The Pharma Innovation Journal 2022; 11(6): 452-455

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 452-455

www.thepharmajournal.com
Received: 13-03-2022
Accepted: 22-05-2022

Surbhi Suman
Assistant Professor, Career Point University, Kota, Rajasthan, India

Ankita Sharma
Ph.D., Scholar, JNKVV, Jabalpur, Madhya Pradesh, India

Corresponding Author:
Surbhi Suman
Assistant Professor, Career Point University, Kota, Rajasthan, India

Microwave power level impact on the drying kinetics and quality of carrot Pomace

Surbhi Suman and Ankita Sharma

Abstract
Pomace has a high content of tocopherols, phytosterols, carotenoids, and antioxidant activity, making its use in food significant from a nutritional standpoint. The earliest method of food preservation is drying. 250g of pomace was dried in a microwave dryer at 420, 560, and 700W of power level. Drying took place in falling rate period and constant rate period was absent in both drying experiments. The moisture diffusivity varied in the range of 1.29×10^{-8} m²/s to 4.28×10^{-8} m² /s. β-carotene range was found between 1.02 mg/100g and 3.36 mg/100g. Ascorbic acid range was found between 0.75 mg/100g and 1.425 mg/100g. Maximum redness was found in sample dried at 420W microwave power level.

Keywords: Pomace, dehydration, microwave, power and diffusivity

Introduction

The addition of a considerable amount of carrot to one's regular diet improves nitrogen equilibrium. Carrot drying is an essential part of its value enhancement. Dehydrated carrot gratings can be used to make slices, gajar halwa, and other desserts using skim milk, sugar, and other ingredients (Manjunatha *et al*., 2003) [10]. After processing fruits and vegetables, the processed fruit business has experienced 25% losses and wastages, with 10% occurring during distribution and 7% occurring during consumption. Organic waste from juice extraction, including as peel, stem, core, seeds, and pomace, is a major source of trash. Fruit-processing plant by-products have unexplored potential for manufacturing low-cost natural biocomponents with food uses. As a result, it is critical to pay attention to how tonnes of pomace produced each year are used to address environmental challenges and establish new revenue streams. Pomace has a high content of tocopherols, phytosterols, carotenoids, and antioxidant activity, making its use in food significant from a nutritional standpoint. Hussein *et al*., (2015) [7] investigated the feasibility of making high-dietary-fiber jam from fruit and vegetable by-products. The jam made from carrot peel, apple pomace, banana peels, and mandarin peels was high in dietary fibre, vitamin C, enhanced minerals, total flavonoids, and antioxidant activity, according to the author. By converting by-products into a high-value product, food firms can lower their costs while increasing earnings, so improving their competitiveness. The major purpose is to draw attention to the possibilities of fruit and vegetable processing waste, particularly pomace. Pomace is the solid remnants of fruits and vegetables after they have been pressed for juice or oil. Due to the high moisture content, it is perishable.

Materials and Methods

Fruit

Carrot was purchased in Udaipur, Rajasthan's local market (India). To remove clinging contaminants, the carrot was thoroughly washed three to four times under tap water. It was peeled out and the juice extracted, and the remaining pomace was blanched in hot water at 90°C for 3 minutes with a 1:6 pomace to water ratio, then dipped immediately in normal water for 3 minutes to avoid overcooking and the blanched product was kept in strainer (Chantaro *et al*., 2008) [3].

Drying Kinetics

This drying experiment also included the use of a lab microwave drier with a maximum frequency range of 2450 MHz. It has a working chamber with dimensions of 700×700×550 mm and three 100 mm diameter vents on the upper side.

A roundabout turntable made up of Teflon material having diameter 600 mm and height of the rim about 120 mm is used inside the chamber for increasing the consistency in drying. For admission and outlet air from the working chamber, an air blower or exhaust fan is provided. Air blows at velocity of 0.75 to 1.0 m/s. On the turntable inside the microwave compartment, fresh carrot pomace samples with known beginning moisture content were equally disseminated. Carrot pomace sample was weighted in every 5 min till completion of experiment (up to EMC). Microwave power levels value given as 420, 560 and 700 W respectively and the average values were used for calculation.

Moisture Content
On the basis of the dry matter of the sample, the moisture content of the sample was assessed throughout numerous trials at various periods. Moisture content (db) during drying was calculated (Brooker *et al.*, 1974) [2] as:

$$Moisture\ Content = \frac{W_{\theta}-DM}{DM}\times 100 \qquad (1)$$

Where,
W_{θ}= Weight of sample at time θ, g
DM = Dry matter of the sample, g

Drying rate
The moisture content data collected during the trials was analysed to determine how much moisture was lost from the samples over time. The drying rate of sample was calculated by following mass balance equation (Brooker *et al.*, 1974) [2].

$$R = \frac{WML}{Time\ Interval\ (min.)\times DM} \qquad (2)$$

Where,
R = Drying rate at time, g water/ g-min
WML = Initial weight of sample – Weight of sample after time

Moisture Ratio
The moisture ratio was calculated by using the following equation:

$$Moisture\ Ratio = \frac{M-M_e}{M_o-M_e} \qquad (3)$$

Where,
M = Moisture content at any specified time t (per cent db)
M_e = Equilibrium moisture content (per cent db)
M_o= Initial moisture content (per cent db)
M_e in comparison to M_o and M is very small, hence M_e can be neglected and moisture ratio can be presented in simplified form (Doymaz, 2004b; Goyal *et al.*, 2007) [5, 6].

$$MR = \frac{M}{M_o} \qquad (4)$$

Moisture Diffusivity
Fick's second law, which is theoretically defined by the classical mass balance equation, has been utilised for evaluating the moisture transport mechanism of the falling rate zones (Crank, 1975) [4] as,

$$\frac{\partial M}{\partial \theta} = \frac{\partial}{\partial R}\left(D_d \frac{\partial M}{\partial R}\right) \qquad (5)$$

Where,
M = moisture content, kg water per kg dry solids
θ = time, s
R = diffusion path or length, m
D_d = moisture dependent diffusivity, m^2/ s

With the premise that moisture migration was induced by diffusion, minimal shrinkage, constant diffusion coefficients, and temperature, the solution of Fick's second law in slab geometry was as follows: (Crank, 1975) [4]:

$$MR = \frac{M-M_e}{M_o-M_e} = \frac{8}{\pi^2}\sum_{n=1}^{\infty}\frac{1}{(2n+1)^2}exp\left[\frac{-(2n+1)^2\pi^2 D_{eff} t}{L^2}\right] \qquad (6)$$

For long drying periods, above Eqn. 6 can be further simplified to only the first term of the series as,

$$ln\left(\frac{M-M_e}{M_o-M_e}\right) = ln\frac{8}{\pi^2} - \frac{\pi^2 D_{eff} t}{L^2} \qquad (7)$$

Where,
MR = Moisture ratio, dimensionless
M = Moisture content at any time, g H_2O/g dry matter
M_o= Initial moisture content, g H_2O /g dry matter
M_e = Equilibrium moisture content, g H_2O /g dry matter
D_{eff} = Effective diffusivity in m^2/s
L = thickness of carrot pomace layer (0.002 m)
n = Positive integer
t = Time (s)

A general form of above Eqn. 7 could be written in semi-logarithmic form, as follows:

$$\ln(M_R) = A - Bt \qquad (8)$$

Where, A is constant and B is slope.
From above Equation 7 a plot of ln (MR) versus the drying time gives a straight line with a slope B as,

$$Slope = \frac{\pi^2 D_{eff} t}{L^2} \qquad (9)$$

The effective diffusivity was determined by substituting value of slope B and thickness L from above equation 9.

Determination of β - carotene
AACC technique 14-50 will be used to determine β-carotene in fresh and rehydrated carrot samples, which works on the premise of solvent-extraction of pigments and measuring colour absorbance with a UV-Visible spectrophotometer at 435.8 nm. The β-carotene content then calculated (mg/g) using Eq. given below (Johnson *et al.*, 1980):

$$\beta-\text{Carotene}\left(\frac{\mu g}{g}\text{ or ppm}\right) = \frac{\text{sample abs.}\times 0.4}{1.6632\times\text{sample mass(db)}}\times 100 \qquad (10)$$

Where 1.6632 is conversion factor 1 μg pigment absorbance in 1 g of sample of 1.0 cm cuvette, 0.4 is the volume (L) of the solvent used for extraction of the pigments**.**

Determination of Ascorbic Acid Content
The concentration of ascorbic acid in carrot pomace powder was determined using a titration technique (Ranganna, 2000) [2] using dye solution of 2, 6-dichlorophenol indophenol.

Dye factor was determined by the following equation:

$$Dye\ Factor = \frac{0.5}{Titrate\ Vol.} \quad (11)$$

Ascorbic acid was estimated as mg of ascorbic acid per ml and was determined by the following equation:

$$Ascorbic\ acid\ \left(\frac{mg}{mL}\right) = \frac{titrate\ Vol.(mL\ of\ dye\ used) \times dye\ factor \times Vol.made\ up \times 100}{aliquot\ of\ sample\ taken\ for\ estimation \times Vol.of\ sample} \quad (12)$$

Colour

Colour of carrot Pomace powder was measured using a Hunter Lab Colorimeter (Model CFLX/DIFF, CFLX-45).

Results and Discussion

Preparation of sample

The juice from the carrot was extracted using a juicer, and the Pomace was separated. Pomace was properly rinsed under running water. 250g of Pomace were blanched in boiling water with a 1:5 ratio for 3 minutes, then dipped immediately in normal water for 3 minutes to avoid overcooking, and then kept in strainer.

Initial moisture content

The oven drying method was used to determine the initial moisture level of carrot Pomace. The initial moisture content was found as 705.67, 716.38 and 749.52 per cent (db).

Drying Characteristics of Carrot Pomace

Fresh Carrot pomace samples were blanched and dried under microwave dryer at 420, 560 and 700W.

Effect of power level on moisture content

Carrot pomace required 60 to 180 min to dry under microwave drying to bring down initial moisture content ranging from 705.67 to 749.52 per cent (db) to final moisture content in the range of 8.45 to 9.78per cent (db) (Fig. 1) at different studied power levels.

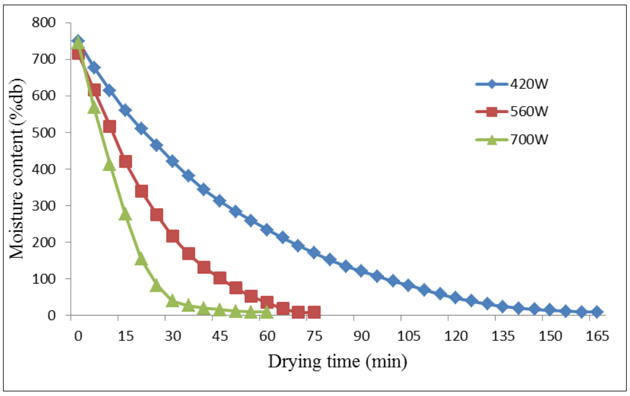

Fig 1: Variation in moisture content of carrot pomace with time at 420, 560 and 700W power level

Effect of power level on drying rate curves

In Fig 2, the drying rate of carrot pomace was estimated and plotted against moisture content at various microwave power levels. The drying rate for carrot pomace sample was observed at initial stage of drying 14.532, 20.161 and 35.521 g-water/ g-DM-min at 420, 560 and 700Wof drying power respectively.

Table 1: Drying rate equation with respect to moisture content

Microwave power level (W)	Equation	R^2
420	$0.0093x^2 + 1.7076x + 0.5233$	0.9896
560	$-0.2945x^2 + 4.927x + 0.4705$	0.9912
700	$-0.7515x^2 + 10.277x – 0.7361$	0.9906

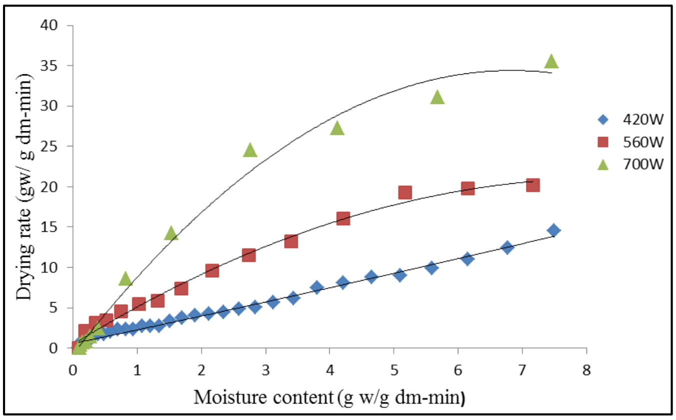

Fig 2: Variation in drying rate of carrot Pomace with moisture content at 420, 560 and 700W power level

Effect of power level on moisture diffusivity

Microwave drying moisture loss data was evaluated, and moisture ratios at various time intervals were calculated. The ln (MR) was plotted with drying time in order to find out moisture diffusivity for carrot Pomace. The variation in ln (MR) with drying time of carrot Pomace has been presented in Fig. 3 for microwave drying.

Table 2: Moisture diffusivity values for dried carrot Pomace

Microwave power level (W)	Regression equation	Moisture diffusivity (m^2/s)	R^2
420	y = -0.0318x + 0.5371	1.29×10^{-8}	0.9421
560	y = -0.0659x + 0.5233	2.67×10^{-8}	0.9301
700	y = -0.1057x + 0.2766	4.28×10^{-8}	0.9899

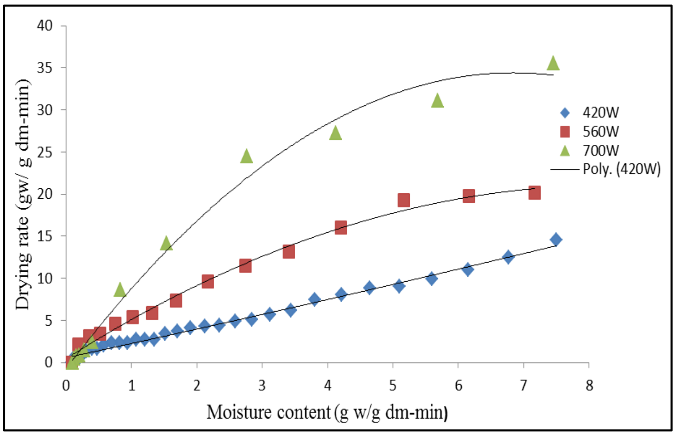

Fig 3: Variation in drying rate of carrot Pomace with moisture content at 420, 560 and 700W power level

Quality Analysis of microwave dried carrot Pomace

On the basis of β– Carotene

Changes in β-carotene concentration as a result of different drying conditions ranged from 1.02 to 3.36 mg/100g as the microwave power level in the microwave dryer increased from 420W to 700W (Table 3). A retention trend of β-carotene in pomace during drying was similar to the earlier findings with drying of carrots (Banga and Bawa, 2002) [1].

Table 3: β-carotene values for dried carrot Pomace

Microwave Dryer	
Microwave power level (W)	**β-carotene mg/100g**
420	3.36
560	3.16
700	1.02

On the basis of ascorbic acid

In dried Pomace heat labile nature of ascorbic acid reduced its availability from 1.425 to 0.75 mg/100g as power level increased from 420 to 700W. (Table 4)

Table 4: Ascorbic Acid values for dried carrot Pomace

Microwave Dryer	
Microwave Power level (W)	**Ascorbic acid (mg/100g)**
420	1.425
560	1.2
700	0.75

Colour

The absolute values of a perfect reflecting diffuser measured under the same geometric conditions were used to compare the colour values measured with a hunter lab colorimeter. Observations were taken at room temperature 30.5 °C and 25 per cent relative humidity and values are given in Table 5.

Table 5: Colour (L, a and b) values for dried carrot Pomace

Microwave Dryer			
Microwave power level (W)	**L**	**a**	**b**
420	75.2	25.4	42.1
560	68.5	22.1	29.3
700	60.1	19.2	18.1

Conclusion

The minimum drying time taken at 700W microwave power level. Drying takes completely in falling rate period. Moisture diffusivity increases with increase in power level of microwave dryer. It was found maximum at 700W microwave power level. β-carotene and ascorbic acid content decreases with increase in power level of microwave dryer. It was found maximum at 420W microwave power level. Redness of the sample decreases with increase in power level and found maximum at 420W microwave power level.

References

1. Banga R, Bawa AS. Studies on carrot drying. Journal of Food Science and Technology. 2002;39:467-672.
2. Brooker DB, Bakker FW, Hall CW. Drying and Storage of Grains and Oilseeds. The AVI Publishing Company, Inc. Westport, Connecticut, 1974, 56-71.
3. Chantaro P, Devahastin S, Chiewchan N. Production of antioxidant high dietary fiber powder from carrot peels. Food Science and Technology. 2008;41:1987-1994.
4. Crank J. The Mathematics of Diffusion (2nd Edition) UK, Clrendon Press. 1975.
5. Doymaz I. Convective air drying characteristics of thin layer carrots. Journal of Food Engineering. 2004a;61:359-364.
6. Goyal RK, Kingsly ARP, Manikanthan MR, Ilyas SM. Mathematical modelling of thin layer drying kinetics of plum in a tunnel dryer. Journal of Food Engineering. 2007;79:176-180.
7. Hussein AMS, Kamil MM, Hegazy NA, Mahmoud KF, Ibrahim MA. Utilization of Some Fruits and Vegetables By-Products to Produce High Dietary, 2015.
8. Johnson RA, Quick JS, Donnelly BJ. Note on comparison of pigment extraction and reflectance colourimeter method for evaluating semplinacolor. Cereal Chemistry. 1980;57:447-448.
9. Lomauro CJ, Bakshi AS, Labuza TP. Moisture transfer properties of dry and semi-moist foods. Journal of Food Science. 1985;50:397-400.
10. Manjunatha SS, Kumar BL, Mohan G, Das DK. Development and evaluation of carrot kheer mix. Journal of Food Science and Technology. 2003;40(3):310–312.https://www.researchgate.net/publication/293034576_Development_and_Evaluation_of_Carrot_Kheer_Mix
11. Prakash S, Jhab SK, Datta N. Performance evaluation of blanched carrots dried by three different dryers. Journal of Food Engineering. 2004;62:305-313.
12. Ranganna S. Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2000, 190-210.
13. Tutuncu AM, Labuza TP. Effect of geometry on the effective moisture transfer diffusion coefficient. Journal of Food Engineering. 1996;30:433-437.