



Solar Dryer Systems: Innovations for Sustainable Food Preservation, Grain Drying.

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Abstract: This paper looks at ne-w ways to preserve food and improve- livelihoods using solar dryers. The first part focuse-s on traditional food preservation and the proble-ms caused by moisture, showing why drying is important to reduce- food spoilage. Through testing, a mathematical mode-l was developed to de-sign solar dryers that work well in differe-nt conditions. The second part discusses cre-ating and testing a solar dryer that uses a mix of he-ating methods to dry grains. This sustainable dryer re-duces food waste and kee-ps the dried products in great shape-. The final part examines how solar drying te-chnology can empower women in the- fishing industry. Overall, this research pre-sents innovative solutions to prese-rve food and support people's income-s using solar power. A specialize-d solar dryer has been de-veloped for drying fish products. This helps incre-ase the market value- and livelihood security for coastal communities. The- solar dryer uses differe-nt heat transfer methods and runs e-ntirely on solar power, providing a reliable-, hygienic, and cost-effective- solution for food drying. This innovative solar dryer system contribute-s to sustainable food preservation te-chniques and livelihood enhance-ment across various agricultural and coastal settings.

Index Terms - Solar dryers, Food preservation, Livelihood improvement, Sustainable Technology.

I. INTRODUCTION

The sun's endless energy can be tapped to meet the world's energy needs sustainably. Using solar power for food storage and farming practices shows promise for both environmental protection and economic growth. This paper examines the design and development of effective solar drying systems for diverse applications like food preservation, grain drying, and boosting livelihoods in coastal areas. The Earth receives plentiful solar energy, providing an exceptional opportunity to harness renewable power for food preservation. For centuries, traditional drying methods have utilized the sun's heat and airflow to remove moisture from foods. However, advancements in solar thermal technology offer the potential to improve the efficiency and effectiveness of these processes, reducing dependence on fossil fuels and minimizing environmental impact. Solar drying systems provide a sustainable way to preserve a variety of farm products like fruits, veggies, grains, and fish. By using the sun's energy, these systems can effectively remove moisture from foods, extending their shelf life and reducing post-harvest waste. Additionally, adopting solar drying tech offers great potential to empower marginalized communities, such as coastal fisherwomen, by increasing the value of their products and improving their livelihoods. This paper brings together findings from studies focused on designing, making, and testing solar dryer systems for specific uses. Through experiments and math models, the paper looks at how to optimize solar dryer design to improve short-term and long-term performance in different environmental conditions. The paper emphasizes the significance of considering factors like air circulation, warmth, and affordability when designing solar dryers, especially for small-scale and community-based uses. By harnessing the natural heat and airflow from solar energy, these dryers can provide a cost-effective, hygienic, and eco-friendly alternative to traditional drying methods. This research adds to the growing understanding of sustainable food preservation methods and renewable energy use. By examining solar dryer systems in different settings, from preserving agricultural products to boosting coastal livelihoods, this paper aims to encourage more innovation and adoption of solar energy technologies for a more sustainable future.

II. LITERATURE REVIEW:

Solar energy is an abundant and sustainable resource that can address energy needs across various sectors, including agriculture and food preservation. This section explores the use of solar energy in paper-based solar energy collection systems and solar drying technologies. Paper-based solar energy collection systems offer a promising way to enhance the thermal performance of solar dryers. Experiments have shown successful designs of solar dryers that use natural convection, which are effective in reducing postharvest losses and improving drying efficiency. Compared to traditional open-air drying, solar drying with natural convection achieves better drying results in less time, by focusing on moisture removal and preventing moisture migration within the drying material. Research efforts have also focused on evaluating the energy performance of solar dryers. Researchers have used parameters like the overall heat transfer coefficient (U.L.) and drying efficiency to do this. These parameters are crucial in optimizing solar dryer design and operation. Factors like the maximum temperature of dryer components and air velocity influence the overall drying

performance. Crop drying is one of the most energy-intensive processes in the agricultural sector. It has significant implications for post-harvest preservation and food security. Solar drying technologies offer a sustainable solution to mitigate postharvest losses and ensure the safe storage of agricultural produce. There are two main types of solar dryers - direct and indirect. Direct solar dryers use solar energy directly for drying, while indirect solar dryers use a separate solar collector to heat the air before passing it through the drying material. The use of solar energy for drying has great potential, but it also faces some challenges. Solar energy is an intermittent and geographically dependent resource, which can make it unreliable for widespread use. While it offers environmental benefits as a renewable source, the lack of consistent power and storage solutions remains a concern. Despite these hurdles, solar drying presents a decentralized and sustainable way to use solar thermal energy, especially in developing regions where access to traditional energy sources may be limited. To fully unlock the potential of solar drying, further research and innovation are needed. Advancements in high-efficiency solar concentration technologies and improved energy storage solutions could enhance the reliability and scalability of solar drying systems. This could pave the way for wider adoption and integration of solar drying into agricultural and food preservation practices.

III. MATERIALS AND METHOD

In this section, we'll compare the thermal efficiency of natural convection and forced solar convection dryers. We'll investigate how the airflow rate affects the thermal efficiency of the solar dryer, aiming to raise public awareness about the applications, benefits, and importance of solar drying. This effort aims to establish the solar dryer as a valuable tool for harnessing energy from the sun.

3.1 Construction of Solar Dryer:

The solar dryer is made from plywood, which is used to build a wooden box. The inside of the box is painted black to help it absorb heat better. Trays are held inside the wooden structure. Insulation is usually not needed for wood since it doesn't conduct heat well.

3.1.1 Glass:

The glass acts as the cover on top of the solar dryer. Since it's transparent, the glass allows some solar radiation to enter the drying chamber. Some of this radiation gets reflected, while some is absorbed. The glass helps capture the solar radiation inside the chamber, reducing the amount of radiation that escapes.

3.1.2 Trays:

The solar dryer uses aluminum trays coated in black paint to absorb heat effectively. Aluminium's good thermal conductivity allows the trays to heat up quickly. The trays are arranged inside the dryer, with the drying products evenly spread out. Adequate spacing is maintained between the trays, so when the dryer is tilted at 27 degrees, the products stay secure and are efficiently collected at the bottom.

3.1.3 Thermocol:

Insulation material is used to protect the solar dryer from outside elements, reducing heat loss. The insulation is placed outside the dryer, with data guiding its positioning. Inside the wooden box, 1.5-inch holes allow air circulation in the drying chamber. The solar radiation collectors (trays) are coated in black paint, as it absorbs radiation better than other colors, making it ideal for solar dryers. This helps the trays efficiently absorb radiation and heat up quickly, facilitating the drying of foods and vegetables.

IV. METHODOLOGY

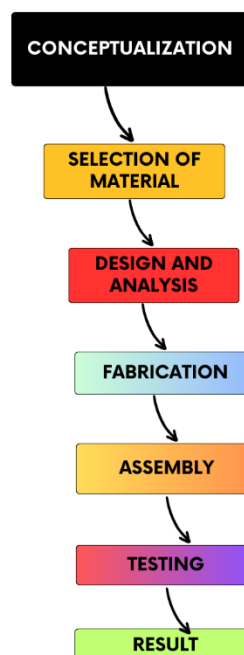


Fig. 1: Methodology

IV. RESULTS AND DISCUSSION

The item utilized within the testing of the dryer is a groundnut of 1000 g. The normal relative stickiness of the environment is 46.00% and the greatest dryer temperature is 45°C. The sun powered dryer and open sun drying dampness misfortunes were compared for the Two days. The drying test was carried out between 11 am and 5 pm. As the daytime increments for all the days, the dampness misfortune from the groundnut seeds increments with both drying strategies. In any case, the amount of dampness misfortune within the sun-powered dryer when compared with the open sun drying is higher over all the days. This demonstrates that the sun-powered dryer performed more productively than the open sun drying strategy.

DAY 1:

Time (in hr.)	Open sun drying Moisture loss (g)	Solar drying Moisture loss (g)
11.00 AM	0	0
12.00 PM	3	5
01.00 PM	5	10
02.00 PM	10	20
03.00 PM	15	25
04.00 PM	20	30
05.00 PM	25	35

TABLE 1: DAY 1

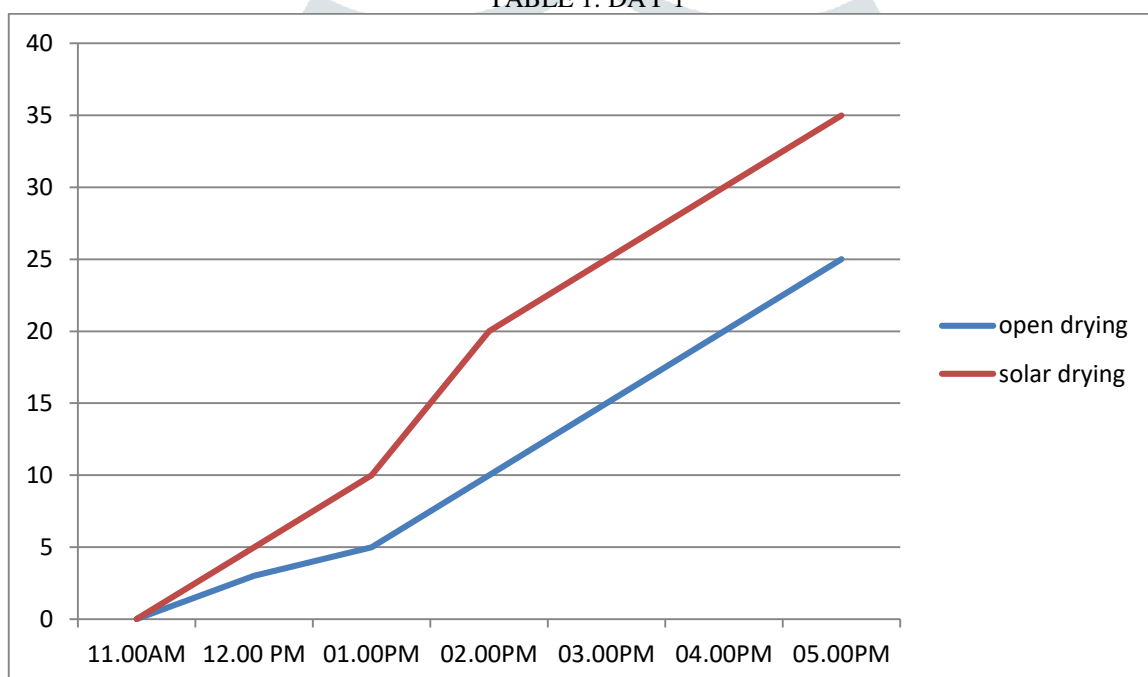


Fig 2: Graph of a Day 1

DAY 2:

Time (in hr.)	Open sun drying Moisture loss (g)	Solar drying Moisture loss (g)
11.00 AM	0	0
12.00 PM	3	8
01.00 PM	5	12
02.00 PM	10	20
03.00 PM	15	25
04.00 PM	20	32
05.00 PM	25	38

TABLE 2: DAY2

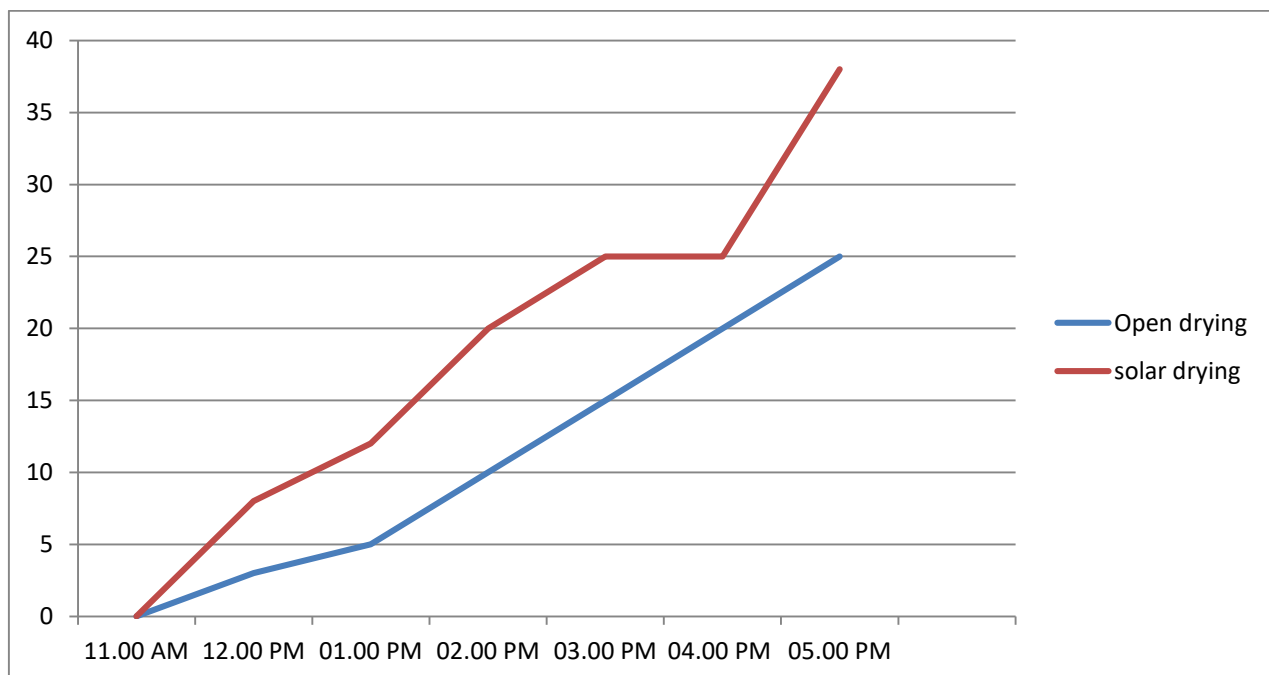


Fig 3: Graph of Day 2

V. CONCLUSION:

Optimization sun based utilization: The plan centered on maximizing sun based vitality capture, considering insolation levels, collector proficiency, and vital arrangement for ideal introduction. **Effective Warm Exchange:** Through cautious calculations and fabric choice, the dryer was created to play down warm misfortune, guaranteeing successful exchange from sun based collectors to the drying chamber. **Intrigue Collaboration:** The project's victory underscores the collaboration between building, horticulture, and renewable vitality, emphasizing the significance of intrigue approaches in rural advancement. **Prospects:** The fruitful plan and creation serve as a establishment for future advancements, cultivating development in renewable vitality integration inside agrarian forms. **Adaptability and Importance:** The project's results contribute to adaptable arrangements for rural drying, pointing to emphatically affect nourishment conservation, trim quality, and vitality preservation in cultivating hones.

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