International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 11 Nov. 2022, pp: 498-502 www.ijaem.net ISSN: 2395-5252

Experimental Investigation of Pentagonal Shaped Solar Drier

C. Anbumeenakshi[1, A]*, R. Aravind[2], K. Karthick[3], S. Anishkumar[4]

[1,] *Associate Professor, K.L.N. College of Engineering, Pottapalayam – 630612, India*
[2,3,4] *U.G Students, K.L.N. College of Engineering, Pottapalayam – 630612, India*

Submitted: 05-11-2022 Accepted: 15-11-2022

ABSTRACT: Drying is one of the traditional methods for preserving agricultural products. About 20-25 percent people does not have enough food to eat. It has been estimated that world as a whole more than 25-30 percent food grains and 30-50 percent vegetables, fruits etc. are lost before it reaches to the consumers. Many of our food crops are 80-90% water and most of this needs to be removed for long term .To overcoming spoiling problems of vegetables, and fruit; various preserving methods are used and renewable sources are best for this purpose by which we can save energy for preservation and keeping the product in their natural flavor. Thus in this experimental study a pentagonal shaped solar drier was designed and fabricated and solar drying was adopted to preserve the vegetables and it was identified it reduces the moisture content and it is highly efficient.

Keywords: direct method, moisture, vegetables, pentagonal

I. INTRODUCTION

Most of the agricultural products have moisture content which makes them vulnerable to microbial and other spoilages due to biochemical reactions. Therefore drying has to be carried out to preserve the agriculture products from spoiling. Solar drying technique is a suitable method to preserve the agricultural products. Solar dryers are devices that use solar energy to dry substances, especially food. Solar dryers use the heat from sun to remove the moisture content of food substances.. Solar driers are fully sealed so that air does not enter. Air flow in the drier must be avoided, because the fluctuation in air flow causes increase in moisture content inside the drier. There are two general types of solar dryers: Direct Solar Drying and Indirect Solar Drying. Direct solar drying method is one which the substances are dried under a solar drier with sunlight only. This does not require any electrical or electronical components or solar panels for drying. This method is one of the oldest methods for drying. The drying process takes place between the solar period i.e 10AM – 3PM.

- In this method of drying, there is a fluctuation in temperature and humidity inside the drier
- This method is cheaper when compared to Indirect Drying method.
- The output and efficiency depends on the varying temperature in the environment.

In many parts of the world there is a growing awareness that renewable energy has an important role to play in extending technology to the farmer in developing countries to increase their productivity (Waewsak, et al., 2006). Solar thermal technology is a technology that is rapidly gaining acceptance as an energy saving measure in agriculture application.

The simplest design for a solar dryer was developed by the Brace Research Institute, Canada, (1975). It is essentially a hot box where fruits, vegetables or other materials can be dehydrated on a small scale The construction of such a dryer can take many forms. Nevertheless, certain specifications were recommended. The experimental results at Kanpur, India (Chantawanasri, 1978) for the drying of fruits and vegetables showed that solar-drying saved considerable time compared. With sun-drying in the open. Also, the product obtained from the solar dryer was found to be superior in taste and odour to sun-dried produce and was not contaminated by dust or infested by insects.

proposed for the selected crops. The empirical constants of Henderson's equation were obtained for all the materials from investigation, which are not available in the literature. The proposed empirical correlation suggested that it could well describe the drying kinetics of the selected crops.

Sehery et al. [1] It discusses testing of the dryer for its ability in drying fruits and vegetables by comparing it with traditional drying. Some parameters like ambient, heat collector, and chamber temperature measurements were tested; the energy generated by the collector and the dryer efficiency were calculated. Drying temperature is considered to be the most important factor in the drying operation. The chapter concludes that in all trials, solar drying is a more efficient method for drying all samples of fruits and vegetables, especially for grapes, figs and onion, grapes dried using mixed mode from 83% to 30% moisture in 4 days. Drying temperatures and performance energy output are used in evaluating the collector efficiency.

HadiSamimi and Akbar Arabhosseini [2] This study was aimed to examine the effect of sun tracking system on the solar drying kinetics of biological materials. A lab-scale PV-assisted solar drying system equipped with a sun tracking unit was designed and fabricated to study the drying behavior of tomato slices during the drying process. The samples were tested at different air velocities (0.5–2 m/s) and product thicknesses (3–7 mm) with and without application of sun tracking system. The effect of sun tracking system on the drying behavior of tomato slices was evaluated by considering the drying time, effective moisture diffusivity and activation energy. According to the results obtained, the sun tracking system profoundly shortened the drying time about 16.6% to 36.6%. Application of the system substantially increased the effective moisture diffusivity in the ranges of 9.1–64.6% and the activation energy without any negative effect on the quality parameters of dried samples, i.e., color, rehydration ratio, and shrinkage. Overall, the sun tracking system could be a promising approach not only for accelerating solar drying process but also for propelling this drying technology one step further towards the industrial applications.

Badgujar [3] The performance of an indirect forced convection and desiccant integrated solar dryer has been investigated for drying green peas and pineapple slices with and without the reflective mirror. The inclusion of reflective mirror on the desiccant bed increases the drying potential considerably. The useful temperature rise of about 15℃ was achieved with mirror, which reduced the drying time by 3 h and 4 h for green peas and pineapple, respectively. Also, the pick-up efficiency, drying rate and average dryer thermal efficiency were relatively higher, when compared to solar drying and desiccant integrated drying. Uniform drying in all the trays were achieved with good quality in terms of color and microbiological decay, when compared to solar drying. Taste of the dried pineapple is satisfactory. The desiccant material is stable even after continuous operation fo rmore than a year. The dryer can be used for drying various agricultural products. It can reduce drying time and improve quality of the dried product.

Sebaii and Shalaby [4] reviewed the use of solar energy in recent years had reached a remarkable edge. The continuous research for an alternative power source due to the perceived scarcity of fuel fossils is its driving force. It had become even more popular as the cost of fossil fuel continues to rise. Of all the renewable sources of energy available, solar energy is the most abundant one and is available in both direct as well as indirect forms. Solar energy applications were divided mainly into two categories: the first is the direct conversion to electricity using solar cells (electrical applications). The second is the thermal applications. The latter include solar heating, solar cooling, solar drying, solar cooking, solar ponds, solar distillation, solar furnaces, solar-thermal power generation, solar water heating, solar air heating, etc. Detailed description, fundamentals and previous work performed on solar dryers and solar air heaters, as the vital element for the indirect and mixed modes of solar dryers, were presented in the present review paper.

Mekhelif et al. [5] The present study is a state of art on the numerous new and feasible technologies of solar energy applications in the agricultural sectors. It discusses about the importance of solar energy as environmental clean technologies and the most reliable energy source. This study covers different types of solar energy systems like as solar photovoltaic and solar thermal for pumping water, drying crops, cooling the storages and producing heating/cooling greenhouses. It has been proven that photovoltaic systems and/or solar thermal system would be the suitable options in agricultural application and especially for the distant rural area.

From the literature study it was identified that pentagonal shaped solar drier was not studied hence in this experimental study pentagonal shaped solar drier was designed and fabricated and it its effectiveness was studied.

II. EXPERIMENTAL SETUP

The experimental setup comprises of Aluminium channels –flat and right angled,L clamps 4mm thick Fibre glasses,200 micron solar drying sheet,Central hollow shaft,Wooden plates and Bearings. In this study the design structure is widely divided into two main structures Viz. the bottom pentagonal structure and the top pentagonal cone structure.

The bottom pentagonal structure was constructed first.In this structure, the aluminium channels are attached together with L clamps adjusted from 90 to 108 degree. These are assembled together using a hand drilling machine. The aluminium channels were drilled together, acrylic sheets were then added at the edges. The top and bottom of the design were attached together using M steel L shaped clamps. At the edges of the aluminium channels SS L shaped clamps were attached .

Flat aluminium channels were attached to vise and was bent at both the tips of the flat aluminium channels. These bent areas were screwed to the top or the bottom frame using hand drilling machine and drill screws.Two wood pieces were taken an machined at square shape. These were then marked at the size of the bearings and machined in such a way that the bearing will be submerged into the wood. This process was carried out in a 4 jaw chuck lathe. After this one wood piece was glued to the supporting table. Another wood was cut into the shape of pentagon. The pentagonal wood piece was screwed to the top end of the aluminum channels.

Next the Velcro is attached to aluminium surface using screws and hand drilling machine. Then measurements were taken accordingly and the drying sheets were cut according to them. And each and every side of the drier vents were closed in such a way that air does not pass through.One side of the drier is a detachable end where Velcro is attached. This is considered as the only opening side of the solar drier. Now the central pole is place and SS L clamps are attached by welding process. These plates are welded in the way that they are only at the bottom structue of the drier.After this, all are assembled together and vegetables are placed in the drier plates.The drying process is carried out during the solar period of 10A.M to 3P.M

Fig. 1: pentagonal Shaped Solar drier

III. RESULTS AND DISCUSSION

The working of solar drier is mainly based on the solar energy emitted from the sun. Weights of the vegetables were noted before and after chopping them. Vegetables were fine chopped and placed in the drier at 10.00 AM sharply. Before loading the vegetables the Atmospheric temperature and the temperature inside the drier were noted. The weight of the vegetables was measured at every 30 min from 10 AM to 3PM. Fig. 2 to Fig.6 graphs represent the weight drop (moisture drop) in each vegetables.

Vegetables were arranged in the plates based on this moisture content and their fiber structure. The order of priority is

- Tomato
- Carrot
- Green bell pepper
- String less beans
- Green chilli

The moisture drop of each and every vegetable was measured

The moisture drop = [(w-d) / w]*100

W= Net weight, d= weight after drying

and the Fig.7 graph shows the total moisture drop of all the 5 vegetables. From the graph it was identified that every vegetable has lost its moisture content when they were exposed to solar drying.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 11 Nov. 2022, pp: 498-502 www.ijaem.net ISSN: 2395-5252

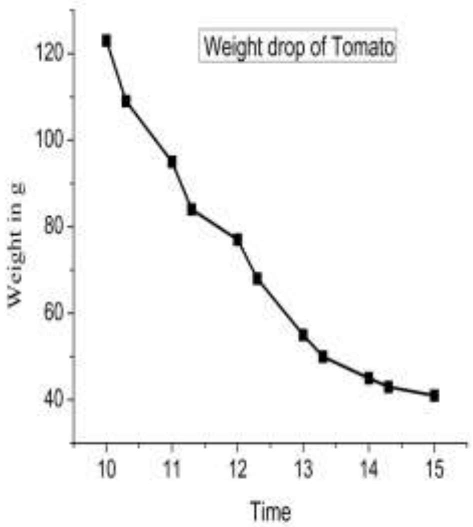

Fig. 2 Weight drop of tomato in g

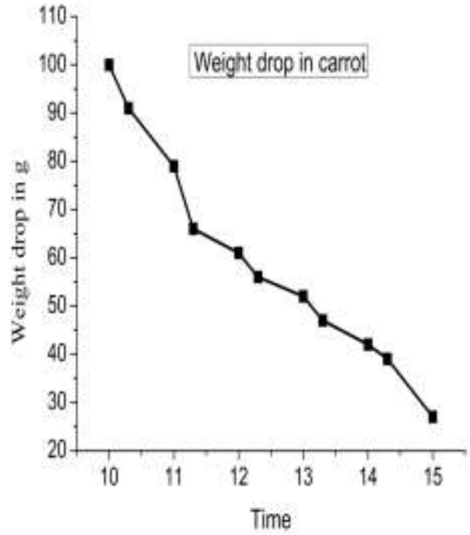

Fig. 4 Weight drop of carrot in g

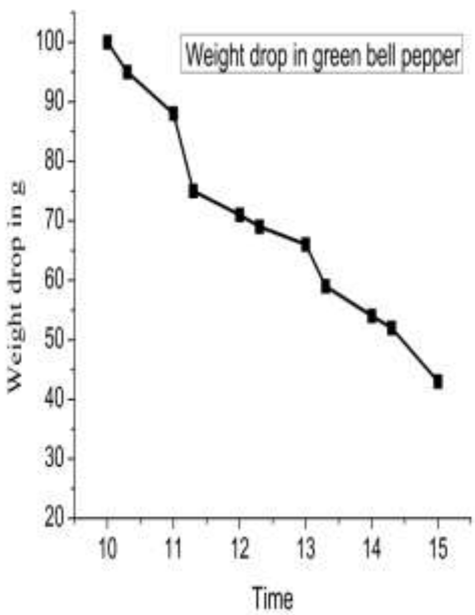

Fig. 3 Weight drop of green bell pepper in g

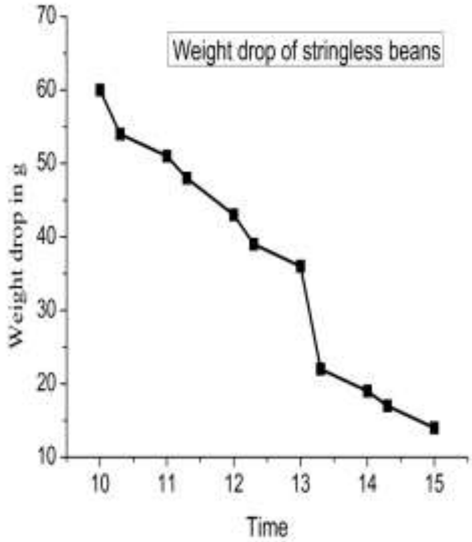

Fig. 5 Weight drop of string less beans in g

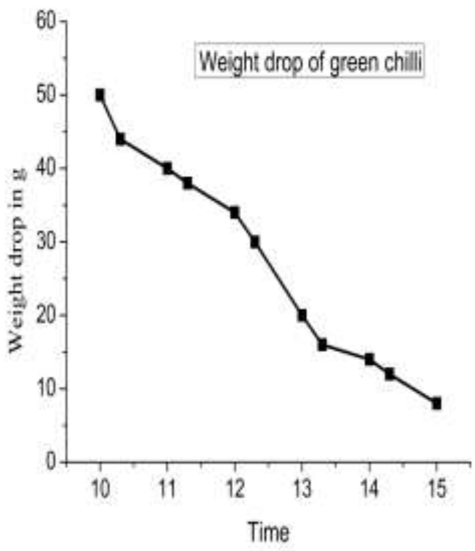

Fig. 6 Weight drop of green chilli in g

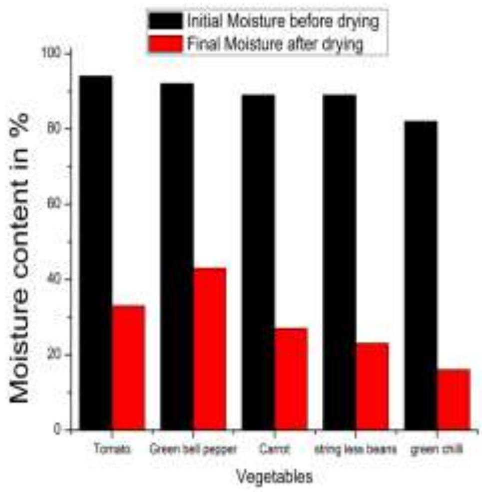

Fig. 7 Comparison of Moisture content

IV. CONCLUSIONS

An experimental study has been carried out to investigate the effect of pentagonal shaped solar drier and from the study it is found that Pentagonal structured solar drier is effectively used in drying vegetables namely tomato, green bell pepper, carrot, stringless beans and green chili. The pentagonal shaped structure helps to dry five different types of vegetables simultaneously. Thus this solar drier can be used commercially for preserving the vegetables and the shell life of the vegetable can be increased. The other benefit is that, this method is based on direct solar drying method and it does not involve any electrical or electronic components.

Acknowledgements

The authors would like to thank the Management of K.L.N. College of Engineering for providing the facilities to carry out the research work.

REFERENCES

[1]. A. A. Sehery, Y. M. Gallali, M. Wafa, Preservation of Fruits and Vegetables Using Solar Dryers. A Comparative Study for Solar and Natural Drying of Grapes, Figs, Tomatoes and Onions. IV. Temperatu, World Renewable Energy Congress VI, 2000, Pages 2167-2169

[2]. Hadi Samimi and Akbar Arabhosseini, Accelerating drying process of tomato slices in a PV-assisted solar dryer using a sun tracking system, Renewable Energy,2018

[3]. V.R.Badgujar, An experimental investigation of solar dryer with regenerative desiccant material for multicrops, International Journal of Engineering Research and Applications, Vol. 2, Issue 3, May-Jun 2012, pp.3144-3149.

[4]. A.A.El-Sebaii , S.M.Shalaby, Solar drying of agricultural products: A review, Renewable and Sustainable Energy Reviews,Volume 16, Issue 1, January 2012, Pages 37-43

[5]. S.Mekhilef, S.Z.Faramarzi, R.Saidur, ZainalSalam,The application of solar technologies for sustainable development of agricultural sector, Renewable and Sustainable Energy Reviews Volume 18, February 2013, Pages 583-594