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Drying kinetics of apple pomace by-product using Refractance Window

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INTRODUCTION & AIM

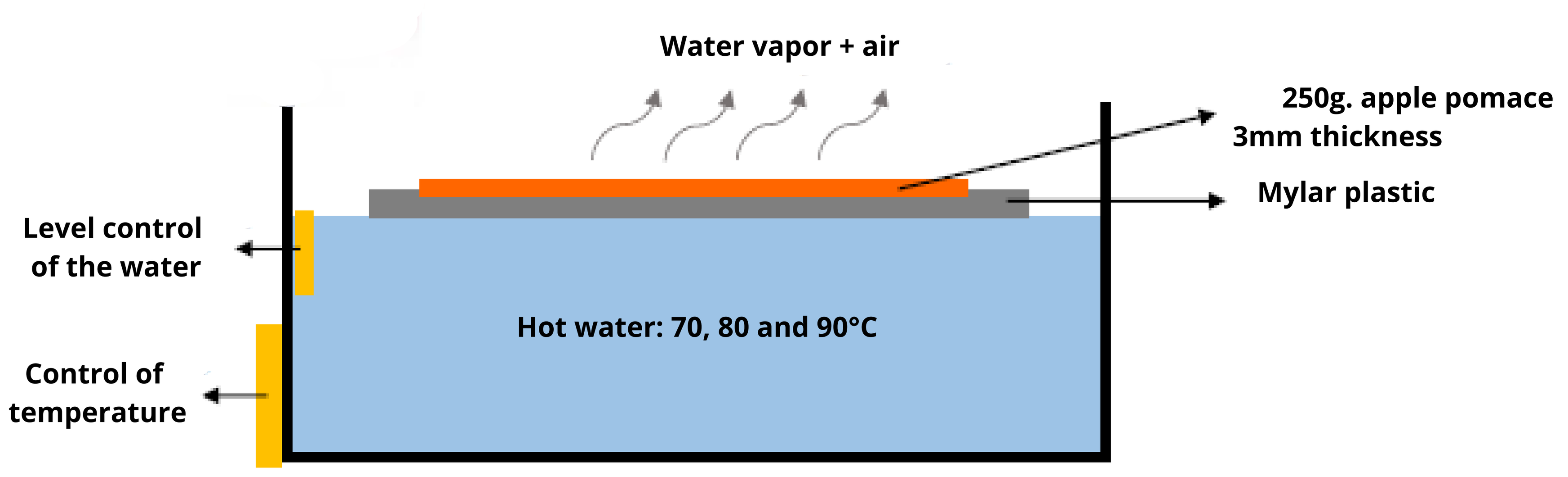
Apple pomace is a byproduct obtained from pressing apples, primarily in the natural apple juice manufacturing industry. The polyphenols, which have bioactive effects, are mostly found in the pomace due to their predominant location in the peel.

Drying is one of the oldest preservation methods, used to reduce the water content in foods, improving their storage, transportation and durability. The process consists of removing water through evaporation by applying heat, which consumes large amounts of energy. A key challenge is achieving efficient and environmentally sustainable drying. There are advanced technologies, such as refractance window drying, that allow rapid and efficient drying, maintaining the quality of the food in terms of nutrients, texture and color. This method uses indirect heat and a plastic film to facilitate the transfer of thermal energy, resulting in high quality products.

The objective of this work was to study the refractance window drying kinetics of apple pomace with a focus on the development of ingredients from this byproduct.

METHOD

In this study, thin layer drying of apple pomace was investigated using the refractance window (RW) technique. First, the initial humidity of the samples was determined using a standardized method and, subsequently, drying processes were carried out at different temperatures, specifically temperatures 70, 80 and 90 °C

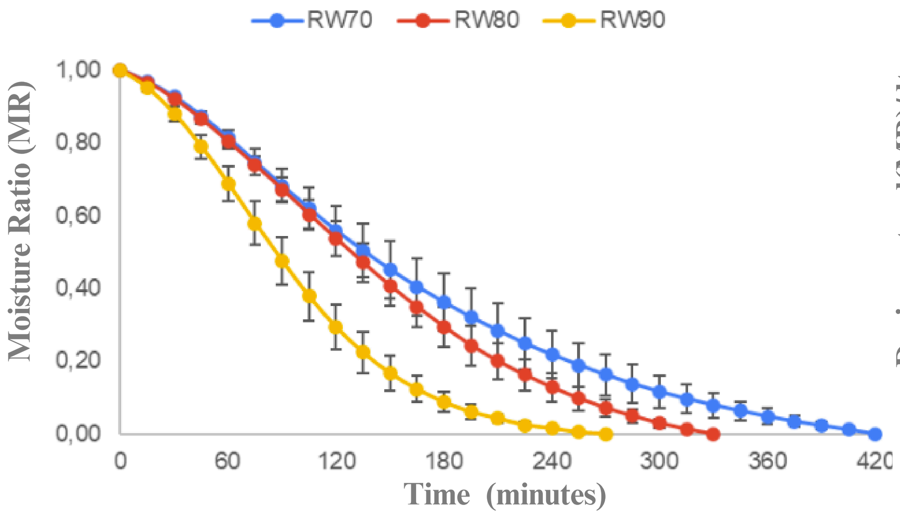


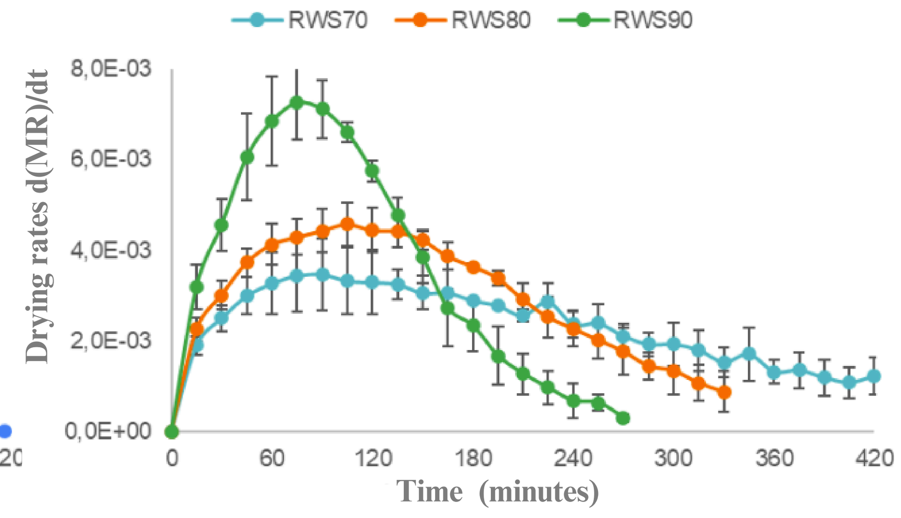
The moisture ratio (MR) was calculated and drying rate curves were constructed. In addition, the effective diffusivity coefficient (Deff) and activation energy (Ea) were determined by applying the Arrhenius equation. While to model the drying kinetics, several mathematical models were used, such as Newton, Henderson and Pabis, Page and Weibull.

The determination of the total polyphenol content was carried out by spectrophotometry at 765 nm, following the Folin-Ciocalteau method described by Singleton and Rossi (1965). Both wet and dry apple pomace samples were evaluated before and after treatments. To quantify polyphenols, a standard curve was constructed with gallic acid, which was used to interpolate the results. The calculations were expressed on a dry basis.

RESULTS & DISCUSSION

Drying apple pomace at 70°C, 80°C and 90°C shows that as the temperature increases, the drying time decreases significantly. When going from 70 to 80°C, the time is reduced by 90 minutes, and from 70 to 90°C, by 150 minutes, due to greater heat transfer. Drying rates are higher at the begining, with RWS90 being 1.56 times higher than RWS70. Drying has three phases: heating, constant and decreasing speed, with the latter predominating.





The diffusivity and activation energy (Ea = 34.87 kJ/mol) increase with temperature. The Weibull model fits better, with lower error values and better statistical indices (R^2 and RMSE) compared to other models.

Coefficient of determination R square (R^2%)			
Model	**RW70**	**RW80**	**RW90**
Newton	93,9	88,6	90,4
H-P	92,2	94,5	95,2
Page	99,9	99,8	99,9
Weibull	**99,9**	**99,8**	**99,9**

T. ª (°C)	Deff $x10^{-10}$ (m^2/ s)	Polyphenols mg EAG/ 100 g.b.s
Control	-	461,78 ± 1,53a
70	1,48 ± 0,19a	211,40 ± 0,41b
80	1,85 ± 0,22a	287,51 ± 0,29c
90	2,92 ± 0,19b	259,32 ± 0,68bc

Root Mean Square Error (RMSE)			
Model	**RW70**	**RW80**	**RW90**
Newton	$6,47x10^{-2}$	$8,80x10^{-2}$	$8,49x10^{-2}$
H-P	$4,95x10^{-2}$	$7,14x10^{-2}$	$6,94x10^{-2}$
Page	$9,77x10^{-3}$	$1,44x10^{-2}$	$5,31x10^{-3}$
Weibull	**$9,68x10^{-3}$**	**$1,40x10^{-2}$**	**$5,19x10^{-3}$**

The samples dried at 80 °C had a significantly higher concentration of polyphenols compared to 70 °C, and also compared to 90 °C, although not significantly compared to the latter.

CONCLUSION

Drying apple pomace is more efficient at higher temperatures, significantly reducing the time and increasing the drying speed. The Weibull model offers the best fit to predict the process, surpassing other models in statistical precision. Drying at 80°C is the most effective for preserving the polyphenols of apple pomace, which can be used as functional additives in food products, offering antioxidant and preservative benefits.

FUTURE WORK / REFERENCES

Puente-Díaz, L., Spolmann, O., Nocetti, D., Zura-Bravo, L., & Lemus-Mondaca, R. (2020). Effects of Infrared-Assisted Refractance WindowTM drying on the drying kinetics, microstructure, and color of Physalis fruit purée. Foods, 9(3), 343. https://doi.org/10.3390/foods9030343