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Horseradish tree (*Moringa oleifera*) as a food product: value chain in the island of Ometepe, Nicaragua

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ABSTRACT

Objective: To establish a local market and generate the value chain of horseradish tree (*Moringa oleifera*) as a food product to produce dietary supplements.

Design/Methodology/Approach: We propose a strategy to introduce horseradish tree to the island of Ometepe, Nicaragua, based on the concept of value chain analysis and the characteristic of sustainability. Four analysis aspects were taken into consideration: a) production, b) sustainability, c) socioeconomic, and d) political. Likewise, requirements and barriers to the introduction of horseradish tree as a sustainable food product were identified.

Results: Using synthetic fertilizers or pesticides is not recommended for the commercial production of horseradish tree leaf powder. From the polyculture farming of horseradish tree alone a $7,500-$8,000 USD yield in a 1-ha plot has been projected in the local economy for the first year and between $14,200 and $15,200 USD in the following years.

Study Limitations/Implications: Although the horseradish tree contributes to an improved nutrition, the consumption of the fresh parts of this species involves a change in the food culture.

Findings/Conclusions: Horseradish tree leaf powder is a viable alternative organic food and has the potential to respond to malnutrition in Ometepe, Nicaragua. It also represents a net profit between $5,050 and $5,600 USD in the first year and between $11,200 and $12,200 USD in subsequent years.

Keywords: Horseradish tree, horseradish tree powder, food value chain, food diet.

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INTRODUCTION

Horseradish tree is a species also known as moringa, drumstick tree, ben oil tree, and benzolive tree. It is a fast-growing, medium-sized, drought-resistant tree that is widely cultivated and naturalized in tropical and subtropical regions of the world. It is native to

Image by Iskandar Ab. Rashid at Pixabay

the sub-Himalayan regions of India, Pakistan, Bangladesh, and Afghanistan, where it has been traditionally used as a medicinal and nutritional plant (Radovich, 2011). This tree belongs to the monogenetic family Moringaceae, of which *Moringa oleifera* Lam. is the most known and used species (Nadkarni, 1976).

This tree has a short lifespan (around 20 years). Its height can range from 5 to 10 m and it is considered a small- to medium-sized tree (Reyes-Sánchez *et al.*, 2006; Reyes-Sánchez and Mendieta-Araica, 2017). It has trippinate compound leaves with 1-2 cm long, large, green to dark green, elliptical leaflets. It has 10-25 cm long, white to cream flowers. The horseradish tree fruit is a three-lobed capsule called a pod. The immature green pods turn brown as they mature and dry at the end of their cycle. Each pod contains 15-20 large seeds with paper-like wings.

This plant has recently gained importance due to its multiple uses and benefits. All parts of the horseradish tree are valuable and can be used to produce fertilizers, animal feed, dietary supplements, medicines, cosmetics, and biodiesel, as well as to purify water (Radovich, 2011). Studies have been carried out to identify its nutritional and medical values (Moringa Delight, 2020). The highly nutritious leaves, fruits, flowers, and immature pods are eaten as vegetables. The leaves are rich in β-carotene (vitamin A), protein, vitamin C, calcium, iron, and potassium, and they also are a source of natural antioxidants (Siddhuraju and Becker, 2003). Several case studies have been carried out to determine the nutritional value of fresh and dried horseradish tree leaves in multiple countries (Canett-Romero *et al.*, 2016); however, these values showed variations attributable to such factors as the analysis method, genetic background, and environmental conditions, as well as the cultivation method and its processing (CSA-FAO, 2018).

Regardless of the results, horseradish tree is believed to offer a local and profitable response to malnutrition in the tropical and subtropical regions of the world. It is particularly useful in those regions, because the leaves appear at the end of the dry season, when some other sources of green leafy vegetables are still available (Bonal-Ruiz *et al.*, 2012). Once dried, horseradish tree leaves can be kept for a long time, the cost of storage and processing is low, and they can be available all year round (Kar *et al.*, 2013). Horseradish tree production costs are low, it is grown in hot climates, it tolerates poor quality soils with a lack of water, and it is resistant to most pests and diseases (Kar *et al.*, 2013). As a consequence of the abovementioned characteristics, horseradish tree is of great interest to some non-governmental organizations (NGOs), which promote its multiple benefits. These NGOs promote its cultivation, local marketing, and sustainable consumption on the island of Ometepe, Nicaragua, where it is grown but not consumed.

There is scant information about the various processes, from cultivation, management, and harvest, to marketing, consumption, and health and economic benefits for local communities. Therefore, the objective of this work was to design a strategy aimed at establishing a local market and generating value chains that allow the community to obtain multiple benefits from the tree.

MATERIALS AND METHODS

The study area was limited to the island of Ometepe, located in Lake Nicaragua, in southern Nicaragua (11° 23' 00" and 11° 36' 00" N and 85° 26' 00" and 85° 43' 00" W) (Figure 1). This lake is part of a long tectonic depression that extends in the center of Central America, comprising an extension of about 500 km, from the Gulf of Fonseca in the Pacific Ocean to the alluvial valley of the San Juan River in the Caribbean Sea. The lake has an area of 8,264 km^2, which includes approximately 310 islands and islets. Ometepe is the largest of such pieces of land (UNESCO-MENR, 2010).

The study for the introduction of horseradish tree was based on the concept of value chain analysis, which has been accepted as an important tool for environmental research and development. Importance was attached to four aspects: a) production, b) sustainability, c) socioeconomic, and d) political. Likewise, existing requirements or barriers to the introduction of horseradish tree as a sustainable food product were identified. Similarly, information about the volume of production, losses, costs, sale price, required quality, sale regulations, taxes, and policies that impact the product was collected.

RESULTS AND DISCUSSION

The planning of this project required a high investment cost, especially to obtain access to a land plot, which was only possible through the involvement of an NGO. Likewise, to increase horseradish tree production, investment costs must be reduced; otherwise, additional financing must be obtained. Similarly, investment costs of the raw material processing must be reduced, production capacity must be increased, and production must be diversified.

To identify the production profitability, the market price of the final products must be incorporated. However, this information is not available at the study site. Therefore, the market price of powdered horseradish tree leaf in other countries is taken as a reference and tourists from those countries are asked how much they would be willing to pay for

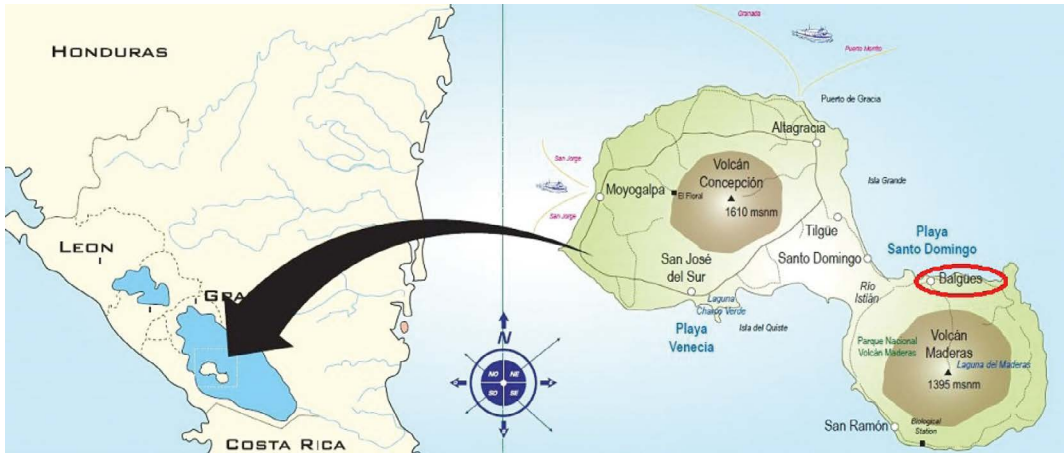

Figure 1. Location and map of the island of Ometepe, Nicaragua (Nicaragua-Conociendo Nuestro País, 2020).

200 g of the said product (Figure 2). Based on these results, the price of 200 g of powdered horseradish tree leaf was set at $5 USD.

Residents considered that the diversity of responses meant that it was an inadequate consultation procedure. It is assumed that, for this sector, the sale price must be lower since it will be produced locally and will be available directly from the producer and the local sales outlets.

Production

In general, three different ways of cultivating horseradish tree were found, which differ in the destination of some of the products to be marketed or the main purpose of the tree. The first was aimed at the intensive production of leaves. The second includes the complete development of the tree and is often known as a pod production method that also allows the production of leaves, but in smaller quantities. The third consists of a polyculture cultivation.

Based on the cultivation of 1 ha of land, a marketing pilot project was established; once the product is successful, the project can be expanded. However, given the lack of an agronomic program for its cultivation, the following assumptions were established based on the mapping carried out: a) establishment of polyculture with a 2×3 m configuration, resulting in a density of 1,650 trees per ha; b) use of locally collected seeds; c) use of manure and mulch, as the main sources of fertilization; d) manual pest management; e) three cuts in the rainy season and one in the dry season, during the first year; f) five cuts in the rainy season and one in the dry season, during the second year; and g) transportation of the product on horseback.

A passive solar dryer was used for processing and grinding was carried out with mechanical equipment. Fifteen sale points were considered, including stores and drugstores, with products mainly aimed at local people in 10 communities and 15 sale points exclusively aimed at tourists. An external motorcycle service was used to transport the final product to the sale point.

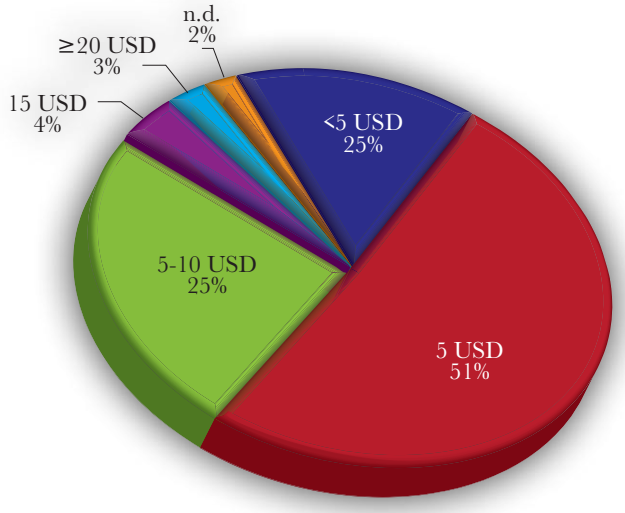

Figure 2. Price that tourists would pay for 200 g of powdered horseradish tree leaf. n.d.=not defined.

Sustainability

The introduction of horseradish tree as a food product has both positive and negative environmental aspects.

The positive environmental aspects are: a) horseradish tree cultivation offers the possibility of improving existing agricultural practices through the use of agroecological practices (*e.g.*, promoting the production of compost and reducing the use of petrochemicals); b) horseradish tree cultivation requires few inputs, no synthetic fertilizer, pesticides, or irrigation system are necessary, and, overall, manure as organic fertilizer is only required the first year during planting; c) horseradish tree leaf powder can potentially become a certified organic product; d) the promotion of polyculture in the study area provides environmental benefits such as weed suppression, reduction of insect damage through an improved balance of pests, better use of soil nutrients, and erosion control; and e) the production of horseradish tree powder requires a low input of electricity, since everything is done with passive solar energy.

The negative environmental aspect is the difficulty to reuse or recycle the waste from the production of horseradish tree, which poses an environmental and health risk.

Socioeconomic aspects

Horseradish tree polyculture diversifies the income, allowing farmers to become independent from the single-crop market. Higher income generation per hectare is possible, considering that horseradish tree can be harvested during the dry season. In addition, horseradish tree production reduces the dependence on imported dietary supplements, which implies employment creation and added value to the local economy. Horseradish tree has the potential to alleviate malnutrition in the study area and eventually promote a healthier behavior in local eating patterns. Over time, other uses can emerge, such as forage for animals.

Political aspects

There are no current health and quality standards for the production of horseradish tree leaf powder, no system monitors compliance with agricultural regulations, and the waste management system in the area is inadequate. Therefore, greater political intervention is required to reduce the negative environmental and social impacts of horseradish tree leaf powder production and to promote general economic development.

CONCLUSIONS

Given the current conditions on the island of Ometepe, Nicaragua, the powdered tree leaf represents a more viable alternative for the consumption of horseradish by local communities and foreign tourists through nutritional supplements. To make its consumption more attractive, an organic horseradish tree production program can be implemented. However, there are no quality certification and health standards for the consumption of horseradish tree leaf powder. The investment required to establish a horseradish tree plantation is high and there is no state funding or tax benefits in the horseradish tree value chain, despite its outstanding position as a sustainable niche market

and employment generator. In addition, a hectare of horseradish tree could add to the local economy between $7,500 to $8,000 USD in the first year and between $14,200 and $15,200 USD in the following years. The net profit in the first year would amount to $5,050-$5,600 USD and $11,200-$12,200 USD in subsequent years.

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