

Research Article

MOESUN: The Mobile Solar Dehydrator, An Overview

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Abstract: Seeing the lack of food source over the years with a greater rise during the pandemic and a contribution of increasing population, it is of utmost importance for the masses to seek ways to preserve and improve food sorting methods. As dehydrating foods has been one of the more primordial methods of food conservation, the team seeks to innovate a better dehydrator for home use. MOESUN provides the convenience for homeowners and small businesses to dehydrate food through the portable solar dehydrator. A compact solar dehydrator, this innovative design is space saving and easy maneuverable within the homeowner's yard. It can be set to face the Sun movement throughout the day to provide optimal food dehydration. MOESUN can be considered as a solar oven with a primary function as a dehydrator. As MOESUN is fully covered by polycarbonate-based material, this dehydrator provides a more hygienic alternative to the regular sun drying method.

Keywords: dehydrator; solar dried; heat retention.



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1. INTRODUCTION

Various factors that include political and social conflicts, socio-economic conditions, natural hazards, climate change, and pests that are currently happening all over globally has caused an increase in chronic and acute hunger (Aday, 2020; World Bank, 2021). Even with these factors contributing to the rising food hunger and scarcity globally, the sudden pandemic that hit worldwide for the past 3 years has also affect food security. Despite the shift towards endemic, food security problems will continue to rise over the next few years. With these factors contributing to food security, it is of utmost importance to seek methods of improving shelf life of harvest cropped to improve food security. It is estimated that there can be at least 40 to 50 percent of post-harvest losses in developing countries due to the easily perishable nature of the crops and the inability to preserve crops before degradation (Wakholi, 2015).

The open drying process is one of the methods for food preservation. A study by Hernandez et al and Garcia et al discusses on how there are an abundant of fruit production during harvest season in Ecuador but lacks in useful shelf life which gives the stakeholders in the agroindustry to utilize different preservation method (Hernandez, 2010,2014; Garcia, 2015). This preservation method uses direct solar exposure to remove moisture content from the products. By dehydrating these crops, produce can be kept longer, and food wastes can be avoided in the long run. While this method is economical on a large scale due to it cheaper operating costs as compared to an electrical dehydrator, this method poses problems as in it freely exposed to the unpredictable weather, animal attacks, dusts, and fungi. Not only that, but the unpredictable weather would also affect the moisture removal rate from the products as heat is not maintained as it lacks the enclosure. An electrical dehydrator may solve this problem as heat is circulated within an enclosed space, however, electricity consumed by the dehydrator would become additional costs which will be incurred in the final product price. With the enclosed drying area or more commonly called as the solar dehydrator, dried products are less exposed animal attacks, pests, and dusts, making them more hygienic by lacking food contamination and has better quality, flavorful nutrient-dense food (Abideen, 2019).

While the solar dehydrator poses quite the advantage, it was suggested that a forced convection solar dryer provides a better control on the required drying air conditions as compared to natural convection solar dryer which does not require any other energy during operation (Pangavhane, 2002). However, the team focuses on studies to seek the optimal design for the natural convection solar dehydrator. As natural convection solar dehydrator such as MOESUN is much more economical than forced convection solar dryer, this product would attract a target of lower income bracket groups to use for their business. An optimally design product would give a better utilization and efficiency to the solar dehydrator. Previous studies (Mustayen, 2014; Zheng, 2017) showed parameters such as sample thickness and drying tray material are just as important to the performance of the solar dehydrators. Not only that, but there were also previous papers that studied wall color and profile effects on the effectiveness of a solar dehydrator (Katunsky, 2022; Halidi, 2022)

2. METHOD & MATERIAL

A solar dehydrator, by its brand name, MOESUN, is constructed for the study. The solar dehydrator frame is made of steel, and it is enclosed using circular-shapes transparent polycarbonate sheets. The dehydrator is placed on an open area, not to be obstructed by the trees and building and in the lines of sunset and sunrise to obtain maximum solar exposure. The dehydrator is left for a maximum of 8 hours a day and to be observed hourly for its temperature reading. Data is also taken during cloudy windy weather to seek whether the dehydrator works during a less hot weather. The effectiveness of the mobile solar dehydrator is measured through temperature difference and the amount of moisture loss that can be obtained during a specific period. A high temperature difference would indicate sunlight is able to penetrate through the walls of the dehydrator and focus the heat on it.

3. FINDINGS

Table 1 shows the percentage moisture content loss for different slicing sizes. Table 2 exhibits the percentage moisture content loss for specimens used on different colored drying tray. Table 3 exhibits the maximum average temperature difference on different wall color for mobile solar dehydrator.



Figure 1. A construction of MOESUN, the mobile solar dehydrator

Table 1. Percentage moisture content loss for different slicing sizes.

Slicing Size (mm)	Averaged Moisture Content Loss (%)
3	84.15
5	82.91
7	73.17

Table 2. Percentage moisture content loss for specimens used on different colored drying tray.

Drying Tray Color	Averaged Moisture Content Loss (%)
Non-color coated	85.40
White	86.05
Black	84.95

Table 3. Maximum average temperature difference on different wall colored mobile solar dehydrator

Wall Color	Maximum Average Temperature Difference (°C)
Non-color coated / transparent	10.2
Yellow	5.2
Black	3.4

4. DISCUSSION

Based on Table 1, slicing size with the least thickness has the highest moisture loss when being dried for eight hours. This correlates with the study conducted by Dhalsamant that showed the thinnest slice would have the most moisture loss for the same drying time (Dhalsamant, 2018). A longer drying time is needed for thicker slicing size as there are more moisture or water content in thicker slices to achieve the same amount of moisture loss. Transparent wall or non-colored dehydrator wall has the highest maximum average temperature difference at 10.2 °C as shown in Table 2. Black has the lowest amount of temperature difference at 3.4 °C. This is true as light is much less penetrable through black colored wall when compared to transparent and yellow-colored walls (Katunsky, 2022). As black paint absorbs all the sunlight instead of reflecting it, there was not enough light that penetrates through the wall to provide the same amount of heat as the transparent colored walls. This concept is also applicable to the drying tray result as shown in Table 3. White colored drying tray has the highest specimen

moisture loss at 86.05 % and black colored drying tray has the lowest specimen moisture loss at 84.95% with the same drying time and slicing size. As less light is reflected, less heat is reflected to the specimens used for drying. As a result, less moisture is lost during the drying process.

5. CONCLUSION

It can be concluded that the above parameters mentioned and experimented do affect the effectiveness of a mobile solar dehydrator. Based on these data, potential users may need to adjust their drying time accordingly to achieve needed moisture loss specified by the users. While all these factors do contribute to designing an effective mobile solar dehydrator, it must also be emphasized that weather also plays a contributing role to the dehydrator. During rainy season, users of MOESUN may opt to add on a fan to further expedite the drying process in the mobile solar dehydrator. However, this would come as additional costs and also a need for a different design construction which must be included in any clients' consideration for MOESUN.

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References

- Abideen, Z., Aziz, S., Aisha, E., Hafiz, K., & Rehman, A. (2019) Drying of tomato using indirect solar dryer. *ESTIRJ* 3(1), 9-13.
- Aday, S. and Aday, M. S. (2020). Impact of COVID-19 on the food supply chain. *Food Quality and Safety*, 4(4), 167-180.
- Dhalsamant, K., Tripathy, P.P., Shrivastava, S.L. (2018) Food and Bioproducts Processing Heat Transfer Analysis During Mixed-Mode Solar Drying of Potato Cylinders Incorporating Shrinkage. *Food Bioprod. Process.* 109, 107-121.
- García, A. I, Justinovich, S., Angel, L., & Heredia, T. (2015) Secadero solar forzado para productos agrícolas. *Averma*, 19(2), 21-28.
- Halidi, S.N.A.M., Dahlan, A., Jini, I.H., Mafazi, N.W. (2022) Exploratory Temperature Comparison on Different Profiles of Polycarbonate Corrugated Sheet for Mobile Solar Dehydrator. *Proceedings of the 7th International Conference and Exhibition on Sustainable Energy and Advanced Materials*, 438-442.
- Hernández, R. J., Martínez, V. O., Quinto, D. P., Cuevas, D. J., Acosta, O. R., & Aguilar, J.O. (2010). Secado de chile habanero con energía solar. *Revista Iberoamericana de Tecnología Postcosecha*, 10(2), 120-127.
- Hernández, R. J., Flores, M.F., Acosta, O.R. & Barbosa P. G. (2014) Secado solar de productos agrícolas. *Caos Conciencia*, 8(1), 25-34.
- Katunský, D., Dolníková, E., Dolník, B., Krajníková, K. (2022) Influence of Light Reflection from the Wall and Ceiling Due to Color Changes in the Indoor Environment of the Selected Hall. *Applied Sciences* 12(10), 5154.
- Pangavhane, D. R., Sawhney, R. L., & Sarsavadia, P. N. (2002) Design, development, and performance testing of a new natural convection solar dryer. *Energy* 27(6), 579-590.
- The World Bank Brief (2021). Food Security and COVID-19, last accessed 2021/09/10.
- Wakholi, C., Cho, B.-K., Mo, C., Kim, M.S. (2015). Current State of Post-harvest Fruit and Vegetable Management in East Africa. *J. Biosyst. Eng.* 40, 238-249.
- Zheng, W., Zhang, H., You, S., Fu, Y., & Zheng, X. (2017) Thermal performance analysis of a metal corrugated packing solar air collector in cold regions. *Applied Energy*, 203, 938- 947.