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Monitoring Temperatures in a Solar Dehydrator

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Abstract: ***This project presents the implementation of an in real time automatic temperature monitoring system in a solar dehydrator, this for educational purposes and collaborative research in the area of Industrial Maintenance. The infrastructure for monitoring and storing data is developed through an Arduino network. This article presents the main considerations of the development of this project, such as: temperature storage, verification procedures, the automatic system programming procedure in the Arduino microcontroller, and the installation of the monitoring prototype, consisting of type J temperature sensors and an Arduino microcontroller. The process consists in the monitoring of temperature in the dehydration of apples. The final application shows that an adequate temperature monitoring is a crucial factor in order to achieve well dehydrated product. As well, the evaluation of the temperatures can assure a suitable thermodynamic control to optimize resources with a significant contribution to the innovation and development of automatic systems.***

Keywords: automatic, automatically, dehydration, monitoring, maintenance

1. Introduction

Dehydration is one of the oldest ways to process food pursuing to conserve an organic product, because its water content, allows germs to reproduce easily which causes the fruit to rot within a short time, therefore, the technical and economic feasibility of the use of the solar dehydrator is evaluated, depending on the selection of technology and the necessity to cover demand to the process of dehydration of the fruit (in this case: apples).

Temperature monitoring is the systematic process of collecting, analyzing and using temperature data through an automatic system based on Arduino that will allow us to visualize the internal environment of a solar dehydrator. The study of the temperature variation favors the dehydration process, providing advantages, such as the best use of resources and optimizing temperatures for a better productivity.

This automatic temperature monitoring system consists of an Arduino Mega 2560 microcontroller hardware and an open source language software “Arduino Language".

It consists of electronic prototypes that facilitate the collection and analysis of temperature data and enable to visualize the internal behavior of the solar dehydrator.

The main issue is to solve inefficiencies regarding time and heat exposure of the treated fruit, which, because of calcination will therefor represent a loss of product caused by a prolonged exposure and other factors which can now be easily controlled.

2. Theoretic Framework

Osmotic dehydration (DO) is a conservation technique widely used as pretreatment in other conservation processes. The application of vacuum in the DO increases the elimination of water and therefor the effectiveness index (I.E). The objective of this project was to evaluate different pressures (Atmospheric and two vacuum levels) on the kinetics of DO and I.E in banana slices. The OD was made with 55 ° Brix sucrose solutions. The application of vacuum pressures in the DO of the banana slices favored the loss of water (ΔM_a), the gain of solids (ΔM_s), the reduction of weight (ΔM_p) and the I.E. [1]

The berry is a highly perishable fruit due to its high water content. The objective of this investigation was to increase the useful life of the blackberry by a combined method of *osmodehydration - dehydration* by means of hot air. The ripe fruit was cut in halves in order to be subjected at a first stage to osmodehydration using honey syrup in three concentrations: 60, 65 and 70 ° Brix, for a period of 12 hours. The criteria for determining the best treatment were moisture loss and sensory analysis. In the second stage, the berries from the best osmodehydration treatment were subjected to dehydration by hot air at two temperatures: 50 and 60 ° C for 8 hours. The best treatment was selected based on color (L *, a *, b *) and sensory analysis. In the first stage the best treatment turned out to be the osmodehydrated fruit in honey syrup at 65 ° Brix. In the second, the best was drying at 60 ° C. [2]

Sliced *royal gala* apples were use. 5mm thick wedges were dehydrated at 65 ± 5 ° C for a time of 4 hours. The color was measured by means of Hunter's tristimulus colorimeter with an illuminant of D ° 65. The wedges were treated with 1% citric acid, which showed the greatest luminosity in L*. *Key words: apple, color, dehydration, antioxidant, coordinates L * a * b *. [3]*

The data acquisition system for the solar food dehydrator at the Technological University of Ciudad Juarez was a non-experimental, qualitative, descriptive, applied, with an informative styled methodology. The main result was designing of the data acquisition, proposing a device to which the sensors will be connected to, and this, connected to a computer. In the simulation, the data of the four main factors that affect the operation were obtained from the solar dehydrator. *It should be dully noted that due to the characteristic wind factor of the city; the sensors may be periodically damaged causing the need to replace them. [4]*

3. Methodology

The monitoring carried out for the solar dehydrator will be fundamental to determine the optimization of the internal temperature. The dehydrator has the following dimensions; 2 meters of base by 1 meter wide, having a height of 62 cm in its lowest part and with 1 meter in its upper part, resulting in a slope of 79 °, *as shown in figure 1*. Internally it consists of 1 tray of mosquito netting where the wedges are placed at a height of 12 cm with respect to the base of the dehydrator; the material of the bed is polyurethane in order to maintain the temperature inside the solar dehydrator. In addition, on its upper part has a glass of 2 meters long by 1 m wide by 4 mm thick.

Figure 1: Solar Dehydrator

The development of this project is divided into the following stages:

a) Installation of the components in the solar dehydrator

The materials needed for monitoring the internal temperature of the solar dehydrator are; 3 type "J", thermocouples which measure a temperature range between 0 ° to 750 ° C. with an *Analog to Digital* MAX7566 signal converter. Electronic circuit with four relays, the function of the first three is to have the thermocouples connected, and which will only be activated one by one to send the signal to the Max7566 converter, and this converter sends the signal to the *Arduino*. The fourth relay is responsible for the activation of a fan which will have the function of keeping the internal temperature homogeneous. The matrix keyboard allows access to the menu programmed in the *Arduino* which will give different options, among them, the option of saving the temperature data for its later behavior analysis, according to what is shown in the programming logic, this menu is shown in an *LCD* or also called a *display*. The Arduino will have the necessary programming for the proper functioning of: control, display and save readings of the temperatures of the dehydrator, *as shown in Figure 2.*

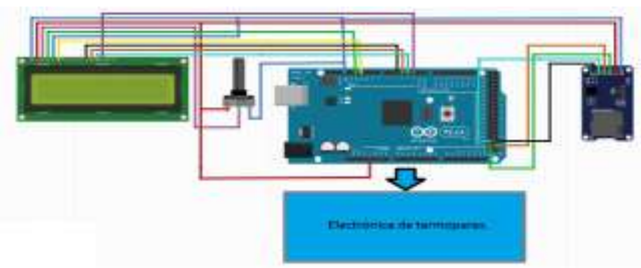

Figure 2: Solar dehydrator controller electronic diagram

b) Monitoring

The Arduino, together with the LCD and a flash memory, allow us to overview and store temperature information, *as shown in figure 3*, in order to analyze and determine if the temperature is adequate, if it is not, the *temperature variable* can be modified in order to improve it according to what is required for the dehydration of the wedges. The temperature is measured using thermocouples to make sure the readings are real, other temperature measuring instruments are used, which enable the user to compare and be sure that the temperature given by the thermocouples are as close to adequate as possible, that is to say, to reduce as minimum as possible the probability of a failure of readings.

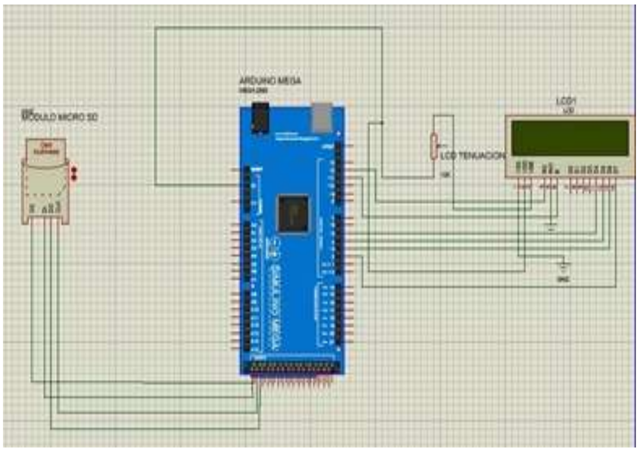

Figure 3: LCD and flash memory in the monitoring system

c) Variable sample

As can be seen in Table 1, these readings are stored in a micro SD memory to graph and analyze the behavior of the internal temperature of the dehydrator.

Temperatura Termopar 1	Temperatura Termopar 2	Temperatura Termopar 3	Tiempo
11	8	12	3:35:00
12	10	12	3:35:05
14	9	13	3:35:10
11	9	12	3:35:15
15	10	12	3:35:20
12	9	13	3:35:25
13	10	13	3:35:30
11	10	13	3:35:35
11	10	12	3:35:40
12	10	13	3:35:45
12	10	13	3:35:50
13	10	13	3:35:55
13	11	14	3:36:00
13	10	14	3:36:05

Chart 1: Thermocouple readings

Figures 5 and 6 show the data of each zone that measure the thermocouples for one hour without the control of the fans, this to know how the dehydrator is located before the internal air flow, which will maintain an homogeneous temperature as much as possible.

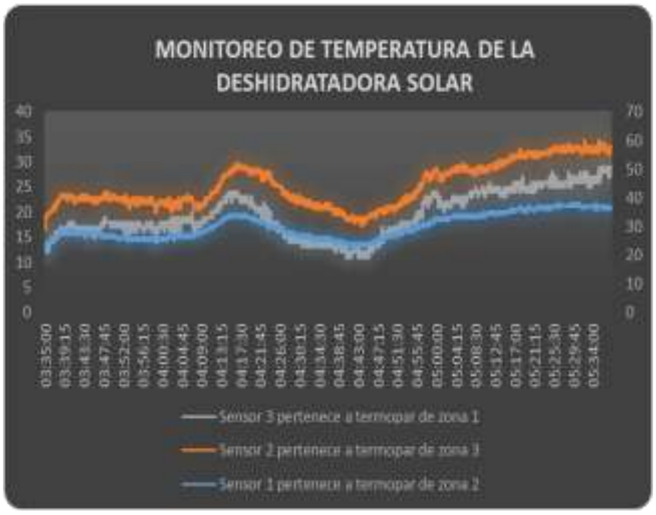

Figure 5: Dehydrator's temperature behavior

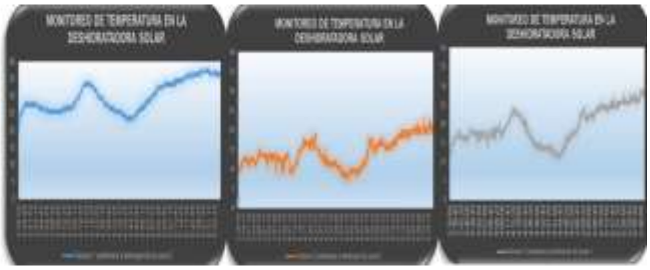

Figure 6: Individual thermocouple behaviors

4. Conclusions

According to the temperature reading and by taking 20 samples per minute for each *J type* thermocouple, it allows enables to visualize the behavior of the internal temperature of the dehydrator, this controlled temperature generates an efficient dehydrated product of high quality, and in this way, the user may determine the possible operation sequences for the temperature control in very hot days, when activating in automatic drive allowing to maintain a constant temperature.

References

[1] Ormaza Z. A. M.1 & Ayala A. A. A.2 & Vargas S. L. C.3 (2014) Deshidratación Osmótica de Banano Bocadillo (Musa acuminata Colla). II Congreso Internacional de Investigación e Innovación en Ingeniería, Ciencia y Tecnología de Alimentos – IICTA.

[2] Galvis V. J. A.1 & Guzmán R. M.2 & Zambrano A. L. Y.3 (2014) Conservación de la Mora (Rubus glaucos Benth) por los Métodos Combinados de Osmodeshidratación – Deshidratación por Aire Caliente. II Congreso Internacional de Investigación e Innovación en Ingeniería, Ciencia y Tecnología de Alimentos – IICTA.

[3] Valencia F.1 & Rodríguez P.2 & Soledad H. M. 3 (2014) Evaluación del Color Durante la Deshidratación de Manzana Royal (Malus domestica). II Congreso Internacional de Investigación e Innovación en Ingeniería, Ciencia y Tecnología de Alimentos – IICTA.

[4] Muñoz E. I† & Castañeda L. P. & Alvarado B. G. (2016). Sistema de adquisición de datos para un deshidratador de alimentos solar. Revista de Aplicaciones de la Ingeniería.

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