E-ISSN: 2663-1067
P-ISSN: 2663-1075
NAAS Rating: 4.74
www.hortijournal.com
IJHFS 2025; 7(5): 85-90
Received: 03-02-2025
Accepted: 10-03-2025

Vedantam Sai Krishna
Assistant Professor, Processing and Food Engineering, Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Vallu Tejaswini
Assistant Professor, Soil and Water Engineering, Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Mude Vinayak
Assistant Professor, Farm Machinery and Power Engineering, Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Sundaragiri Rahaman
Assistant Professor, Farm Machinery and Power Engineering, Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Pulugu Indraja
Assistant Professor, Soil and Water Engineering, Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Corresponding Author:
Vedantam Sai Krishna
Assistant Professor, Processing and Food Engineering, Department of Agricultural Engineering, Aditya University, Surampalem, Andhra Pradesh, India

Development and quality evaluation of a solar dried mango leather

Vedantam Sai Krishna, Vallu Tejaswini, Mude Vinayak, Sundaragiri Rahaman and Pulugu Indraja

DOI: https://www.doi.org/10.33545/26631067.2025.v7.i5b.299

Abstract
Mango is a vital tropical and subtropical fruit crop with high water content, approximately 87%. Mango leather, a traditional and highly valued product, is prepared from ripened Banganapalli mango pulp through solar drying. At Aditya University, a direct solar drying method was employed to develop high-quality mango leather while maintaining its nutritive value and sensory attributes. The drying process aimed to reduce the moisture content of mango pulp from an initial 87% to 12-20%, thereby inhibiting microbial growth and ensuring product preservation. The mango pulp was dried at temperatures ranging from 49 °C to 65 °C over a period of 14 to 16 hours, resulting in a final moisture content of 18-20%. The drying approach ensured that the mango pulp was not directly exposed to sunlight, which helped retain the inherent flavour and nutritional quality. The processed mango leather exhibited desirable texture, colour, and shelf stability, making it suitable for long-term storage. This study demonstrates the efficacy of direct solar drying in producing high-quality mango leather while maintaining its sensory and nutritional properties.

Keywords: Mango leather, solar drying, Banganapalli mango

1. Introduction
Mango (*Mangifera indica* L.), popularly known as the king of fruits, holds immense economic and cultural significance in tropical and subtropical regions, particularly in India, the world's leading producer. Valued for its exquisite taste, vibrant color, and nutritional profile, mango has secured its place as a preferred fruit both domestically and internationally. India accounts for approximately 21.8 million metric tonnes of mango production with a productivity of 9.7 metric tonnes per hectare. The mango season typically starts from mid-February and peaks until mid-July, offering an abundant yield during this period. Despite its remarkable qualities, the high moisture content (73.9-86.7%) of mangoes renders them highly perishable, leading to significant post-harvest losses if not preserved. The pulp, rich in essential nutrients such as β-carotene, vitamin C, and various organic acids, is not only nutritionally beneficial but also prone to rapid spoilage. To mitigate this challenge, drying techniques, particularly solar drying, have gained prominence as an effective method to reduce moisture content and extend shelf life. Reducing the moisture content to 12-20% effectively prevents microbial growth, making dried mango leather a practical and long-lasting product.

Mango leather, a traditional dehydrated fruit product, is valued for its chewy texture, natural sweetness, and nutrient retention. It is also referred to as fruit leather or fruit slab and is widely consumed as a snack or dessert. Unlike fresh mangoes, mango leather is lightweight, portable, and has an extended shelf life, making it an ideal value-added product. Solar drying, being an economical and sustainable method, preserves the natural flavor and nutritional integrity of the fruit. Among various drying techniques, direct solar drying has been shown to maintain better quality by minimizing direct exposure to sunlight, thereby retaining the mango’s sensory attributes.

Previous studies have demonstrated the efficiency of solar drying methods in preserving the quality and prolonging the shelf life of mango-based products. Dissa compared direct and indirect solar drying of mangoes, finding that indirect methods achieved higher drying rates but at increased costs, while direct drying was more suited for small-scale, traditional applications. Panchal *et al*. (2013) [21] designed a simple solar dryer specifically for mango slices, demonstrating efficient moisture reduction and enhanced product quality. Sengar developed a multi-rack foldable solar dryer for mango flakes, emphasizing the importance of controlled drying conditions to maintain nutritional and sensory qualities. Additionally, Sharma evaluated different solar dryer types, highlighting the cabinet solar dryer's potential for domestic-scale drying of fruits and vegetables. The present study at Aditya University focuses on the development and quality assessment of mango leather using a direct solar dryer. This research aims to optimize the drying parameters and enhance the quality characteristics of the final product. By evaluating physicochemical properties and sensory acceptance, this study aims to establish a reliable and sustainable method for producing high-quality mango leather, thereby supporting the agricultural sector with a value-added product that contributes to both economic and nutritional security.

2. Materials and Methods

Fresh mango samples were collected from local fruit and vegetable markets, at Surampalem village, near Aditya University, ensuring diversity by sourcing from multiple vendors. This approach aimed to capture variations in mango quality, enhancing the reliability of the drying process and the applicability of the developed mango leather.

2.1 Solar dryer description

The cabinet dryer functions as a direct solar drying system, utilizing solar radiation that passes through the glass cover to heat the interior. The energy absorbed by the black-coated surfaces raises the internal temperature, creating an optimal environment for drying. As the temperature increases, moisture evaporates from the drying product and is carried away by the airflow, which enters from the bottom and exits through a vent positioned at the top right. This setup efficiently removes moisture while maintaining consistent drying conditions. The cabinet dryer is particularly suitable for drying small batches of fruit, making it ideal for domestic and household applications.

Fig 1: Mango leather Solar Dryer

2.2 Methodology

Ripe Banganapalli mangoes were carefully washed and peeled to ensure cleanliness. The pulp was extracted manually by squeezing the fruit, followed by blending with an electric blender to achieve a smooth, consistent texture. The resulting pulp, containing around 15.1% total solids, was stored at -18°C until further use. To increase the Total Soluble Solids (TSS) from 15.1% to 30%, the pulp was heated at a temperature range of 80-90 °C. The heated pulp was then divided into two separate batches, each treated with distinct formulations by incorporating either sugar or jaggery. After thorough mixing, the blends were allowed to cool. The prepared mixture was then evenly spread as a thin layer on stainless-steel trays, which had been lightly coated with ghee or oil to prevent sticking.

Subsequently, the trays containing the mango pulp mixtures were placed in the drying chamber of a cabinet dryer, where the temperature was maintained between 49°C and 60°C. The drying process lasted approximately 12 to 16 hours, aiming to reduce the moisture content to a stable level of 12-20% (wet basis). Once drying was complete, the mango leather was cut into bars and stored at room temperature, wrapped in aluminium foil to maintain quality and freshness.

Fig 2: Preparation of mango leather from pulp

2.3 Sampling

The preparation of mango leather involved developing four distinct formulations using mango pulp as the primary ingredient, combined with either sugar or jaggery. These formulations were categorized based on their ingredient composition and thickness as follows:

1. **Sugar-Based Formulations**
   - S1 (1.5 mm)**:** Comprised of 67% mango pulp and 33% sugar.
   - S2 (3 mm): Comprised of 70% mango pulp and 30% sugar.
2. **Jaggery-Based Formulations**
   - J1 (1.5 mm): Comprised of 67% mango pulp and 33% jaggery.
   - J2 (3 mm): Comprised of 70% mango pulp and 30% jaggery.

The mango pulp was blended thoroughly and mixed with either sugar or jaggery according to the specific formulation. The prepared mixtures were then uniformly spread on stainless steel trays to achieve the desired thickness (1.5 mm or 3 mm) and dried using a solar dryer at a temperature range of 49-60 °C for approximately 14-16 hours. Once drying was completed, the mango leather was cut into bars, packed in aluminum foil, and stored at room temperature for subsequent quality evaluation.

Table 1: Proportion of Mango Pulp developed from sugar and jaggery

Sample	Formulation	Mango Pulp	Sugar (S)	Jaggery (J)
Sugar	S1 (1.5 mm)	67%	33%	-
	S2 (3 mm)	70%	30%	-
Jaggery	J1 (1.5 mm)	67%	-	33%
	J2 (3 mm)	70%	-	30%

3. Results and Discussion

3.1 Drying characteristics Solar Dried Mango Leather

For experiment with load, 1 kg of fresh mango pulp with 4 different formulations having initial moisture content 87% respectively and the products were loaded in tray and kept inside the solar drying chamber. The experimental data were recorded after every 2 or 3hour. To determine the moisture content 1000 g of sample was taken and the moisture content present inside the products at different stages of drying was calculated by weighing the sample for every 2 or 3 hour duration. It was observed that initial weight of the mango leather sample was reduced from 1000g to 262.17g for S1 and J1 and for S2 and J2 from 1000g to 216.17 g with initial moisture content 87% and 87%, respectively to final moisture content 19% (S1) and 18% (J1) and final moisture content 20% (S2) and 19% (J2), respectively. The drying time was observed as 13 sunshine hours to reduce moisture content of mango leather.

3.2 Drying characteristics Solar Dried Mango Leather with (S_1: Sugar-1.5mm)

The drying process of mango pulp using a solar dryer demonstrates a clear relationship between temperature, drying rate, and moisture reduction as shown in Fig. 3. During Day 1, the drying started at a relatively low temperature of 31 °C, and the drying rate was initially zero due to the high moisture content of 82.3%. As the temperature rose to 44 °C by 11:00, the drying rate increased to 6.1 gm/hr, indicating the onset of efficient moisture removal. The peak temperature of 52 °C at 14:00 significantly increased the drying rate to 7.6 gm/hr, showing that higher temperatures effectively accelerate moisture evaporation.

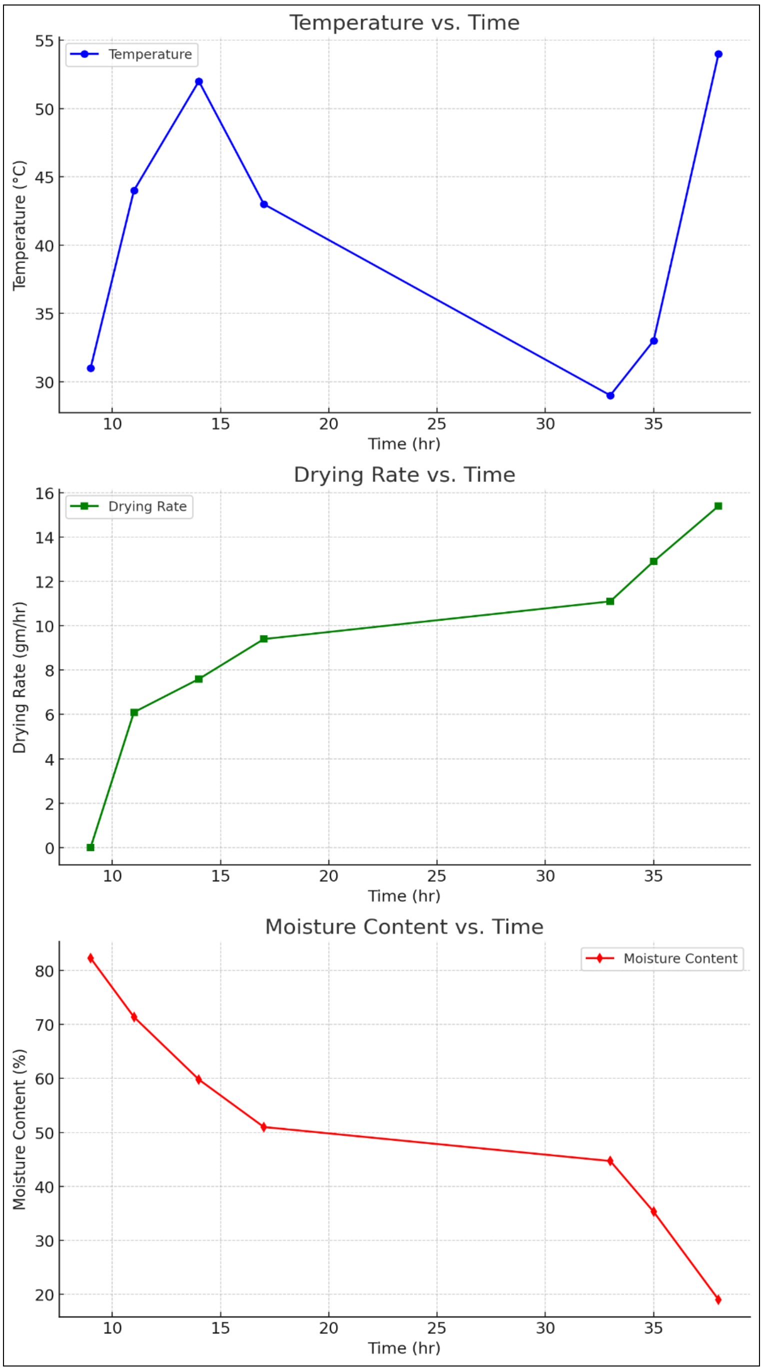

Fig 3: Variation of Temperature: Drying Rate: Moisture Content with time (S_1)

On Day 2, after a night of rest when the temperature dropped to 29 °C, the drying resumed with a higher efficiency, as evidenced by an increased drying rate of 11.1 gm/hr at 9:00. This indicates that the initial moisture removal during the previous day facilitated faster drying when resumed. The highest drying rate of 15.4 gm/hr occurred at 14:00 when the temperature peaked at 54 °C, suggesting that both the prolonged exposure and elevated temperature played key roles in enhancing the drying efficiency.

3.3 Drying characteristics Solar Dried Mango Leather with (J_1: Jaggery-1.5 mm)

The drying process of mango pulp in Fig. 4 shows a clear correlation between temperature, drying rate, and moisture content reduction over time. Initially, the temperature increases significantly from 31 °C to a peak of 52 °C on Day 1 at 14:00, followed by a slight decrease to 43 °C by 17:00. On Day 2, the temperature starts lower but again reaches a peak of 54 °C at 14:00. The drying rate follows a similar pattern, gradually increasing as the temperature rises, with a noticeable spike on Day 2 when the temperature is at its highest. This increase in drying rate is indicative of enhanced moisture removal at elevated temperatures. The moisture content, initially high at 82.1%, decreases consistently throughout the drying period, with a more rapid decline on Day 2 as the drying rate accelerates. This trend indicates that the combination of prolonged drying time and higher temperatures significantly contributes to moisture reduction in mango pulp. Overall, the data suggests that optimizing temperature settings, especially during the later stages of drying, can markedly improve drying efficiency and moisture reduction.

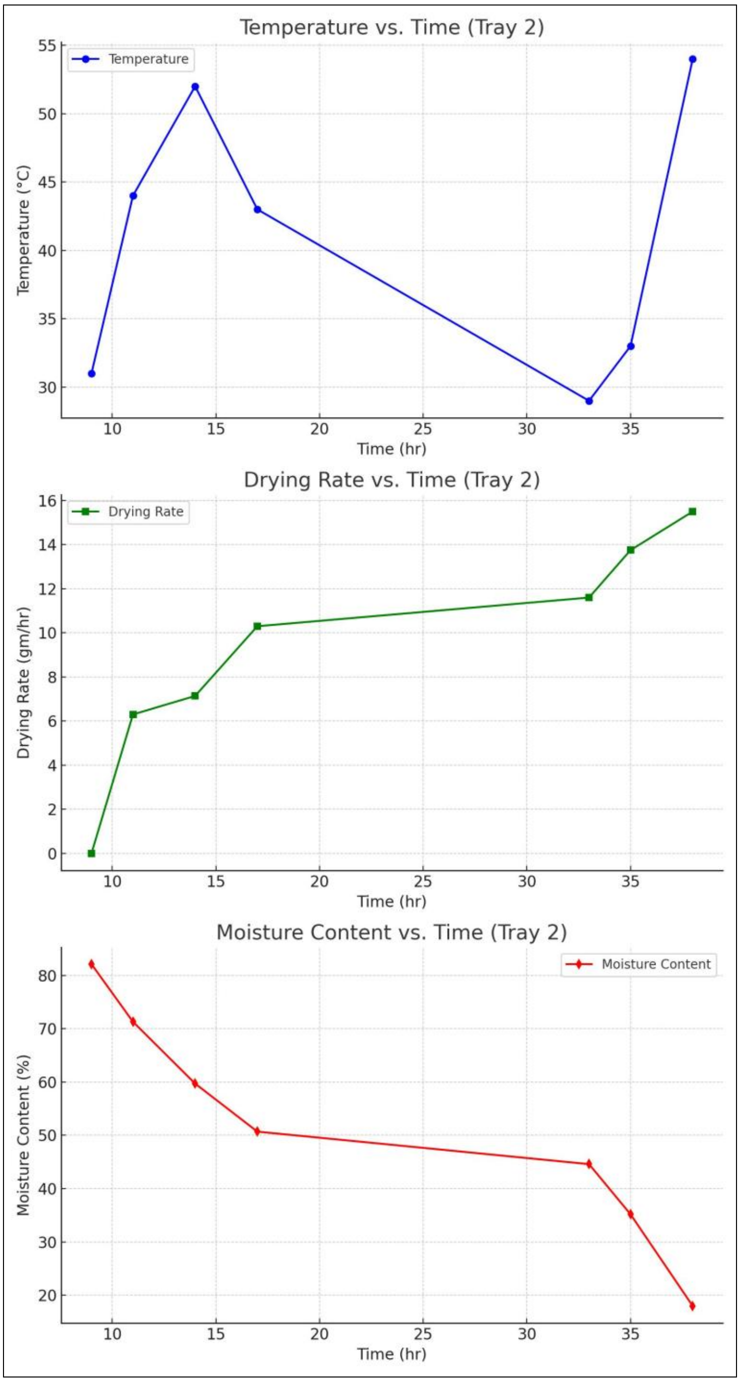

Fig. 4: Variation of Temperature: Drying Rate: Moisture Content with time (J_1)

In solar drying of mango leather, the moisture content of the mango pulp was reduced from 87.0% (w.b) to 19% (w.b) for sample S1 and 18% (w.b) for sample J1 within 13 sunshine hours. The amount of moisture content was measured by oven dry method with 105 °C for 24 hours. Europe (2012) that sets the final moisture content for a dried mango leather to be not more than 15-20% (wet basis). This can be attributed to the fact that a higher drying temperature was recorded in the dryer as a result of direct exposure to the sunlight.

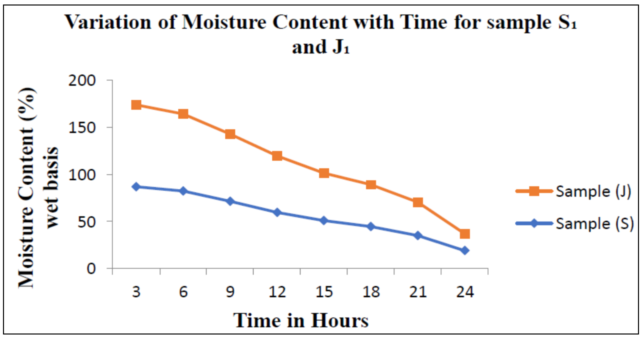

Fig 5: Variation of Moisture Content with time (S_1 and J_1)

This Fig. 6 shows that the drying rate was determined for the solar drying mango leather samples S1 and J1 the results showed that there was no constant rate of drying there is a gradually increase in the drying rate with the time. This is because of uneven heat to the drying chamber. The drying rate was increased initially from 0 to 15.4gm/hr (S1) and 15.5gm/hr (J1).

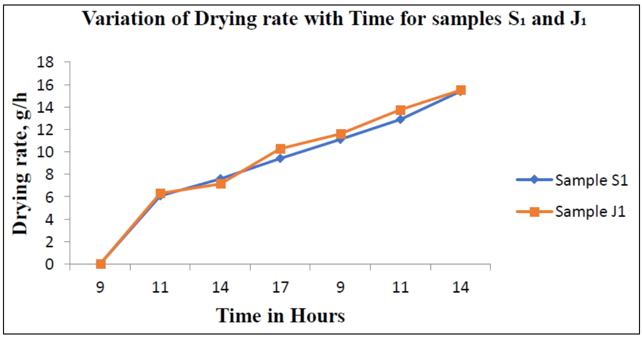

Fig 6: Variation of Drying rate with time (S_1 and J_1)

This Fig. 7 shows that the variation of temperature with time. The temperature inside the drying chamber initially at 9'O clock it was 31 °C for first batch of sample (S1 and J1) and reached to the 54 °C in the 2pm of the Day 2 where the mango leather reached to the final moisture content.

The variation of temperature with time for second batch of sample (S2 and J2) inside the drying chamber initially it was 30 °C and reached to the 52 °C in the 2pm of the day 2 where the mango leather reached to the final moisture content.

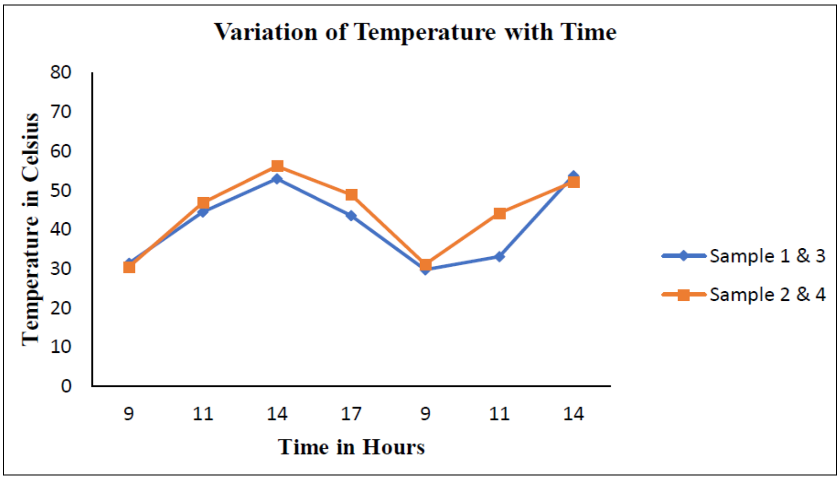

Fig 7: Variation of Drying rate with time (S_1 and J_1)

4. Conclusion

The analysis of the drying process reveals that the developed solar dryer significantly improves the drying efficiency and quality of mango leather compared to traditional open sun drying methods. The solar dryer effectively reduces moisture content from an initial 87% to a final range of 18-19% within 14-16 hours, while maintaining the quality attributes of the mango leather. This efficiency is attributed to the controlled temperature environment within the dryer, which ranges from 30 °C to 65°C, allowing for faster moisture removal and reducing the risks associated with environmental contamination commonly observed in open sun drying. Additionally, the partitioned stainless steel tray design facilitated the simultaneous drying of different mango leather formulations, proving the system's versatility. The structured airflow due to the exhaust fan further enhances moisture removal, leading to consistent drying rates.

The formulation analysis highlights that variations in thickness and the use of sugar or jaggery had minimal impact on the final product quality, indicating that the dryer can accommodate various formulations without compromising the end quality. Furthermore, the retention of intrinsic quality parameters such as vitamin C and total sugars suggests that the solar dryer is not only efficient but also capable of preserving essential nutrients. The use of high-density polyethylene packaging with aluminum foil at room temperature ensured the stability and shelf life of the dried product. Therefore, the developed solar dryer proves to be a sustainable and efficient alternative for preparing mango leather, demonstrating substantial advantages over conventional sun drying by offering improved drying time, product quality, and hygiene.

5. References

1. Akpan GA, Onwe DN, Fakayod OA, Offiong UD. Design and development of an agricultural and bio-materials cabinet tray dryer. Int J Food Eng Technol. 2016;2(1):34-42.
2. Basumatary B, Roy M, Basumatary D, Narzary S. Design, construction and calibration of low cost solar cabinet dryer. Int J Environ Eng Manag. 2013;4(4):351-8.
3. John C, Domingo A. Preparation and consumer acceptance of Indian mango leather and osmo-dehydrated Indian mango. Asian Pac Multidiscip Res. 2017;5(3):123-7.
4. Economic Commission for Europe. Draft standard concerning the marketing and commercial quality control of dried mangoes. Geneva; 2012. p. 7.
5. Elumalai PV. Investigation of nano composite heat exchanger annular pipeline flow using CFD analysis for crude oil and water characteristics. Case Stud Therm Eng. 2023;49:102798.
6. Forson FK, Nazha MAA, Akuffo FO, Rajakaruna H. Design of mixed-mode natural convection solar crop dryers: Application of principles and rules of thumb. Renew Energy. 2007;32(14):2306-19.
7. Garg HP, Krishnan KP, Thanvi PC, Pande PC. Development of a low-cost solar agricultural dryer for arid regions of India. Energy Agric. 1987;6(1):35-40.
8. Bishwash H, Bobadi S, Nikam M. Design & material optimization of a solar dryer-tray section. ResearchGate. 2017;27-34.
9. Venkatesh JD. Shot peening effects on Cr-Mo-V steel: a comprehensive study of microstructure, surface roughness, residual stress, and mechanical behaviour. Eng Res Express. 2024;6(3). Available from: https://iopscience.iop.org/article/10.1088/2631-8695/ad777f
10. Tshimenga K, Mwamba I, Kayola J, Mulumba L, Gitago G, Tshibad CM, *et al*. Comparison of two drying methods of mango (oven and solar drying). MOJ Food Process Technol. 2017;5(1):240-3.
11. Krishna VS, Mathew G. Development of a solar copra dryer incorporated with evacuated tubes. Int J Curr Microbiol Appl Sci. 2018;7(6):2457-65. https://doi.org/10.20546/ijcmas.2018.706.292
12. Krishna VS, Jain SK, Panwar NL, Sunil J, Wadhawan N, Kumar A. Emergence of Internet of Things technology in food and agricultural sector: A review. J Food Process Eng. 2024;47(8):e14698. https://doi.org/10.1111/jfpe.14698
13. Krishna VS, Sagili JL, Dikkala PK, Sridhar K. Functional, thermal, pasting, and rheological properties of gluten-free maize composite flour: Effect of moth bean flour and hydrocolloid addition. J Food Process Preserv. 2021;45:e16104. https://doi.org/10.1111/jfpp.16104
14. Kumar J, Rajesh GM, Singh G, Sambasiva Rao P, Kumar P. Monitoring land use dynamics and agricultural land suitability in Samastipur District, Bihar using Landsat imagery and GIS. J Clim Change. 2024;10(4):43-53. https://content.iospress.com/articles/journal-of-climate-change/jcc240031
15. Diamante LM, Bai X, Busch J. Fruit leathers: Method of preparation and effect of different conditions on qualities. Int J Food Sci. 2014;2014:1-12.
16. Mohanraj M, Chandraseker P. Comparison of drying characteristics and quality of copra obtained in a forced convection solar drier and sun drying. J Sci Ind Res. 2008;67:381-5.
17. Mustayen AGMB, Mekhilef S, Saidur R. Performance study of different solar dryers: A review. Renew Sustain Energy Rev. 2014;34:463-70.
18. Rajeshwari N, Ramalingam A. Low cost material used to construct effective box type solar dryer. ResearchGate. 2012.
19. Onigbogi IO, Sobowale SS, Ezekoma. Design, construction and evaluation of a small-scale solar dryer. J Eng Appl Sci. 2012;4:7-21.
20. Pakhare VV, Salve SP. Design and development of solar dryer cabinet with thermal energy storage for drying chilies. Int J Curr Eng Technol. 2016;5:358-62.
21. Panchal VS, Pandey AA, Kharche S, Pathan F. Heating of air with the help of the solar evacuated tube. Int J Adv Res Dev. 2018;3(4):156-8.
22. Singh PK, Logesh K, Kumar SS, Kannan S, Tejaswini V, Soudagar MEM, Obaid SA. Revolutionizing the material performance of AZ64/ZrB2 composites for engineering applications. Rev Materia. 2025;1-10. http://dx.doi.org/10.1590/1517-7076-rmat-2024-0356
23. Kalogirou SA. Solar dryer—Industrial process heat, chemistry applications, and solar dryers. Renew Energy. 2014;10(4).
24. Paul SC. Comparative study of mango leather. J Food Technol Rural Ind. 2011;10-13.
25. Sukhatme SP. Solar energy - Principles of thermal collection and storage. 2nd ed. New Delhi: Tata McGraw Hill; 1996.