RESEARCH ARTICLE

Exploring the use of *Moringa oleifera* as a vegetable in Agua Caliente Nueva, Jalisco, Mexico: A qualitative study

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Abstract
People in Mexico speak of the medicinal properties of *Moringa oleifera* ("moringa"), but they know less about its nutritive properties. A qualitative, participatory approach was utilized to explore the use of moringa as a vegetable in Agua Caliente Nueva, Jalisco, by enrolling 14 female participants (mothers over 18) who were nutritional gatekeepers of the family and were responsible for preparing family meals using moringa leaves. Participants prepared meals with moringa and participated in semi-structured interviews to record their perceptions of foods, shopping habits, and knowledge and experience using moringa. The study objectives were to assess the regional acceptability and feasibility of introducing a readily available and nutritious plant into diets, and to examine whether moringa could potentially serve as part of a solution to the double burden of malnutrition in Mexico. Findings suggest that given its ability to thrive in this dry tropical region, moringa has the potential to be recognized as a viable component in the traditional diet in this small "ejido" communal farming community.

KEYWORDS
biocultural diversity, diabetes, diet, nutrition, obesity

1 | INTRODUCTION

*Moringa oleifera* (hereinafter referred to as "moringa") is recognized in tropical and subtropical regions of the world as the "tree of life" because of its myriad medicinal and nutritional properties. Known to be used as an alternative to Western medicine, it is said that every part of the moringa plant can be used for a medicinal purpose, such as inhibiting fibrosis, having antimicrobial and anti-inflammatory properties, lowering blood glucose levels, and potentially reducing the occurrence of tumors (Babu & Chaudhuri, 2005; Bichi, 2013; Brilhante et al., 2017; Leone et al., 2016; Pirrò et al., 2016). Additionally, in many parts of Africa and Asia, people have used moringa as a dietary supplement because of its high vitamin and mineral content; its leaves can be eaten fresh, cooked, or dried and stored (Table 1). When dried, the leaves can be stored for an extended period, making it a stable vegetable source. Moringa has been used in countries such as India, Pakistan,
Although there is existing literature that supports the use of moringa as a vegetable and potential weapon against malnutrition in south Asia and parts of Africa, less is known about its usage in Latin America, specifically in Mexico. Mexico is of interest because moringa likely first reached the Americas via the Pacific coast of Mexico as part of the galleon trade between Manila and Acapulco, with the earliest known records of its arrival in the Americas being from Mexico (Olson & Fahey, 2011). Mexico is also of interest because the double burden of malnutrition is prevalent in Mexico, where nearly three quarters of the population aged 15 years or older are identified as overweight or obese (OECD, 2019; Popkin et al., 2019). Food environments, specifically food deserts and food swamps, serve as optimal conditions for obesity to manifest due to the convenience of empty calorie, shelf-stable packaged and highly processed foods (Chen et al., 2016; Cooksey-Stowers et al., 2017). A nutritious plant such as moringa, with low maintenance needed for its rapid growth and drought resistance, has the potential to make a significant impact in Mexico today. However, more research needs to be done to identify areas of opportunity for introducing it to help combat the complicated manifestations of malnutrition and obesity among the country’s population.

The ideal investigation would aim to fill in the gaps about moringa usage in Mexico and evaluate whether residents would be willing to incorporate the plant into their diets for nutritional benefits. Researchers would visit a community in Mexico where moringa was prevalent and engage with residents about their exposure or knowledge about the plant. This would allow researchers to assess existing knowledge about moringa, its use among a small subpopulation in Mexico, and whether it would be possible for future interventions to introduce moringa as a vegetable in the diet. This investigation would target women, ideally those with children, because mothers tend to be the nutritional gatekeepers of the household (a nutritional gatekeeper is the main individual in the household who makes decisions related to food purchasing and preparation) (Allen & Sachs, 2007; Wansink, 2003). By interviewing this group, researchers would be able to gather insights regarding perceptions of “good” versus “bad” foods and whether these perceptions would impact food shopping habits. The ideal investigation would include a participatory component where these women would be given moringa leaves and be encouraged to prepare meals with them. This would allow researchers to assess the acceptability and feasibility of introducing moringa as a vegetable to households throughout Mexico as a potential method to tackle the double burden of malnutrition in the country.

To provide such data, the objectives of this study were to assess how nutritional gatekeepers in a small town within an ejido (a collectively owned agricultural community, recognized by the Mexican government) made food decisions based on perceptions of nutrition, availability of food, and shopping habits, and how *Moringa oleifera* was used in Mexico, specifically among populations in small towns or villages. Additionally, this study aimed to ascertain whether this group possessed knowledge of moringa’s health-promoting or medicinal properties, and whether the participants were amenable to incorporating a new element to their meals in efforts to improve the nutritional values of their family diets. This study may function as a gateway

### TABLE 1  Nutritional composition of *Moringa oleifera* (dried) leaves.

The macronutrients, vitamins, and minerals have been frequently reported and widely reviewed. This table presents consensus values along with the references from which those values were chosen. Only the predominant glucosinolate, glucomoringin, has been reliably measured across a wide number of cultivars, and we report that value herein. A variety of other bioactive phytochemicals, predominantly flavonoids, have also been reported, but not across a wide selection of cultivars or wild accessions.

| Nutrient                  | Amount in one serving (10 g) dried moringa powder |
|---------------------------|---------------------------------------------------|
| Protein (g)†              | 2.91                                              |
| Total Carbohydrate (g)†   | 4.1                                               |
| Fiber (g)†                | 4                                                 |
| Fat (g)†                  | 0.52                                              |
| Calories (kCal)†           | 32.9                                              |
| Calcium (mg)†             | 160.5                                             |
| Magnesium (mg)†           | 28.34                                             |
| Potassium (mg)†           | 174.5                                             |
| Iron (mg)†                | 2.82                                              |
| Zinc (mg)†                | 0.29                                              |
| Copper (µg)§              | 96                                                |
| Manganese (µg)§           | 598                                               |
| Molybdenum (µg)§          | 14                                                |
| Sodium (mg)§              | 1.2                                               |
| Phosphorus (mg)§          | 48                                                |
| Sulfur (mg)§              | 93.6                                              |
| Vitamin C (mg)†           | 17.2                                              |
| Thiamin (mg)†             | 0.26                                              |
| Niacin (mg)†              | 0.82                                              |
| Vitamin B-6 (mg)†         | 0.24                                              |
| Folate (µg)†              | 54                                                |
| Vitamin A, RAE (µg)§      | 364                                               |
| Riboflavin (mg)§          | 0.53                                              |
| Glucomoringin (µmol)§     | 750                                               |

†Waterman et al. (2021).
§Gopalakrishnan et al. (2016).
Olson et al. (2016).
¶Chodur et al. (2018).

Bangladesh, the Philippines, Senegal, and Malawi as a dietary supplement, not only for nursing mothers, but also for preventing malnutrition, including deficiencies of micronutrients such as vitamins A and C, zinc, iron, and calcium (Babu, 2000; Hager et al., 2017; James & Zikankuba, 2017; Kasolo et al., 2010; Olson et al., 2016). Ongoing studies continue to explore how moringa is used in other regions of the world (Brilhante et al., 2017; Fahey, 2017; Kou et al., 2018; Meireless et al. 2020; Mohanty et al., 2020; Nova et al., 2020).
example for future, larger-scale evaluations of the potential to deliberately use and introduce *Moringa oleifera* to as a solution for malnutrition in Mexico.

### 2 | METHODS

This was a study to explore the perceptions of foods and diets in the household, and the feasibility and acceptability of *Moringa oleifera* as a vegetable in Agua Caliente Nueva, an ejido in Jalisco, Mexico, with a total population size of approximately 750 residents, based on satellite canvassing using Google Earth and door-to-door canvassing conducted by the researchers in 2015 (INEGI, n.d.). A qualitative, mixed-methods approach was applied, using semi-structured interviews conducted in Spanish, and a community participatory function similar to the Trials of Improved Practice (TIPs) approach, developed by the Manoff Group. TIPs is a formative research method that invites a limited number of participants to test a new practice and share their feedback with researchers before an intervention is implemented (Dickin et al., 1997; Gittelsohn et al., 2006; The Manoff Group, 2005; The Manoff Group, n.d.). These participants, also known as TIPs consultants, provide valuable insight, which helps researchers adjust and refine an intervention before it is launched on a wider scale. Observations were held to witness the process of preparing meals with moringa. The observations took place after a cooking demonstration was conducted to depict how to use moringa in traditional Mexican meals. The cooking demonstration and observations were modeled on the TIPs approach (Dickin et al., 1997; The Manoff Group, 2005; The Manoff Group, n.d.).

Purposive sampling was used for this study to intentionally target a subgroup in this community. Inclusion criteria included women, specifically mothers over the age of 18 who resided in Agua Caliente Nueva, who: (a) were the main food preparers of their household, (b) agreed to attempt incorporating moringa leaflets into their meals, and (c) were available to participate in an interview after using moringa. This method of sampling was chosen because in this community and in Mexico women traditionally make food purchasing and preparation decisions in their household (Allen & Sachs, 2007; Bee, 2014; Kimoto et al., 2014; Quisumbing et al., 2014). Sixteen female participants were recruited to take part in the study, with ages ranging between 24 and 72 years. Two participants dropped out when one moved to a different city and one had a family emergency. Two participants were interviewed together (mother and daughter), for a total of 13 interviews. All participants elected to participate in the study without compensation or incentives.

One participant who had prior experience cooking with moringa leaflets was identified and recruited to conduct the cooking demonstration. The demonstration was scheduled to be held in mid-July 2017, and two in-person invitations and reminders were provided one week and three days prior to the event. Four participants attended the cooking demonstration, one of whom was the demonstrator herself, who prepared quesadillas using moringa as portrayed in Figure 1. All the participants in the study were provided two loosely packed quart-sized bags of moringa leaves, one after the cooking demonstration and another a few days prior to each scheduled interview. They were instructed to attempt preparing a palatable dish or "culinary creation" using the leaflets, based either upon the demonstration or through their own improvisational skill as food preparers/cooks. Fresh moringa leaves were harvested by the study team from a mature local moringa tree previously identified (Figure 2a), one compound leaf containing many leaflets, per participant, and they were placed in quart-sized cloth canvas bags. The leaves were distributed to each participant immediately after harvesting to ensure that they were freshly picked off the tree. Upon distribution of the moringa leaves, interview and observation dates were scheduled with the 14 participants. A few days prior to each scheduled interview, each participant was provided a second leaf of moringa to prepare something different or to use in case they did not prepare the first bunch they received while they were still fresh. The researchers were able to observe six participants as they picked the leaflets off the leaves and used them to prepare meals for their families (Figure 2b). Four participants did not end up using the moringa leaves that were offered to them but agreed to participate in their interviews. The interviews and observations took place between July and August 2017 in Agua Caliente Nueva.

The interviews were conducted in Spanish and consisted of a total of 53 questions (Supporting Information Material S1), with the interviews ranging from 25 minutes to one hour long. Some questions were skipped based upon answers to the previous question, and whether the interviewer judged them relevant to a particular household situation. Two main topics were discussed during the interview: (a) food and diets within the home and (b) moringa in Agua Caliente Nueva and in

![FIGURE 1](image1) Tortillas as prepared during the cooking demonstration. Ingredients used in this demonstration included flour tortillas, cheese, and moringa leaflets stripped from complete leaves.
FIGURE 2  (a) Moringa oleifera leaves on a twig. (b) Moringa leaves are compound (they have many small leaflets borne on a branching frame). Both the petiole (the “stalk” that holds the whole leaf) and the main rachises (the main “branches” of the leaf) are tough and generally not eaten. Thus, when preparing fresh moringa leaves in a food product, one separates the leaflets from the rachises and uses the leaflets in cooking. Variation in how much rachis is included in a preparation is probably a major contributor to variation in nutritional content across moringa samples. Scale (spaces between black lines on background) in b = 10 cm.

3  |  RESULTS

3.1  |  Food and diets within the household

During discussions regarding food and diets within the household, participants were asked to think of “good” versus “bad” foods, referenced in Table 2. As examples of “good” foods, 85% and 77% of participants named vegetables and fruit, respectively. Following this, 38% of participants (5 out of 13 interviews) thought fish and dairy were considered good foods as well. In contrast, when probed on examples of “bad” foods, 88% of participants thought of red meats such as pork and/or beef and 77% of participants thought of instant, processed, or canned foods. Direct quotations from participants (below) are italicized and are followed by the participant’s number in parentheses (see Table 3).

Approximately one-third of participants believed starches were bad for one’s health but continued to incorporate tortillas into meals. In one interview, a participant stated that she “knew tortillas were bad,” but continued to prepare meals that incorporated tortillas anyway. Another participant attributed consumption of these foods to weight gain:

“...we don’t know that what we eat makes us get fatter... What happens is, is that sometimes, we eat and get fat, and after, we (demonstrate difficulty breathing) ...Because they eat taquitos, quesadillas, and they contain a lot of fats.” (P12)

Most participants were of the opinion that red meats, particularly pork, were considered “bad” foods due to their high cholesterol and fat contents. Others named instant, processed, and canned goods as unhealthy because of their preservatives and how foods could keep for an unnatural length of time with these ingredients. However,
TABLE 2  Examples of “good” versus “bad” foods in the household, as reported by participants. Bolded are examples of foods named by a majority of participants when asked to describe examples of “good” versus “bad” foods.

| Examples                      | No. of interviews | Percentage scoring in this category |
|-------------------------------|-------------------|-------------------------------------|
| Good foods                    |                   |                                     |
| Vegetables                    | 11                | 85%                                 |
| Fruit                         | 10                | 77%                                 |
| Fish                          | 5                 | 38%                                 |
| Dairy                         | 5                 | 38%                                 |
| Cereals                       | 4                 | 31%                                 |
| Eggs                          | 4                 | 31%                                 |
| Legumes                       | 4                 | 31%                                 |
| Chicken                       | 4                 | 31%                                 |
| Red meat (pork, beef)         | 3                 | 23%                                 |
| Seafood                       | 2                 | 15%                                 |
| Broths                        | 1                 | 8%                                  |
| Farm animals                  | 1                 | 8%                                  |
| Grass-fed chicken             | 1                 | 8%                                  |
| Bad foods                     |                   |                                     |
| Red meat (pork, beef)         | 11                | 85%                                 |
| Instant/processed/canned foods| 10                | 77%                                 |
| Starches (bread, flour)       | 4                 | 31%                                 |
| Dairy                         | 3                 | 23%                                 |
| Fast food                     | 3                 | 23%                                 |
| Fats or oils                  | 2                 | 15%                                 |
| Shrimp                        | 2                 | 15%                                 |
| Sweets (candy, cookies, juices)| 2             | 15%                                 |
| Spicy food (chilies)          | 2                 | 15%                                 |
| Eggs                          | 1                 | 8%                                  |
| Chicken                       | 1                 | 8%                                  |

Participants were asked about the types of foods eaten at home, and more specifically what their partners and children consumed. Table 3 describes each participant’s household demographics and method of cooking. A majority of the women interviewed had children who still lived at home, and many mentioned that they listened to their partner’s or children’s preferences when preparing meals. For example, one participant mentioned that she did not typically cook meat because her son was not fond of it, while another participant stated that her children preferred textured vegetable protein so she would include that in meals over ground animal meat. Participants also shared a spectrum of responses from their husbands’ and children’s opinions regarding vegetables. Some participants perceived their children’s preferences to be due to their upbringing around food:

“And my kids also enjoy vegetables, but not as much as I do. It depends on how I prepare it. Because there are some ways I’ll prepare food that they won’t like, but other ways I prepare it that they like it and think it tastes good.” (P1)

“Ah, he thinks the same [that vegetables are very good and very nutritious]. Because I taught him.” (P12)

Another participant attributed her sons’ dietary preference shifts with age:

“They said they didn’t want [vegetables]…[when they were younger] they ate them.” (P13)

As the main food preparers, the participants shared coping mechanisms to encourage their family members to eat more “good” foods such as vegetables. One participant shared that she disguised vegetables by blending them into sauces, juices, and soups to ensure that children would eat the vegetables. Because a diverse range of fruit was not readily available in the town, participants utilized food preservation methods (such as freezing) when they encountered seasonal fruit at grocery stores outside of town or during produce truck visits.

3.2  |  Moringa in Agua Caliente Nueva and in the home

Previous studies reveal that moringa arrived on the Jalisco coast through two mechanisms: through traditional horticulture that has taken place over centuries and through recent imports from India. In probing what the study participants understood about how the plant arrived in their town, most participants shared that they first learned about moringa from one of the study team (MEO) who maintains the International Moringa Germplasm Collection. One participant shared an anecdote of a man from a town called Arroyo Seco, in the same ejido as Agua Caliente Nueva, who traveled to Navojoa, Sonora, a city approximately 16 hours north along the coast from Agua Caliente Nueva, and returned to the town to distribute Moringa seeds to town residents. According to her, these residents shared seeds with their social networks and moringa eventually arrived in Agua Caliente.
TABLE 3  Participant household demographics and prior experience with moringa

| Participant ID | Participant age | Number of members in household | Number of children | Method of cooking | Prior exposure/knowledge of moringa |
|----------------|-----------------|-------------------------------|--------------------|------------------|-------------------------------------|
| 1              | 45              | 5                             | 3                  | Leña (open-fire stove) | Prior use of leaflets and flowers    |
| 2              | 72              | 2                             | 5 (1 passed away so 4 now) | Stove and leña | Prior use of leaflets and seeds     |
| 3              | 57              | 3                             | 4                  | Stove             | Prior use of leaflets and seeds     |
| 4              | 29              | 4                             | 2                  | Stove             | Prior use of leaflets and seeds     |
| 5              | 46              | 3                             | 3                  | Stove and hornilla (burner) | Prior use of leaflets and seeds     |
| 6              | 41              | 10                            | 3                  | Stove and leña   | None                                |
| 7              | 60              | 2                             | 4                  | Stove             | Prior use of seeds                  |
| 8              | 36              | 4                             | 2                  | Stove             | Prior use of seeds                  |
| 9              | 39              | 4                             | 2                  | Stove and leña   | Prior use of seeds                  |
| 10             | Did not disclose during interview | 2                           | 1                  | Stove             | Prior use of leaflets and seeds     |
| 11             | 24              | 3                             | 1                  | Stove and leña   | Prior use of leaflets and seeds     |
| 12             | 30              | 7                             | 1                  | Leña              | Prior use of leaflets               |
| 13 (Mother)    | Did not disclose during interview | 5                           | 5                  | Stove and leña   | None                                |
| 14 (Daughter)  | Did not disclose during interview | 3                           | 1                  | Stove             | None                                |

1Stove = bottled natural gas stove.

Nueva. Herbarium records document the presence of the plant being cultivated as an ornamental in the area for at least 50 years (Lott, 1985).

All the participants were aware that moringa existed in the community and knew how to identify the plant when walking around the town, referenced in Table 3. Some shared that they would bring moringa seed pods home to take the seeds as pills, while others stated that their families or friends would bring seeds for them to take.

When prompted about uses for moringa, participants provided many different ailments for which moringa could be used, documented in Table 4. One participant referred directly to the plant as “arból de la vida (tree of life) because it helps with a lot of things.” A majority of participants stated that moringa could be used to treat diabetes. Of these participants, four provided anecdotes or personal experiences regarding their use of moringa to treat diabetes. For example:

“Well, it’s medicinal because there was a woman here who had a really bad case of diabetes and she couldn’t get up. And they said she would die, and one of her brothers went to Sinaloa and bought back moringa and gave her moringa. And for ten years the woman took moringa and was able to get up and walk around.” (P2)

“More people take it for their diabetes… I know a woman who takes the seeds every day for her diabetes… She says she feels a lot better and she doesn’t need medicine anymore.” (P9)

TABLE 4  Participant reports of therapeutic and curative uses for moringa

| Uses                        | Count (# of interviews) | Percentage |
|-----------------------------|-------------------------|------------|
| Treat diabetes              | 11                      | 85%        |
| Reduce stress/help with relaxation | 5                      | 38%        |
| Treat or prevent cancer     | 5                       | 38%        |
| Gain energy                 | 4                       | 31%        |
| Lose high cholesterol       | 4                       | 31%        |
| Aid digestion               | 3                       | 23%        |
| Heart health                | 3                       | 23%        |
| Improve vision              | 3                       | 23%        |
| Lower high triglycerides    | 3                       | 23%        |
| Weight loss                 | 3                       | 23%        |
| Alleviate headaches         | 2                       | 15%        |
| Express breastmilk          | 2                       | 15%        |
| Relieve knee pain           | 2                       | 15%        |
| Lower blood pressure        | 2                       | 15%        |
| Sleep aid                   | 2                       | 15%        |
| Treat anemia                | 2                       | 15%        |
| Treat bloating/gas          | 2                       | 15%        |
| Treat or prevent flu        | 2                       | 15%        |
| Kidney health               | 1                       | 8%         |
| Purify the blood            | 1                       | 8%         |
“It’s been about three years since I started using moringa. And my knees don’t hurt, I walk well, I don’t have diabetes, I don’t have problems with my heart. I feel that using moringa has helped me a lot.” (P10)

More than half of the 14 participants used moringa in some form prior to the interview. Some participants stated that they took the seeds like pills:

“I am using [the seeds]… I’m not sick right now, but I take it for prevention. And now I like it, because it gives me energy. When I am about to start doing something, I take the seeds beforehand.” (P8)

“I take the seeds. I peel off the shell of the seed, crush it a little, and then I take it. I take two in the morning, two in the middle of the day, and two in the afternoon.” (P2)

Other participants incorporated the leaflets or flowers into their meals:

“For the quesadillas I’ll put in cheese and moringa leaflets. And if I make salsa, I’ll use moringa leaflets, some tomatoes, and a little bit of cilantro, and a little bit of onions, and a little bit of garlic, and some salt, and that’s it.” (P1)

“I’ve used moringa when preparing meat, quesadillas, in chicken, salsa, and in agua fresca, and only the seeds. Also, my husband uses the flowers in tea.” (P10)

Participants revealed that moringa did not have a particular odor and was easy to incorporate into dishes. One participant shared that it was similar to cilantro:

“For me, it’s a vegetable that’s normal like cilantro. I don’t use cilantro, but I want to think that this is good, so I want to put [moringa] in because it doesn’t have much flavor.” (P11)

Another participant demonstrated that she could incorporate it into starch foods such as sopes (fried corn dough cakes in Figure 3). Other participants replicated the cooking demonstration examples and created quesadillas and agua frescas (fruit juice preparations) using moringa leaflets. When asked about their families’ reactions to the meals using moringa, the responses ranged from negative to positive:

“[Daughter] said she didn’t like it. But that’s just the way she is.” (P8)

“Well, because [my children] said there wasn’t much difference in flavor, and it didn’t take away from the flavor of the original meal, and they couldn’t taste the Moringa. It’s kind of like a condiment, and nothing else, but with little flavor.” (P5)

“Oh, if I prepare food for [my husband], he likes it.” (P12)

Results from this study suggest that introducing Moringa oleifera as a vegetable to households throughout Mexico can be a free or at the very least a low-cost means to combat the double burden of malnutrition in the country. Women are the primary group of individuals to engage in such an intervention due to their roles as the main food shoppers and preparers of their households. Future studies should continue engaging communities in Mexico about moringa and provide interventions where they are encouraged to use the plant as a vegetable for its nutritional values.

4 | DISCUSSION

4.1 | Food in Agua Caliente Nueva

Nearly all participants reported that fruit and vegetables were considered “good” foods. They mentioned that vegetables were good for digestion, preventing illness, and one participant perceived vegetables as having properties that helped expel mercury from the body if one consumed seafood. Some other “good” foods that were named included legumes, cereals, and eggs.

Participants perceived a variety of foods as “bad,” and although some shared the perception that tortillas were unhealthy, they were still an essential component to household meals. Traditionally, tortillas and beans are a central part of the Mexican diet, which was...
demonstrated by their availability in the corner stores and the tortilla delivery service in the town (Kimoto et al., 2014). Carbohydrates (such as flour, corn, or bean tortillas for instance) are a necessary component to one’s diet, both for human development and for energy to complete daily activities (Hardy et al., 2015). Some participants correlated excess simple carbohydrate consumption with overweight or obesity prevalence in their community, but incorrectly assumed that consumption of tortillas was bad in all regards. This may be due to participants’ information-seeking behaviors and identifying sources to which they deemed reliable.

The global food system has led to some shifts in the Latin American food environment, including the retail sales of food. Packaged and processed foods are produced in large volumes and featured more prominently in stores, which contribute to the shifts in diets, increased consumption of processed foods such as canned goods, and subsequent rise in obesity rates in countries like Mexico (Corvalán et al., 2017; Popkin, 2014; Popkin & Reardon, 2018). Interviews with participants in this study indicate a willingness to incorporate other nutritious components such as moringa to make their meals healthier.

There were different sources from which participants obtained information regarding food; some learned through the health clinic in town, others from the internet, and also from knowledge passed down from family members such as their mothers and grandmothers. This information-seeking behavior indicates initiative taken by the study population to look up information about food but raises concerns about the validity of the information that they gather. Additional factors to consider include the varying levels of access to sources of information, whether credible, to identify “good” versus “bad” foods. Although the internet can serve as a method for accessing accurate information, it may also be a potential avenue for spreading inaccurate data, or misinformation, to individuals.

4.2 | Women’s roles in the household

Throughout the data collection process, the participants’ responses indicated that they were the decision-makers when it came to food purchases from the corner stores in town and from the produce sellers who drove their small truckloads of fresh fruit and vegetables into town twice a week, as well as when it came to meal preparations for their children and partners.

Many dishes were prepared based on what was available, such as the tomatoes and onions that were sold at the corner stores, or fresh seafood caught from the neighboring seacoast. Participants shared a range of methods to incorporate “good” foods into household meals, and tried similar strategies when incorporating moringa leaflets to their dishes. Their knowledge of their household members’ dietary preferences, food preparation prowess, and creativity demonstrated through this study suggest that researchers should engage women for future nutrition interventions (Allen & Sachs, 2007; Bee, 2014; Kimoto et al., 2014; Quisumbing et al., 2014).

The study found that women’s roles as caretakers influenced their children’s dietary choices. Participants with younger children stated that they found value in teaching them what they learned from the health clinic, such as benefits of eating fruits and vegetables. Women engaged in nutrition interventions are in unique positions to steer their young children’s dietary choices.

4.3 | Moringa: perceptions and experiences

Through this study, it was evident that throughout Agua Caliente Nueva, everyone knew something about moringa. Participants shared that they either learned about moringa through immediate or extended family, family friends, from earlier work in the area by researchers at the International Moringa Germplasm Collection, fellow community members, the television or internet, or someone outside of town. This social network could serve as a means to disseminate information regarding the use of *Moringa oleifera* leaflets as a vegetable in future nutrition interventions.

Despite the stated physical barriers to accessing healthy, nutritious options in town such as diverse vegetable and fruit choices, residents in Agua Caliente Nueva have a vegetable that is within walking distance of their homes: moringa. The 10 participants who did use the moringa provided in the study created a variety of foods such as *agua fresca*, in broth, sauces, salads, and condiments for other meals. They provided feedback from their perspectives that moringa did not have a distinct flavor, texture, or smell. They liked that was nutritious, could be used in place of cilantro as a garnish, and be incorporated in nearly any meal. However, the researchers recognize that one leaf of moringa will not significantly alter the flavor, texture, or color of a dish or meal component. The participants’ use of moringa suggests that there is a willingness to incorporate this vegetable as an add-on, but further exploration is required to understand whether larger amounts of moringa leaflets would still be palatable to these families.

The positive feedback garnered from participants through this study confirms that there is a level of feasibility and acceptability of incorporating moringa as a vegetable into traditional Mexican dishes. Because this plant is readily available throughout town, is easy to grow and maintain in the region’s dry tropical climate, moringa is a viable, easily accessible vegetable option for the residents of Agua Caliente Nueva. It would be beneficial to encourage this community to utilize their social networks and spread their new knowledge that moringa can be used not only medicinally but also integrally as a nutritious vegetable in Mexican traditional dishes.

It was found that the participants were open to and enthusiastic about embracing moringa as a vegetable in their households, but there are some potential barriers that stand in the way of fully integrating it into meals. As one older participant said, *flojera* (laziness) can lead to the dismissal of trying new things or putting in the work to make moringa-incorporated juices in lieu of the easily accessible Coca-Cola beverages. Additionally, participants shared some mixed reviews from family members who tried moringa-incorporated dishes: participants reported that their children were opposed to trying it because they feared the new food, while others shared that their children were not open-minded enough to try moringa.
Recognizing these barriers related to perception of feasibility among food preparers for incorporating a new vegetable into daily meals as opposed to going the convenient route and of acceptability among children to try new vegetables are the initial first steps to influencing behavior change in the household. More research is needed to continue exploring pathways that make it convenient for household food gatekeepers to incorporate moringa leaflets in their meals. Additionally, it would be instructive to perform follow-up with these women through further observations to see how they are successful in encouraging their children and partners to eat vegetables, and more specifically larger amounts of moringa.

4.4 | Strengths

There is demonstrable evidence that moringa is widely recognized in the community for its medicinal properties, and this study suggests that it can be recognized for its nutritive properties as well. The Agua Caliente Nueva community of fewer than 800 residents is close-knit, allowing for the sharing of information and knowledge about moringa.

Although moringa was introduced to this community, it has the ability to thrive with only minimal care. As researchers continue developing cost-effective, sustainable nutrition interventions to improve the nutritional status of vulnerable populations, they should consider identifying and utilizing indigenous plants like moringa to address the micronutrient deficiencies that are so rampant in those areas and that are so nicely addressed by adding moringa to the diet.

4.5 | Limitations

Due to the time constraints of this project, the research was conducted within a two-month time frame. Given the time of year for this study (July to August 2017), some residents were not in town and unavailable to participate in the study, resulting in a smaller source population from which to recruit eligible participants. With this small sample size, it is plausible that data saturation was not reached and that new information and themes could emerge from additional data with additional participants. However, small sample size notwithstanding, the population of Agua Caliente Nueva is so small, close-knit, and relatively homogeneous that these findings may be useful for other members of the community seeking inspiration for future small-scale nutrition interventions. Larger sample sizes and longer duration interventions will aid in assessing the feasibility that this community and others like it may embrace moringa as a nutritious vegetable that can be incorporated into local cuisine.

As a new resident of the community, the primary researcher on-site (BCC) spent the first three weeks building rapport by visiting local tiendas and homes to allow the local community members to familiarize themselves with her presence and the reason for her stay. During the interviews, it was sensed that social desirability bias came into play with some participant responses; participants may have provided answers to interview questions based on what they determined was relevant to the researcher and the study. These instances were noted in the written field notes and reviewed during the analytic memo writing sessions.

Participants were provided two loosely packed quart-sized bags of moringa leaves at two different points of time during the study. This amount of moringa incorporated into meals may not be significant enough to alter the taste, texture, or color of what is consumed. Future iterations of this study should consider providing larger amounts of fresh moringa leaves or dried moringa leaf powder equivalent to the recommended dietary allowance for protein, 0.8 grams of protein per kg of body weight, as set by the World Health Organization, with clarified instructions to use the entire amount in one component of a meal, as opposed to a garnish (WHO, FAO, UNU, 2007).

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DEDICATION

The researchers dedicate this contribution to Balbir Mathur, the visionary founder of Trees for Life International.

AUTHORS’ CONTRIBUTIONS

BCC, JWF, and MEO co-designed the study aims and objectives. BCC developed the data collection tools, collected the data in the field, and prepared the first draft of the manuscript. MEO and JWF initiated the study. All authors refined the study and participated in the data analysis and revisions of the manuscript, and all authors approve of this manuscript.

CONFLICTS OF INTEREST

BCC and MEO declare that they have no conflicts of interest to disclose. JWF has consulted for both food and supplement companies in the past year.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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