ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 3, March 2016

Solar Powered Automatic Fruit Drying System

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ABSTRACT:- Solar Powered Automatic Fruit Drying System is a small scale fruit drying machine which is useful to dry different types of fruit. To make their usage efficient, they can be dried and preserved so that fruits can be used over a long period. Preserving fruits by drying is an important operation continued from prehistoric period. Infrared radiation can be used for grape drying purpose. It is unique process and distinctly different from conventional or natural drying. The natural drying process has many drawbacks, such as requiring more time, large investment on space requirement and infrastructure for drying process, which cannot be afforded by a middle class farmer. The financial up gradation of a farmer in developed countries is possible by providing him the modern, automatic and low-cost fruit drying unit. This paper describes a controlled environment which is suitable for small scale fruit drying process within a closed chamber, using Microcontroller (89s52). To start with, the infrared light is used to internally heat the fruit to remove the water content within the fruit. Then the air is blown inside the chamber to maintain the humidity below a specified level and exhaust the humid air out of the chamber. Microcontroller (89s52) is used to control the functions of heating, blowing the air and giving time indication & maintain constant throughout the chamber. After the completion of the drying process a buzzer is activated for the duration of ten seconds to indicate the end of the drying process. A text message is also sent to the farmer through GSM to intimate him if he is not around. The expectation by consuming less time compare to conventional drying process. Solar panel is used to supply power to microcontroller.

***Key Words*: Fruit drying, solar panel, microcontroller based, controller, LM 35, sensor, 8952**

I. INTRODUCTION

Food drying is a method of food preservation in which food is dried (dehydrated or desiccated). Drying inhibits the growth of bacteria, yeasts, and mold through the removal of water. Dehydration has been used widely for this purpose since ancient times; the earliest known practice is 12,000 B.C. by inhabitants of the modern Middle East and Asia regions [1]. Water is traditionally removed through evaporation (air drying, sun drying, smoking or wind drying), although today electric food dehydrators or freeze-drying can be used to speed the drying process and ensure more consistent results.

In India different types of fruits and vegetables are available in various regions of the country. All these agricultural products grows in different seasons and in a particular area only. These agricultural products are used by people all over India and abroad. It also requires the transportation of fruits from the food production areas to the fruit consumer areas. This needs a proper preservation of fruit during transportation, as the transportation period may be greater than the natural life of the fruit . To avoid fruit damage and long usage, fresh fruits are converted to dry fruits. Healthy and nutritious fruits can be given to people to enjoy dry fruits as snack. Dehydration is also used to lower the cost of packing, storing and as it reduces weight and volume of the final product. Dried food can be made from lower quality fruits and vegetables that might otherwise be wasted.

A microcontroller based system that enables to simultaneous monitoring was utilized. There is a LM35 sensor as the inputs of system which is temperature. The output of LM35 is continuously monitored with the main processor and given functions based on fruit types are executed. The selected fruits were put in a dryer. This will ensure drying even in the poor weather conditions because of an enclosed chamber. The accurate control over the drying process due to a closed loop, control system reduces the drying time. Higher temperatures and the penetration of infrared rays used in the compact drying chamber facilitate the confinement of heat energy. This paper describes a design idea to produce small scale low cost with good quality dry fruit product to the consumer which is perseveres with its original taste without leading to caramelization (Sugar Burning) and reduction in the nutritional value. The quality and color of the dried product depend upon the techniques used for drying process. Another parameter used in analyzing the drying process is drying rate which is referred to as time taken to dry the fruit. The drying rate affects the color and quality of the dried product.

II. BLOCK DIAGRAM

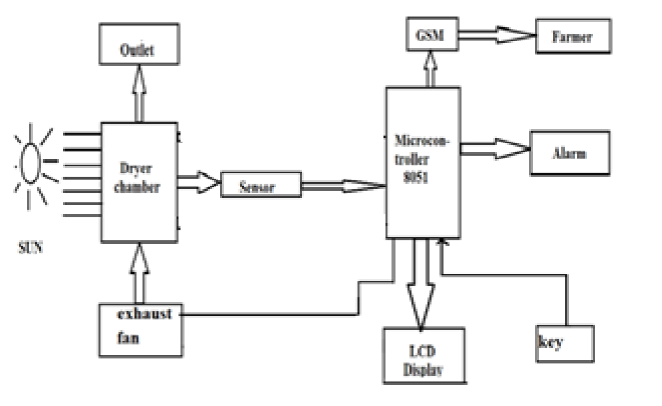

Fig 1:-Block diagram of fruit drying system

The block diagram of the entire system is shown in figure 1. In this system a LM 35 sensor is used. Sensor is

used to read the temperature in the unit. Sensor is connected to microcontroller through ADC. A controlled environment which is suitable for small scale fruit drying process within a closed chamber, using Microcontroller (89s52)[3]. This automation process when completed is informed to the farmer. Solar energy is utilized for dehydrating the fruits and vegetables. Over drying and under drying are harmful[3], for agricultural products. Over drying causes discoloration due to caramelization and reduction in nutritional value. On the other hand, under drying or slow drying results in deterioration of the food quality due to fungal and bacterial action. The solar panel is used to power the microcontroller.
The microcontroller is used and programmed to control and manage the overall process of the unit. Different fruits will have different temperatures to dry. The switch buttons are used to set required temperature. LM 35 Sensors is used to read the temperature in the cabinet connected to 89s52 Microcontroller through ADC. A display is use to see the process continuously for the temperature value and time to dry the particular fruit. If the monitoring temperature is greater than the set temperature value, turn on the fan else turn off. Once the process is completed it will generate the alarm and send SMS to the farmer as shown in fig.1.

A solar dryer chamber comprises of a wooden box with certain length & width covered with a glass as shown in fig 2. The inside surface is made black because a black surface absorbs 98% of the incident heat of the sunlight. So,to absorb the maximum heat, the surfaces of the solar chamber are painted black. Secondly, this unit are let in the open air. So, there are maximum possibilities that the heat may be lost in the atmosphere. So, our task of drying would not be accomplished if the heat is lost. Therefore, to prevent the loss of heat this unit is made with insulators. The automatic drying unit is shown in fig 2.

III. WORKING

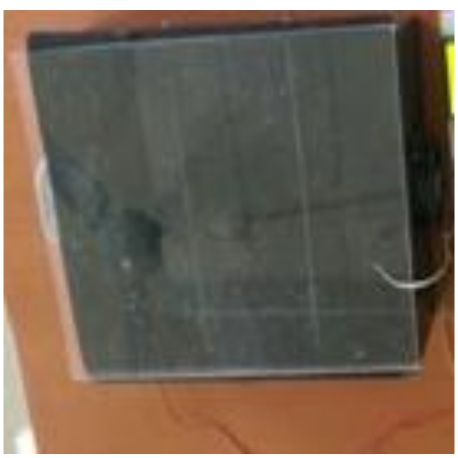

Fig 2:- Automatic drying unit

A part of incidence solar radiation on the glass cover is reflected back to atmosphere and remaining is transmitted inside the drying chamber. Further, a part of transmitted radiation is reflected back from the surface of the crop on the wire mesh. The remaining part is absorbed by the surface of the crop. Due to the absorption of solar radiation, crop temperature increases and the crop starts emitting long wavelength radiation which is not allowed to escape to atmosphere due to presence of glass cover unlike open sun drying. Thus the temperature above the crop inside drying chamber becomes higher. The glass cover serves one more purpose of reducing direct convective losses to the ambient which further becomes beneficial for rise in crop and drying chamber temperature respectively [4]. However, convective and evaporative losses occur inside drying chamber from heated crop. The moisture, that is the vapor formed due to evaporation, is taken away by the air entering into the drying chamber from one end and escaping through the hole provided at the top with the aid of the supplied dc fan as shown in Fig.2

IV. CIRCUIT CONSTRUCTION & WORKING

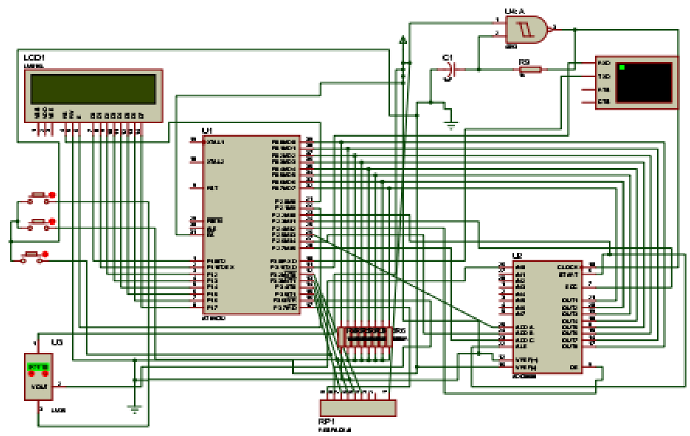

Fig 3:- circuit diagram

The circuit diagram is a shown in fig 3.The 5v power supply given to the monitoring and controlling unit with microcontroller (89C52) is obtained using the solar panel. The figure shows that by the VOUT of temperature sensor i.e. LM35 is connected to IN0 (pin 26) of ADC 0808. The output of ADC is given to port 0 (pin 32-39) of microcontroller. The microcontroller processes this input. The LCD is connected to port 1 & 2.

Once unit is turn on, reference temperature is set by using three switches which will be displayed on LCD. The temperature is continuously sensed by temperature sensor i.e. LM35. The LM35 sensor are mounted on a cabinet and interfaced with 89c52 microcontroller. This in turn helps to compare the reference chamber temperature and display on LCD connected to 89s52 microcontroller as shown in fig.3. Based on comparison of reference temperature value and sensor value the fan will be run to glow the air in the chamber to maintain uniformity and reduce the chamber temperature, by automatically turning on the fan through triggering the relay circuit which is connected to output pin of microcontroller. The hot air created in the chamber, passes over the trays where it comes into contact with the substance to be dried and carries away the moisture. The humid air, is thus expelled out from the chamber through a moisture exhaust. Once the process is completed, it generate the alarm by turning on buzzer circuit and send SMS to the farmer to indicate status of the drying process through GSM module which is interface with UART module of microcontroller as shown in fig.3. The moisture content of the fruit with respect to time of the natural drying process is compared with designed automatic drying unit. It was observed that automatic drying unit gives better performance in terms of drying rate compared to conventional method. The temperature to be maintained within the chamber depends on the initial contents of the fruits and the effect of temperature on the contents.

V. RESULTS

The dryer chamber is of a wooden box cotted with block color. Top surface is covered with glass of thickness 2cm .The fan is connected inside the chamber as shown in fig.2. Infrared radiation can be used for grape drying purpose [2]. Experiment was conducted for the fruits like grapes for a day and the results of moisture content and time were recorded. It was observed that automatic drying unit gives better performance in terms of drying rate compared to conventional method. The temperature to be maintained within the chamber depends on the initial contents of the fruits and the effect of temperature on the contents. The temperature and humidity are dependent on the user requirement. Humidity gradient to remove the water content in the fruit was varied by varying the fan speed. Drying times vary based on your location, humidity, temperature and size of item. The general rule is that the more surface area exposed; the faster the drying time. It is important to slice foods to the same thickness for a more consistent drying time. A common mistake in dehydrating is thinking if you increase the temperature, you decrease the drying time. If you increase the temperature too much, case hardening may occur.

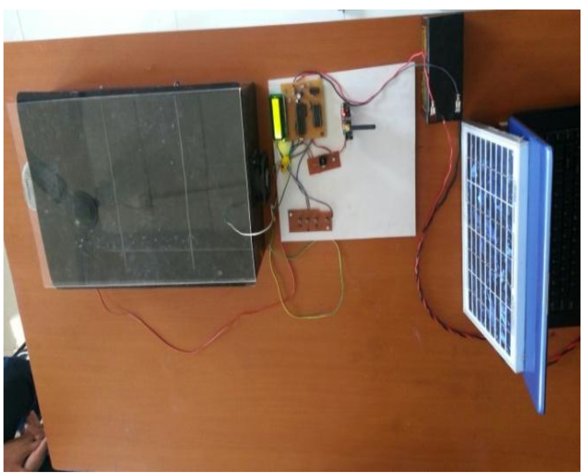

Fig4:- fruit drying system

VI. ADVANTAGES

1. It was observed that automatic drying unit gives better performance in terms of drying rate compared to conventional method. Using automatic drying unit it requires 3 to 4 days to dry grapes where as conventional method requires 7 to 8 days for the same.
2. Quality of dry fruit is better as compared to conventional method.
3. As solar panel is used for it does not cause pollution. Also the maintenance cost is less.
4. This unit can be used in remote area as solar energy is available everywhere.
5. Dust does not come in contact with the produce thereby ensuring good quality of the dried product.
6. The unit also sends SMS to the farmer to indicate status of the drying process through GSM module

VII. DISADVANTAGES

1. As this unit uses only one fan the temperature inside may go beyond the temperature required for drying the fruits.
2. Limited amount of fruits can be dried.

VIII. FUTURE SCOPE

The disadvantage of temperature going beyond required temperature can be removed by increasing the number of fans. The quality and color of the dried product depend upon the techniques used for drying process. Another parameter used in analyzing the drying process is drying rate which is referred to as time taken to dry the fruit. The drying rate affects the color and quality of the dried product. The system can be used in food factories. The size of the unit can be increased to dry more amounts of fruits.

IX. CONCLUSION

It was observed that automatic drying unit gives better performance in terms of drying rate compared to conventional method. Using automatic drying unit it requires 3 to 4 days to dry grapes where as conventional method requires 7 days for the same. Quality of dry fruit is better as compared to conventional method. As solar panel is used for it does not cause pollution. Also the maintenance cost is less. This unit can be used in remote area as solar energy is available everywhere. Dust does not come in contact with the fruits thereby ensuring good quality of the dried product.

The system requires lower space and minimal installation time, less time to dry the product (as compared to natural drying), is durable with minimal maintenance. Unit can be made available in varied capacities, depending on the effective tray area and user requirement. The system can be made more economical by making a provision for drying variety of fruits in a single unit[7]. This arrangement can be made possible by using sensor networks for various fruits. To make it economically viable for farmers, an application specific integrated circuit by embedding the digital circuit into a chip, can be produced in a large scale.

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