringa at 5%, Moringa at 10%) in order of preference. The tests were done with sweetened cereal, salted cereal, with low caloric density (10-12g/100g of DM) and high caloric density (16-20g/100g of DM).

Overall, there was not a significant preference for a cereal mixture at 5% Moringa content over one with no Moringa content, whereas the mixture at 10% Moringa content was considerably less liked than the mixture with no Moringa content (whether it was sweet or salty, of high or low caloric density). In addition, the green colour the cereal takes on because of the Moringa content does not seem to bother the mothers.

When assessing the results of the testing, the tests were positive, especially in Togo where the inhabitants are used to eating leaf vegetables frequently. The tests proved that we can incorporate up to 15% Moringa flour in baby cereal without problems (even though the baby cereal containing less Moringa is preferred) therefore Moringa leaves can substantially increase traditional baby cereal's protein and vitamin content.

These results can serve as a base for the future stages of building awareness and encouraging widespread use of Moringa in baby cereals.

Formulas for Moringa-enriched flour mixtures

In the following charts are a series of balanced formulas. These formulas cover children's needs in proteins, lipids, carbohydrates, essential fatty and amino acids, as well as certain minerals and vitamins.

By using foods widely available for these formulas, two issues arise: not all the micronutrient needs are perfectly met (as opposed to costly commercial formulas in industrialized countries where vitamin and mineral are added) and some data on the levels of micronutrients of the foods used are not available.

Nevertheless the formulas given here, perhaps not perfect, are (i) balanced in macronutrients, (ii) rich in micronutrients and (iii) produced from food available on the African market and available at a low cost and (iv) a considerable improvement to traditional cereal mixtures.

For the preparation of the cereals, the grains must be roasted and ground. The cereal mixture is made by adding boiling water and cooking it over heat for 10 minutes. **These infant cereals are to be eaten in addition to maternal milk for children of 6 months and older at each meal.**

Formula 1

Ingredients	**Quantity (in grams per 100g of flour)**
Roasted maize flour	67
Moringa leaf powder	15
Roasted cowpea seed flour	13
Palm oil	5
Salt with iodine and fluoride	0,6

Formula 2

Ingredients	**Quantity (in grams per 100g of flour)**
Roasted millet flour	60
Moringa leaf powder	16
Roasted soy bean flour	24
Salt with iodine and fluoride	0,6

Formula 3

Ingredients	**Quantity (in grams per 100g of flour)**
Roasted sorghum flour	30
Roasted millet flour	24
Moringa leaf powder	10
Roasted soy bean flour	26
Sugar	10
Salt with iodine and fluoride	0,6

Because of physical anomalies, a severely malnourished child cannot tolerate either iron or normal quantities of protein, fat and sodium. Severely malnourished children have very specific needs and the rehabilitation stage must be done under strict medical surveillance. That is why we do not recommend the use of Moringa leaves for the initial treatment of acute malnutrition.

Conclusion

The production of Moringa leaf powder can be a revenue-generating activity for rural African families, even on small plots with minimal investment. Use of Moringa leaf powder to enrich infant cereals is theoretically possible, as an incorporation of 5%-15% of Moringa powder for 100g of flour is accepted by mothers and children. Standards for its quality control need to be determined (maximum degree of humidity, absence of pathogenic germs), and most importantly its packaging standards and shelf-life need to be defined in order to guarantee the product's nutrient stability. The incorporation of Moringa leaf powder in manufactured infant cereal could create other problems, such as the loss of vitamins due to high temperatures. Collaborating with businesses would help this product take its place in African countries' nutrition policies.