Comparative analysis of drying properties of sole fish (*Cynoglossus malabaricus*) dried using open sun, solar-LPG and infrared dryer

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Drying is one of the most commonly used energy-intensive preservation methods in post-harvest processing of food materials. Food materials, such as various fruits, vegetables, herbs, and other agricultural products are dried to reduce their water activity to a microbiologically safe level. Reducing the water activity of food products down to a level that prevents bacterial growth, enzymatic reactions, and other deteriorative processes, extends their shelf life. The high moisture content of fish makes it extremely perishable. It is therefore dried to extend its shelf life and make it available all year round. As per FAO (2020), 17 million metric tons of fish, accounting for 12% of global fish production, were consumed in dried, salted, and smoked forms (Neranjala, Eranga, and Dissanayake, 2022). Dried fish export from India increased from 7,506 tons in 1995 to a commercial scale of 88,997 tons in 2017 (Madan et al., 2018). The nutritional value and quality of the dried fish are also retained after drying (Al Banna et al., 2022). Traditionally, fish is sun-dried in the open space. It is the cheapest method of drying that exposes fish to sunlight and natural wind movement. The effectiveness of the drying is determined by prevalent weather conditions, moreover hygiene of the process is not ensured.

Solar drying method that eliminates the drawback of open-sun drying is drying using a solar-LPG hybrid dryer which harnesses thermal energy and stores it for a few hours by using the flat plate water collectors. This method allows fish products to be dried hygienically, and under controlled conditions, producing high-quality products. In comparison to conventional open-sun drying, the drying period is also shortened (Murali, Amulya, Alfiya, Delfiya, and Samuel, 2020). Advanced drying methods such as infrared (IR) drying, which uses IR radiations to penetrate the product increase the rate at which moisture is removed from the product, shorten the drying time and enhances the quality of the dried product (Prashob, Aniesrani Delfiya, Murali, Alfiya, and Samuel, 2022).

The current study examines how drying method affect the quality and drying characteristics of *Cynoglossus malabaricus*, also called tongue sole fish. Sole fish is widely consumed in the form of dried fish in Kerala. Sole fish was dried by three methods; a batch-type infrared dryer, a solar-LPG hybrid dryer, and open sun drying. Sole fish purchased from local fish landing centre was thoroughly cleaned, and was subjected to drying. The initial moisture content of the fish was measured using the gravimetric method. Weight loss during drying was measured at an interval of 60 minutes. The chamber temperature of the solar LPG dryer and IR dryer was set at 60°C. The sample was kept under direct sunlight for open sun drying. Temperature and humidity readings ranged between 32.55 to 40.9°C and 59.18 to 29.04% respectively when measured every 60 minutes using a datalogger (EMCON, Kerala). Vernier calipers were used to measure the initial and final dimensions of the sample to find out the percentage of shrinkage. The method described by Doymaz and Ismail (2011) was used to determine the rehydration ratio of dried sole fish. The different methods employed for drying is depicted in Figure 1.

Table 1. Drying and quality characteristics of sole fish

Drying method	Drying time (h)	Final moisture content (%)	Average drying rate (g/gsolids.h)	Shrinkage (%)	Rehydration ratio
Open sun drying	19	16.77	0.15	24.85	1.66
Solar-LPG hybrid dryer	11	14.82	0.26	17.77	1.77
Batch type infrared dryer	8	12.78	0.36	16.05	1.95

(a) Open sun drying (b) Solar-LPG hybrid dryer (c) Batch type IR dryer

Fig. 1. Different drying techniques employed for sole fish drying

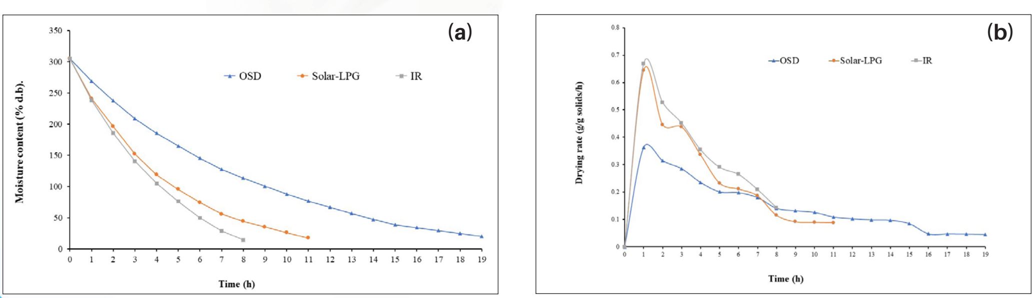

Fig. 2. Change in moisture content (a) and drying rate (b) of sole fish against time in different drying methods

Fig. 3. Sole fish before and after drying in Batch-type IR dryer

The sole fish sample had an initial moisture content of 75.32 (% w. b.) which was reduced to 16.77(% w. b.) in open sun-dried fish, 14.82 (%w. b) in Solar-LPG dried fish, and 12.78 (% w. b.) in batch type infrared dryer (Fig. 2a). The sample dried in Batch type infrared dryer dried in 8 h. The samples dried under an IR dryer showed the highest drying rate (0.36 g/g solids/h) followed by a Solar-LPG hybrid dryer (0.26 g/g solids/h) and open sun drying (0.15 g/g solids/h) (Fig. 2b). The quality characteristics of dried sample is given in Table 1. Batch-type infrared dryer had the least shrinkage (16.05 %) after drying, followed by Solar-LPG hybrid drying (17.77 %) and the maximum shrinkage of 24.85% was observed in open sun drying. The rehydration ratio was found highest for sole fish dried in batch type infrared dryer, followed by solar-LPG dryer and open sun drying.

From the study, it was concluded that, batch type IR dryer was found to be most efficient for drying sole fish. IR drying takes only less time to dry the sample. Moreover, IR drying improved the drying rates when compared to solar-LPG hybrid drying and open sun drying with less shrinkage and better rehydration.

References

Al Banna, M.H., Hoque, M.S., Tamanna, F., Hasan, M.M., Mondal, P., Hossain, M.B., Chakma, S., Jaman, M.N., Tareq, M.A., and Khan, M.S.I. (2022). Nutritional, microbial and various quality aspects of common dried fish from commercial fish drying centers in Bangladesh. Heliyon. 8, Article e10830. https://doi.org/10.1016/j.heliyon.2022.e10830.

Doymaz, I., and Ismail, O. (2011). Drying characteristics of sweet cherry. Journal of Food and Bioproducts Processing, 89, 31–38. https://

doi.org/10.1016/j.fbp.2010.03.006.

Madan, M.S., Kalidoss, R., Ranjith, L., Narayanakumar, R., Aswathy, N., and Kanthan, K.P. (2018). Economics and marketing of dry fish production in Thoothukudi District, Tamil Nadu, India. International Journal of Fish, 65(4), 135-141. https://doi.org/10.21077/ijf.2018.65.4.53463-16.

Murali, S., Amulya, P.R., Alfiya, P.V., Delfiya, D.A., and Samuel, M.P. (2020). Design and performance evaluation of solar-LPG hybrid dryer for drying of shrimps. Journal of Renewable Energy, 147, 2417-2428. https://doi.org/10.1016/j.renene.2019.10.002.

Neranjala, T.P.U., Eranga, W.G.D., and Dissanayake, D.C.T. (2022). Dried fish production and trade in Negombo, Sri Lanka. Sri Lanka Journal of Aquatic Science, 27(1), 31-43. https://orcid.org/0000-0001-8270-1641.

Prashob, K., Aniesrani Delfiya, D.S., Murali, S., Alfiya, P.V., and Samuel, M.P. (2022). Drying of shrimp using hot air-assisted continuous infrared drying system. Journal of Food Process and Preservation, 46(9). Article 16364. https://doi.org/10.1111/jfpp.16364.