Journal of Advanced Zoology
ISSN: 0253-7214
Volume 44 Issue S-6 Year 2023 Page 2048:2056

Effect of different drying techniques on the quality attributes and antioxidant properties of green banana pulp

Pragati Kumari [1], Seyashree Hazra[2], Najmun Nahar[1]*
[1]Department of Food Science, Maulana Abul Kalam Azad University of Technology, West Bengal, India.
[2]Department of Food Technology and Biochemical Engineering, Jadavpur University, Kolkata, India
*Corresponding author's Email ID: najmun.nahar@makautwb.ac.in

Article History
Received: 28 September 2023
Revised: 21 October 2023
Accepted: 02 November 2023

Abstract
The green banana is a major crop in the tropics and subtropics. Raw bananas are packed with many nutrients and phytochemicals, which play a significant role in promoting health. Preserving green banana pulp is challenging because of its high moisture level. Drying is a crucial component in conserving and exploiting residual pulp materials. This study is innovative in investigating various drying techniques for banana pulp and subsequently conducting a comparative analysis of different drying techniques concerning their outcomes. The physiochemical characteristics such as moisture diffusivity, texture, color, and phytochemicals are also thoroughly examined.
The study determined that the Midlli model is the best drying model based on a low RMSE value and AIC value. Porosity (55.3 %) is very high in the Microwave at 450 watts. Bulk density and particle density values in the Microwave at 450 watts were 0.21 gm/cm3 and 0.47 gm/cm3. Hot air-dried products have the highest whiteness (L*: 86.01) than the other dried samples. The redness (a*: 3.53) and yellowness (b*: 17.62) of the Microwave drying at 900 watts is more than other dried samples. Hardness (4.13 N), chewiness (26.61 kg-mm), and resilience (0.0043 J/m3) were low in the product dried at 450 watts in Microwave drying. It was found that microwave-dried samples are closely related to each other compared to others. On an overall basis, it was found from the study that Microwave drying is considered the most effective drying technique, resulting in the highest concentration of readily accessible antioxidants content (742.30 **µg/g)**, and other parameters.
Keywords: Banana Pulp, Drying kinetics, Phytochemicals, Organoleptic properties.

1. Introduction

People are becoming increasingly aware of the importance of a healthy diet. Banana (Musa paradisiac, Family Musaceae) is a major tropical and subtropical fruit crop. They require cooking and are used when green or under-ripe. They are a staple food in tropical regions of the world and are used in varied ways like steamed, fried, etc. Because of the presence of phytochemicals and nutrients, bananas are considered an important fruit in terms of nutritional value and properties (Ashokkumar et al., 2018).
Raw bananas have more dietary fiber because of their high resistant starch content. The Green Banana contains fiber 3 grams, Potassium 9% of the daily value (DV), Vitamin B6 25% of the DV, Vitamin C 11% of the DV, Magnesium

7% of the DV, Copper 10% of the DV, Manganese 14% of the DV (Sidhu & Zafar, 2020). Raw bananas have a low glycemic index of 42.

In addition to lowering the product's moisture content and extending its storage life, drying significantly reduces the cost of packaging, storing, and transporting the product (Onwude et al., 2016). Drying has a major impact on the sample's antioxidant content, texture, and color, all of which are frequently acknowledged as important elements in determining consumer acceptability of a product.

Thin-layer drying models, mathematical equations that represent this phenomenon, show how water is removed from a thin layer of solid material as it dries. It is well acknowledged that texture and color play a key role in influencing consumer acceptance of a product.

Thus, the purpose of the study is to examine the impact of seven drying on drying kinetics, texture, color, antioxidant content, and activity to produce banana pulp with the best qualitative and quantitative attributes.

2. Materials and methods

2.1 Raw materials

Raw Banana (Musa paradisiac, Family Musaceae) was brought from the local market.

2.2 Chemicals

All reagents were purchased from Sigma-Aldrich (Mumbai, India), and SD Fine Chemicals (Mumbai, India).

2.3 Preparation of sample

Raw Banana was taken and washed properly. After washing peeling of the banana was done then it was cut into slices of thickness of 4-5mm and a diameter of 20-30mm using a clean stainless-steel knife. On a dry basis (db), the initial moisture content of the collected green banana pulp was around 75% and the final moisture content was around 3%. For each drying, around 70 gm of sample was taken. During drying, they were placed on a Petri plate with a diameter of 14.7 cm and 1.5 cm in length, and the plate was placed at the center of the driers until constant weight was attained. After drying, samples were placed in a desiccator to maintain the moisture level and used for further analysis.

2.4. Drying methods

2.4.1. Hot air oven drying (HD)

The hot air oven (Mac Pharma Tech, SS-24, India) was used to dry banana pulp. Throughout the procedure, the temperature was maintained at 60°C (Liu et al., 2017) with an air velocity of 1 m/s. The total time taken for HD was noted as 5 hours, and weight (wt.) was taken at 30-minute intervals.

2.4.2. Microwave drying (MWD)

The drying was carried out using a microwave oven (CE1041DFB/XTL, working frequency – 2450 MHz, Samsung, India) with configurable irradiation time and the following power levels- 900, 600, 450, 300,180 and 100 Watt. Irradiation time was adjusted according to the power levels.

2.4.3 Sun drying (SD)

Experiments with sun-drying were conducted during the period of the last week of April to 1st week of May in Haringhata, Nadia, and West Bengal. From 10:00 am to 4:00 pm. The total time taken for SD was noted as 12 hours, and weight (wt.) was taken at 1.15 hrs. intervals.

2.5. Analysis of Drying

The moisture content (MC) of the sample was calculated as follows: Saha et al., (2019) reported the calculation of the sample's moisture content using a formula that was specified as follows:

$$M_t = \frac{W_t - W_{dry}}{W_{dry}} \quad (1)$$

W t and W dry denote the wt. of the sample at time t and ∞ (dry matter). The sample's moisture ratio was determined through the following equation (2) collected from (Deng et al., 2018).

$$MR = \frac{(M_t - M_e)}{(M_0 - M_e)} \quad (2)$$

Mt, Mo, and Me denote the moisture content at time t, 0 (initial moisture content) and ∞ (equilibrium moisture content) respectively.

The equilibrium moisture level for each run was obtained by measuring the ultimate moisture content (Saha et al., 2019).

2.6. Drying kinetics

The application of thin-layer drying models is commonly utilized in characterizing the drying kinetics of fruits and vegetables. Semi-theoretical and empirical models are the thin-layer models used most frequently in characterizing the drying process (Demir et al., 2007; Onwude et al., 2016). The solutions to Fick's second rule and several simplified variants are typically used to create the semi-theoretical and empirical models which show a better match to the experimental data and give insight into the transport mechanisms (Janjai et al., 2011). The thin-layer drying models utilized in this study are presented in Table 1.

Table 1: List of drying models

Drying Model	Equation	
Lewis	MR=exp(-kt)	(3)
Page	MR= exp(-kt^n)	(4)
Henderson Pabis	MR=a exp(-kt)	(5)
Logarithmic	MR= aexp(-kt)+c	(6)
Wang and Singh	MR=1+at+bt^2	(7)
Midilli et al.	MR= exp(kt^n)+bt	(8)
Weibull	$MR = \exp(-(\frac{t}{\alpha})^{\beta})$	(9)

Where t denoted time in min, k was noted as the drying rate constant (min^{-1}), and the drying constant was indicated as a, b, n, g, and c. The low value of root mean square error (RMSE), and Akaike information criterion (AIC) were used to evaluate how well the model fits the drying data (Mewa et al., 2018; Nahar, Hazra, et al., 2022).

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \hat{x}_i)^2}{N}} \quad (10)$$

$$AIC(M_k) = -2 \log L(M_k) + 2k \quad (11)$$

$L(M_k)$ is the likelihood corresponding to the model M_k with dimension k.

2.7. Physiochemical properties

The ash content of the green banana sample can be calculated by the following formula:

$$Ash\ content\ \% = \frac{weight\ of\ ash}{weight\ of\ sample} \times 100 \quad (12)$$

The bulk density of the raw banana sample was measured by the procedure described by the procedure described by Gursoy et al., (2013) [12]. The following formula calculated the percentage of porosity of raw banana samples.

$$Porosity\ (\%) = (1 - \frac{PD}{BD}) \times 100 \quad (13)$$

BD is the bulk density, and PD is the particle density of the green banana.

2.8. Texture profile analysis (TPA)

A TA. XT texture analyzer (Stable Micro System Ltd, TA. XT Express, UK) was used to conduct TPA testing (Nahar, Hazra, et al., 2022). The TPA of the banana samples was determined using an aluminum cylindrical probe with a 36-mm diameter (P/36R).

2.9. Color measurement

The color measurements were made using a Hunter Lab colorimeter (Hunter Associates Laboratory Inc, 45/0 of color flex, USA) followed by Nahar et al 2022 [11]. The color difference value (ΔE*) was used to calculate how much the slices of raw banana changed color as they dried.

$$\Delta E = \sqrt{(L_i^* - L_0^*)^2 + (a_i^* - a_0^*)^2 + (b_i^* - b_0^*)^2} \quad (14)$$

2.10. Antioxidant properties

In a lab sonicator (Trans-O-Sonic/D150-IM, device located in Mumbai), solutions of 1 g powder in 20 mL 80% methanol followed by 1 hr. incubation at 60◦ C were subjected to sonication for 30 mins to complete the extraction. The solution was centrifuged in a high-speed centrifuge (Supra 22K, Hanil, Korea) at 8900 rpm for 10 min at 4°C. Then the supernatant will be collected in the Tarson tube for further analysis. The antioxidant content and antioxidant activity were determined from extracts following the procedure described by (Nahar et al., 2023).

2.11. Statistical analysis

WPS Workbench Ink. (World Programming, WPS Analytics, UK) was used for all mathematical modeling, while MINITAB 19.0 (Minitab, Inc., Pennsylvania, PA) was used for data analysis.

3. Result and discussion

3.1. Drying kinetics

The declining rate era was when drying was most prevalent. Microwave drying is primarily caused by electromagnetic radiation. To quickly remove water vapor from food products, rapid energy is generated inside the product first. This rapid energy binds with the product's moisture to create internal vapor pressure (Dronachari & Yadav, 2015). The optimum drying method to dehydrate the product is microwave drying, according to studies (Hernández-Ortega et al., 2013; Singh et al., 2010). The activity of polyphenol oxidase was high at temperatures ranging from 55 to 75 °C, however, it was shown to be rapidly lowered during different drying methods (Mphahlele et al., 2016). In this investigation, a hot air oven dryer of 60 °C was used to dry the material.

Table 2: Thin layer drying models of green banana pulp

Process	Lewis model: MR=exp(-kt)					
	k				RMSE	AIC
HD	0.000118				0.0540	-21.1
MD900	0.00735				0.0975	-11.6
MD600	0.000665				0.0391	-25.4
MD450	0.0084310				0.0388	-26.3
MD300	0.00423				0.104	-10.7
MD180	0.00109				0.102	-10.8
MD100	0.000449				0.0940	-12.2
SD	0.0000385				0.101	-11.1
	Page model: MR= exp(-ktn)					
	k	n			RMSE	AIC
HD	0.0000193	1.20			0.0456	-23.0
MD900	0.000348	1.62			0.0450	-23.2
MD600	0.000665	1.53			0.0391	-25.4
MD450	0.0031985	1.19			0.0233	-33.8
MD300	0.0000961	1.68			0.0445	-23.4
MD180	0.0000101	1.68			0.0422	-24.2
MD100	0.00000617	1.55			0.0524	-20.8
SD	0.0000000560	1.64			0.0515	-21.1
	Henderson Pabis model: MR=a exp(-kt)					
	k	a			RMSE	AIC
HD	0.000133	1.12			0.0484	-22.0
MD900	0.00926	1.25			0.0753	-15.0
MD600	0.0134	1.67			0.0315	-28.9
MD450	0.0094933	1.13			0.0294	-30.0
MD300	0.00534	1.27			0.0827	-13.5
MD180	0.00139	1.28			0.0805	-13.9
MD100	0.000549	1.22			0.0791	-14.2
SD	0.0000480	1.22			0.0834	-13.3
	Logarithmic model: MR= a exp(-kt)+c					
	k	a	c		RMSE	AIC
HD	0.0000826	1.24	-0.227		0.0423	-23.7

MD900	0.00161	3.22	-2.18		0.0121	-43.8
MD600	0.0119	1.57	-0.0318		0.0323	-28.0
MD450	0.00724	1.140	-0.09614		0.01983	-35.8
MD300	0.00161	2.03	-0.973		0.0282	-30.1
MD180	0.000499	1.80	-0.727		0.0318	-28.2
MD100	0.000113	2.66	-1.65		0.0207	-35.1
SD	1.32e-7	1.74e+2	-1.73e+2		0.00763	-51.1
	Wang and Singh Model: $MR=1+at+bt^2$					
	a	**b**	**c**		**RMSE**	**AIC**
HD	0.9580722	-7.952153e-05	1.610272e-09		0.0473	-21.9
MD900	1.0326375	-5.068213e-03	3.287568e-06		0.0123	-43.4
MD600	1.1195623	-7.801726e-03	1.380734e-05		0.0489	-21.3
MD450	0.9517651	-5.643889e-03	8.593826e-06		0.0288	-29.8
MD300	1.0557806	-3.159487e-03	1.872609e-06		0.0261	-31.4
MD180	1.0679479	-8.518494e-04	1.462969e-07		0.0284	-30.0
MD100	1.0056802	-2.937674e-04	1.315649e-08		0.0206	-35.2
SD	1.0018559	-2.305740e-05	1.429173e-12		0.00763	-51.1
	Midilli et al. model : MR= exp(ktn)+bt					
	k	**n**	**a**	**b**	**RMSE**	**AIC**
HD	1.326e-04	9.571e-01	1.007e+00	-9.070e-06	0.0414	-27.1
MD900	0.0014855	1.1658705	1.0043090	-0.0017035	0.0135	-47.3
MD600	7.335e-04	1.512e+00	1.010e+00	-3.963e-06	0.0426	-26.5
MD450	0.0049742	1.0872907	1.0014677	-0.0001745	0.0199	-40.3
MD300	0.0003109	1.4051000	0.9890534	-0.0003859	0.0231	-37.6
MD180	3.581e-05	1.453e+00	9.870e-01	-7.452e-05	0.0250	-36.1
MD100	1.237e-04	1.069e+00	9.997e-01	-9.339e-05	0.0208	-39.4
SD	6.681e-07	8.980e-01	1.001e+00	-2.275e-05	0.00764	-57.5
	Weibull Model : $MR = \exp(-(\frac{t}{\alpha})^{\beta})$					
	α	**β**			**RMSE**	**AIC**
HD	8563.	1.20			0.0456	-23.0
MD900	136.	1.62			0.0417	-27.9
MD600	119.	1.53			0.0362	-30.4
MD450	122.	1.20			0.0216	-39.8
MD300	245.	1.68			0.0412	-28.1
MD180	950.	1.68			0.0391	-29.1
MD100	2280.	1.55			0.0485	-25.2
SD	25729.	1.64			0.0515	-21.1

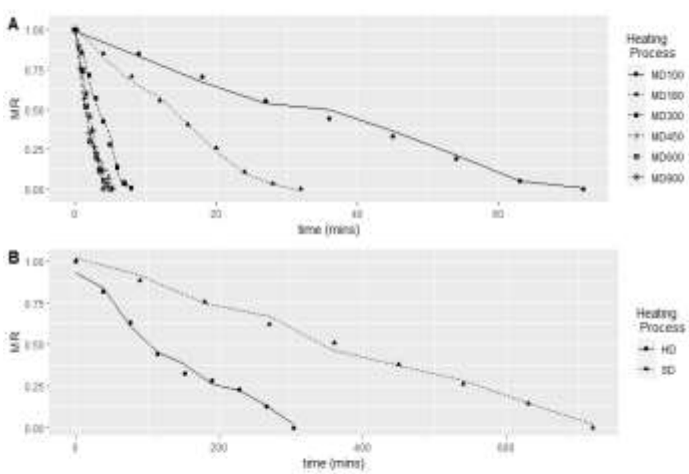

Figure 1: MR against time graph of green banana pulp dried by a) Microwave drying at 100 W, 180 W, 300 W, 450 W, 600 W, and 900 W. b) Hot air drying, and Sun drying (left side)
Figure 2: Images of fresh and different types of dried banana pulp (right side)

The total time length recorded for HD, SD, and MD at (100W, 180W, 300W, 450W, 600W, and 900W) was 300 minutes, 720 minutes, 72 minutes, 32 minutes, 8 minutes, 5 minutes 20 seconds, 5 minutes, and 4 minutes, respectively. Table 2 summarizes the values of seven thin-layer drying models and describes the best-suited model for drying. The complexity of the model rises with the number of constants. Lewis and Page models are regarded as simple models because they only include one and two constants, respectively. The Midilli et al. model was found to have the lowest RMSE (0.0135 to 0.00764) and AIC (-26.5 to -57.5), making it the model that is best suited for drying green banana pulp. According to another study (Ertekin & Yaldiz, 2004; Nahar, Hazra, et al., 2022; Nahar, Raychaudhuri, et al., 2022; Nema et al., 2013), the Midilli model was the best drying model suited to dry eggplant, ginger lotus rhizome, etc. Based on the Midilli model, a graphical depiction (Figure 1) is plotted. Figures 1(a) and (b) depict the rate of moisture decrease over time under various drying settings. According to the study, Diffusivity with moisture content decreased abruptly in the first phase of the falling rate period, but diffusivity with moisture content decreased slowly in the second part of the falling rate period. Based on the linear structure of the curve at 450 slopes from the origin, we may conclude that the projected model is a good fit for the actual drying data. Figure 2 displays the images of fresh and dried products.

3.2. Structural analysis

The structural qualities of green banana samples were evaluated under various situations by comparing the hardness, Fracturability, adhesiveness, springiness, cohesiveness, gumminess, chewiness, resilience, and porosity of the products (Table 3). Hardness was raised in the following sequence for different drying procedures: MD-450 W< HD< MD-100< MD-600 W<MD900 <SD< MD-300 W< MD-180 W. Porosity for various drying processes were in the following order: (Table 3): MD-450 W> MD-180 W> MD-600 W=HD> MD-100>MD900 >MD-300 W>SD. A pressure gradient formed within the dried material during the drying process as a result of the evaporation process. Microwave drying, according to Paengkanya et al., (2015) [21], enhanced the hardness and toughness of Banana chips. The microwave's high power resulted in a large percentage of perforation and vacuum portion of the structure. Thus, increased microwave power was responsible for poorer banana sample hardness and resilience, more structural breakdown, and larger porosity. Structured fragmentation had decreased in the absence of electoral heat. In a sample study of black gram nuggets, hardness increased with decreasing porosity and moisture value, and the same type of study was reported in date flesh (Rahman & Al-Farsi, 2005). In the microwave study, the MD 450 W method performed best in terms of low hardness, poor resilience, and high porosity.

Table 3: The textural parameters of green banana pulp as influenced by drying.
.

Process	Hardness (g.f)	Fractur-ability (g.f)	Adhesive-ness(g.sec)	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience	Porosity (%)
MD 100	429.51	687.94	-164.22	0.51	0.21	67.58	64.87	0.0065	33
MD 180	820.82	1565.83	-177.42	0.53	0.27	213.73	112.21	0.0053	45
MD 300	644.46	1287.50	-236.74	0.52	0.127	81.94	45.06	0.006	23
MD 450	421.43	602.49	-138.94	0.50	0.15	52.96	26.61	0.0043	53
MD 600	457.20	722.13	-217.96	0.73	0.38	161.1	115.06	0.0095	39
MD 900	506.01	1026.99	-211.59	0.78	0.23	134.52	89.57	0.0063	32
HD	427.68	701.89	-445.79	0.48	0.37	170.47	67.5	0.0113	39
SD	549.91	1138.14	-123.95	0.47	0.19	109.53	51.95	0.014	5.9

3.4. Color

Color changes in food items are evaluated using the three chromatic coordinates L, a, and b, which stand for brightness/darkness, redness/greenness, and yellowness/blueness respectively (Table 4). The kinds and amounts of certain elements determine this. Following a heat treatment, color changes are mostly caused by the browning process and pigment oxidation (Nahar, Hazra, et al., 2022; Nahar, Raychaudhuri, et al., 2022). The complete microwave drying technique considerably darkened the banana samples, as seen by the high and low L*, a*, and b* values. The ΔE and lightness values corroborated the fact that all HD and SD samples had greatly lightened and had better color accuracy. If sample drying procedures were separated by blackening, they may be discovered in this sequence (higher ΔE: MD900 W > MD600 W > MD450 W > MD300 W > MD180 W > MD100 W > HD > SD and lower L* value). Apinyavisit et al. (2017)[6] reported similar experimental results in prior investigations. The color shift was caused by the cellular structure's nonenzymatic browning and superior degree of breakdown at high temperatures when the samples were dried in the microwave at varied powers.

Table 4: The color value of dried green banana pulp

SAMPLE	MD 100	MD 180	MD 300	MD 450	MD 600	MD 900	HD	SD
L^*	81.21	78.55	77.01	77.87	76.73	76.50	86.01	84.34
a*	1.43	1.82	1.96	2.42	3.16	3.53	0.7	1.22
b*	14.32	15.25	15.82	16.52	17.36	17.62	13.5	13.14
ΔE	6.5616	8.4257	9.7166	9.9849	11.4876	11.9542	6.4136	5.6064

3.5. Antioxidant content and activity

Together TPC both free and bound forms are called total antioxidants of phenolic compounds, containing a huge number of phenolics that have been measured using six different drying methods. The antioxidant content is highest in MD-450 W and lowest in SD. Long-time exposure to hot air generally causes oxidation and as a result, the antioxidant capacity of the product is reduced. When compared to other fruits, bananas have a comparatively high concentration of phenolic compounds, which are necessary secondary metabolites (Anyasi et al., 2018). Gallic acid, catechin, epicatechin, and myricetin3-O-rhamnosyl-glucoside were also found in ripe and unripe banana flour varieties. According to Turola Barbi et al., (2020) [24], the food industry can also utilize phenolic compounds as food additives to prevent lipid oxidation processes in food compositions. With its high TPC, M-450 W has the potential to be used as a raw material in functional food. Here the observed trend of the antioxidant activity of the given samples are: MD450 W (742.30 **µg/g)** > MD300 W (720.13 **µg/g)** > MD600 W (710.09 **µg/g)** > MD900 W (629.58 **µg/g**) > MD180 W (625.35 **µg/g)** > MD100 W (612.63 **µg/g)** > HD (338.43 **µg/g**) > SD (213.19 **µg/g)**. The main enzyme responsible for enzymatic oxidation during microwave drying is high-temperature active polyphenol oxidase, giving the unbound antioxidant molecules the highest visibility. based on the aforementioned, banana samples with high antioxidant capacities may have a high value for their prospective health-promoting effects. As a result, drying banana in a microwave at 450 W was a great way to produce the highest-quality items.

4. Conclusion

Green banana is a multipurpose, affordable vegetable high in phytochemicals. According to the findings of the study, high temperatures and prolonged heat exposure degraded the product's quality. As a result, optimizing the power level at Microwave Drying is critical to restoring banana quality. After analyzing the drying kinetics, it was discovered that the Midilli Model was the best for understanding the drying properties of bananas, with the lowest RMSE and AIC values. Except for MD100 W and 180 W, microwaves all dry for approximately 10 minutes, indicating the most suited ways with high potential for saving energy, cost, and time. MD 450 W samples have a low hardness, a high phenolic content, and a high porosity. Overall, when all parameters are considered, MD 450 W is the most often used technique for drying bananas. As a rich source of phenolic and flavonoid chemicals, dried banana pulp has a promising future in the food and pharmaceutical industries.

Reference

Anyasi, T. A., Jideani, A. I. O., & Mchau, G. R. A. (2018). Phenolics and essential mineral profile of organic acid pretreated unripe banana flour. *Food Research International*, *104*, 100–109. https://doi.org/10.1016/j.foodres.2017.09.063

Ashokkumar, K., Elayabalan, S., Shobana, V., Kumar, P., & Pandiyan, M. (2018). Nutritional value of banana (Musa spp.) cultivars and its future prospects: A review. *Current Advances in Agricultural Sciences(An International Journal)*, *10*(2), 73. https://doi.org/10.5958/2394-4471.2018.00013.8

Demir, V., Gunhan, T., & Yagcioglu, A. K. (2007). Mathematical modelling of convection drying of green table olives. *Biosystems Engineering*, *98*(1), 47–53. https://doi.org/10.1016/j.biosystemseng.2007.06.011

Deng, L. Z., Yang, X. H., Mujumdar, A. S., Zhao, J. H., Wang, D., Zhang, Q., Wang, J., Gao, Z. J., & Xiao, H. W. (2018). Red pepper (Capsicum annuum L.) drying: Effects of different drying methods on drying kinetics, physicochemical properties, antioxidant capacity, and microstructure. *Drying Technology*, *36*(8), 893–907.

https://doi.org/10.1080/07373937.2017.1361439
Dronachari, M., & Yadav, B. K. (2015). Application of microwave heat treatment in processing of pulses. *Journal of Academia and Industrial Research*, *3*(9), 401–407.
Ertekin, C., & Yaldiz, O. (2004). Drying of eggplant and selection of a suitable thin layer drying model. *Journal of Food Engineering*, *63*(3), 349–359. https://doi.org/10.1016/j.jfoodeng.2003.08.007
Gursoy, S., Illinois, S., & Watson, D. G. (2013). Microwave drying kinetics and quality characteristics of corn. *International Journal of Agricultural and Biological Engineering*, *6*(1), 90–99. https://doi.org/10.3965/j.ijabe.20130601.009
Hernández-Ortega, M., Kissangou, G., Necoechea-Mondragón, H., Sánchez-Pardo, M. E., & Ortiz-Moreno, A. (2013). Microwave dried carrot pomace as a source of fiber and carotenoids. *Food and Nutrition Sciences*, *04*(10), 1037–1046. https://doi.org/10.4236/fns.2013.410135
Janjai, S., Precoppe, M., Lamlert, N., Mahayothee, B., Bala, B. K., Nagle, M., & Müller, J. (2011). Thin-layer drying of litchi (Litchi chinensis Sonn.). *Food and Bioproducts Processing*, *89*(3), 194–201. https://doi.org/10.1016/j.fbp.2010.05.002
Liu, J., Yang, H., Cudennec, C., Gain, A. K., Hoff, H., Lawford, R., Qi, J., de Strasser, L., Yillia, P. T., & Zheng, C. (2017). Challenges in operationalizing the water–energy–food nexus. *Hydrological Sciences Journal*, *62*(11), 1714–1720. https://doi.org/10.1080/02626667.2017.1353695
Mewa, E. A., Okoth, M. W., Kunyanga, C. N., & Rugiri, M. N. (2018). Drying modelling, moisture diffusivity and sensory quality of thin layer dried beef. *Current Research in Nutrition and Food Science*, *6*(2), 552–565. https://doi.org/10.12944/CRNFSJ.6.2.29
Mphahlele, R. R., Fawole, O. A., Makunga, N. P., & Opara, U. L. (2016). Effect of drying on the bioactive compounds, antioxidant, antibacterial and antityrosinase activities of pomegranate peel. *BMC Complementary and Alternative Medicine*, *16*(1), 1–12. https://doi.org/10.1186/s12906-016-1132-y
Nahar, N., Hazra, S., Raychaudhuri, U., & Adhikari (Nee Pramanik), S. (2023). Development of a novel poushtic powder: Nutritional characteristics, organoleptic properties, morphology study, storage, and cost analysis, of supplementary food for a vulnerable group in Midnapore. *Research Journal of Pharmacy and Technology*, 1951–1959. https://doi.org/10.52711/0974-360x.2023.00320
Nahar, N., Hazra, S., Raychaudhuri, U., & Adhikari, S. (2022). Effect of different drying methods on drying kinetics, modeling, energy-economic, texture profile, color, and antioxidant of lotus rhizomes (Nelumbo nucifera). *Journal of Food Processing and Preservation*, e16842. https://doi.org/10.1111/jfpp.16842
Nahar, N., Raychaudhuri, U., & Adhikari, S. (2022). Effect of drying on kinetics, physiochemical, and antioxidant properties of black gram nuggets. *Legume Science*. https://doi.org/10.1002/leg3.170
Nema, P. K., Mohapatra, D., Daniel, A., & Mishra, S. (2013). Modeling pulse microwave drying kinetics of ginger (Zingiber officinale R.). *Journal of Food Research and Technology*, *1*(2), 46–58.
Onwude, D. I., Hashim, N., Janius, R. B., Nawi, N. M., & Abdan, K. (2016). Modeling the thin-layer drying of fruits and vegetables: A review. *Comprehensive Reviews in Food Science and Food Safety*, *15*(3), 599–618. https://doi.org/10.1111/1541-4337.12196
Paengkanya, S., Soponronnarit, S., & Nathakaranakule, A. (2015). Application of microwaves for drying of durian chips. *Food and Bioproducts Processing*, *96*, 1–11. https://doi.org/10.1016/j.fbp.2015.06.001
Rahman, M. S., & Al-Farsi, S. A. (2005). Instrumental texture profile analysis (TPA) of date flesh as a function of moisture content. *Journal of Food Engineering*, *66*(4), 505–511. https://doi.org/10.1016/j.jfoodeng.2004.04.022
Saha, S. K., Dey, S., & Chakraborty, R. (2019). Effect of microwave power on drying kinetics, structure, color, and antioxidant activities of corncob. *Journal of Food Process Engineering*, *42*(4). https://doi.org/10.1111/jfpe.13021
Sidhu, J. S., & Zafar, T. A. (2020). Chemical composition and nutritional profile of raw and processed banana products. *Handbook of Banana Production, Postharvest Science, Processing Technology, and Nutrition*, 207–225. https://doi.org/10.1002/9781119528265.CH11
Singh, K., Pannu, M. S., Singh, P., & Singh, J. (2010). Effect of wheat grass tablets on the frequency of blood

transfusions in Thalassemia Major. *Indian Journal of Pediatrics*, *77*(1), 90–91. https://doi.org/10.1007/s12098-010-0002-8

Turola Barbi, R. C., Silveira Hornung, P., Ávila, S., da Silva Bambirra Alves, F. E., Beta, T., & Hoffmann Ribani, R. (2020). Ripe and unripe inajá (Maximilia maripa) fruit: A new high source of added value bioactive compounds. *Food Chemistry*, *331*. https://doi.org/10.1016/j.foodchem.2020.127333