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Obtaining Yacon Flour (*Smallanthus sonchifolius*)

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Abstract

The aim of the research is to design a process for obtaining flour from Yacón (Smallanthus Sonchifolius), without affecting the organoleptic and nutritional characteristics of the same, for which, the physical and chemical analysis of the product was carried out. the raw material, determining that the main problem is the high moisture content, since it reaches a value of 87,22%; to reduce it, we proceeded to slice into sheets of 3 mm thick to have a larger surface area and proceed with drying, after which the process variables were determined at 65 ° C drying and 67% relative humidity, generating they control temperature tables, curves of drying speed and humidity loss curves, after which, the calculation was made to determine the drying time of 4,8 hours, thus guaranteeing a final humidity of 7, 5%, with which, we proceed to the reduction of size and finally obtain their flour, which is analyzed at the laboratory level whose parameters are within the norm for human consumption.

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Keywords

Engineering and chemical technology, Process design, Unit operations, Yacon, Physical-chemical and microbiological analysis

Introduction

In recent years the food consumption of the population requires consuming products that have a low caloric content, which manages to counteract the sedentary life and stress caused by a demanding lifestyle (YAN, y otros, 1999). In Ecuador, as in the rest of the South American continent, dietary habits have been changing and this has denoted a modification of the production and marketing systems, this has encouraged a diversification in the supply of products. This is where Yacon presents an opportunity to develop a new line of products with high nutritional value, given that the majority of flour obtained industrially is from cereals.

The Yacon (Smallanthus Sonchifolius) is a root grown in the temperate zones of the Andean region, characterized by its somewhat crispy texture and its sweet taste, the plant can reach from 1, 5 to 2 m in height. Its root is well known in Asian countries, due to its ability to produce a commercial harvest at any time of the year. The roots have a humidity of 90% and according to the compilations made on this plant the amount of sugars represent up to 67% of the total dry weight, however these data may vary depending on the region where it was grown (GRAU, y otros, 1997).

The present investigation has the objective of the design of a process of obtaining of Yacon flour since it is a raw material of easy culture and with nutritional characteristics very good for the human health. This poses a viable alternative because it is a novel product, providing the population with a source of income. The Yacon flour is subjected to a process of removal of the skin by means of abrasive brushes to later reduce it into slices of 3 mm in thickness, since this guarantees a reduction in the drying time (BRITO, 2001) to which Yacon is submitted.

The importance of this research lies in the contribution of scientific and technical information on how to design a process that makes effective use of Yacon, which, in the long term, would generate an interest in its industrial exploitation and thereby impacting the development of dedicated people to its cultivation. That is why laboratory experiments were carried out that helped to obtain reliable data that seek to solve the possible problems involved in the design of a process adapted to this raw material.

Materials and Methods

The Yacon was washed, then the cut was made in sheets of 3 mm thickness (100 g of fresh raw material is taken for its respective analysis), and it was placed in the 5 trays of the dryer, it was determined every 15 minutes the weight of the raw material until it remains constant, after which the grinding and sieving process was carried out, samples of Yacon flour were taken according to what is described in the NTE INEN 0617 standard: 81 Flours of Vegetable Origin , guaranteeing the quality of the same, for which, three samples of 100 g of experimentally obtained Yacon flour were collected, vacuum packed and stored in clean and dry containers, fully sealed and properly labeled in such a way that the number is appreciated of identification and the date of sampling, these samples are subsequently transported to the laboratory for the corresponding physical-chemical and microbiological analysis.

The physical and chemical characterization was carried out on the raw material and flour obtained from the following parameters: Ash, Protein, Moisture, Fat, Total dietary fiber and total Carbohydrates, and microbiological to the product obtained from: Mesophilic Aerobics, Total Coliforms, E. Coli, Salmonella, Molds and Yeasts.

Results and Discussions

In order to design the process of obtaining Yacon flour, characterization analyzes of the raw material were carried out, since it will serve to establish the design variables to be controlled.

A drawback evident in the laboratory analysis is the large amount of moisture that fresh Yacon has, this directly influences the conditions to which the drying process must be carried out. A measure to be taken to avoid spreading in the drying process consists of slicing the Yacon into 3mm thick sheets in order to increase the drying area (Fig. 1).

Stage Drying

In each drying experimentation process, 1000 grams of unprocessed raw material were used, divided into 5 trays in the dryer used.

The experimental data showed that the moisture loss of Yacon stabilizes after having elapsed between 4, 5 and 5 hours. With which, it could be intuited that equilibrium moisture had been reached and to avoid damage to the organoleptic characteristics of Yacon. In addition, if the drying process is extended there is a risk that the external moisture will be absorbed from the product again, leading to a higher thermal energy expenditure.

Flour obtained

The fresh Yacon presented certain differences in terms of fiber and carbohydrates, this is mainly due to aspects of the land where it was grown, as well as the genetic variability in each geographical area of the plant. This ended up affecting the final characteristics of the flour, however, this does not influence the organoleptic quality of the flour.

An important aspect that must be controlled is the final microbial load presented by Yacon flour. Only aseptic conditions guarantee that the presence of microorganisms does not exist, in this case the experiments carried out were developed under rigorous aseptic conditions avoiding possible problems of microbiological contamination.

Humidity is a critical variable to control, which is why the design should be aimed at meeting the maximum moisture requirements allowed by the reference standards, in the graph (1–4) it is evident that the proposed process design satisfactorily meets the required requirements. Through the experimental data of drying, obtained in the experimental laboratory tests, it was calculated that the proposed process will be able to process 200 kilograms of Yacon every hour to reach a production of 19, 11 kilograms of Yacon flour per hour (Table 1–4).

Table.1 Caracterización físico química del yacón fresco

No.	PARAMETERS	UNITS	RESULTS	METHODS
1	Ashes	%	0,71	INEN 401
2	Protein	%	0,35	INEN 1670
3	Humidity	%	87,21	INEN 1235
4	Grease	%	0,65	INEN 523
5	Total dietary fiber	%	0,47	INEN 522
6	Total carbohydrates	%	9,80	INEN 398

Source: Vacacela P., 2018.

Table.2 Comparison of physical chemical requirements for Yacon flour

No.	PARAMETERS	UNITS	DRY BASE WEIGHT (BIBLIOGRAPHY)	DRY BASE WEIGHT (EXPERIMENTAL)
1	Ashes	%	1,1 – 6,7	4,34
2	Protein	%	1,3 – 7,3	2,55
3	Humidity	%	-	7,5
4	Grease	%	1,0 – 5,7	0,989
5	Fiber	%	0,3 – 1,7	11,1
6	Carbohydrates	%	67	73,5

Source: Vacacela P., 2018

Table.3 Microbiological analysis of Yacon flour

No.	PARAMETERS	UNITS	NTE INEN 616	EXPERIMENTAL
1	Aerobic mesophilic	UFC/g	100000	$1,0x10^3$
2	Total coliforms	UFC/g	100	<10
3	E. Coli	UFC/g	0	<10
4	Salmonella	UFC/25g	0	Not detected
5	Mohos	UFC/g	500	80 (e)
6	Leaven	UFC/g	500	50 (e)

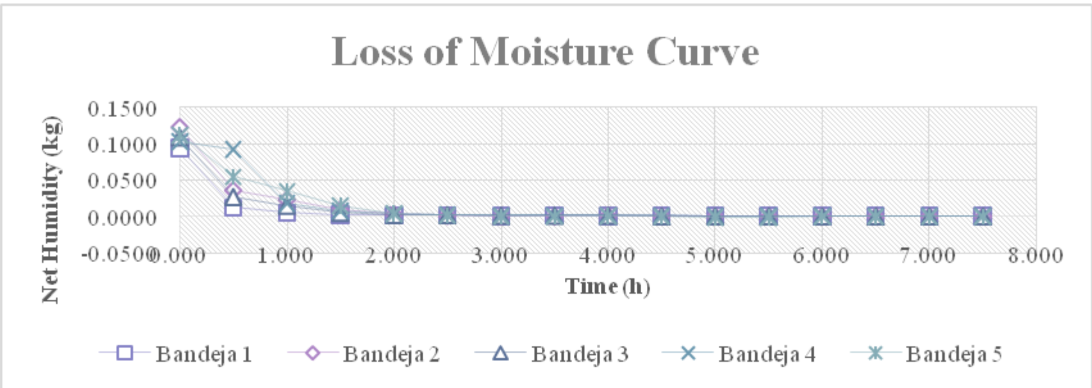
Source: Vacacela P., 2018

Table.4 Proposed design data

No.	VARIABLE	UNITS	AMOUNT
1	Mass flow of process input	Kg/h	200
2	Mass flow of air input to the process	Kg/h	11090,9979
3	Drying temperature	°C	65
4	Heat to be supplied(air)	kJ/h	3854427,07
5	Drying time	h	4,7722
6	Thermal efficiency	%	60

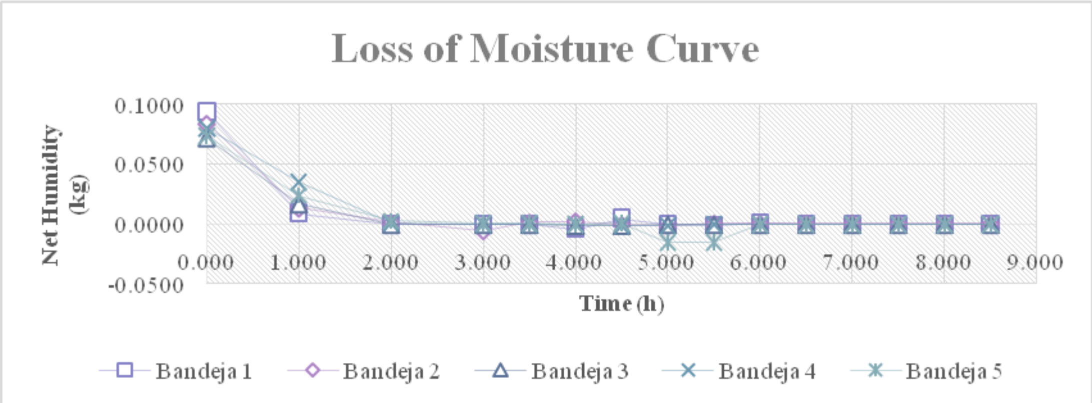
Source: Vacacela P., 2018

Graphic.1 Moisture loss curve for sample 1



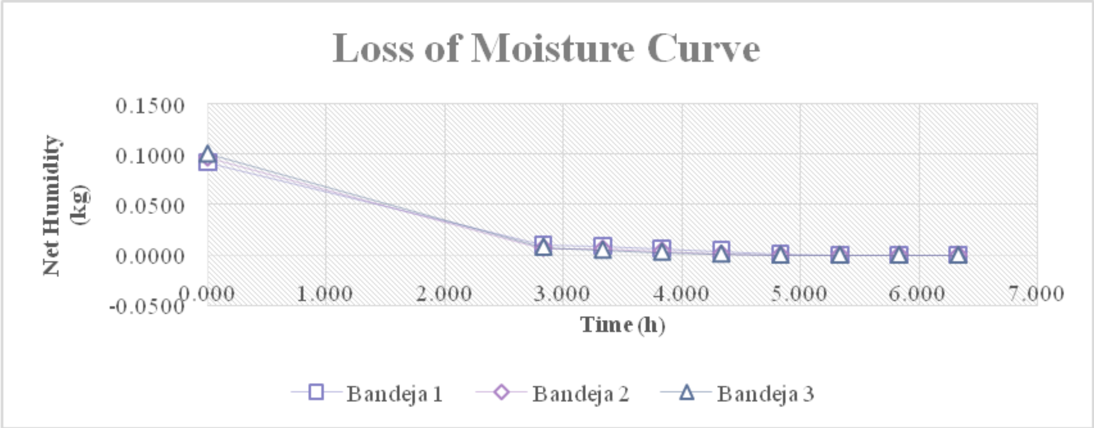
Source: Vacacela P., 2018

Graphic.1 Moisture loss curve for the sample 2



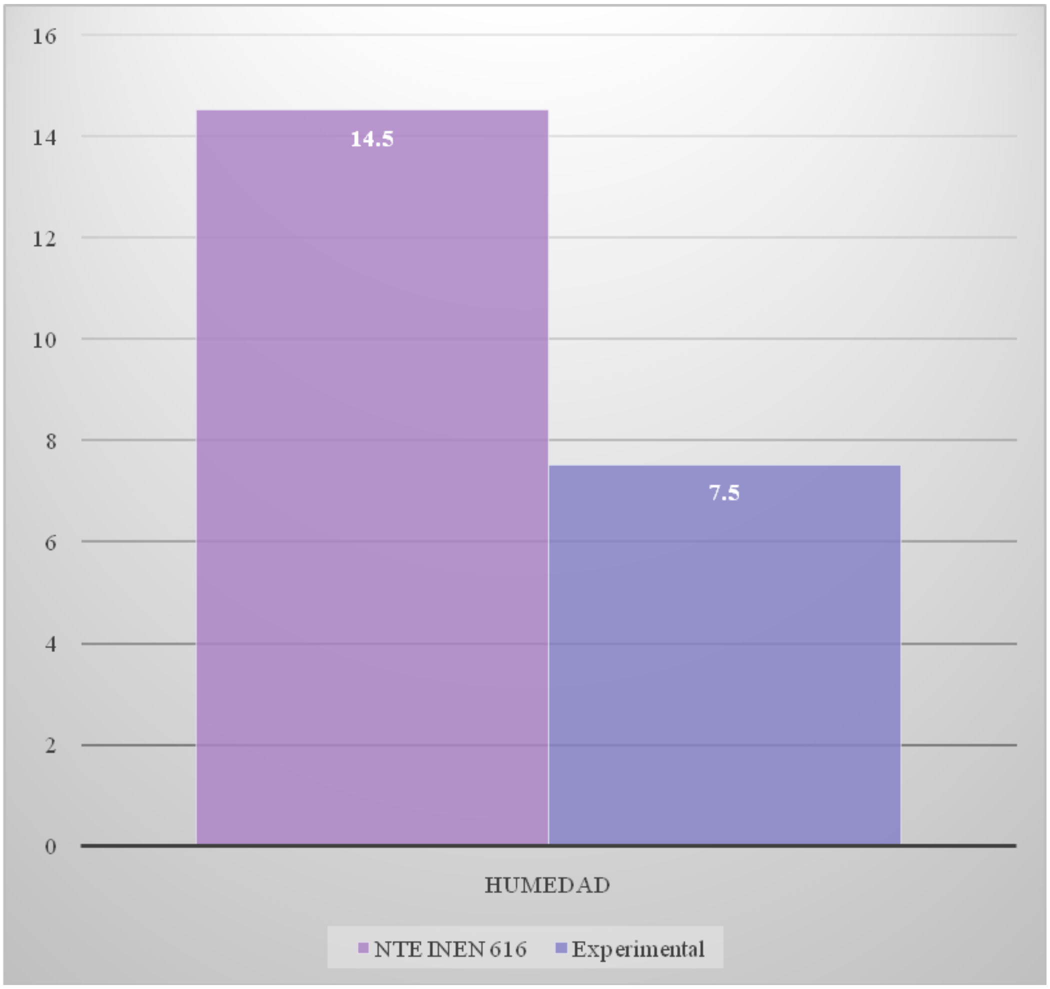
Source: Vacacela P., 2018

Graphic.3 Moisture loss curve for the sample 3



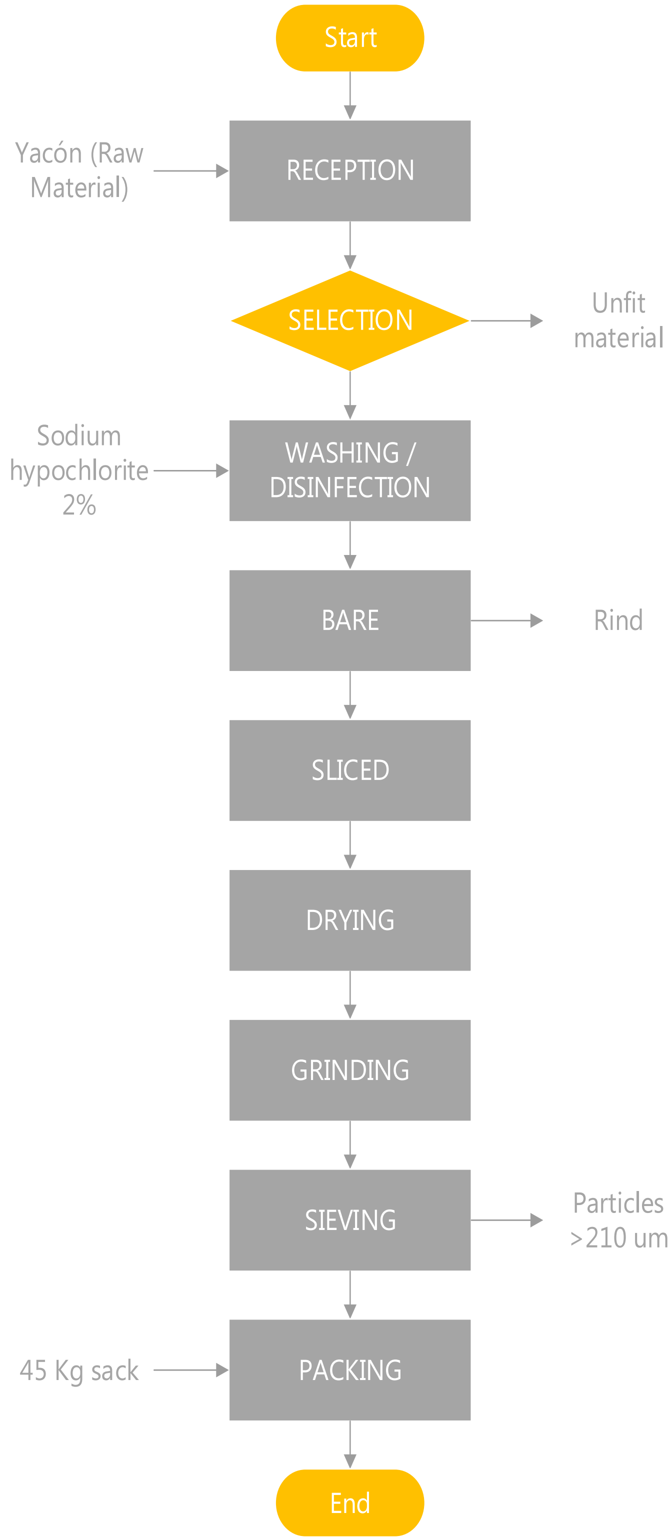
Source: Vacacela P., 2018

Graphic.2 Comparison of humidity requirements



SOURCE: Norm NTE INEN 0616:2016 Wheat flour. Requirements Ecuadorian Standardization Service, VACACELA P., 2018

Figure.1 Yacon flour production process diagram



Source: Vacacela P., 2018

The main reason for obtaining a small mass flow is due to the large amount of moisture contained in the raw material. In addition, it should be considered that the availability of raw material is currently low, since the Yacon is an Andean crop not very exploited in the region of the central sierra; it is therefore expected, in view of the increase in demand for this raw material, that farmers in the region invest more in the cultivation of Yacon.

In order to make the drying process as efficient as possible, it is required to supply an air flow of 11091 kilograms per hour at an average temperature of 65 ° C, this in order to avoid physical damage due to excess temperature which has repercussions Directly in nutritional aspects to the Yacón. A drawback that can occur in the drying stage is the increase in the relative humidity of the environment, thus limiting the amount of humidity that can be eliminated in each hour, which would extend the processing time a little.

The heat flux necessary to raise the ambient air temperature is 3854427,07 kJ / h, of which it is estimated that 7702,8 kJ / h will be used to heat the dry base of the raw material to 65 ° C. As can be seen, the main problem is the high moisture content of the Yacon, requiring an amount of energy to eliminate all the water contained. Even so, it is expected to reach a thermal efficiency of 60%.

Conclusions of the study are as follows:

The proposed design managed to obtain Yacon flour with a humidity of 10% in 4, 8 hours.
The physical-chemical analysis shows that the Yacon has a humidity of 87,2%
The engineering calculations estimate a mass flow of 19,1 kg/h of Yacon flour produced
The physical and chemical analyzes of the flour samples obtained in the laboratory show that the final moisture of the flour was 7,5%

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