

Challenges in the Development of Micronutrient-rich Food Ingredients from Soya Beans and Moringa Oleifera Leaves

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Abstract

Background: Food-based strategies favouring local multi-nutrient food materials are the best suitable and sustainable strategies for combating micronutrients malnutrition. Using soybean and moringa oleifera plant materials are considered as cheap and sustainable approaches for fighting micronutrients malnutrition in the developing countries including Tanzania. Moringa Oleifera plant and soybeans contain protein with good balances of all essential amino acids, and vitamins especially vitamin A (β -carotene) and C, and high percentage of calcium, manganese, iron, copper, zinc, phosphorus, iodine, sulphur and selenium. Since the levels of vitamin A and C, and iron in soya foods is low, it is opted to incorporate moringa leaves into soya foods and thus to raise the contents of these micronutrients. **Objective:** The aim of this project is to develop food products and ingredients that are rich in multiple micronutrients from soya beans and moringa oleifera leaves, especially vitamin A and iron for feeding preschool children, pregnant and lactating women, and people living with HIV/AIDS. **Methods:** The stability of soya-moringa foods in the form of powder and beverage are being investigated to establish engineering process control parameters for handling, processing conditions, and storage, and for maintaining the efficacy of functional ingredients throughout the food value chain. The processing methods being studied include drying by biomass dryers, soaking soya beans, blanching, grinding and mixing conditions (co-grinding), and pasteurization. In order to ease transfer of research results to the food processing sector, the project is collaborating with Dar es Salaam Functional Foods and Nutraceuticals Cluster. **Results:** The results show the variability of product characteristics depending on the processing operations. Different processing conditions may produce products of different sensory characteristics (i.e. texture, flavour, aroma and colour). Microbiological stability and physico-chemical stability are being investigated to establish the shelf-life for these products. Also, the characterization of the products in respect to their nutritional composition is being undertaken.

Introduction

Micronutrients are food ingredients needed by the body in small quantities for growth and functioning of the immune and reproductive systems. Micronutrients include vitamins such as vitamin A and C, and minerals like iron, iodine, zinc, and selenium. Deficiency in micronutrients results into micronutrients malnutrition, which is estimated to affect more than 2 billion people worldwide. Developing countries are the most affected where vitamin A, iron and iodine deficiencies are the most prevailing forms of micronutrients malnutrition. In the case of Tanzania it is estimated that 45% of children under the age of five are affected by iron deficiency anaemia and 37% are estimated with sub-clinical vitamin A deficiency. About 80% of pregnant and lactating women are anaemic due to iron deficiency.

Food based strategies are considered as sustainable solutions for combating micronutrient malnutrition. Unfortunately, there is no single food that contains all of the micronutrients. Cereals, roots and tubers which are major staple food ingredients in Tanzania and other developing countries, are general are low in micronutrients.

Utilization of soya beans and moringa oleifera as cheap indigenous plants are considered as the best approach towards fighting micronutrients malnutrition in a cheap and sustainable manner. While soya beans contain high quality protein, minerals and phytochemicals, moringa oleifera leaves are also concentrated with higher amounts of vitamins, minerals and phytochemicals. The food system where soya beans are synergistically balanced with moringa oleifera leaves could have unique nutrients for feeding and nourishing the immune system thereby alleviating most of nutrition based diseases.

Soya beans and moringa oleifera leaves are abundantly available in many parts of Tanzania. Unfortunately, their production and consumption is still at a very low stage. Soya beans are processed and used to fortify cereal flours for children, mothers and sick people. Utilization of moringa oleifera leaves is completely a new phenomenon. The trees are used to make the living fence especially by communities in coastal regions. A few years ago the tree cultivation was promoted by the company “Optima Africa” for its seeds. Unfortunately, the project was not successful and farmers were left without knowing further what to do with their trees.

Because of their diverse compositions, functional food systems comprising soya beans and moringa oleifera leaves pose technical challenges for production of products with high nutritional value, good taste and flavour, and have stable shelf-life.

Vitamin A (potassium, magnesium, calcium, manganese, iron, copper, zinc, phosphorus, iodine, sulphur and selenium	Phenolic antioxidants, e.g. flavonoids
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Figure 1: Nutrients present in soya beans and moringa oleifera leaves

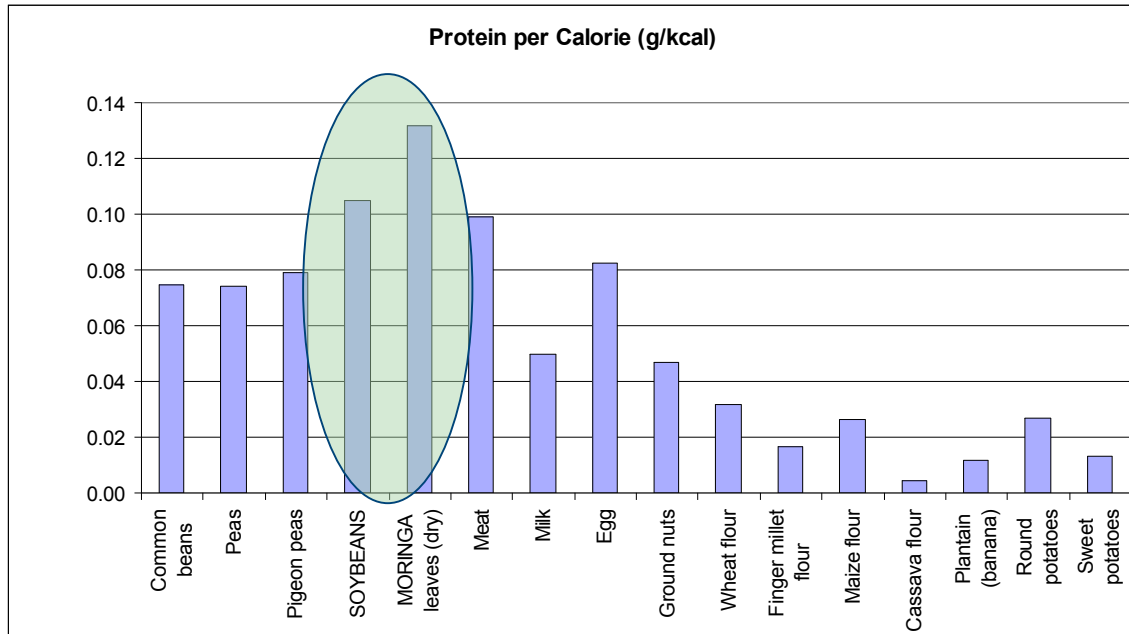


Figure 2: Protein per Calorie of soya and moringa in comparison to other foods

Status of R&D Activities on development of foods rich in micronutrients in the Department of Chemical and Process Engineering (CPE – UDSM)

The project is aiming at developing functional foods and nutraceuticals from indigenous plant materials which are rich in micronutrients, quality proteins and phytochemicals. The present project is dealing with development of functional foods in the form of flour and liquid from soya beans and moringa leaves.



Figure 3: Moringa oleifera leaves (left) and soya bean seeds (right)

The potential of soya beans and moringa oleifera leaves to satisfy daily micronutrient intake requirements

The requirements of nutrients differ according to individuals. Depending on their ages, the groups can be divided into children, women, men and sick people. Of all, special micronutrients requirements are for young children, pregnant and lactating mothers, and people living with HIV/AIDS (PLWHA). **Table 1** shows the micronutrients requirements for children at the age of 1 – 3 years, and pregnant and lactating mothers. The content of micronutrients in the soya beans and moringa oleifera leaves is given to show their potential to provide the required amount. The 100g of moringa oleifera leaves can meet the daily requirements of vitamin A for 17 children at the age of 1 – 3 years, ten pregnant women and seven lactating mothers. The same amount of moringa oleifera leaves are sufficient to supply the kid with vitamin C for 7 days, the pregnant woman for 4 days and lactating mother for 3 days.

Table 1: Reference Nutrient Intakes (RNI) for various consumer groups and contents of micronutrients in soya beans and moringa oleifera leaves

	1 - 3 yrs (RNI/day)	Pregnant (RNI/day)	Lactating (RNI/day)	Soya beans (100g)	Moringa (100g)
Iron	10mg	27mg	15mg	7- 8.6mg	7mg
Vitamin A	400mg	700mg	950mg	263 -380mg	6800mg
Vitamin C	30mg	50mg	70mg	0	220mg

The possibilities to use soya beans and moringa oleifera to produce foods rich in micronutrients

The intention of producing the food that is rich in micronutrients should consider factors influencing losses or damaging the nutrients. For example, in the processing of soybeans to produce soymilk, the final product soymilk contain only 7% of the original iron, and about 0.80% of vitamin A originally present in the soya beans. More than 90% is lost during processing. It is therefore very important to consider the effects of processing methods on the quality of desired soya-moringa foods. The processing should satisfy the conditions that the nutrients are not damaged and the food quality is preserved during processing and storage. **Table 2** compares the content of micronutrients in the raw materials and those remaining in the food product (soymilk) after processing.

Table 2: Influence of processing conditions on the quality of soya-moringa foods

	Soya beans (100g)	Moringa (100g)	Soymilk (100g)	Soya-moringa foods (100g)
Iron	7- 8.6mg	7mg	0.58mg	???
Vitamin A	263 -380mg	6800mg	3mg	???
Vitamin C	0	220mg	0	???

The food qualities desired by consumers are that the food should be safe, nutritious, tasty and have stable shelf-life. Various methods are known for removal of anti-nutritional factors and toxic compounds from soya beans.

Impact of Processing Operations on Food Quality

Processing operations can have diverse impact on the quality of soya-moringa foods. With diverse compositions of these nutrients rich materials, the loss of nutrients can occur because of the followings:

- Loss of sensory characteristics (texture, flavour, aroma, shape and colour)
- Loss of water-soluble nutrients (minerals, water-soluble vitamins and sugars)
- Degeneration of lipids to form a wide variety of undesirable or toxic compounds
- Destruction of heat-labile vitamins, amino acids and lipids
- Destruction of oxygen-sensitive vitamins

Challenges in processing soya and moringa leaves into quality foods

The quality assurance of soya-moringa foods have to meet the following challenges:

- Variability of soya and moringa leaves off-notes
- Interaction of soya and moringa leaf compounds (Biochemistry of soya and moringa)
- Geographic / origin of soya and moringa leaves
- Food formulations and process
- Packaging
- Acceptability by consumers

Table 3: Effects of processing on the stability of micronutrients

<i>Stability of minerals</i>	<i>Stability of vitamin A</i>	<i>Stability of vitamin C</i>
<ul style="list-style-type: none"> • Minerals are relatively stable than vitamins • Their bioavailability affected by heat, light and air • Copper, iron and zinc react with protein and carbohydrates • Minerals lost in soaking and blanching processes 	<ul style="list-style-type: none"> • Vitamin A sensitive to atmospheric oxygen in the presence of trace minerals • Unstable at acidic conditions (pH < 5) • Susceptible to oxidation in air • Inactivated by UV light • Relatively stable in heat processing 	<ul style="list-style-type: none"> • Unstable in air in the presence of moisture and metal ions e.g. Cu, Fe, Zn • Unstable in alkaline conditions (pH > 7) • Unstable in acidic conditions (pH < 4) • Lost during blanching (up to 30%) • Lost during pasteurization (up to 25%)

Approaches in the development of soya-moringa foods and their commercialization

- Study the effects of processing methods on the nutritional and sensory qualities of soya-moringa foods (flours and beverages)
- Study the influence of acidity (pH) on the stability of vitamins A and C in soya-moringa beverages
- Initiation of the collaborating partnership between SMEs, government and university to commercialize and transfer technology

Results

The processing methods being studied include drying by biomass dryers, soaking soya beans, blanching, grinding and mixing conditions (co-grinding), and pasteurization.

The results show the variability of product characteristics depending on the processing operations. **Figure 4** and **Figure 5** shows how different processing conditions may produce products of different sensory characteristics (i.e. texture, flavour, aroma and colour). Microbiological stability and physico-chemical stability are being investigated to establish the shelf-life for these products. Also, the characterization of the products in respect to their nutritional composition is being undertaken.



Figure 4: Effects of processing methods on the quality of soya-moringa beverages

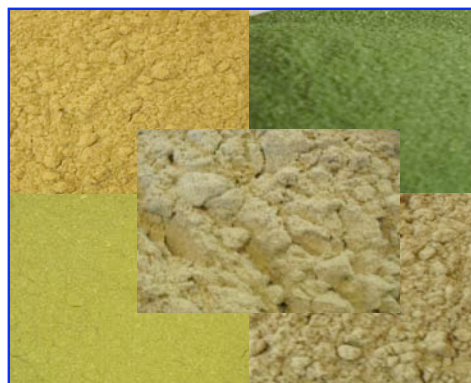


Figure 5: Effects of processing methods on the quality of flours

In order to transfer the research results to the community, the project is collaborating with the Dar es Salaam Functional Foods and Nutraceuticals Cluster. The cluster is made up by micro, small and medium scale food processors; farmers; central government department, local government authorities (municipal councils); and equipment manufacturers.

Food products by cluster food processors include functional foods (e.g. soya-moringa flour/powder, juices, milkshakes, breakfast cereals, pasta, instant porridge, nutritious bars). Nutraceutical products include moringa leaf extracts, and tablets, capsules and tincture.

Opportunities for Soya-Moringa Foods

- Increasing health consciousness among consumers and concern about their dietary intake;
- New research on the links between diet and health, including the prevention of chronic disease;
- Ageing populations in many countries prone to degenerative disorders such as cancer, heart disease, osteoporosis, diabetes and stroke;
- Growing pressure on public health spending, leading to a greater emphasis on prevention and more individual responsibility for health;
- Changes in the regulatory framework.