Selcuk Journal of Agriculture and Food Sciences

http://sjafs.selcuk.edu.tr/sjafs/index

Research Article

SJAFS

(2022) 36 (1), 58-62

e-ISSN: 2458-8377

DOI:10.15316/SJAFS.2022.009

Usage Opportunities of Pomegranate (Punica Granatum) Peel Dried with Different Methods in Whole Wheat Flour Chips

Nilgün ERTAŞ[1,*], Mine ASLAN[1]

[1] Necmettin Erbakan University, Faculty Of Engineering-Architecture, Department of Food Engineering, Konya, Turkey

ARTICLE INFO

Article history:
Received date: 14.11.2021
Accepted date: 04.03.2022

Keywords:
Pomegranate peel
Vacuum drying
Convection drying
Microwave drying
Chips

ABSTRACT

In this study, pomegranate peels were dried using three different drying methods, vacuum, microwave and convective. Dried peels were ground into powder and replaced (0, 5 and 10%) with whole wheat flour in chips formulation to enhance functional properties of chips. Some physical (diameter, thickness, spread ratio and weight), chemical (total phenolic content and antioxidant activity), color and texture properties of chips samples were determined. While the chips obtained with addition of microwave dried peels were brighter, higher values of yellowness were determined with vacuum dried peels. The increased ratio of pomegranate peel powder caused a decrease in diameter and spread ratio values of chips. The utilization of 10% pomegranate peel powder decreased the hardness of the chips samples. The addition of pomegranate peel powder was increased in total phenolic content and antioxidant activity of chips. As a result, pomegranate peel powder can be used as a functional ingredient in snacks product formulation.

1. Introduction

Health consciousness and a healthy lifestyle increase consumers' demand for functional snacks to provide more nutritional sources in the daily diet. Today, many snack products such as chips, crackers, biscuits and cakes are offered for consumption. Many attempts and studies on the improvement of the functional and nutritional properties of snack products have been found in the food industry. For this purpose, there are studies carried out using Moldavian dragonhead leaves in corn snacks (Wójtowicz et al., 2017), tomato in functional snacks (Wójtowicz et al., 2018) and Dracocephalum moldavica L. seeds in snacks (Oniszczuk et al., 2021) in the literature.

Pomegranate peel, which is an important waste product, constitutes approximately 40% of the fruit. Pomegranate peel has a high dietary fiber content (72.68% / 100g) (Gullon et al. 2015), and the majority of dietary fiber (42.53% / 100g) is water-insoluble dietary fiber (Viuda-Martos et al., 2013). Compared to the pulp part of the pomegranate peel, the total phenolic content, total flavonoid, proanthocyanidin and ascorbic acid amounts are approximately 10-fold, 4-fold, 2-fold and 1.2-fold higher, respectively (Negi et al., 2003). Various phenolic substances taken into the body with the consumption of pomegranate peel can have a reducing effect on cardiovascular diseases, cancer varieties, hypoglycemic, apoptotic, anti-inflammatory, anti-parasitic (Sikora et al., 2008; Anderson et al., 2009; Abdel-Rahim et al., 2013). Pomegranate peel powder and extract are included in many product formulations such as bread (Altunkaya et al., 2013), biscuit (Ismail et al., 2014), sponge cake (Zhang et al., 2017) and bio-yogurt (Ibrahim et al., 2020).

Drying is one of the oldest methods of removing water that causes product deterioration due to microbial growth and chemical reactions. Convective hot air, microwave, infrared and vacuum are common in drying techniques. Drying type and condition have an important effect on the quality of end-products (Süfer et al., 2017).

Convective hot air drying is the most common method used for drying food. This drying method has high drying temperature, long drying time and negative effects on nutritional and sensorial properties. Vacuum and microwave drying has several advantages such as lower drying temperature, higher drying rate, uniform energy transmission on the material and suitable end-product properties (Incedayi et al., 2016; Demiray et al., 2017).

* Corresponding author email: *dr.nilgunertas@gmail.com*

Consequently, by-products that are obtained during the processing of pomegranate cause environmental pollution and economic losses. Evaluation of nutritionally and functionally valuable these by-products are important in terms of both food enrichment and economic gains. The objective of this study was to investigate the effect of using pomegranate peel powder in the formulation of chips.

2. Materials and Methods

2.1. Materials

The ingredients used in chips production, whole wheat flour, red pepper powder, garlic powder, cumin and salt were purchased from local markets. Pomegranate was purchased from the local market and washed and the peel was separated by manually removing the seeds. Peels were sliced with the size of 2 mm.

2.2. Drying methods

Fresh pomegranate peels were dried until a constant weight by various drying methods as follows. The peel was dried using three different methods; hot-air drying, microwave drying and the vacuum drying. i) convectional hot-air drying; fresh pomegranate peels were kept in the pre-heated hot air oven (model KD 200, Nüve, Turkey) at 60 °C for 12h; ii) a microwave drying was performed at 360 W for 25 min; (LG SolarDOM, MP-9485, Seul, South Korea) iii) vacuum drying was performed at 60 °C for 7 h, (JSR, JSVO-60T, Gongju, South Korea) respectively. The dried peels were ground with a grinder (Alveo, AHE.OG.01, Konya, Turkey) and sieved with a 500 μm sieve to obtain pomegranate peel powder. Pomegranate peel powders stored at room temperature (25 °C) in polyethylene bags until further analyses.

2.3. Chips production

The basic formulation of chips production was formed 100 g whole wheat flour, 2.5 g salt, 2 g garlic powder, 1 g red pepper powder, 1 g cumin, and water. Other samples were produced by replacing 0, 5 and 10 % flour with pomegranate peel powder dried with different methods. All ingredients were mixed with a Hobart mixer (Hobart UK, London). The water in the dough formulation was gradually added to the mixture and mixed. The obtained chips dough is wrapped in cling film. The hydration was provided by wrapping it and keeping it in the dark for 30 minutes. The obtained chips dough was divided into 2.5 g pieces and the dough pieces were compressed in between two Teflon plates for 2.5 min at 300 °C. Chips samples were stored at room temperature until used for further analysis.

2.4. Physical analysis

Color analysis of chips samples was carried out using Hunter Lab Chroma Meter (Minolta CR-400, Osaka, Japan). Color values of the chips were recorded as L* indicted the lightness, which varies from 0 to 100 (black to white), a* varies from negative to positive (green to red), and b* from negative to positive (blue to yellow). a* and b* values were used to calculate the saturation index (SI) ($[a^2 + b^2]^{1/2}$) and hue angle (arctan [b*/a*]). Firstly, the instrument was calibrated with a white reference tile. Then, the color measurement values were determined three times and at five different points for each sample

The diameter and thickness of the chips samples were measured with a digital micrometer (0.001mm, Mitutoyo, Minoto-Ku, Tokyo, Japan). Diameter and thickness measurement values were determined at five different points for each sample. The spread ratio was found using the following equation:

Spread ratio = Diameter / Thickness

The hardness and fracturability values of the chips samples were measured using a texture analyzer (TA-XT plus, Stable Microsystems, England). The test conditions in this study were as follows: Pretest speed: 1.0 mm/s, test speed: 3.0 mm/s, posttest speed: 10 mm/s, distance: 5 mm.

2.5. Chemical analysis

Extracts of chips samples for total phenolic content (TPC) and antioxidant activity analyses were carried out by agitating 2 g sample with 10 ml solvent (methanol:HCl:water, 8:1:1, v/v/v) in a shaking water bath at room temperature (25 °C) and by centrifugation at 3.000 rpm for 10 min. TPC was determined using Folin-Ciocalteu method. TPC content was measured with a Biochrom spectrophotometer (Biochrom, Libra S22, England) at 760 nm. Results were expressed as milligrams of gallic acid equivalents (GAE) per 100 g of dry weight (Gao et al., 2002; Beta et al., 2005).

Antioxidant activity was carried out using the DPPH (2-2-Diphenyl-2-picrylhydrazyl) method (Gyamfi et al., 1999; Beta et al., 2005). The DPPH scavenging capacity was determined as spectrophotometric (Biochrom, Libra S22, England) by measuring the decrease in absorbance at 517 nm. Antioxidant activity value as inhibition percentage was calculated according to equation:

Inhibition%=[(Abscontrol–Abssample)/Abscontrol]× 100

2.6. Statistical analysis

All measurements were performed in duplicate for each sample. The results were expressed as mean ± standard deviation. Statistical analyses were performed using the Statistical software JMP 5.0.1 (SAS Institute). The averages of the main variation sources were compared at $p < .05$ level.

3. Results and Discussion

Product color plays an important role in food selection by influencing taste thresholds, sweetness perception, acceptability, food preference, and pleasantness (Clydesdale,1993). Color values of chips samples are given in Table 1. According to pomegranate peel drying methods, the highest L* values, brightness of chips samples were obtained with microwave, followed by vacuum and convection dried samples ($p<0.05$). Pomegranate peel drying methods found no significant ($p>0.05$) on chips a* values. Similar to the brightness, the drying method caused a significant change in b* value of the chips samples. Among pomegranate peel drying methods, only vacuum drying had a significanly higher yellowness values of the chips, but convection and microwave drying methods were determined as similar according to b* values.

When the results were compared in terms of substitute ratio, high usage rates significantly caused a significant decrease from 61.16 to 55.54 in L* values, from 8.49 to 5.97 in a* values and from 24.62 to 18.83 in b* values. This decrease in L* and b* values can be explained by decomposition of chlorophyll and other pigments and the increase in enzymatic and non-enzymatic browning reactions during baking with high utilization ratio of pomegranate peel powder in the formulation (Maskan, 2001; Bölek, 2020). A similar result was also reported a decrease in L* and b* values of cookies with the incorporation of pomegranate peel (Ismail et al., 2014). According to the pomegranate peel drying methods, the highest saturation index values were determined in chips samples containing vacuum drying powder. The saturation index values of the chips samples in the present study are given in Table 1, saturation index value (23.72) and of chips produced by vacuum dried pomegranate peel was signifcantly higher than that of convection dried pomegranate peel (22.73) and microwave dried pomegranate peel (22.31). It can be seen that the higher the substitute ratio of pomegranate peel powder, the greater the decrease ($p < 0.05$) in saturation index (from 26.04 to 19.76). Differences in hue angle values were found no significant in terms of pomegranate peel drying methods and substitute ratio ($p>0.05$).

Table 1
Color properties of chips samples.

Factor	*L**	*a**	*b**	Saturation Index	Hue Angle
Pomegranate peel drying methods					
Vacuum	58.06±2.55^{b}	7.54±0.89^{a}	22.48±2.16^{a}	23.72±2.30^{a}	71.47±1.09^{a}
Convection	55.62±4.74^{c}	7.22±1.31^{a}	21.55±3.03^{b}	22.73±3.27^{b}	71.56±1.06^{a}
Microwave	60.68±0.49^{a}	6.82±1.41^{a}	21.23±2.78^{b}	22.31±3.05^{b}	72.31±1.60^{a}
Substitute ratio (%)					
0	61.16±0.04^{a}	8.49±0.19^{a}	24.62±0.25^{a}	26.04±0.18^{a}	70.98±0.58^{a}
5	57.66±2.40^{b}	7.12±0.76^{b}	21.81±1.08^{b}	22.95±1.21^{b}	71.95±1.33^{a}
10	55.54±4.41^{c}	5.97±0.61^{c}	18.83±1.11^{c}	19.76±1.17^{c}	72.41±1.41^{a}

Means followed by the same letter within a column are not significantly different from each other ($p> 0.05$).

The effect of the pomegranate peel drying methods and substitute ratio on the diameter, thickness and spread ratio values of chips samples are shown in Table 2. In terms of the pomegranate peel drying methods, the diameter, thickness and spread ratio values of chip samples dried vacuum, convection and microwave were changed between 42.35 mm and 43.10 mm for diameter; 1.28 mm and 1.45 mm for thickness; and 30.03 and 33.85 for spread ratio values, respectively. However, these value differences were found to be insignificant ($p>0.05$).

When diameter and thickness values were evaluated in terms of substitute ratio, it was observed that as pomegranate peel powder substitute ratio increased, a significant decrease in the diameter values ($p<0.05$) and a slight increase in the thickness values of chips samples were determined (Table 2). The chips samples without pomegranate peel powder had a higher spread ratio than chips samples containing 5% and 10% pomegranate peel powder. These results are consistent with Ranjitha et al. (2018) reported that a decrease in the diameter in the cookies samples containing a different ratio of pomegranate peels and defatted soybean flour combination (Ranjitha et al., 2018) and pomegranate peel (Jandal and Naji, 2021).

Table 2
Diameter, thickness and spread ratio properties of chips samples.

Factor	Diameter (mm)	Thickness (mm)	Spread ratio
Pomegranate peel drying methods			
Vacuum	42.35±2.79^{a}	1.28±0.19^{a}	33.85±6.92^{a}
Convection	42.95±2.11^{a}	1.45±0.15^{a}	30.03±4.71^{a}
Microwave	43.10±2.37^{a}	1.35±0.15^{a}	32.29±4.19^{a}
Substitute ratio (%)			
0	45.50±0.00^{a}	1.23±0.14^{b}	37.26±4.00^{a}
5	42.68±0.87^{b}	1.35±0.10^{ab}	31.78±2.65^{b}
10	40.22±0.84^{c}	1.50±0.17^{a}	27.12±3.42^{b}

Means followed by the same letter within a column are not significantly different from each other ($p> 0.05$).

Weight, hardness and fractuability properties of chips samples are presented in Table 3. Drying methods used in pomegranate peel and substitute ratio demonstrated no significant effect on weight values of chips samples. When the results are examined in terms of pomegranate peel drying methods, the hardness values of chip samples were shown a difference between 1019.77 g and 1202.57 g. Moreover, according to the substitute ratio, the lowest hardness value was found in the chips samples containing pomegranate peel powder at 10% ratio, while the hardness value of chips samples without pomegranate peel powder and containing 5% pomegranate peel powder were found a similar (p>0.05). The hardness value associated with the gluten network structure refers to the force necessary to break the end-product. The hardness value associated with the gluten network structure refers to the force necessary to break the end-product (Urgancı and Işık, 2021). The decrease in the gluten network leads to be weaker and fragile structure of the product (Silva et al., 2013). Therefore, the decreased gluten structure with the high substitute ratio of pomegranate peel powder in the chips formulation decreased the hardness values in this study. In the chips, samples containing vacuum dried pomegranate peel powder was lower fractuability values than that of others. As seen in Table 3, the substitution ratio had no significant effect on the fractuability values of the chips samples.

Table 3
Weight, hardness and fractuability properties of chips samples.

Factor	Weight (g)	Hardness (g)	Fractuability (mm)
Pomegranate peel drying methods			
Vacuum	1.20±0.09^{a}	1019.77±250.54^{b}	31.76±0.26^{b}
Convection	1.20±0.11^{a}	1119.59±129.15^{ab}	31.96±0.13^{a}
Microwave	1.18±0.10^{a}	1202.57±72.75^{a}	32.01±0.04^{a}
Substitute ratio (%)			
0	1.30±0.00^{a}	1245.96±33.78^{a}	31.90±0.18^{a}
5	1.18±0.08^{a}	1143.76±115.78^{a}	31.86±0.28^{a}
10	1.10±0.00^{a}	952.21±192.18^{b}	31.98±0.10^{a}

Means followed by the same letter within a column are not significantly different from each other (p> 0.05).

Total phenolic content and antioxidant activity values of chips samples are given in Table 4. When the results were compared in terms of pomegranate peel drying methods; it was seen that the TPC values of the chips samples incorporation with different drying pomegranate peel powder was found significantly similar (p>0.05). TPC values of chips samples with vacuum, convection and microwave drying pomegranate peel powder were determined 36.98 mg GAE g^{-1}, 35.67 mg GAE g^{-1} and 36.66 mg GAE g^{-1}, respectively (p>0.05). As shown in Table 4, an increase in the substitution ratio of pomegranate powder used in the chips formulation was significantly increased in TPC values (p <0.05). The use of the highest substitution ratio provided a 1.33-fold increase in TPC values in chips samples. Salem et al. (2020) reported that pomegranate peel powder increased the TPC of biscuit samples in parallel with an increased substitution ratio.

The antioxidant activity values of chips samples containing vacuum, convection and microwave drying pomegranate peel powder were found as 80.59%, 79.47% and 80.88%, respectively, but this difference was found to be insignificant (p>0.05). When the antioxidant activity content is evaluated in terms of the pomegranate peel powder substitute ratio, antioxidant activity values increased from 71.91% to 86.55 with an increasing ratio (from 0 to 10%). A similar trend was recorded by Urgancı and Işık (2021) reporting a significant increase in both TPC and antioxidant activity values of biscuits fortified with pomegranate peel powder.

Table 4
Total phenolic content and antioxidant activity properties of chips samples.

Factor	TPC (mg GAE g^{-1})	Antioxidant activity (%)
Pomegranate peel drying methods		
Vacuum	36.98±13.33^{a}	80.59±6.85^{a}
Convection	35.67±12.52^{a}	79.47±6.77^{a}
Microwave	36.66±12.90^{a}	80.88±7.22^{a}
Substitute ratio (%)		
0	20.06±0.91^{c}	71.91±7.22^{c}
5	42.41±1.60^{b}	82.47±2.33^{b}
10	46.85±1.93^{a}	86.55±1.63^{a}

Means followed by the same letter within a column are not significantly different from each other (p> 0.05). Chemical analysis results are given on dry matter. TPC: Total Phenolic Content.

4. Conclusion

This research was supported by the TUBITAK PublicFoundationsResearch-Development ProjectsSupportingProgramme (1007) project, number 106G053. The authors would like to acknowledge the financial support of TUBITAK and to thank the Director of the Project, Prof. Dr. İsmail ÇAKMAK.

In this study, the effect of pomegranate peel dried with three different methods on chemical, physical, color and texture properties of chips samples was studied. In terms of the pomegranate peel drying methods, a protective effect was shown microwave drying on the L* value and vacuum drying on the b* value. The increase of pomegranate peel powder content showed a decreasing effect on L*, a* and b* values. Pomegranate peel powder caused a decrease in diameter and spread ratio, and an increase in thickness values. Hardness values of chips samples decreased as the high used ratio of pomegranate peel powder in the formulation increases. Although the drying method did not have a significant effect on the TPC and antioxidant activity values, the high substitute ratio increased the TPC and antioxidant activity values. In conclusion, a new functional chips production was developed by pomegranate peel powder instead of whole wheat flour.

5. Acknowledgements

Author Mine ASLAN is a 100/2000 The Council of Higher Education PhD Scholar.

6. References

Abdel-Rahim EA, El-Beltagi HS, Romela RM (2013). White bean seeds and Pomegranate peel and fruit seeds as hypercholesterolemic and hypolipidemic agents in albino rats. *Grasas y Aceites* 64(1): 50-58.

Altunkaya A, Hedegaard RV, Brime L, Gökmen V, Skibsted LH (2013). Antioxidant capacity versus chemical safety of wheat bread enriched with pomegranate peel powder. *Food & Function* 4(5): 722-727.

Anderson JW, Baird P, Davis Jr RH, Ferreri S, Knudtson M, Koraym A, Waters V, Williams CL (2009). Health benefits of dietary fiber. *Nutrition Reviews* 67(4): 188-205

Bölek S (2020). Effect of dried pomegranate (Punica granatum) peel powder on textural, sensory and some physicochemical characteristics of gluten-free biscuits. *Kahramanmaras Sutcu Imam University Journal of Engineering Sciences* 23(4): 209-218.

Buchaillot A, Caffin N, Bhandari B (2009). Drying of lemon myrtle (Backhousia citriodora) leaves: retention of volatiles and color. *Drying Technology* 27(3): 445-450.

Clydesdale FM (1993). Color as a factor in food choice. *Critical Reviews in Food Science and Nutrition* 33(1): 83-101.

Demiray E, Seker A, Tulek Y (2017). Drying kinetics of onion (*Allium cepa* L.) slices with convective and microwave drying. *Heat and Mass Transfer* 53(5): 1817-1827.

Ibrahim A, Awad S, El-Sayed M (2020). Impact of pomegranate peel as prebiotic in bio-yoghurt. *British Food Journal* 122(9): 2911-2926.

Incedayi B, Tamer CE, Sinir GÖ, Suna S, Çopur ÖU (2016). Impact of different drying parameters on color, β-carotene, antioxidant activity and minerals of apricot (*Prunus armeniaca* L.). *Food Science and Technology* 36(1): 171-178.

Ismail T, Akthar S, Riaz M, Ismail A. (2014). Effect of pomegranate peel supplementation on nutritional, organoleptic and stability properties of cookies. *International Journal of Food Sciences and Nutrition* 65(6): 661-666.

Jandal MM, Naji EZ (2021). Study the Effects of replacement different percentages of pomegranate peels in the manufacture of cookies and its impact on the chemical, physical, sensory properties and antioxidant activity of the produced cookies. *Tikrit Journal for Agricultural Sciences* 21(1): 129-137.

Maskan M, (2001). Kinetics of color change of kiwi fruits during hot air and microwave drying. *Journal of Food Engineering* 48(2): 169-175.

Oniszczuk T, Kasprzak-Drozd K, Olech M, Wójtowicz A, Nowak R, Rusinek R, … Oniszczuk A (2021). The Impact of Formulation on the content of phenolic compounds in snacks enriched with *Dracocephalum moldavica* L. seeds: introduction to receiving a new functional food product. *Molecules* 26(5): 1245.

Ranjitha J, Bhuvaneshwari G, Jagadeesh SL (2018). Effect of different treatments on quality of nutri-enriched cookies fortified with pomegranate peel powder and defatted soybean flour. *International Journal of Current Microbiology and Applied Sciences* 7(2): 3680-3688.

Salem BR (2020). Use of tomato pomace, mango seeds kernel and pomegranate peels powders for the productıon of functıonal bıscuıts. *Zagazig Journal of Agricultural Research* 47(4): 1011-1023.

Sikora E, Cieslik E, Topolska K (2008). The sources of natural antioxidants. *Acta Scientiarum Polonorum Technologia Alimentaria* 7(1): 5-17.

Silva E, Birhenhake M, Scholten E, Sagis LMC, Van Der Linden E (2013). Controlling rheology and structure of sweet potato starch noodles with high broccoli powder content by hydrocolloids. *Food Hydrocolloids* 30(1): 42-52.

Süfer Ö, Sezer S, Demir H (2017). Thin layer mathematical modeling of convective, vacuum and microwave drying of intact and brined onion slices. *Journal of Food Processing and Preservation* 41(6): e13239.

Urganci U, Işik F (2021). Quality Characteristics of biscuits fortified with pomegranate peel. *Academic Food Journal* 19(1): 10-20.

Wójtowicz A, Oniszczuk A, Oniszczuk T, Kocira S, Wojtunik K, Mitrus M, ... Skalicka-Woźniak K (2017). Application of Moldavian dragonhead (*Dracocephalum moldavica* L.) leaves addition as a functional component of nutritionally valuable corn snacks. *Journal of Food Science and Technology* 54(10): 3218-3229.

Wójtowicz A, Zalewska-Korona M, Jablonska-Rys E, Skalicka-Wozniak K, Oniszczuk A (2018). Chemical characteristics and physical properties of functional snacks enriched with powdered tomato. *Polish Journal of Food and Nutrition Sciences* 68(3).

Zhang Y, Song KY, Joung KY, Shin SY, Kim YS (2017). Effect of pomegranate (*Punica granatum* L.) peel powder on the quality characteristics, retrogradation and antioxidant activities of sponge cake. *The Ko0072ean Journal of Food And Nutrition* 30(3): 578-590.