Moringa Oil Expeller

Remartin S. MAGLANTAY*1

Abstract

The project presented focuses on the development of a harvesting tool for the extraction of oil from the seeds of the moringa trees. Moringa have an extraordinarily nutritional potential that can help, at least short-term, to solve problems associated with poor nutrition in the area. Furthermore, moringas naturally prosper all over the archipelago, making it an accessible and inexpensive resource. One of the major concerns regarding the extraction process has been the reabsorption of the oil due to the elastic property of the seeds. This factor is important because a significant percentage of the oil extracted can potentially be reabsorbed, consequently limiting the efficiency of the extraction process. I consequently selected a continuous system that could better ensure a constant pressure, which seems desirable. Moreover, inevitably the design is a compromise between efficiency and cost. Therefore, it was necessary to select a design that could be cheaply produced, limiting also the necessity to produce the whole design from scratch. The final design consists of a meat grinder that ends with a shaft attached with a choke assembly for compressing the cake to extract oil. Fresh seeds are inserted in a cone shaped feeder, while the cake flows out the smaller end of the cage and oil is collected in a container. This project represents a first step into the development of an extraction tool that maximizes the extraction of oil from moringa seeds, and consequently the consumption of the seeds themselves, not exploited so far.

1. Introduction

1.1 Significance

1.1.1 Local Conditions

Moringa, which is locally known as "malunggay", has been a part of the Filipino lives for a long time. Moringa can be planted virtually anywhere with minimum supervision and care. It can be seen growing almost in every backyard and vacant lots around the country. It is sometimes revered as a miracle tree. „Malunggay" leaves have long been believed to have abundant nutritional value. Moringa seeds, in the other hand, get less attention and value. Recent studies show that essential oils from Moringa seeds are highly in demand especially in the skin care and cooking industries. To tap this abundant source of income, we need to have equipment that is affordable, locally available and east to operate that will serve the purpose of extracting essential oil from moringa seeds to give farmers added value to their products.

1.1.2 Global Conditions

According to the "Development Potential for Moringa Products" in 2001, India is the world's largest producer of moringa fruits with an annual production of 1.1 to 1.3 tonnes of fruits from an area of 38,000 hectares. As for moringa seeds, traditional methods whereby powdered seed is boiled in water and the released oil is skimmed off the surface of the water have, in the past, produced very low yields. Attempts using other manual expression systems (e.g. hydraulic presses) have resulted in similar poor yields. Therefore, there does not yet appear to be a definitive solution to the question of which type of press is the most effective to get acceptable yields.

1.1.3 Activities in the Philippines

In 2004, Sen. Loren Legarda champions the popularization of Moringa. She proposed that the Philippines, being an agricultural country, make Moringa one of the priority crops. Legarda urged to noodle makers such as Universal Robina Corp., Nestlé Philippines Inc., Monde Nissin Corp. and Uni-President Philippines Corp. to find ways to add malunggay and other nutrients to noodles, for which Filipinos now spend P13 billion a year. This is, in essence, because locally manufactured instant noodles were included in the "basic necessities" category under the Price Act.

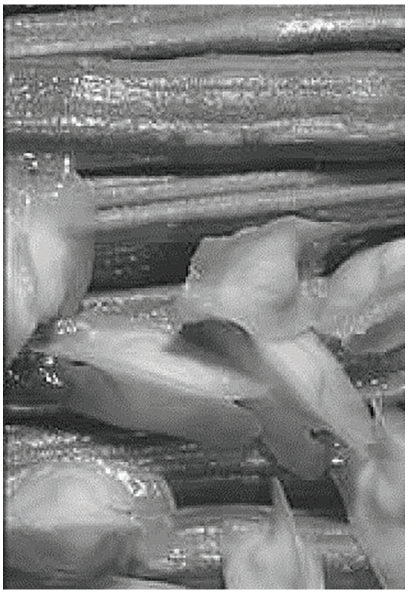


Figure 1. Moringa Oleifera seeds

1.2 Objectives

- To develop an equipment that can get at least 30-40% yields of oil from moringa oleifera seeds that is locally available, affordable and easy to operate.
- To provide means of extracting moringa oil to harness its nutritional properties and other properties that can benefit the Filipino people.

*1 *Senior Science Research Specialist*
Metals Industry Research and Development Center, Bicutan, Taguig City, Philippines

- To increase the potential income of our local farmer from cultivating moringa trees.

2. Review of Literature

2.1 Scientific Framework

2.1.1 Oil Extraction

Most of the available oil extraction machines require the seeds to be heated to lower the viscosity of the oil and allow it to escape easily from the seed during compression.

Types of Oil Extraction Machines

a. Screw Press (Expeller)

An expeller consists of a helical thread (worm assembly) which revolves concentrically within a perforated cylinder (the cage or barrel). The barrel is usually formed by a series of axially-placed lining bars contained within a robust frame.

This type of press is more commonly used nowadays due to that a screw press oil expeller allows for continous feeding unlike other methods of pressing.

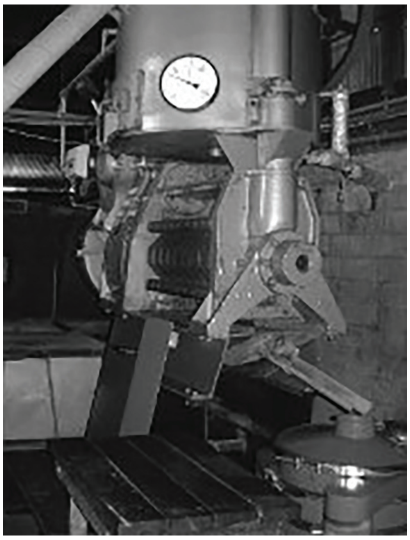


Figure 2. Large scale screw expeller

- Variable Diameter

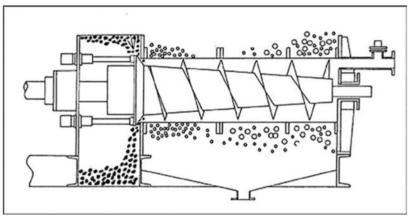


Figure 3. Variable Diameter Screw Press

This type of expeller employs a screw that has an increasing minor diameter. The varying diameter provides the compression needed to expel the essential oil from the seeds. The minor diameter is inversely proportional with the cross-sectional area between the screw and the cylinder, thus, pressing the seeds and extracting oil.

Figure 4. Variable Pitch Screw

This type of expeller employs a screw that has a decreasing pitch along its entire length. This provides the compression needed to expel the essential oil from the seeds. The pitch of the screw is directly proportional with the cross-sectional area between the screw and the cylinder, thus, pressing the seeds and extracting oil.

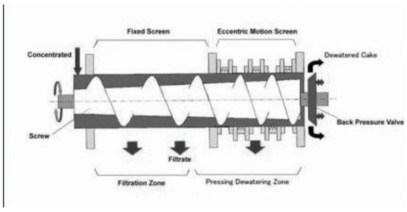


Figure 5. Variable pitch and variable diameter screw

This type of expeller employs a screw that has both a decreasing pitch and an increasing diameter along its entire length. The decreasing pitch and the increasing diameter simultaneously provide a much larger compression ratio compared to the other types of screw expeller given the same geometric proportions.

b. Ram Type Press

A long pivoted lever moves a piston back and forth inside a cylindrical cage constructed from metal bars spaced to allow the passage of oil. At one end of the piston's stroke, it opens an entry port from the seed hopper so that seed enters the press cage.

When the piston is moved forward, the entry port is closed and the oilseed is compressed in the cage. As a result, oil is expelled from the oilseed and emerges through the gaps in the cage. Compressed seed is pushed out through a circular gap at the end of the cage.

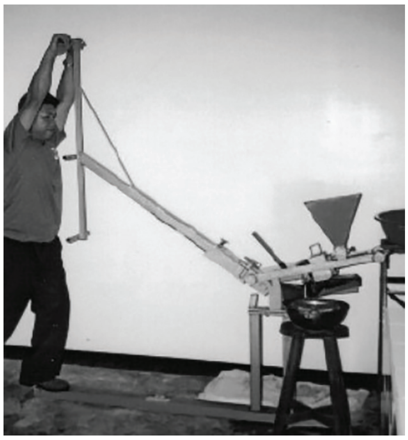


Figure 6. Ram Press

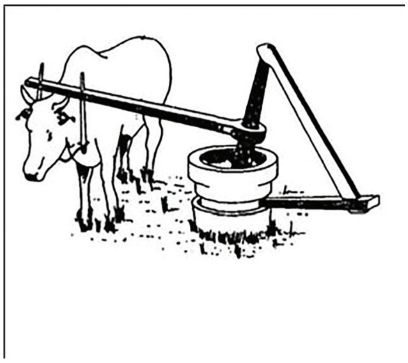


Figure 7. Example of a Ghani

c. Ghani

The ghani consists of a large mortar and pestle, the mortar being fixed in the ground and the pestle being moved within the mortar by animal traction (donkey or mule) or (more commonly) a motor. Oilseeds are placed in the mortar and the pestle grinds the material to remove the oil. The oil runs out of a hole in the bottom of the mortar and the cake is scooped out by hand. This method is slow and requires two animals, replacing the tired one with another after about 3-4 hours of work. Motorized Ghanis are now also being used to replace the animal and increase productivity.

2.1.2 Moringa Oleifera

Moringa oleifera is the most widely cultivated species of a monogeneric family, the Moringaceae, that is native to the sub-Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan. This rapidly-growing tree, was utilized by the ancient Romans, Greeks and Egyptians; it is now

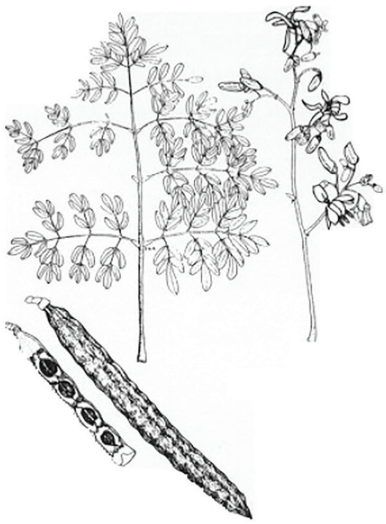


Figure 8. Illustration of moringa leaves and fruits containing moringa seeds

Figure 9. Moringa Oleifera

widely cultivated and has become naturalized in many locations in the tropics. It is a perennial softwood tree with timber of low quality, but which for centuries has been advocated for traditional medicinal and industrial uses. It is already an important crop in India, Ethiopia, the Philippines and the Sudan, and is being grown in West, East and South Africa, tropical Asia, Latin America, the Caribbean, Florida and the Pacific Islands. All parts of the Moringa tree are edible and have long been consumed by humans. This study will focus on one of the many parts of the moringa oleifera, which is its seeds, most especially in the moringa seed oil (yield 30-40% by weight).

Moringa seed oil, also known as Ben oil, is sweet non-sticking, non-drying oil that resists rancidity. It has been used in salads, for fine machine lubrication, and in the manufacture of perfume and hair care products but, the seeds are also eaten green, roasted, powdered and stepped for tea or used in curries. This tree has in recent times been advocated as an outstanding indigenous source of highly digestible protein, Ca, Fe, Vitamin C, and carotenoids suitable for utilization in many of the so-called "developing" regions of the world where undernourishment is a major concern.

Sulviculture
Moringa oleifera is easily established by cutting or by seed. Seed can be sown either directly or in containers. No seed treatment is required. The rapidly germinating seedlings can reach 5 m in one year if sheltered from drying winds and provided with enough water.

Plants rose from 1 m cuttings beat pods from the second year of growth onwards, with maximum production at 4 to 5 years. In a favorable environment an individual tree can yield 50 to 70 kg of pods in one year.

Harvest and Yield
Perennial types raised by cuttings take nearly a year to bear fruit. The yield will generally be low (80-90fruit/year) in the first two years of fruit-bearing. This gradually increases to 500-600 fruit/tree/ year in the fourth and fifth years. The pods are harvested mainly between March and June. A second crop is normally harvested from September to October.

Annual moringa types are seasonal in terms of fruit- bearing and the crop sown during September comes to harvest within six months. Fruit of sufficient length and girth are harvested before they develop fibre. The harvest period extends for 2-3 months and each tree bears 250-400 fruit depending on the type.

Market Awareness
The oil for cosmetic use this is generally a low volume high value market. Although this is a market that can be opened up, it can take a number of years for the cosmetic industry to accept that what is being offered has qualities of some unique benefit and to then develop consumer products based around it. This is a potential market for Moringa oil but it is one that may take several years to develop. With respect to the commercial edible oil market this will probably be the most difficult market to target. Firstly, the oil comes into competition with the commodity oils such as palm and sunflower oil and, as such. If direct competition were to be considered then it would have to compete on price, which is unlikely. Moringa oil could be produced to match this price, if production is expanded a great deal. Secondly, this is new oil that has not been previously offered for sale as an edible product. Whether or not it will be accepted on the market will depend very much on the consumer and how the product is marketed to persuade the consumer to alter their purchases.

3. Methodology

3.1 Benchmarking
The prototype in this study was compared, with respect to its output with a commercially available multi-seed oil expeller, the piteba oil expeller.

Figure 10. Piteba Universal Expeller

Piteba is not rated for use with moringa oil, but due to its compact for our testing results, design and relatively easy operation we used this product as benchmark of comparison for the prototype being develop in the project. Piteba Oil Expeller was tested using Jatropa seeds with a yield of, approximately, 27-40% oil.

3.2 Testing

The test followed testing procedures used for the Piteba Universal Oil Expeller. This allowed easier benchmarking between our new prototype and the said universal oil expeller.

The test is designed to monitor and record the mass of pressed cake and the volume of oil extracted during a specified amount of time and from a specified mass of seeds. Jatropa seeds, which are readily available, will be used during the initial testing. This verified the capability of the prototype in extracting oil from seeds given that a decorticated jatropa seed and a moringa seed has the same consistency making it suitable for the experiment.

After verification, Moringa seeds were used to determine the prototype's actual capacity and output efficiency. Testing was separated into two batches, one batch of decorticated seeds and one batch of non-decorticated seeds. Recommendations was made, based on testing data gathered from the actual moringa seeds testing, to optimize the efficiency of the prototype and enhance quality of oil produced by the said prototype.

As reference, the following are the results from the Piteba testing done by the Engineering for Developing Communities Uganda Project Team under the Columbia University's Engineers without Borders (CU-EWB) Uganda program, in collaboration with Pilgrim, a Ugandan NGO.

Table 1. Raw Data

Run	Time (minutes)	Time (hours)	Mass of Input (grams)	Volume of Output from Oil Slit (mL)	Mass of Output from Oil Slit (grams)	Volume of Decanted Output (mL)	Mass of Output from Screwcap (grams)
1	5	0.083333333	100 ± .05	15 ± 1.25	17 ± .05	8 ± 1.25	59.9 ± .05
2	3.966666667	0.066111111	100 ± .05	17 ± 1.25	16.8 ± .05	9 ± 1.25	79.8 ± .05
3	2.35	0.039166667	100.1 ± .05	17 ± 1.25	13.9 ± .05	10 ± 1.25	77.5 ± .05
4	2.566666667	0.042777778	100 ± .05	22.5 ± 1.25	21.8 ± .05	11.5 ± 1.25	77.8 ± .05
5	20	0.333333333	500 ± .05	84 ± 1.25	82.2 ± .05	32 ± 1.25	356.8 ± .05
6	8.733333333	0.145555556	280 ± .05	20 ± 1.25	20.8 ± .05	7 ± 1.25	211 ± .05
7	8.166666667	0.136111111	283 ± .05	46 ± 1.25	45 ± .05	10 ± 1.25	231.5 ± .05
8	8.333333333	0.138888889	283 ± .05	42 ± 1.25	40 ± .05	8 ± 1.25	236.8 ± .05
9	18.55	0.309166667	179.7	85 ± 1.25	85	22 ± 1.25	65.8 ± .05

Table 2. Data on rate of expulsion

Run	Extrapolated Volume of decanted oil/ Hour (mL/ Hr)	Extrapolated Volume of total oil/ Hour (mL/ Hr)
1	96	180
2	136.1344538	257.1428571
3	255.3191489	434.0425532
4	268.8311688	525.974026
5	96	252
6	48.09160305	137.4045802
7	73.46938776	337.9591837
8	57.6	302.4
9	71.15902965	274.9326146
Average	122.5116436	300.2062016
Standard Deviation	83.24110321	120.4597041

Table 4. Data on the percentage of input and output pressed cake

Run	Percentage of mass unaccounted for
1	23.1
2	3.4
3	8.691308691
4	0.4
5	12.2
6	17.21428571
7	2.296819788
8	2.190812721
9	16.08235949
Average	9.508398489
Standard Deviation	8.070556294

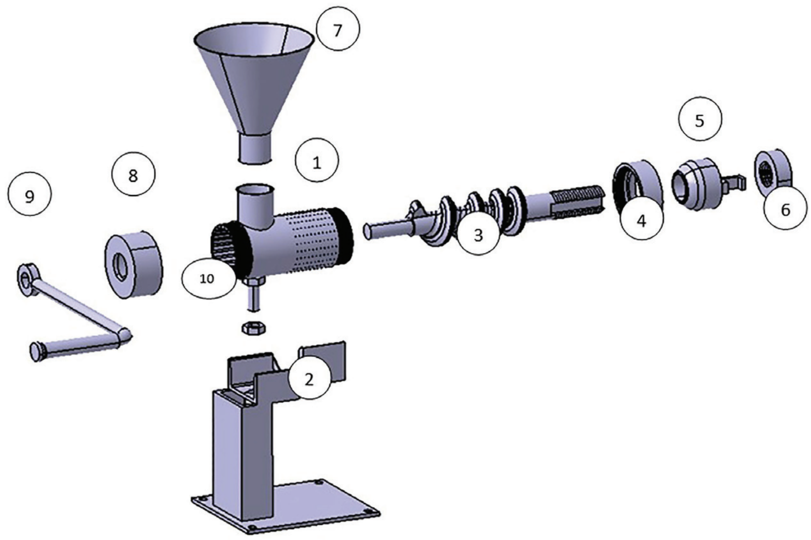
Table 3. Data on amount of oil the settles out of the original output

Run	Volume of Output from Oil Slit (mL)	Volume of Decanted Output (mL)	Percentage of total oil output that is actually oil
1	15	8	53.33333333
2	17	9	52.94117647
3	17	10	58.82352941
4	22.5	11.5	51.11111111
5	84	32	38.0952381
6	20	7	35
7	46	10	21.73913043
8	42	8	19.04761905
9	85	22	25.88235294
Average	38.72222222	13.05555556	39.55261009
Standard Deviation	28.23020447	8.398081792	15.08985652

Table 5. Data on percentage of the input that is not found in either the seedcake mass or oil output mass

Run	Mass of Input (grams)	Mass of Seedcake (grams)	Percentage of Input that is Seedcake
1	100	59.9	59.9
2	100	79.8	79.8
3	100.1	77.5	77.42257742
4	100	77.8	77.8
5	500	356.8	71.36
6	280	211	75.35714286
7	283	231.5	81.80212014
8	283	236.8	83.67491166
9	179.7	65.8	36.61658319
Average	213.9777778	155.2111111	71.52592614
Standard Deviation	136.3871766	106.6677721	14.85060161

4. Design of the Oil Expeller



Parts:
1. Barrel
2. Stand
3. Screw
4. End Cap
5. Choke
6. Choke Adjuster
7. Hopper
8. Front Cap
9. Bearing
10. Handle

5. Discussion of Results and Findings

Tests resulted positively, however, due to heat application using kerosene as fuel ads impurities to the extracted oil which results into discoloration.

Moreover, accumulation in the exposed part of the barrel was observed during the test.

Due to the bigger diameter of the barrel, a bigger amount of force should be applied to turn the screw and compress the seeds inside the barrel.

Materials used in the fabrication of the parts were steel which resulted to rusting after use.

The cake thickness varies with the settings applied. The thinner the setting of the cake, the greater amount of force should be applied in turning the screw.

The stand should be properly mounted in a flat and stable surface.

Table 6. Result of Testing

TRIAL	SEED QUANTITY (g)	OIL QUANTITY (mL)
1	200	18
2	200	19
3	200	17

6. Summary and Conclusion

A screw enclosed in a barrel with groove on the walls created an impact in crushing the seeds inside the barrel which causes the extraction of oil upon compression of the screw towards the choked area at the end of the screw. Continues application of heat to the barrel significantly improves the extraction process while reducing the residual oil on the cake produced.

7. Recommendation

I recommend that since the oil extracted will be used for human consumption, metals with direct contact with the seeds and oil therein should be food grade metal to increase the quality of oil produced.

To further increase the quantity of oil extracted, a longer screw should be used and increase the quantity of holes in the barrel for better oil flow.

Denaturalized alcohol should also be used as fuel in heat application for cleaner and carbon free process.

8. Literature Cited

a) Engineering for Developing Communities, Oil Press Project, http://www.civil.columbia.edu/edc/edc_2008/oilpress.html
b) General Nutrients, website http:\\www.moringaoil.com
c) Rajangam J., Azahakia Manavalan R. S., Thangaraj T., Vijayakumar A. and Muthukrishan N., STATUS OF PRODUCTION AND UTILISATION OF MORINGA IN SOUTHERN INDIA, Development Potential of Moringa Products, 2001
d) Sutherland J.P., Folkard G.K. and Poirier Y.L., MORINGA OLEIFERA. THE CONSTRAINTS TO COMMERCIALISATION, Development Potential of Moringa Products, 2001
e) Practical Action, Technology Challenging Poverty - Oil Extraction
f) Agro-forestry Species Highlights, Moringa oleifera: A Perfect Tree for Home Gardens, April 1993
g) Jed W. Fahey, Sc.D. , Johns Hopkins School of Medicine, Department of Pharmacology and Molecular Sciences, Lewis B. and Dorothy Cullman Cancer Chemo protection Center, Moringa oleifera: A Review of the Medical Evidence for Its Nutritional, Therapeutic, and Prophylactic Properties. Part 1; Trees for Life Journal, www.TFLJournal.org
h) Christine Herrera, Manila Standard Today, Loren pushes moringa-fortified noodles, Dec. 24, 2007.