Development and Analysis of a Product Made from Pink Pine Nuts in the South of Nuevo León

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***Abstract*— Nowadays one of the most evident problems in Mexico is hunger, malnutrition, and food safety, according to The Hunger Project México (2016) the 23.3% of the total population lives in poverty food, and the 12% suffer chronic malnutrition. Applying innovative tendencies and the industrial engineering, our project provides the option for the generation of a food product that is consider organic waste in this case is the "pink pine nut" this, because to its properties and benefits among which are, control in levels of fats, high protein concentration, and also fatty acids that are essential as omega 3 and 6. In addition to minerals such as Iron (Fe), Magnesium (Mg) and Potassium (K) necessary for the proper functioning of the body. This project was managed for the municipality of Aramberri located in the state of Nuevo León since the pink pine nuts are abundant in this region and wasted on a large scale.**

***Index Terms*—Pine nuts, organic waste, pink pine nuts processing**

I. Introduction

Your goal is to simulate the usual appearance of papers in the. We are requesting that you follow these guidelines as closely as possible. One of the most difficult challenges nowadays is the fight against malnutrition, this is a term that refers to the deficiencies, excesses and imbalances of a person's caloric and nutrient intake. It covers three large groups of conditions [1]:

1. Malnutrition: wasting (insufficient weight regarding size), growth retardation and underweight (insufficient weight for age).
2. Micronutrient related malnutrition: lack of micronutrients (lack of important vitamins or minerals) or excess micronutrients.
3. Overweight, obesity and non-transmissible diseases related to food (such as heart disease, diabetes and some cancers).

According to the World Health Organization [1] 52 million children under the age of 5 are emaciated, 17 million are severely emaciated, 155 million are stunted and 41 million are overweight or obese. In addition, 45% of deaths of children under 5 are related to malnutrition. In most cases this occurs in low and middle income countries. The repercussions on the development and economic, social and medical consequences of global malnutrition are serious and lasting for the population and for the countries [1].

On the other hand, in Mexico malnutrition shows alarming figures. This problem affects children and adolescents. Malnutrition during childhood has negative impacts for the rest of life such as the insufficient development of the immune system [2]. According to UNICEF [2], in Mexico 1 in 8 girls and boys under 5 suffer from chronic malnutrition, with the states of southern Mexico being the most affected, especially rural communities and indigenous households. In parallel, 1 in 20 girls and boys under 5 years old and in every 3 between 6 and 19 years are overweight or obese. This positions Mexico as one of the countries that lead in childhood obesity worldwide [2].

Well-structured nutrition from the early stages of life is decisive for good physical and mental development, as well as for enjoying the benefits of good health for a long time [3]. The World Health Organization mentions various actions that must be carried out by the member states and international associations to reduce the alarming numbers of malnutrition. Among these actions is the creation of environments conducive to the implementation of integral food and nutrition policies. Also, include national nutrition plans in all effective health interventions that have effects on nutrition. Finally, stimulate the development of policies and programs outside the health sector to improve nutrition [3]. However, these actions will not be enough to eradicate this problem around the world, so it is necessary to join these efforts.

As for Mexico, this is a country with an ideal geographical and climatic conditions for the production of grains, seeds, fruits and vegetables. In addition to having a great natural diversity in which the pine can be found. This tree is characterized by a height between 5 and 10 meters, produces reddish cone-shaped flowers that, when mature, protect the seed of our interest: the pinion. This type of pine has characteristics that allow its prevalence in Mexican territories such as its ability to resist droughts and inhabit semi-arid areas. According to the National Commission for the Knowledge and Use of Biodiversity, the highest concentrations of pinion can be

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found in the State of Nuevo León, in the Sierra Madre Oriental, although it can also be found in the Sierra Madre Occidental [4].

In recent years the pine nut has generated great interest for experimentation as a low-cost food thanks to its high nutritional content. Moreno *et al*. [5] studied the marketing margins of pine nuts in Tlaxcala, Mexico. In previous studies the pine nut is revealed as a raw material for the preparation of salty or sweet foods, without intervening in the natural qualities of the product. Thanks to its high development potential, the pine nut allows the elaboration of various products such as cookies, chocolates, beer, jam, side dishes, liquor and mash [6].

Table I shows the elements that the pinion contains in 100 grams in net crude weight according to the National Institute of Nutrition [7].

TABLE I. AMOUNT IN GRAMS CONTAINED IN 100 GRAMS OF PINE NUT

Element	Grams quantity
Fatty	61.3
Carbohydrates	16.8
Fiber	1.1
Protein	15.3
Water	3.1

In addition to high nutritional value it has organoleptic qualities [8]. It even contains omega 9, 6 and 7 [9].

Taking into account that the pinion is a product with high nutritional levels, low cost and very abundant in our region, it is very interesting to create a collection center for the marketing of the pine nut in our country and seek to enter new markets with this product to provide low-income communities the option of a product suitable for improving health conditions. For this reason, a study will be developed for the validation of the project.

The novelty in this investigation consists in the use of the pink pine nut for the elaboration of a product with high nutritional levels, which are validated by means of the fatty acid process. In addition, the dehydration process has been carried out under strict regulations so that the original characteristics of the pinion are not lost. Finally, the viability of a collection and marketing center for this product in the municipality of Aramberri located in the State of Nuevo León in Mexico was determined since this municipality is abundant of the pink pine nut. The pink pine nut market in Aramberri is a business opportunity, which would help the economic growth and development of the municipality. In addition to providing new sources of employment generation.

II. METHODOLOGY FOR THE VALIDATION OF NUTRITIONAL VALUES IN THE PINK PINE NUT

A. Dehydration Process of the Pink Pine Nut

The pink pine nut was dehydrated in an industrial dryer with the purpose of eliminating the remaining water. The process was operated by temperature oscillations to generate heat fluxes and thereby optimize the dehydration time. The dehydration time of the pink pine nut is 30 hours in which the concentrations of water in the pink pine nut were completely eliminated. Table II shows the humidity values of the pinion. The product was weighed before entering the industrial dryer and after finishing the process in order to monitor the dryness and moisture loss behavior. When the pinion remained in constant weight this indicated that the product was ready for the next process. In this case the humidity percentage was also determined. The pink pine nut has 11.3% humidity. Subsequently, the dehydrated pinion was sprayed with the help of a mill, which took a time of 5 to 6 minutes. Then with the powdered pinion it was necessary to sift it, in this case at 150 microns.

TABLE II. TIME AND TEMPERATURE DURING THE DEHYDRATION PROCESS OF THE PINK PINE NUT

Intlet Temperature (T)(℃)	Time (t) (hrs)	Initial quantity (gr)	Final quantity(gr)
50	4	1000	948
30	6	948	928
40	4	928	911
30	6	911	901
50	4	901	893
30	6	893	887
40	4	887	887
30	6	887	887
50	4	887	887

B. Procedure for Sample Preparation in Determining Fatty Acid Profile

Give all authors' names; use "et al." if there are six authors or more. Papers that have not been published, even if they have been submitted for publication, should be cited as "unpublished" [4]. Papers that have been accepted for publication should be cited as "in press" [5]. In a paper title, capitalize the first word and all other words except for conjunctions, prepositions less than seven letters, and prepositional phrases. To begin the process, it was necessary to weigh 0.04 g of dehydrated and sieved at 150 microns, pink pine nut in a 12 ml vial with screw cap and Teflon septum. Subsequently, 1 ml of internal solution (Tridecanoic) of 5,000 mg / L was added. In addition to 2 ml of toluene. Finally, 2 ml of a 7% in methanol sulfuric acid solution was added. The vial was placed in an 80c a water bath for one hour. The vial was allowed to cool and then approximately 4 ml of hexane was added and stirred for 1 minute. Image 1 shows the sample preparation [10]. (see Fig. 1)

Figure 1. Sample preparation.

During the separation phase, the vial remained at rest. The upper phase or hexane was poured into a 10 ml volumetric flask. This flask was diluted with hexane and transferred to the 12 ml vial for preservation and for further analysis. For the analysis of the extract it was necessary to use a gas chromatograph with FID detector and BPX-70 column (30 m, 0.25 mm ID, 0.25 m film). With the information contained in the GC, the necessary calculations for the fatty acid profile were performed. Consult the AOAC method 996.06 [11].

C. Fatty Acid Test

To continue with the analysis of our sample it was necessary to perform the fatty acid profile to determine the components of the pink pine nut, in this case we used the Soxhlet method. The extraction of fatty acid profiles in the pink pinion by means of the Soxhlet method was carried out in parallel with the gas chromatography for the analysis of the fatty acid content in the pink pinion. It is necessary for the pink pine nut sample to be previously subjected to a dehydration and sieving process to eliminate biases in the results of the fatty acid profile. The Soxhlet method works with hexane: acetone (85:15). The pink pine nut sifted at 150 microns was placed in the porous filter located in the Soxhlet extractor chamber. The extract (hexane: acetone) that is inside the flask was heated, and then began with the condensation of the vapors that go down the filter that contains the pink pinion sample, extracting the soluble analytics.

When the level of extract condenses in the chamber and reaches the upper part of the lateral siphon, the extractor, with the analytical dissolved, ascends through the siphon and returns to the boiling flask. This process should be repeated until analytical extraction of the pine nut sample is completed and concentrated in the extract. 200 ml of solvent hexane: acetone (85:15) were used for this process to extract the fatty material from the pink pine nut. The pink pinion sample was placed in a cartridge made with filter paper and placed in the flask. Table III shows the weight of the sample and the flask being analyzed.

TABLE III. SAMPLE WEIGHT AND FLASK WEIGHT

Sample	Weight of the sample (g)	Weight of the flask (g)
1	30	112.20

The time for the method of fatty acid determination in the Soxhlet equipment was 9 hours. When the extraction was finished, the sample was concentrated by a rotary evaporator at a temperature of 50 ℃. Once the solvent was removed from the oil, the flask was weighed with the oil content. Table IV shows the percentage of fatty material in the pink pine nut.

TABLE IV. PERCENTAGE OF THE FATTY MATERIAL OF THE PINK PINE NUT SAMPLE

Sample	Flask weight without oil (g)	Flask weight with oil (g)	Oil weight (g)	Fatty material percentage % (p/p)
1	112.20	129.32	17.12	57.33

Table V shows the concentration of the compounds found during the development of the fatty acid process.

TABLE V. CONCENTRATION OF THE METABOLITES IN & P/P, IN THE FATTY MATERIAL BASE FOR THE SAMPLE. FATTY ACID AND SECONDARY METABOLITE PROFILE, % P/P.

Palmitic	Esteric	Oleic	Linoleic	Linolelaidic	Alfa Linolenic	Resveratrol	Esterol
4.02	1.9	5.3	40.43	0.1	0.1	0.1	0.1

Similarly, Table VI shows the concentration of secondary fatty acids.

TABLE VI. CONCENTRATION OF FATTY ACIDS AND SECONDARY METABOLITES, MG/G OF THE DEHYDRATED AND SIFTED TO 150 MICRONS SAMPLE.

Palmitic	Esteric	Oleic	Linoleic	Linolelaidic	Alfa Linolenic	Resveratrol	Esterol
16.4	9.3	25.3	160.33	0.5	0.5	0.5	0.5

III. TECHNICAL FEASIBILITY

The technical feasibility is an evaluation that was made to show that the product is innovative. Several important aspects were realized, among which the main ones stand out:

- Process mapping
- Possible production scenarios

In the process mapping all those main activities, as well as actors, were taken into account, considering that the process starts from the collection of the pinion to the finished product. For the process mapping (Fig. 2.), all the activities that need to be done to collect the pinion were taken into account.

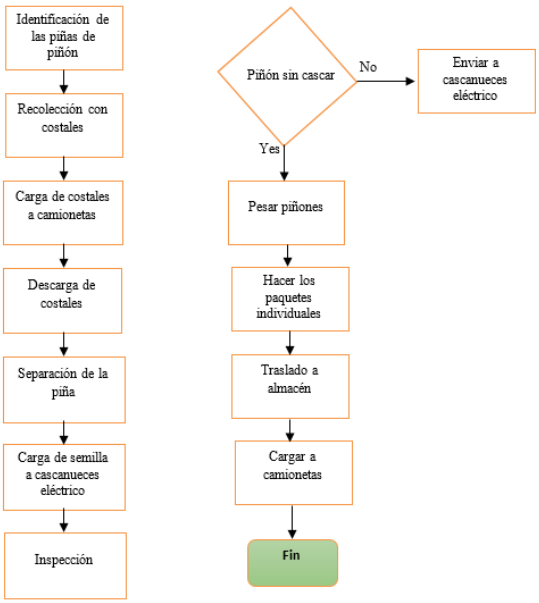

Figure 2. Process mapping

The first thing that is done is pinion pineapple identification. Once identified, these are collected and then loaded into the vans that will be collected. Once in the collection center, the seeds are charged to the electric

nutcracker to subsequently do the washing, drying and sieving process at 150 microns. Finally, different products are presented with sieving. For the possible production scenarios, several machines that could be used, both automatic and manual were considered and it was finally decided that a semi-manual shaker machine will be used. The equipment that was selected to have in our collection center is the electric nutcracker since it is the equipment that meets the requirements we need for the project and in addition to this, it has the lowest cost. It is enough for the production that we are going to have annually and above all it does not need import, which can lower the price up to 8 times less. Its installation is simple as well as its use.

Once the final layout design was done, we proceeded to find the optimal location for the collection center. The two main options were in the southern part of Aramberri state. Galena was also taken into consideration, however, this option ended up being discarded. It was determined that the ideal location would be Arramberri, Nuevo León.

IV. Market Feasibility

There is a clear market feasibility thanks to the conditions that are presented for the pink pine nut in Mexico. The volumes that competitors handle are relatively low compared to the amount of pink pinion that these areas can generate. This means that much of the raw material is not collected at this time and that gives the project space for growth. At the moment there are few pine nut suppliers, especially in northern Mexico. The price of the pinion is also a factor that will benefit this project since there will be a considerable supply of pink pinion thanks to the strategies and support that the government of the State of Nuevo León offers for the collectors. Different presentations of the pink pinion were developed to obtain greater utility of the product. From a technical perspective, a longer period of expiration of the various products that were made thanks to the dehydration processes we have carried out is confirmed.

V. Product Variations

Fig. 3 shows two of the variations of products that can be sold to final consumers. The product on the left is goat cheese with natural pink pine nut accompanied by crackers. The product on the right is pesto with pink pine nut also accompanied by crackers.

Figure 3. Different presentations of pink pinion products

In Fig. 4 four different products can be seen. Among these are the roasted pink pine nut, pink pine nut with and blueberry, praline pine nut and pine nut cream.

Figure 4. Products derived from pink pine nut

VI. Economic Feasibility

The most important thing in the economic feasibility study is to verify that the project is profitable. To determine this return, the initial investment values and the cash flows were obtained each year to obtain an Internal Rate of Return (IRR) of 20% with a Trema of 10% and a positive Net Present Value (NPV).

In the specific case of the warehouse center for the collection of the pink pine nut, an initial investment of 1,394,200 mexican pesos was considered (Fig. 5), composed of an investment in assets of 1,108,700 mexican pesos and 235,500 mexican pesos of expenses and unforeseen expenses.

Table VII shows the costs. These costs were classified into two categories: investment costs and production costs. It is important to note that production costs are shown in monthly amounts.

Figure 5. Total planned investment of the project

TABLE VII. Project Cost

Investment costs (concept)	Quantity ($)
Establishment Construction	837, 000.00
Furniture	8, 000.00
Machinery	65, 000.00
Computer equipment	13, 500.00
Vehicles	180, 000.00
Software	3, 200.00
materials	3, 800.00
Legal advice	8,000.00
Contingency reserve fund	220, 700.00
Cost of Production by month	
Maintenance	$2,000.00
Clean	$250.00
Phone	1,588.00
Office material	500.00
Human resources	25, 564.00
Services	17, 000.00

In summary, considering all this information the Internal Rate of Return (IRR) was calculated, taking into account the initial Investment, the flows from year 1 to 5 were calculated (Table VIII).

TABLE VIII. CASH FLOW STATEMENTS

Initial investment ($)	Cash flow statement				
	Flow year 1 ($)	Flow year 2 ($)	Flow year 3 ($)	Flow year 4 ($)	Flow year 5 ($)
1,394,200	677,640	405,413	433,883	464,082	496,109

To finally obtain an IRR of 24% with a Minimum Acceptable Performance Rate (TREMA).

VII. FINANCIAL FEASIBILITY

Regarding the financing study, it was observed that there are many opportunities to obtain both internal and external funds. The different funds were analyzed, and the Institutional Fund for Regional Development for Scientific, Technological and Innovation Development (FORDECYT) by CONACYT (National Council of Science and Technology) was selected, since the requirements and are accomplished and the amount is within the limits.

VIII. FEASIBILITY RESULTS

This project shows a fairly reliable viability and with a lot of potential due to the circumstances that presently occur. There is enough space to enter and grow in the market. Feasibility studies mark that this is a good project and that there is not much competition at the moment. In addition, a small investment is needed and the profit per sale is large compared to other products in the gourmet sector. Also, it is shown that the initial investment will be recovered in a short time and profits will be obtained, boosting the economic development of the municipality of Aramberri. When all the information and analysis of the studies prepared is collected, it can be concluded that there is a good opportunity for investors in this sector and that it promises many gains in the short and long term.

The pink pine nut collection and marketing project shows that it has a good future if the initial investment required to start the project is obtained. With the support of several collaborators, exhaustive studies have been carried out on different aspects to analyze in order to determine if there is space and growing market in the gourmet sector of pink pine nuts in Mexico and abroad. Currently, there is not a strong presence of suppliers of this product and there is much area of opportunity for growth and pioneering. The pink pine nut is the most expensive seed in the world and is widely used for gourmet cooking. There is little competition and most are in southern Mexico apart from the fact that suppliers handle low volumes of this product. It does not take much work force or a considerable investment since the product preparation process is simple and fast. This helps to accelerate the time in which the investment is recovered, in this way the invitation for investors is much more tempting.

IX. CONCLUSIONS

This project is an opportunity to improve economic development for Aramberri, Nuevo León, Mexico in the sense of involving people and investing in sectors with new market and growth hope. With the help of investors, partners and collaborators, this project will support these areas economically and socially. On the other hand, it involves many actors so that these areas become present on the map and there are more projects to be able to include the community and support it both in its economic and social development. An analysis of new products that can be made with this seed such as jams, creams, cheeses, roasted pink pine nuts, pink pine nuts, praline pink pine nuts and pine nut pesto was made. These products have a high nutritional index and to validate this claim it was necessary to carry out the dehydration process, sieving and subsequently the fatty acid profile, which allowed us to observe that the pink pine nut has a high amount of omegas, in addition this product is low cost since it is a wasted and discarded seed most of the time. It is important to mention that this project was probed by the Government of the State of Nuevo León specifically by the Secretary of Regional Development of the Government of the State of Nuevo León.

CONFLICT OF INTEREST

We declare that we don't have conflict of interest.

AUTHOR CONTRIBUTIONS

The contribution of Maria in this project was the analysis of the nutritional information and validation of this information.

The contribution of Nancy in this project was support with the laboratory methods for preparation of the samples and laboratories procedures.

The contribution of Andras was with the technical feasibility

The contribution of Daniel was the market feasibility

The contribution of Fatima was with the design of the product and economic study.

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