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Refractance Window Dryer: An Innovative Approach to Modern Drying

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Scene 1: A conversation among different dryers in the laboratories of the Department of Processing and Food Engineering, Punjab Agricultural University.

Refractance window dryer (RD): "Hello, everyone, why does everyonelook so sad?

Tray dryer (TD): "Hello, RD, being in the corner feels lonely".

Spray dryer (SD): "Hello, RD, same situation here as well".

Freeze dryer (FD): "Hey, RD, same brother".

Refractance window dryer: "What happened? Are students not using you for drying purposes?".

Tray dryer: "RD, students say the products are not up to the mark. The quality is not good as well as the appearance is not appealing".

Spray dryer: "RD, for me it's all about high cost and temperature. They say I am very costly machinery and the product has to undergo high temperature. Hence, they lose their nutritive value".

Freeze dryer: "RD, although I preserve the quality of dried product, I take a lot of time to dry the product. These days students are very busy, they want everything to be done as early as possible. Above all, I am high maintenance like SD".

Refractance window dryer: "Oh! Now I get it, it's upsetting when no one uses us for drying of crops".You know I am the solution to all the problems you have".

Tray dryer: "How are you the solution to the problem we have?"

Spray dryer: "Same here."

Freeze dryer: "Same here."

Refractance window dryer: "Ok, don't get curious, I will tell u."

Tray dryer: I am all ears.

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Spray dryer: I am hearing you.

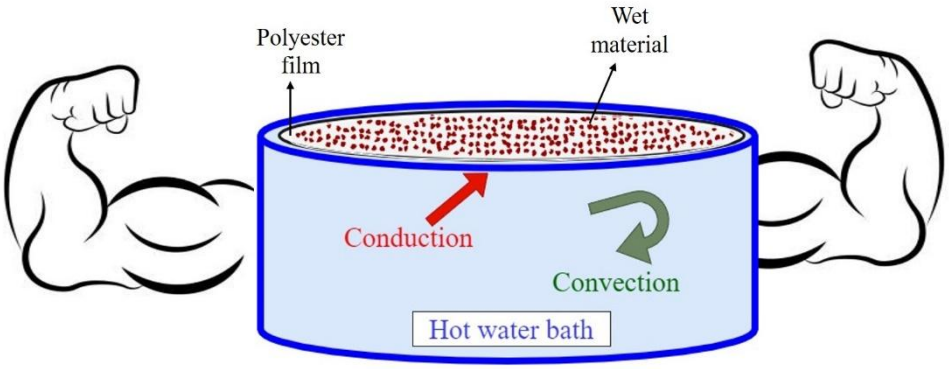
Freeze dryer: Me too.

Refractance window dryer: "You all know, between harvest and consumption, there are significant losses in both the quantity and quality of the fresh product. The extent of these post-harvest losses in fresh produce is estimated to be between 20 and 80 percent, depending on the product and level of post-harvest technology. Fresh food has high water content and requires a suitable method for reducing water content after harvest to extend shelf life".

Tray dryer: "RD, we know this. How is this helping us? This is where we come for use. We are the most important post-harvest process to decrease the water content of fresh produce. You are saying things that everyone knows, but not telling us the solution. Do you agree with me SD and FD?"

Spray dryer and Freeze dryer (together): "Yes, we agree with you."

Refractance window dryer: "Guys, relax and keep on listening to me. Don't get aggressive.Historically, drying processes were energy-intensive, consuming 12 to 20 percent of the total energy required in production. Like, what SD and FD were complaining about. I am a fourth-generation dryer (the most recent breakthrough in drying technology) which is energy efficient while retaining the product's nutritional quality."



Refractance window dryer

'I am THE DRYING-MACHINE'

Tray dryer: "Explain to us the whole story, don't brag."

Refractance window dryer: "Wait, I am telling. I am an indirect type of drying method, not like you, where products come in direct contact with hot air. Hence, making them dark, less tasty and losing their nutritional quality."

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Spray dryer: "What do you mean by indirect-type drying method, don't you use hot air like me and TD?"

Refractance window dryer: "No, I use water as a heating medium and a specialized polyester film to pass heat energy. This film is kept over hot water, which passes heat energy through the water to the material using conduction as a mode of heat transfer. Therefore, the heating material does not touch the food material. By, this way I dry material very fast and I don't need too much electricity like you guys."

Refractance window dryer: "Now you know, how, I am the solution."

Freeze dryer: "Hey, you are not even in our laboratories."

Refractance window dryer: "Oh! Now I get why she is busy making me in her laboratory. You know I feel sad for her. It was a bit challenging for her."

Spray dryer: "What were her challenges?"

Refractance window dryer: "As I said before, I require specialized polyester film for drying. It is not easily available in the market, but after continuous searching, she was able to locate an industry near Ludhiana, Punjab that supplies an identical material."

Freeze dryer: "Everyone, our students are very impressive and hard-working. They always find a solution."

Refractance window dryer: "Yes, I agree with you FD. After finding the polyester film, my development of me started using theoretical calculations. Also, as I said earlier, I am time and energy efficient. I was evaluated using potato crop."

Tray dryer: "You, told us about how good you are but I don't believe you. Let us dry the same products in me and do the quality analysis."

Refractance window dryer: "Sure, let's do it."

End of conversation

Scene 2:Experimental work in the laboratory

After the construction of the refractance window dryer, it was evaluated by drying potato puree. The potato variety employed in the research is widely produced in the Punjab province. This cultivar is generally used for table consumption due to its high reduced sugar content. Several pre-trials were carried out in order to make this variety suitable for processing by lowering the quantities of reducing sugar. Further, the puree made using these potatoes was dried in a refractance window dryer and tray dryer.

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Potato drying was carried out utilising a combination of internal and external factors such as pre-treatment time, total soluble solids in puree, and drying temperature.It was observed that the puree dried in a refractance window dryer took 150 minutes which was faster as compared to the tray dryer which took 540 minutes. Different tests were performed to determine whether the dried potato flakes retained quality or not. It was observed thatrefractance window-dried potato flakes hadbetter nutritive retention than tray-dried potato flakes.

Consumers tend to choose items based on a certain colour. It was noticed that flakes dried by refractance window dryer had a brighter colour and nearly little to no browning. The study indicated that the refractance window drying system is a mild dehydration process, with better retention of nutrients, flavour, and colour in the dried product. Aside from potato puree, the designed dryer was also utilised to dry various fruits such as tomato, papaya, and pumpkin, as well as vegetable purees such as black carrot, ginger, potato and garlic. Similar results were observed like shorter drying time and better-quality flakes as compared to time-consuming drying methods.

This research was also presented at several national and international conferences, where it received several awards. A few national and international publications were published in this research project.

Finally, the proposed method is a simple and low-cost technology that may be used on farms as well. Aside from reducing food waste and prolonging product shelf life, varied energy sources may be used efficiently, for example, water can be heated in several ways by allowing using the least costly energy source. Additionally, customers are gradually looking for nourishing, high-quality foods at modest prices. It is therefore expected that the refractance window dryer will become one of the most popular and accepted techniques in the food sector for the production of powders and flakes of high value and quality. The food powders or flakes obtained can be further fortified in ready-to-eat foods, soups, baby foods etc.

While the refractance window drying process is quick but has room for improvement. An analysis of the relative contributions of the modes of heat transfer to the drying process is necessary to be calculated. The refractive window drying systems currently under development are massive and require more room to deploy in commercial and pilot plant

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applications. As a result, research and design modifications to the refractance window dryers are required to expand their applicability in the food business.

Keywords: flakes, fruits, puree, quality, refractance window dryer, vegetables