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Development of Dehydrator for Domestic Use of Fruits

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Abstract: ***Fruits and vegetables are perishable in nature; spoilage is more due to high moisture loss. To preserve fruits for a longer duration we need to control the moisture loss and restrict respiration rate. Dehydrators available in the market are very expensive & can't be afforded by all. The Dehydrator that we developed is both economically and environmentally friendly and able to dehydrate various fruits in a very short span of time. A food dehydrator is an appliance that has a compact space and hot ventilation that can be used as a dehydrator. Dehydration of foods has two primary purposes: to prolong the shelf life of the food products to be stored and reduce the water content to prevent the growth of microorganisms. The objective of the study based on the machine we created is to use it as a source for humans to know that food can last longer by using the machine. It shows the best effect on the food. This aims to preserve food products from the growth of bacteria and yeast through water removal. The study's findings conclude that this food dehydrator can clearly reduce the burden on consumers, especially in businesses that use food dehydrators to produce sales results. Therefore, consumers who use these food dehydrators can produce more quality and durable food product results. Our developed dehydrator can help in economic terms that can further process food products that are more durable with high quality as well as can save time.***
Keywords: Dehydrator, Preservation, Storage.

I. INTRODUCTION

A food dehydrator is a kitchen equipment that is used to extract moisture from different kinds of foods in order to prolong its shelf life. It is a cost effective method to prepare and store fresh food in the comfort of your own home. The process of food dehydration offers a lot of benefits by allowing the preservation of seasonal food so that it can be made available throughout the year. It also makes it possible to store a appreciable amount of food in a small space. Many of us also take food dehydration as a fun and exciting hobby. Another benefit of dehydrating food is on its nutritional value. When food goes for cooking, its vitamins and nutrients are lost. However, eating raw dried food will ensure that you get all of its sweet rewards. Some dried foods are also stored to beer hydrated and consumed at a future time.

Food dehydration is the process of preserving and extending the shelf life of foods. Heat and air sources are used to remove the water content of foods which then prevents the growth and spread of bacteria. Basically, the goal is to eliminate moisture by using heat like electric or solar to dehydrate foods. Over the years, there have been inventions which included more sophisticated components that allowed the dehydration process to be more effective and efficient.

The modern ways of preservation are more predictable than the traditional ones since they have a consistent source of heat and temperature which are also evenly distributed, thanks to technology. The process of dehydration makes the exterior hard, and so it serves as a shell not allowing bacteria to get in. There are different components of a dehydrator, and most of them include food trays, air vents, fans, and a heating element. Moisture is released into the dehydrator when the food is heated, and they get pushed to the vents by the fan to be released outside of the dehydrator.

Trays come in different designs and sizes which can be stacked or removed. There are types of dehydrators with multiple levels which can be adjusted or rotated to allow changes in ventilation and to accommodate different sizes of food to be dehydrated simultaneously. There are types of dehydrators which offer uniform drying, and there are types where you can place some foods near the source of heat if they require more temperature for drying. Some trays are circular, and they automatically rotate while dehydration is being done.

In order to remove the moisture content on foods, the heat needs to be released through a heating element. The duration of this dehydration process completely depends on the type of food being dehydrated, it could take minutes or even hours. Most of the units are transparent so you can easily check and monitor the foods. Some have built-in timers which automatically turns off once the process is complete. The fans are strategically situated at the top or at the back of the dehydrator for proper heat and air movement. They function as regulators of temperature too. The heat is blown inside the dehydrator by its fans in order to remove the moisture which is then sent out through the vents.

Some of the fruits which are commonly dehydrated are those we add on cereals or bread, and they are cherries, cranberries, pineapple, apricots, apples, grapes, bananas, and plums.

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II. LITERATURE REVIEW

L. Augustus et al (2002) studied that a higher temperature in the drying chamber provides a higher drying rate for two reasons. A higher temperature of the drying air increases its ability to retain humidity. A higher temperature of the drying air allows to heat the product and thus to increase its vapour pressure forcing the moisture to go on the surface faster.

S. Vijay Venkataramana et al (2003) described briefly that the impact of a high velocity of the airflow in the drying chamber is limited and the fluctuations of the air flow velocities are small in the drying chamber and thus can be neglected.

D.I. Onwunde et al (2010) stated that air velocity has small influence on the drying process of most vegetables and fruits.

R. Phinney et al (2015) stated that fruit drying in membrane poches first showed that indirect solar drying was preferable to avoid damaging effects on nutrients or chemicals reactions altering the product. However, more recent results suggest that direct solar radiation is suitable for membrane pouches.

Kumar M Sansaniwal et al (2016) studied performance of a mixed dehydrator with an indirect or direct dehydrator. However, these systems are more complex and less common. Temperature is one of the most important parameter along with air velocity and relative air humidity. It is possible to reduce the drying time for 14.89% to 37.66% compared to a natural solar drying with increasing air velocity in the solar dehydrator.

III. MATERIALS USED:

1) Rectangle non-stick wire rack
2) SMPS (Switching mode power supply)
3) Voltage regulator dimmer
4) Metallic tape.
5) Infrared heating lamp
6) Light bulb holder
7) Cooling fan
8) Card board box with lid
9) Thermometer.
10) Rh meter
11) Aluminium Foil.

IV. METHEDOLOGY & EXPERIMENTATION:

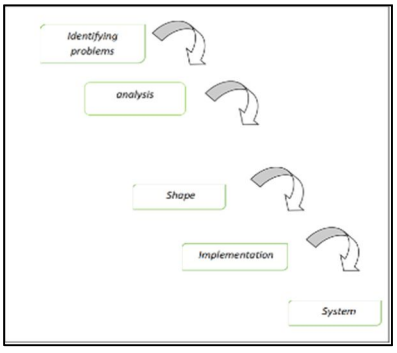

Figure 1 Methodology Flow Chart

In this world surrounded by advances in science and technology, various tools are used to facilitate and expedite work. Preparing food. Especially wet foods that need proper storage. For example, fruits are foods that need to be stored at the right temperature that is at a temperature that is not too low and not too high. The fruit will be affected in terms of nutrition and taste.

Therefore, this food dehydrator is very useful and it is recommended that every home has a multipurpose food dehydrator to facilitate daily work without having to think about weather problems. In addition, there are many advantages to using this versatile food dehydrator. Stored for a longer period of time. This is because, the food that has been dried will be avoided from water where water is one of the main factors bacteria can spoil food. Therefore, dried food should not be stored in the refrigerator, the dry ones only need to be stored in an airtight container and can enjoy food at any time.

A. Objectives

This study has the following objectives:-

1) To study the dehydration of fruits using developed dehydrator.
2) To study the storage life of dehydrated products.
3) Cost analysis of developed product in comparison with commercially available product.

B. Functional Requirements of Electronics Components

1) *Rectangle non-stick wire Rack:* A wire rack allows air to circulate completely around whatever is on it. This means that the dehydrated good will cool faster than if simply left on a trivet.
2) *SMPS (Switching mode power supply):* An SMPS is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. It transfers power from a DC or AC source to DC loads.
3) *Voltage Regulator Dimmer:* Dimmers are devices connected to a light fixture and used to lower the brightness of light. By changing the voltage waveform applied to the lamp, it is possible to lower the intensity of the light output.
4) *Metallic Tape:* It's used for the purpose of seaming, patching and sealing. Here it's highly suitable for sealing off warm air flow ducting.
5) *Infrared Heating Lamp:* It's used to produce heat inside the dehydrator so that hot air can pass through the fruits for dehydration.
6) *Light Bulb Holder:* It's used to hold the bulb properly inside the dehydrator for the precaution that no accident happen to it.
7) *Cooling Fan:* Cooling fan is used to circulate the hot air throughout the dehydrator so that each fruit product dehydrated equally and it also helps in ventilation process.
8) Card Board Box with Lid: It's used as a container in which all the fan and heating element are generally mounted on the inside wall of the unit.
9) *Thermometer:* It's used to check the temperature inside the dehydrator.
10) *Rh Meter:* It's used to check Relative Humidity inside the dehydrator.
11) *Aluminium Foil:* We can put aluminium foil in the dehydrator without worrying about chemical or food poisoning. It's highly resistant to heat and can withstand temperature up to 1220 degrees Fahrenheit.

Table 1- Cost Analysis of the developed Dehydrator:

Sl. No.	Product	Unit	COST (Rs)
1	Bulb holder	1	250
2	Infrared heating lamp	1	700
3	Cooling fan	1	300
4	Spray paint	1	200
5	Aluminium foil	1	90
6	Metallic foil	1	190
7	Cardboard box	1	10
8	Voltage regulator dimmer	1	250
9	Cooling rack	2	300
10	SMPS	1	550

Total cost of our developed "**dehydrator"** is 2840/- RS.

C. Procedure to Develop the Dehydrator for Domestic use of Fruits

Figure 2 Food Dehydrator Developed by us at GIFT Campus

1) First we took a card board box as a container for our food dehydrator machine.
2) Then we collected all electrical equipment such as SMPS, infrared heating lamp, cooling fan regulator dimmer etc. for the controlling of temperature and humidity in the dehydrator.
3) For the heating purpose we used an infrared heating lamp of Philips and to regulate the heat we added a Regulator dimmer and switching mode power supply to provide power as well.
4) For the regulation of air flow through the container we added a cooling fan.
5) Initially we covered the box with aluminium foil and then assembled all the parts along with the racks and then added the lid.
6) For the finishing touch we painted it spray paint on the outside.
7) For better reflection of heat, we added metallic tape in the edges and gaps of the cardboard box from the inside.
8) After finishing the prototype we started our experiments with the food products.
9) We took fruits for our experiment like grapes, banana, apple and pineapple.
10) We did both sun drying and food dehydration to compare the results.
11) Before putting those fruits in the dehydrator we followed some steps like Washing, drying outside moisture, pre-treatment, cutting and weighing.
12) We also measured the temperature and humidity.
13) After the complete dehydration we again the checked the temperature and humidity as well as noted the after weight.

D. Dehydration of Grapes


Figure 3 Dehydration of Grapes

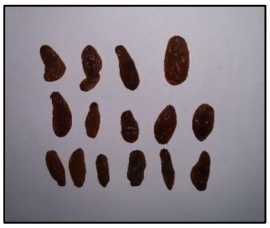
Figure 4 Dehydrated Grapes

1) Pre-treatment- washing
2) No. of pieces taken- 20
3) Initial weight- 60.2g
4) Temperature- 460C
5) Humidity- 40- 45%
6) Final weight- 19.7g
7) Time taken-
a) In Dehydrator- 24 hrs
b) In Sun drying- 12 days

E. Dehydration of Apple


Figure 5 Dehydration of Apple

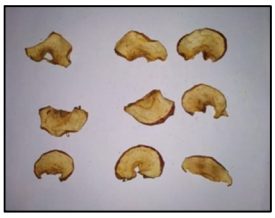
Figure 6 Dehydrated Apple

1) Pre-treatment- washing, cutting
2) No. of slices taken- 24
3) Initial weight- 76.16g
4) Temperature- 48.9^0 C
5) RH- 40%- 65%
6) Final weight- 10.65g
7) Time taken:
a) In Dehydrator- 3 hrs
b) In Sun drying- 8 hrs

F. Dehydration of Banana


Figure 7 Dehydration of Banana Figure 8 Dehydrated Banana

1) Pre-treatment- peeling, slicing, turmeric-water solution coating.
2) Mid treatment- oil coating and Salt addition
3) No. of slices taken- 16
4) Initial weight- 75.38g
5) Temperature- 45.80 C
6) RH- 43%
7) Final weight- 30.2 g
8) Time taken:
a) In dehydrator- 4 hrs
b) In Sun drying- 6 days.

G. Dehydration of Pineapple


Figure 9 Dehydration of Pineapple Figure 10 Dehydrated Pineapple

1) Pre-treatment- washing, peeling and slicing.
2) No. of slice taken- 20
3) Initial weight- 147.79g
4) Temperature- 44.3^0 C
5) RH- 40-45.8%
6) Final weight- 35.49 g
7) Time taken-
a) In Dehydrator: 8 hrs
b) In Sun drying: 14 hrs

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V. RESULTS & DISCUSSIONS

According to our experiment we can see that there is a difference between the initial weight and final weight. It implies that there was moisture loss after the dehydration which indicates to a successful food dehydrator which our group made.
We can see that average temperature for fruit and fruit leather is between 45^0 C -60^0C. Now we can dehydrate our fruits within this temperature range and can get healthy snacks without compromising with the natural nutrition.

Table-2 Calculation of Removed Moisture Content Percentage:

Serial No.	Product	Weight		% of moisture removed	Temp. (in ^{0}C)	RH%		Time (in hr)
		Initial weight (in gm)	Final weight (in gm)			Min.	Max.	
1	Grapes	60.2 g	19.7g	67.27	46	40	45	24
2	Apple	76.16g	10.65g	86.016	48.9	40	65	3
3	Banana	75.38g	30.2g	59.936	45.8	43	__	4
4	Pineapple	147.79g	35.49g	75.98	40	40	45.8	8

Table-3 Commercially available dehydrator v/s our developed Dehydrator:

Sl. No.	Model	Manufacturer	Capacity	Cost	Preferable product
1	Cylin type food dehydrator	Aube Alba	5 stackable	10,000/-	Fruits
2	Electric dry food saver	Paratpar mall	5 stackable	8,999/-	Fruits, vegetables and herbs
3	Food grade Dehydrator	Envop	4 stackable	15,000/-	Fruits
4	Electric Dry Food saver Dehydrator	Rajipo	3 stackable	5,000/-	Fruits and vegetables
5	Food Dehydrator developed by us in GIFT Campus	__	2 stackable	2,840/-	Fruits, Vegetables and herbs

From the above table-3, we can see that the food dehydrator developed by us is cheaper as compare to other food dehydrator available in the market, though it is 2 stackable, but we can add more tray by taking a bigger box. Along with that we can adjust our trays and can increase its capacity.

VI. CONCLUSIONS

Dehydrator for domestic use was developed and assembled in the college campus. The developed dehydrator was used for dehydration of various products. Grapes, Ripe banana, Pineapple, apple was taken for the experiment, where dehydration was observed w.r.t Solar drying. Solar drying couldn't retain the quality and colour as UV rays destroys the characteristics while our dehydrator could retain the colour and quality. Solar drying took more time for dehydration as compared to our dehydrator. Our developed dehydrator could dehydrate fruits in some hours which can be used to increase the storage life.

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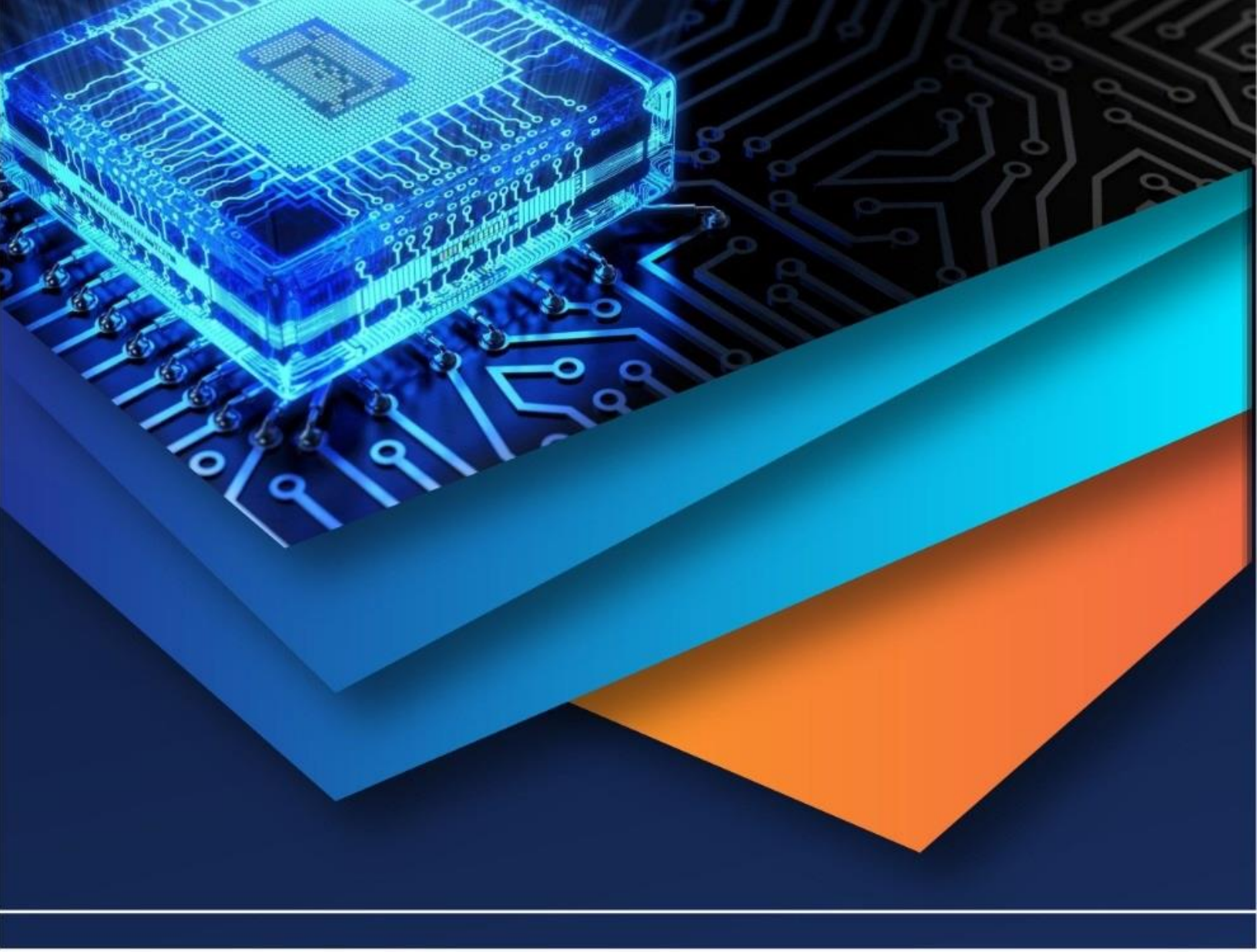

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