International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Performance Evaluation of Domestic Solar Drier Using Forced Convection

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ABSTRACT:

Preservation of food and vegetables by removing moisture present in it is a old traditional technique. The heat present in the sun rays accomplishes this task very easily and economically. To expedite the drying process the solar dryers play vital role. In the study a forced convection system is used to make the drying process fast. Onion, potatoes, spinach and green chillies were dried with help designed solar drier and it is found that onion which is fully moisture vegetables dried up to 91% and potatoes dried up to 88% within 24hrs. While spinach and green chillies dried up to 73% and 67% within 8 hrs.

INTRODUCTION:

Preserving the vegetable by drying it in sunlight is old technique. Moisture present in the vegetables is responsible to decompose the vegetable. The decomposed vegetable is unhealthy to eat and spread bad odour as well. To avoid decompose of vegetables, the moisture present in the vegetables, need to vaporize which can be accomplish by drying them in open sunlight. The drawback of this technique is 'time consuming' and requires sufficient space.

The Solar dryers generate higher temperatures, maintain lower relative humidity, lower product moisture content and reduced spoilage during the drying process as compared to an open sunlight drying technique. In addition, it takes up less space, takes less time and relatively inexpensive compared to artificial mechanical drying method. Preservation of food by using the solar dryer can be seen as one of the solutions to the world's food and energy crises. With drying, most agricultural produce can be preserved and this can be achieved more efficiently through the use of solar dryers.

Drying in sunlight is a simple, quick and low-cost method which do not reduces the nutrient value of these products and maintains the hygiene. Now days for increasing the utility, to improve the shelf life and to provide lead time between various processes, drying is used.

The drying process removes enough moisture from food to significantly reduce the humidity level. Different types of food have a different range of moisture in them. Preserving different types of vegetables in same compartment is challenging task which can be accomplish by forming various steps in the same compartment. In this study a portable, compact and fast drying type of solar drier is successfully designed and tested. The domestic, portable and efficient dryer made in the study serve the purpose by drying different types of vegetables at a time without affecting nutrient value and taste.

The solar energy is abundantly available in the most part of the world. The portable domestic solar dryer is fabricated to cater the day-to-day requirement of vegetables and fruits for a family at low cost. This solar dryer will absorb Solar energy to remove moisture from various vegetables like Onion, Potato, Chilly, Coriander, Currey tree, Spinach, etc. The circulation of the hot air can be done with the help small capacity fan which again works on Solar energy.

METHODOLOGY:

The objective of study is to develop and test a domestic, portable solar dryer using forced type of convection to speed up the drying process. The dryer capacity is of 0.16 m^3 to accommodate roughly 2 kg cut onion or potato. The solar dryer is made from plywood and its front side is having a transparent glass to abstract more solar energy. Four compartments at equal spacing of 0.4m x 0.4m are provided with perforated stainless-steel trays. The sunlight falls on the glass and a solar operated fan provided at the base will circulated the heated air from the bottom front side to top. The dryer is having perforated door at the backside which acts as outlet for the heated air. Toughened glass used on the top of solar Fan as a protective shield and to collect solar energy. The dimensions of this toughened glass is 80cn X 40cm (L x W) thickness of 3mm. The dryer is mounted on caster roller wheels to make it portable.

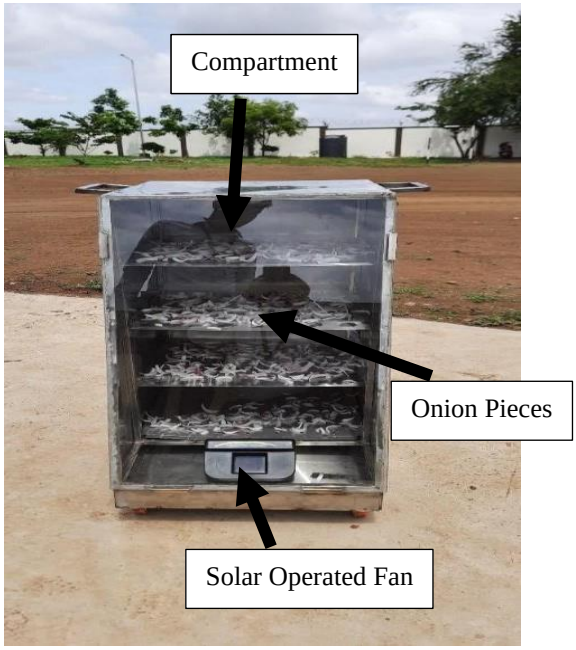

Fig No 1 Solar Dryer with Onion Pieces

Fig No 2 Solar Dryer with Potatoes Pieces

Fig No 1 shows the drying of cut onion pieces wiehging 2kg. Onion contains 90% of water while potatoes contain 80% water and 20% solid. Drying such vegetables requires lot of heat energy and it is time consuming. The proposed solar dryer is having a fan at the base which circulates the heated air in the

compartment to speed up the drying process. the trays are used for keeping the food products on this and this tray loaded into dehydration system. The four trays are used which are of size 40cm by 40cm in width and length. The perforated trays are manufactured by using stainless steel and small holes of 7mm diameter are provided to circulate the air throughout the compartment. Fig No 2 shows image of one tray which is used for keeping food sample on this, likewise Four trays are used to dry the potatoes and other vegetables.

The performance analysis of this system carried out by testing this experimental set up under different atmospheric conditions (temperature), different air flow rate and different food samples and compared these results, this is necessary for the purpose of evaluation of system parameters. Test is carried out at NKOCET, Solapur campus. Among all the other places in Maharashtra, Solapur is one of very few with extended amounts of time as well as plenty of sunshine. Solapur's latitude angle is 17^{o}N and its longitude angle is 75^{o}E, with an average solar radiation of 670 W/m2. Solapur is ridiculously hot, with highs ranging from 30 to 45°C (86 to 113°F) in summer season. Temperatures of 40°C (104°F) or higher are common in Solapur.

RESULTS AND DISCUSSION:

The test is carried out from 10:30am to 4:00pm to take benefit of 80% of solar radiation. Vegetables with higher percentage of water content like onion, potatoes and other like spinach, chilly are selected to carry out the tests. The intensity of solar radiation, inside temperature, exit temperature and ambient temperature are measure at each 30 minutes of interval.

The weight of vegetable is measured at the beginning and end of the day to calculated the amount of water vaporize at the end of the day. The peak of solar intensity is roughly at 1 pm and then it gradually decreasing so the atmospheric temperature is also decreasing this is due to the sun angle changes and its direction. The drying time is depends on the atmospheric conditions, if the atmospheric temperature is more the drying time is less and vice-versa.

CONCLUSION:

The performance of the system is directly based on atmospheric condition, the intensity of the solar radiation, airflow rate and food sample. The performance of an indirect type solar dryer, integrated with latent heat storage material designed, fabricated and investigated for drying spinach, potato, onion chili and grapes. The dryer with heat storage material enables to maintain consistent air temperature inside the dryer. The Design and Development of Domestic Solar Dryer is a unique, compact and Portable. Solar drying has proved to be technically and economically valuable for several crops. However it is, necessary to develop large-scale dryers that may be used throughout the year for different products to make them attractive to the farmers.

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