# Potential Application Of The *Moringa* Species As Natural Supplements In Namibia: A Review

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Received: 14th May, 2016. Accepted: 19th September, 2017. Published: 11th November, 2017.

**Abstract**

The members of the *Moringaceae* tree family show promise as good dietary sources of essential nutrients. *Moringa oleifera* is the most researched species of *Moringa* trees and has gained much recognition for its exceptionally high nutritional value. It is particularly rich in minerals, such as calcium and iron which are essential for growth and development. Indigenous to Namibia, *Moringa ovalifolia* is one of the under-recognized species which could potentially carry the same nutritional importance as *M. oleifera*. Malnutrition remains a major public health problem in Namibia. On average 27% of the Namibian population lives below the poverty line and are at risk of food insecurity. In times of persistent drought, micronutrient malnutrition may become a widespread occurrence. This paper explores the health benefits of nutrients found in *M. oleifera* and *M. ovalifolia*, with particular focus on their potential to alleviate nutrient deficiencies in Namibia.

**Keywords**: Namibia, *Moringa oleifera*, *Moringa ovalifolia*, natural supplement, micronutrients, malnutrition

**ISTJN** 2017; 10:122-132.

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# 1 Introduction

For the past four years, Namibia has been experiencing a persistent drought which was declared a state of emergency by the president of Namibia in May 2013 (United Nations Office for the Coordination of Humanitarian Affairs [UNOCHA] 2013; UNOCHA 2016). About a quarter of the population is estimated to be food insecure and in need of assistance. In fact, the government set aside N$90 million for drought relief between April and July 2016 (UNOCHA 2016). Furthermore, 27% of the Namibian population, an estimated 568 418 people, are living below the poverty line with even higher poverty incidences occurring in rural regions, such as the Kavango, Oshikoto, and Zambezi (United Nations Development Programme [UNDP] 2015a; UNDP 2015b). One of the health consequences of poverty and food insecurity is the lack of dietary diversity, which results in both calorie and micronutrient malnutrition (Amugsi et al. 2014; Migliozzi et al. 2015).

Malnutrition, or inappropriate nutrition, generally encompasses both under- and over-nutrition. However, the focus is placed on the deficiency of nutrition in the context of poverty (Blössner and de Onis 2005). Malnutrition remains a major public health problem in developing countries affecting the growth and development of children, child mortality, and the burden of disease as well as having social and economic consequences (Ijarotimi 2013, Mtambo et al. 2016). Malnutrition impedes not only cognitive and behavioural abilities of children, but also social and economic growth of the community in that malnourished children may not reach their full potential and become skilful and productive adults (United Nations Children's Fund [UNICEF] et al. 2012). According to studies, malnutrition is still highly prevalent in Namibia (16.5%) and one of the main contributors to under-five mortality (Mdala and Mash 2015), while the prevalence of childhood stunting, and thus chronic malnutrition, is about 24% in Namibia at present (Mtambo et al. 2016). Furthermore, studies indicate that malnutrition in hospital patients contributes to morbidity and longer hospital stays (Lim et al. 2012; Norman et al. 2008). In Namibia, many rely on the public health services with the public sector controlling approximately 68% of the total health expenditure (World Health Organization [WHO] 2015).

Macronutrients consist of protein, carbohydrates and fats, which are energy-providing nutrients required in large amounts in the diet to maintain bodily functions (WHO 2016). In developing countries, protein deficiency is widespread as locals rely on cereal crops as their staples (Amugsi et al. 2014; Ijarotimi 2013; Migliozzi et al. 2015). Equally important are the micronutrients, i.e. vitamins and minerals, which the body require in small but specific amounts through dietary intake (Ijarotimi 2013). More than two billion people worldwide are affected by micronutrient malnutrition, such as iron deficiency (Black 2003; Migliozzi et al. 2015). In light of this global issue, Migliozzi et al. (2015) suggested using nutrient-rich lentils and kale to address calorie and micronutrient malnutrition. Similarly, this study aims to provide an alternative in Namibia by looking at the indigenous Moringa trees as the potential source of micronutrients. The tree family, *Moringaceae* has a single genus of 13 *Moringa* species (Padayachee and Baijnath 2012). Of these, the *Moringa oleifera* and *Moringa ovalifolia* is of particular interest to this study as the former is widely cultivated and studied, while the latter is endemic to Namibia but mentioned little in literature. Moringa trees are considered one of the most useful, even life-saving, natural resources (Padayachee and Baijnath 2012). Also, their drought-resistant nature makes them good sources of food during the dry seasons (Anwar et al. 2007; Dhakar et al. 2011; Madukwe et al. 2013). Drawing from the extensive studies carried out on *M. oleifera* worldwide may extend our knowledge on *M. ovalifolia* and its potential as a valuable resource. In drought-stricken Namibia, turning to local resources may be the key to improving nutrition and decreasing the burden of disease, particularly in low-income households.

# 2 Findings

Although there is a wealth of indigenous knowledge on the uses of the various *Moringa* species, *M. oleifera* has been the focus of scientific research and international interest. The other 12 species of *Moringa* are yet to be fully explored and may be under-utilized at present (Padayachee and Baijnath 2012).

## 2.1 *Moringa oleifera*

*M. oleifera* is known by many names, but the name ‘miracle tree’ attests to its remarkable usefulness (Agbogidi and Ilondu 2012). Consequently, this plant has been naturalised in countries other than its native India, including East and West Africa (Madukwe et al. 2013; Padayachee and Baijnath 2012). As a source of food, every part of this tree can be eaten and is packed with nutrients (Dhakar et al. 2011). Table 1 highlights the micronutrient contents of several *M. oleifera* plant parts. The oil obtained from the pods can be used for cooking and never turns rancid, while the flowers are good sources of calcium and potassium (Dhakar et al. 2011). The leaves are particularly good sources of digestible protein, $\beta$-carotene, vitamin C, calcium, iron and potassium (Okiki et al. 2015). The leaves can be eaten fresh as greens, made into tea leaves or stored as a dried powder to be used in various dishes such as soups, porridges and even baked goods (Dhakar et al. 2011; Hassan and Ibrahim 2013; Okiki et al. 2015). The seeds can be powdered into seed cakes and used to purify or soften water, feed animals or alternatively used as organic fertilizer (Emmanuel et al. 2011; Okiki et al. 2015).

More minerals are absorbed by the body with dried or cooked leaves compared to fresh leaves of *M. oleifera*, because the different heating processes results in lower levels of phytate,

Table 1: Reported micronutrient content of Moringa oleifera leaves, leaf powder, seeds and pods in reference to the recommended dietary allowances (RDAs) for adults. (Dhakar et al. 2011; Gopalakrishnan et al. 2016; Institute of Medicine [IOM] 1997, 2000, 2011)

| Micronutrient | Fresh Leaves (per 100g) | Dried Leaves (per 100g) | Leaf Powder (per 100g) | Seeds (per 100g) | Pods (per 100g) | Average RDA for adults (per day) |
|---|---|---|---|---|---|---|
| Potassium (K) | 259 mg | 1236 mg | 1324 mg | - | 259 mg | - |
| Iron (Fe) | 0.85 mg | 25.6 mg | 28.2 mg | - | 5.3 mg | 8-18 mg |
| Zinc (Zn) | 0.16 mg | - | 3.29 mg | - | - | 8-11 mg |
| Calcium (Ca) | 440 mg | 2185 mg | 2003 mg | 45 mg | 30 mg | 1000-1200 mg |
| Magnesium (Mg) | 42 mg | 448 mg | 368 mg | 635 $\pm$ 8.66 mg | 24 mg | 310-420 mg |
| Copper (Cu) | 0.07 mg | 0.49 mg | 0.57 mg | 5.20 $\pm$ 0.15 mg | 3.1 mg | 900 $\mu$g |
| $\beta$-carotene (Vit A) | 6.78 mg | - | 18.9 mg | - | - | 700-900 $\mu$g |
| Vitamin C | 220 mg | 15.8 mg | 17.3 mg | 4.5 $\pm$ 0.17 mg | 120 mg | 70-90 mg |

tannins and polyphenols that hinder absorption (Tessera et al. 2015). When dried, the leaves of *M. oleifera* contain four times the amount of carotene (vitamin A) as carrots, while fresh leaves provide seven times the amount of vitamin C as oranges (Dhakar et al. 2011; Srikanth et al. 2014). Although exact values vary, studies are in agreement that dried *M. oleifera* leaves contain more potassium than bananas, more calcium than milk, and more iron than spinach (Agbogidi and Ilondu 2012; Dhakar et al. 2011; Gopalakrishnan et al. 2016). Studies also report that dried leaves of *M. oleifera* provide proteins of high quality, with good proportions of all essential amino acids which are rarely seen in other plants (Agbogidi and Ilondu 2012; Okiki et al. 2015). The amount of protein is at least twice that of yoghurt, and can significantly contribute to daily protein requirements (Agbogidi and Ilondu 2012; Gopalakrishnan et al. 2016).

## 2.2 *Moringa ovalifolia*

The uses of *M. ovalifolia* are poorly documented, but it is considered edible and potentially as useful as *M. oleifera* (Ananias et al. 2016; Padayachee and Baijnath 2012). Recently, studies have drawn a comparison between *M. oleifera* and *M. ovalifolia* in terms of their metal content (Ananias et al. 2016), flavonoid content (Makita et al. 2016), and antibacterial activity (Shailemo et al. 2016). The former study, which is of current relevance, found the concentrations of elements in seeds of *M. ovalifolia* and *M. oleifera* followed the same general trend. The seeds of both species were abundant in, in decreasing order, potassium, magnesium, calcium, and sodium among macroelements, and iron and zinc among microelements (Ananias et al. 2016). Many times, micronutrient deficiencies do not occur in isolation, but coexist in varying combinations and degrees (Kerac et al. 2014). As a natural supplement packed with micronutrients, *M. oleifera* and *M. ovalifolia* may provide a simple solution to multiple deficiencies.

## 2.3 *M. oleifera* and Iron Deficiency

Iron deficiency is of major concern, affecting about two billion people worldwide, and a major risk factor for disability and death (Black 2003; Boy et al. 2009; Stoltzfus 2003). The World Health Organisation (WHO) estimates that iron deficiency anaemia (IDA) affects 52% of pregnant women and 48% of children in developing countries (Saini et al. 2016). In pregnancy, IDA contributes to maternal and perinatal mortality by increasing the risk of cardiac failure, while children are more likely to suffer direct consequences of IDA, such as impaired muscle function (Stoltzfus 2003). In developing countries, a large percentage of the total daily intake of calories and micronutrients is obtained from staple crops (Saini et al. 2016). Compared to the iron contents of rice (4.23 mg/100 g), maize (2.71 mg/100 g), and pearl millet (3 mg/100 g), typical staples in Namibia, the *M. oleifera* leaf powder provides 28.2 mg of iron per 100 g (Saini et al. 2016). This is apparently 25 times more iron than in spinach (Gopalakrishnan et al., 2016). In IDA, a daily dose of 100-200 mg of iron is recommended. Oral iron supplements can be found in the form of ferrous sulphate 200 mg tablet (65 mg iron), ferrous gluconate 300 mg tablet (35 mg iron), and ferrous fumarate 200 mg tablet (65 mg iron) (Joint Formulary Committee, 2015). Comparable to ferrous gluconate, *Moringa* may be beneficial for the treatment of mild IDA or in patients that have poor tolerance to the gastrointestinal irritation associated with iron supplements.

## 2.4 *M. oleifera* and Calcium Deficiency

*M. oleifera* is also a good source of calcium. The role of calcium in the development and maintenance of strong, healthy bones is well-known (Gupta and Gupta 2014). Adequate dietary intake of calcium contributes to the maintenance of bone mineral content and bone mineral density in adults (Gupta and Gupta 2014). Dietary intake of 1000-1200 mg of calcium is recommended (Bauer 2013). In osteoporosis, that rate of bone loss is reduced by doubling the recommended calcium intake (Joint Formulary Committee 2015). Furthermore, the association between low dietary calcium intake and hypertension has been established in the general population, while recent studies suggest that calcium deficiency may play a role in the development of pre-eclampsia in pregnant women (Hofmeyr et al. 2015). Calcium supplements in the form of calcium carbonate, calcium citrate, calcium gluconate, and calcium lactate are widely available and provide different amounts of elemental calcium; 40%, 21%, 9% and 13% respectively (Bauer 2013). Unfortunately, there is evidence of health risks associated with calcium supplements. Recent studies suggest that the gastrointestinal adverse effects of calcium supplements have greater clinical significance than thought previously. Increased risk of kidney stones is also of concern, as well as the evidence suggesting increased cardiovascular risk due to the acute rise in serum calcium following supplement ingestion (Reid and Bristow 2016). As a result, it is recommended to preferentially increase dietary intake of calcium and reduce the routine use of calcium supplements (Bauer 2013; Reid and Bristow 2016). Some of the best dietary sources of calcium are milk (293 mg/cup, 1 cup is approximately 245 g), cheese (307 mg/40 g), broccoli (43 mg/40 g), and kale (100 mg/67 g) (Bauer 2013; Gupta and Gupta 2014). Remarkably, *M. oleifera* leaf powder provides 2003 mg of calcium per 100g, which is 17 times more than milk (Gopalakrishnan et al. 2016). In fact, the daily iron and calcium requirements of a pregnant woman can be met with just six tablespoons of *M. oleifera* leaf powder (Dhakar et al. 2011; Gopalakrishnan et al. 2016). Moreover, *M. oleifera* may help people that are lactose intolerant, taking dairy-free diet, or concerned with the fat content of dairy products to increase their calcium intake (Gupta and Gupta 2014; Reid and Bristow 2016).

## 2.5 *M. oleifera* and Potassium Depletion

Potassium is typically the most abundant element in plants, and this is true for *Moringa* (Ananias et al. 2016). Potassium is one of the main blood electrolytes and needed for the proper functioning of cells. Deficiency is associated with the increased risk of stroke and kidney stones, as well as increased blood pressure, salt sensitivity, and bone turnover. Severe deficiency may lead to cardiac arrhythmias, muscle weakness, and glucose intolerance. Deficiency is mainly attributed to the excessive loss or poor retention of potassium as inadequate intake of dietary potassium is rare (IOM 2004; Stein 2009). Several medications are known to deplete potassium levels in the body, such as thiazide diuretics, loop diuretics, corticosteroids, aminoglycoside antibiotics and aspirin. Chronic diarrhoea and vomiting may also deplete potassium levels. Potassium supplements, such as Plenish-K®, typically contain 600 mg of potassium chloride (8 mmol of potassium) per tablet and two to six tablets are taken daily as an adjunct to diuretic therapy. Dietary sources of potassium, such as fruits and non-grain vegetables, are typically low in chloride and rich in citrate, a precursor of bicarbonate (IOM 2004). As such, they supply potassium in the form of potassium bicarbonate or potassium citrate, which are associated with reduced risk of kidney stones. In addition, bicarbonate precursors have the ability to buffer diet-derived acids and thereby correct mild metabolic acidosis and prevent bone demineralization (IOM 2004). Banana, a well-known source of potassium, contains 594 mg (15.2 mmol) of potassium per 150 g (Miller 2012). In comparison, *M. oleifera* leaf powder contains 1324 mg (33.9 mmol) of potassium per 100 g. Thus, a few spoonful of *M. oleifera* leaf powder may replace potassium supplements. According to studies, blood pressure is lowered by moderate increase in potassium intake (Cappuccio et al. 2016). This may be another benefit obtained from including *M. oleifera* in the diet.

### 2.6 Other Nutrients

Some micronutrients play a crucial role in immune responses and their deficiencies impair immune competence (Bhutta et al. 2013). It is due to the underlying immune dysfunction that malnourished children succumb to common infections such as diarrhoea, malaria, and pneumonia. Zinc deficiency is particularly implicated in child mortality (Fischer Walker et al. 2009). *M. oleifera* is a good source of immune modulating micronutrients, such as $\beta$-carotene, vitamin C, iron and zinc (Bhutta et al. 2013).

## 3 Conclusion

Currently, many Namibians do not have food security due to the widespread drought and poverty. Such times call for dietary restriction and, thus, more people are at risk of micronutrient deficiencies and associated health problems. Several strategies exist in combating micronutrient deficiencies, such as dietary modification, supplementation and fortification. In this study, the potential of *M. oleifera* and *M. ovalifolia* as natural micronutrient supplements was explored under different situations. In particular, *M. oleifera* is well-studied and known as an excellent source of vitamins and minerals. The potential of *M. ovalifolia* as a source of nutrients in Namibia is enormous as it is endemic to the country, and thus available and affordable to many. A recent study suggests similarities exist in the mineral contents of *M. oleifera* and *M. ovalifolia*. This is promising for future studies in revealing the full nutritional potential of *M. ovalifolia*. In the long run, tapping into local natural resources may help relieve the pressure placed on the public health care system and reduce the burden of disease in the country. *Moringa* trees therefore offer a number of potential solutions to the health of the Namibian population.

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