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Adoption of *Moringa oleifera* to Combat Under-Nutrition Viewed Through the Lens of the "Diffusion of Innovations" Theory

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Moringa oleifera*, an edible tree found worldwide in the dry tropics, is increasingly being used for nutritional supplementation. Its nutrient-dense leaves are high in protein quality, leading to its widespread use by doctors, healers, nutritionists and community leaders, to treat under-nutrition and a variety of illnesses. Despite the fact that no rigorous clinical trial has tested its efficacy for treating under-nutrition, the adoption of* M. oleifera *continues to increase. The "Diffusion of innovations theory" describes well, the evidence for growth and adoption of dietary* M. oleifera *leaves, and it highlights the need for a scientific consensus on the nutritional benefits.*

KEYWORDS *diffusion of innovations theory,* Moringa oleifera*, nutrient supplement*

BACKGROUND

Over 143 million children under the age of 5 in developing countries were undernourished in 2006 (UNICEF, 2007). Food insecurity, lack of access to

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health care (including international food aid), and social, cultural, and economic class, all play a major role in explaining the prevalence of under-nutrition (West et al., 2006). The regions most burdened by under-nutrition, (in Africa, Asia, Latin America, and the Caribbean) all share the ability to grow and utilize an edible plant, *Moringa oleifera,* commonly referred to as "The Miracle Tree" (Palada, 1996; Fuglie, 1999). For hundreds of years, traditional healers have prescribed different parts of *M. oleifera* for treatment of skin diseases, respiratory illnesses, ear and dental infections, hypertension, diabetes, cancer treatment, water purification, and have promoted its use as a nutrient dense food source (Anwar et al., 2007; Castellón and González, 1996; Fahey, 2005; Fuglie, 1999). The leaves of *M. oleifera* have been reported to be a valuable source of both macro- and micronutrients and it is now found growing within tropical and subtropical regions worldwide, congruent with the geographies where its nutritional benefits are most needed.

Anecdotal evidence of benefits from *M. oleifera* has fueled a recent increase in adoption of and attention to its many healing benefits (Fahey, 2005), specifically the high nutrient composition of the plant's leaves and seeds. Trees for Life, an NGO based in the United States has promoted the nutritional benefits of Moringa around the world, and their nutritional comparison has been widely copied and is now taken on faith by many: "Gram for gram fresh leaves of *M. oleifera* have 4 times the vitamin A of carrots, 7 times the vitamin C of oranges, 4 times the calcium of milk, 3 times the potassium of bananas, ¾ the iron of spinach, and 2 times the protein of yogurt" (Trees for Life, 2005). Other NGOs that have been active in promoting the use of *M. oleifera* include, but are not limited to: ECHO (Florida, USA), Church World Service (Indiana, USA), GIANT (Georgia, USA), Helen Keller International (Guinea), and Santé et Nature (Congo).

Feeding animals *M. oleifera* leaves results in both weight gain and improved nutritional status (Hunter and Stewart, 1993; Castellon & Gonzalez, 1996; Rocha & Mendieta, 1998; Nambiar and Seshadri, 2001; Sarwatt et al., 2004; Reyes-Sanchez et al., 2005; Kakengi et al., 2007). However, scientifically robust trials testing its efficacy for undernourished human beings have not yet been reported. If the wealth of anecdotal evidence (not cited herein) can be supported by robust clinical evidence, countries with a high prevalence of under-nutrition might have at their fingertips, a sustainable solution to some of their nutritional challenges.

What started as traditional practice and knowledge is being disseminated by international aid agencies, health care workers, and the private sector, to educate people around the world as a sustainable innovation to combat under-nutrition including micronutrient deficiencies. The "Diffusion of Innovations" theory explains the recent increase in *M. oleifera* adoption by various international organizations and certain constituencies within undernourished populations in the same manner as it has been so useful in

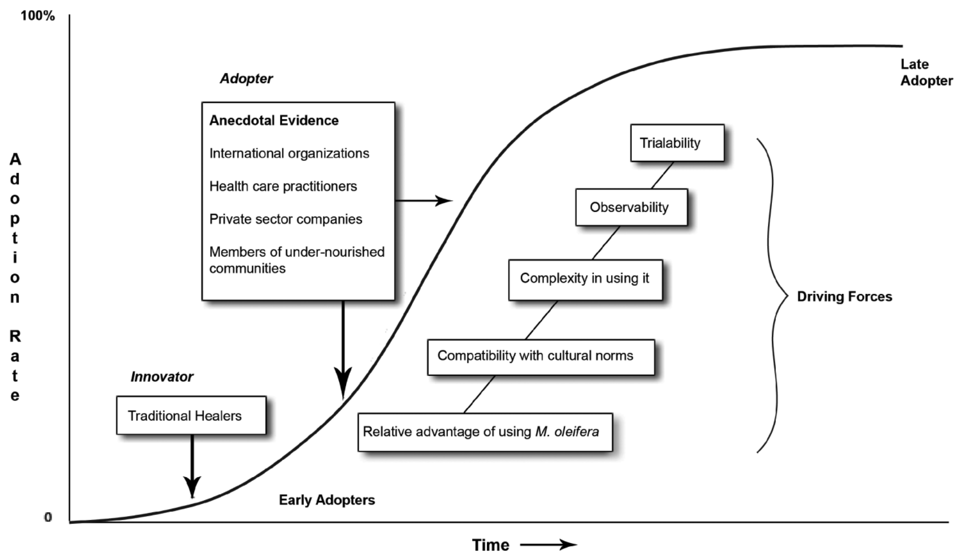

FIGURE 1 Diffusion of innovations theory and evidence for *Moringa oleifera* adoption.

explaining the adoption of many of the innovative agricultural practices in the 1940–1960s (Dearing, 2008).

"Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system . . . it is a kind of social change" (Rogers, 1983). A sigmoidal curve (Figure 1), illustrates the adoption process starting with innovators (traditional healers in the case of *M. oleifera*), who communicate and influence early adopters, (international organizations), who then broadcast over time new information on *M. oleifera* adoption, in the wake of which adoption rate steadily increases. To date, over 1100 people are studying, growing, using, or implementing *M. oleifera* programs (MoringaNews, 2008). According to Rogers (1983), the rate of adoption and possibilities of over-adoption can be predicted using 5 characteristics of a new innovation. In order for *M. oleifera* to be adopted and for its widespread use to be promoted, evidence must be provided for the following 5 attributes: ***relative advantage***, ***compatibility***, ***complexity***, ***observability***, and ***trialability.*** We describe these attributes in context, and provide the evidence pertinent to Moringa consumption, in the following sections.

Relative Advantage

Relative advantage *is the extent to which an innovation is perceived as being better or more useful than the idea it supersedes* (Rogers, 1983). International food supplement programs (e.g., feeding centers and delivery of industrially produced macro- and micronutrients) are highly effective in addressing under-nutrition in developing countries. However, a locally produced food-based approach such as adding *M. oleifera* leaves or powder to a local diet is arguably even more advantageous. Not only are the leaves nutrient-dense (Dhar and Gupta, 1982; D'Souza and Kulkarni, 1993; Seshadri and Nambiar, 2003; Trees for Life, 2005; Broin, 2006) the plant also provides individual households and agricultural societies a sustainable food source and possible microfinance opportunities (Nautiyal and Venkataraman, 1987). Though the benefits of *M. oleifera* are manifold, the primary advantage discussed herein is for undernourished populations to adopt *M. oleifera* for its nutritional benefits since it is rich in a variety of macro- and micronutrients and essential amino acids (see Table 1).

While the reported nutrient content of *M. oleifera* leaves, both fresh, and in powdered form, appears promising in terms of a nutritional supplement, an understanding of the bioavailability of these nutrients is limited to vitamins A and B and calcium. *M. oleifera* is one of the richest natural sources of β-carotene or provitamin A (Kumar, 2004), thus prompting much research interest in India. β-carotene and lutein from *M. oleifera* leaves in India was found to be highly bioavailable in an *in vitro* model (Pullakhandam and Failla, 2007). Using a rat model, the comparative bioavailability of β-carotene in fresh and dried *M. oleifera* leaves was evaluated by Nambiar and Seshadri (2001). Rats receiving *M. oleifera* leaves increased their food intake and weight gain compared to rats given either synthetic vitamin A or vitamin A adequate diets. Though synthetic vitamin A fed rats had the highest serum and liver vitamin A levels, the *M. oleifera* fed rats had significantly higher serum and liver vitamin A levels than at baseline.

The bioavailability of thiamine, riboflavin and niacin from dried *M. oleifera* leaves was evaluated in six 17-20 year old subjects in India. Subjects were given a series of experimental curry-based diets with leaves of trees noted for their contents of thiamine, riboflavin, and niacin (Girija et al., 1982). Diets containing *M. oleifera* leaves resulted in urinary excretion of 11.72% of thiamine, 10.78% of riboflavin, and 9.44% of niacin intake, leading the authors to conclude that this equated to bioavailability.

Dried *M. oleifera* leaves are high in calcium but also contain substantial quantities of oxalic acid, which interferes with the absorption of calcium. Rats were fed calcium-rich diets containing: (a) 15 g dried *M. oleifera* leaf powder, (b) 30 g milk powder, or (c) 4 g dried kilkeerai (*Amaranthus tricolor*) leaf powder per 100 g of basal diet. The calcium contents of the *M. oleifera* leaf diet and the milk diet were the same (ca. 635 mg per 100 g of diet), but the *M. oleifera* leaves had 160 mg oxalates per 100 g diet. Although milk did provide for the best absorption and retention of calcium, 73% of the calcium provided by *M. oleifera* was absorbed and 59% was retained, thus providing a good alternative or ancillary source of calcium when milk is not available (Pankaja and Prakash, 1994).

TABLE 1 Table of *Moringa Oleifera* Leaf Nutrient Composition and Nutrient RDAs* (Trees for Life 2005, The National Academies Press 2002, 2004, 2005)

	Fresh leaves[a] (value/100g edible portion)	Dried leaves[b] (value/24g [≈3tbsp] edible portion)	RDA for healthy children age 1–8 years old[c]
Calories	92 cal	49 cal	
Macronutrients			
Protein	6.70 g	6.5 g	13–19g/day
Fat	1.70 g	0.55 g	30–40 g/day
Carbohydrates	12.5 g	9.2 g	130 g/day
Micronutrients			
Carotene (Vitamin A)	6.78 mg	4.54 mg	.3–.4 mg/day
Thiamin (B1)	0.06 mg	0.63 mg	.5–.6 mg/day
Riboflavin (B2)	0.05 mg	4.92 mg	.5–.6 mg/day
Niacin (B3)	0.8 mg	1.97 mg	6–8 mg/day
Vitamin C	220 mg	4.15 mg	15–25 mg/day
Calcium	440 mg	480.72 mg	500–800 mg/day**
Copper	0.07 mg	0.14 mg	340–440 mg/day
Fiber	0.90 g	4.61 g	19–25 g/day**
Iron	0.85 mg	6.77 mg	7–10 mg/day
Magnesium	42 mg	88.32 mg	80–130 mg/day
Phosphorus	70 mg	48.96 mg	460–500 mg/day
Potassium	.26 g	0.32 g	3.0–3.8 g/day**
Zinc	0.16 mg	.79 mg	3–5 mg/day
Essential Amino Acids[d]			
Histidine	149.8 mg	147.12 mg	8 mg/g protein
Isoleucine	299.6 mg	198 mg	25 mg/g protein
Leucine	492.2 mg	468 mg	55 mg/g protein
Lysine	342.4 mg	318 mg	51 mg/g protein
Methionine + Cysteine	117.7 mg	84 mg	25 mg/g protein
Phenylalanine Tyrosine	310.3 mg	333.12 mg	47 mg/g protein
Threonine	117.7 mg	285.12 mg	27 mg/g protein
Tryptophan	107 mg	102 mg	7 mg/g protein
Valine	374.5 mg	255.12 mg	32 mg/g protein

[a]Trees for Life (2005) reported *M. oleifera* fresh leaf content from Gopalan et al. (1971).
[b]Trees for Life (2005) reported *M. oleifera* dried leaf nutrient content from Fuglie (2001).
[c]Recommended Daily Allowance (RDA) values are given as an estimate of what an individual's recommended intake should be. For the purpose of this paper, these values should be interpreted as a general comparison of leaf content to what an average healthy child should intake. Source: Food and Nutrition Board, Institute of Medicine, National Academy of Sciences Dietary Reference Intake database (2002).
[d]Gopalan et al. (1971) originally expressed amino acid content per g N, and have been converted to mg per 100g leaves.
*Leaf nutrient composition will vary depending on the geographic region the leaves are sampled from and the type of analysis used. This table acts to give a general idea of the nutrient content of the leaves.
**Represents Adequate Intake (AI) for an individual.

Conventional macro- and micronutrient supplements have well-proven efficacy, and *M. oleifera* is likely not a suitable replacement for these nutrient dense supplements. However, it is a ***sustainable*** and ***economically sound*** nutrient-rich food option for populations who suffer from chronic or seasonal micro- and macronutrient deficiencies. The *M. oleifera* tree costs little to plant – in fact aid agencies who are working with *M. oleifera* often donate seeds, and individuals can easily grow, maintain and utilize the tree provided they are not in high-density urban centers. Comparisons have been made with other nutrient-dense leafy vegetables in Niger (Sena et al., 1998) and in Nigeria (Barminas et al., 1998). No other plant, whose nutritional profile compares favorably with that of *M. oleifera*, appears able to match its combination of overall utility, micro- and macronutrient composition, rapid growth habit, high yield leaf production, and survival in harsh climates. This strongly suggests that *M. oleifera* is a unique pan-tropical dietary plant.

Compatibility

Compatibility, *in the context of the diffusion of innovations theory,* ***is*** *a measure of how well an innovation is consistent with existing social and cultural practices, if it is likeable, and if it meets the needs of potential adopters* (Rogers, 1983). Intake of wild plants as food and medicine lies at the foundation of many traditional healing systems. Many traditional agricultural societies rely heavily on edible wild plants to provide important energy and micronutrients throughout the year (Grivetti and Ogle, 2000). A study of dietary intake in the Usumbara Mountains of Tanzania found that wild vegetables accounted for over 80% of all leafy vegetables consumed. These wild vegetables were primary ingredients of side dishes to staple foods in 25–43% of meals (Fleuret, 1979). In more recent studies of local African diets, approximately half of vegetables consumed were from wild sources and they were used as major micronutrient sources especially in times of drought and famine (Uiso and Johns, 1996; Lockett et al., 2000; Grivetti and Ogle, 2000). Food trends show that the use of plants which once offered important flavor, texture satisfaction, and supplied essential nutrients has declined so much in recent years that now 80% of total dietary intake globally comes from: 8 cereals (barley, maize, millet, rice, rye, sorghum, sugar cane and wheat) and 4 tubers (cassava, potato, sweet potato and yam) (Grivetti & Ogle, 2000). This poses potential barriers to nutritional security in developing country regions by: decreasing variety and biodiversity of dietary intake, increasing the possibility of a cereal virus or parasite attacking these grains and causing worldwide famine, and declining promotion of dietary and nutrition knowledge due to lack of food variation (Grivetti and Ogle, 2000). Adopting *M. oleifera* remains consistent with the use of green leafy plant sources and re-introduces diversity along with knowledge of local nutritious plant sources into the diet and the culture.

Acceptance of *M. oleifera* as a nutritional supplement or a food additive in undernourished populations is compatible in those cultures that currently use green leafy plant sources in traditional dishes. Rural populations, and those populations who rely heavily on subsistence farming, may find using

M. oleifera leaves more compatible than purchasing non-locally produced food. Because households can produce their own *M. oleifera* or find it in local markets, they are able to use it just as they would with other locally grown foods such as grains, legumes, root and/or tuber vegetables.

Traditional dishes around the world include green leafy plant sources which can be substituted or augmented with *M. oleifera* leaves. An Indian study evaluated food attitudes in children and infants, where they were given 30 g and 15 g respectively of *M. oleifera* leaves mixed with 10 g of legumes and the dish was found to be coarse and bitter (Gopaldas et al., 1973). In Malawi, 63% of households preferred *M. oleifera* leaves over commonly used pumpkin leaves (Babu, 2000). Nambiar et al. (2003) evaluated the feasibility and acceptability of *M. oleifera* leaf powder used in preschool meals prepared by staff at the Indian Integrated Child Development Scheme (ICDS). Forty children aged 1–5 years were given 5–7 g dried leaf powder added to their daily salty snack. Acceptability (gauged by facial expression, demand for food, and measurement of food left at the end of the meal), was no different than the acceptability of diet to a control group (n = 20) receiving the regular recipe (Nambiar et al., 2003). A similar acceptability trial utilized a panel of 12 women age 18–21 years old given traditional Indian recipes with 6–25 g freshly blanched *M. oleifera* leaves (Nambiar and Parnami, 2008). Pulse recipes that included 20 g of leaves, calculated to give the women 82.5% to 83.3% of their RDA for vitamin A, were the most acceptable. Other studies have demonstrated that peoples' taste perceptions of *M. oleifera* leaves varies from "tasteless" to "slightly bitter" depending on the geographic region from which the leaves come. Children given *M. oleifera* leaves in a variety of traditional Indian recipes revealed no specific like or dislike although mothers reported that children preferred having the leaves incorporated into the cereal-pulse dough which is used in several traditional dishes (Seshadri and Nambiar, 2003). In populations where traditional medicine is practiced and preferred, *M. oleifera* may likely be accepted as a way of treating under-nutrition. However, tradition does play a large role in adoption of certain food sources in which the use of *M. oleifera* leaves or other green leafy vegetables might be challenged.

Complexity

Complexity *is the level to which the innovation is perceived to be difficult to understand or use* (Rogers, 1983). *M. oleifera* is relatively easy to obtain, grow, and use on a regular basis. The tree grows well in climates ranging from warm tropical at sea level, to sub tropical climates up to an altitude of 3000 feet (Palada and Chang, 2003). The maximum temperature for growth varies from 38 to 48°C and minimum temperature from –1 to 3°C. *M. oleifera* prefers sandy soil, though it grows in most soils other than stiff clay of shallow hilly soils (Nautiyal and Venkataraman, 1987; Palada and Chang, 2003).

M. oleifera can be grown from either seeds or from cuttings. Sprouting usually occurs within 2 weeks but can occur in rich soils in as little as 3 to 4 days. In 1 growing season, the tree can grow between 9 and 15 vertical feet. A full grown tree can be pruned to ground level and new shoots with leaves will emerge. Higher leaf production can be achieved if the trees are regularly pruned close to ground level (coppicing) or if individual shoots are regularly harvested. There is an extensive literature, not elaborated upon herein, on proper upkeep and care of *M. oleifera* (Palada and Chang, 2003; Price, 2007).

Once the leaves are harvested and cleaned, they can either be used fresh in meals or dried in the shade to be used at another time. In countries that suffer from annual drought or famine before harvest season, dried *M. oleifera* leaves can be made into a powder and used throughout the year. *M. oleifera* powder is made by crushing and sifting dried leaves. There have been studies on the retention of heat sensitive vitamins, such as vitamin A, during the drying and storage of *M. oleifera* leaves (Seshadri et al., 1997; Seshadri and Nambiar, 2003). For many rural agricultural societies storing grains is common practice (Lockett and Grivetti, 2000), and for many grains shade drying or blanching, is used prior to storage of the food source. Retention of total carotene, β-carotene, and ascorbic acid (vitamin C) was measured following storage for 0, 1, 2, and 3 months (Seshadri et al., 1997). Leaves that were blanched and sulfited compared to blanched-only leaves initially retained more total carotenes, β-carotene, and ascorbic acid but within about 3 months β-carotene levels were about half of original levels, with either method of drying. On the other hand, there were significant benefits of sulfiting on ascorbic acid retention.

Cooking with green leafy plant sources is relatively common, thus the overall complexity of using *M. oleifera* leaves should not deter adoption. However, proper cooking methods resulting in good nutrient retention can become complex. Three recipes of traditional Indian dishes using *M. oleifera* dried leaves were evaluated for retention of β-carotene. "Dhebra", a shallow fried cereal and *M. oleifera* leaf recipe, a steamed cereal and leaf recipe called "muthia", and "dal soup" a boiled pulse and leaf recipe were compared resulting in β-carotene retention per serving being: 69%, 73%, and 35% respectively (Seshadri et al., 1997). Recipes around the world that call for *M. oleifera* leaves often instruct to boil the leaves 1 to 3 times before the food is actually served (Fuglie, 1999). Boiling leaves can often degrade, inactivate, and eliminate heat-sensitive vitamins such (e.g., vitamin A). As more people adopt *M. oleifera*, cooking methods need to be evaluated to ensure that correct information is being disseminated and adopters are benefiting from the leaves as expected.

Observability

Observability *is used to describe how well the results of the innovation can be seen and communicated to others* (Rogers, 1983). The observability factor of *M. oleifera* is perhaps the greatest driving force for people to adopt its use. Not only is the plant appearance unique and its rapid growth almost palpable, but now extensive anecdotal evidence strongly supports the dissemination of information and adoption of its use. Currently there are 1,182 members of the privately run organization that represents itself as "the global Moringa network" (MoringaNews, 2008). MoringaNews was started in 2002 to: "enhance communication and coordination between actors, to provide reliable and checked information to members of the network, and to undertake research when the information is lacking" (MoringaNews, 2008). Fully half of these members claim to be working with Moringa in a health/nutrition capacity. Many of these members represent reputable international organizations and their local counterparts (the balance of governmental, non-governmental, and commercial entities), who are working in rural areas around the world to promote and disseminate knowledge of the benefits of *M. oleifera*. These campaigns are almost exclusively based upon personal testimonials and observation, fueled by traditional medicine knowledge.

In addition to international organizations, commercial retailers and private companies have used anecdotal evidence to promote and sell various products of *M. oleifera*. Among these products are oils extracted from seeds and leaves for skin and cosmetic purposes, in addition to capsules and beverages containing Moringa extracts that are promoted by some as vitamin- and nutrient-rich tonics, and [irresponsibly] as panaceas or miracle cures for a large variety of ailments.

Trialability

Trialability, *in the context of the diffusion of innovations theory, refers to the ability of an innovation to be experimented with* (Rogers, 1983). People around the world experiment with *M. oleifera* leaves on a daily basis, consuming it personally as a vitamin source, or providing it to friends and family members in the form of a beverage, a capsule, powder, and/or fresh leaves. Though trialable, *M. oleifera* has not been rigorously "proven" in the Western medical tradition. Because very few such studies have been completed, the use of *M. oleifera* for treatment of under-nutrition lacks a scientific base in clinical studies demonstrating either efficacy, or lack of toxicity. Furthermore, the studies that have been completed on nutrient content in various global regions are not fully congruent. This is partially due to natural variation among the source of leaves, such as genetic background, environment, and cultivation methods. This also includes the variation due to sample preparation and analysis including time between collection and analysis, mode of preservation between collection and analysis, and the analytical methods (Broin, 2006). Nutrient content data has been published in various forms (e.g., fresh leaf content, dried leaf content or both), and those reporting dried leaf data must differentiate sun drying from shade drying. Though most studies elaborate upon methods of collection and preparation of leaves, the apparent wide variation in the values published in journals reduces credibility in the eyes of some critics.

The lack of robust clinical trials data increases the uncertainty regarding *M. oleifera* nutritional benefits. Uncertainty about adoption of an innovation can lead both to over-adoption by individuals, and to complete lack of adoption due to the unwillingness of thought leaders and lead policy organizations to endorse the innovation. In the case of *M. oleifera*, the innovators or early adopters, (e.g., organizations that disseminate *M. oleifera* information), should provide sound scientific evidence of Moringa's benefits and provide guidance for correct methods and application for use of the leaves. This will provide the comfort and confidence level required by policymakers and decision makers in large international and governmental organizations to support *M. oleifera* as a nutrition intervention, and will also decrease the threat of over-adoption (e.g., use when and where it may not be appropriate for either public health or medical reasons).

DISCUSSION

Clinical trials in human beings needs to be implemented in order to provide researchers, international aid agencies, and health care practitioners with the sound scientific evidence needed to support or discourage the adoption of *M. oleifera*. Such studies should embrace (but not be limited to) the following:

- Adherence to widely accepted ethical guidelines, approval by a local institutional review board, and oversight by a medical professional.
- A randomized double blind placebo-controlled[a] study using an appropriately powered number of infants and/or children within the age range of 6 months to 5 years.[b] Blinding or masking may be problematic in this instance due to the intense green color of Moringa leaves.
- Food sources given to both the intervention and the control group should be likeable and culturally appropriate.
- The amount of *M. oleifera* used in the intervention group should be compared to the dietary reference intakes for the study population to assess adequate nutrient supplementation.

[a] Though *M. oleifera* does not have a strong, noticeable taste, the food the leaves are added to will be notably green. Therefore the placebo should be similar in taste and color, such as lettuce.

[b] WHO recommends infants under the age of 6 months should be exclusively breastfed and therefore should not be included in such a study where complementary feeding is involved.

- Anthropometry (e.g., height, weight, skinfold, and/or upper arm circumference measurements), should be conducted pre-intervention, during, and post-intervention.
- Blood chemistries would be highly instructive to assess bioavailability of nutrients.
- Physical examinations are critical in order to expedite study termination in the event that there are signs of toxicity at any intake level.
- Health care professionals and researchers should be adequately trained to take measurements.
- Findings must be reported in widely accessible journals. Such obligation to report either positive or negative results should be a pre-requisite for the granting of any research funding.

The state of world hunger and under-nutrition is slowly improving and could in some developing regions be close to its achieving the UN Millennium Development goal – halving the proportion of people who suffer from hunger by 2015 (United Nations, 2000). To achieve this goal, nations have relied on food aid programs and manufactured nutrient supplementation. These programs that use manufactured nutrient-rich powders, high-energy food sources, vitamin A drops, and nutrition centers for severely undernourished children have adequately addressed the once bleak world nutritional status. However, as more emphasis is put on local food based approaches, assessment of local resources for improving nutritional status should be further investigated. *M. oleifera* is one example of a nutrient source that can be grown and used at the individual or societal level. By partnering with appropriate educational modalities to describe its uses and nutritional benefits, communities around the world will be able to participate directly in halving the world's hunger and improving nutritional deficiencies.

The evidence provided herein, pursuant to each of the five attributes of the diffusion of innovations theory, support the adoption of *M. oleifera* as a nutrient supplement. However, there are many gaps in the data that will keep large policy advocates and international aid groups from recommending adoption. In accordance with the diffusion of innovations theory, the anecdotal evidence and the currently extant data suggests that even without an appropriately controlled [by Western medical standards] clinical study, a variety of organizations and individuals will continue to use and promote *M. oleifera*. The uncertainty, regardless of how slight, that *M. oleifera* might not be effective in addressing under-nutrition in disadvantaged populations, requires that additional rigorous trials with human volunteers be carried out rapidly, and that the results, whether positive or negative, be disseminated in peer reviewed, widely accessible journals, so that they can receive the imprimatur of the world nutritional science community.

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