



ISSN (E): 2277-7695
 ISSN (P): 2349-8242
 NAAS Rating: 5.23
 TPI 2023; SP-12(7): 824-827
 © 2023 TPI
www.thepharmajournal.com

Received: 02-05-2023
 Accepted: 07-06-2023

Karanam Siva Sai Srinivas
 M.Sc. Student, Department of
 Food Technology and Nutrition,
 School of Agriculture, Lovely
 Professional University,
 Phagwara, Punjab, India

Development of antioxidant-rich chocolate with the incorporation of pomegranate peel

Karanam Siva Sai Srinivas

Abstract

The edible parts of fruits are often eaten and processed industrially, resulting in large amounts of fruit waste such as peels. These fruit wastes can be used as functional ingredients for food production, which can help lower the environmental burden. This project aimed to make dark chocolate with passion pomegranate peels as functional ingredients and helps children who suffering with cancer as additional beneficiary, children like chocolate more than anything. Dark chocolate has high antioxidant activity and is rich in flavonoids that help health. Passion pomegranate peels have high dietary fiber value. Therefore, adding these ingredients can improve the dietary fiber content of dark chocolate. Here is a possible rewrite of the text. We tested how adding passion pomegranate peel affects the nutrition, antioxidants, and taste of dark chocolate. The dark chocolate with pomegranate peel had 64.5% fat, 5.26% moisture, 10.43% protein, 3.33% ash, and 0.93% total dietary fiber. It had much more dietary fiber ($3.05 \pm 0.02\%$) than the plain dark chocolate ($0.92 \pm 0.10\%$), and this difference was statistically significant ($p < 0.05$). We asked 10 people to rate the dark chocolate on its appearance, smell, texture, meltiness, and overall liking on a range from 1 to 9. The average total liking score for the dark chocolate with passion pomegranate peel was 8 out of 9, which means 82% of the people liked it. Here is a possible rewrite of the text. The dark chocolate with passion fruit and citrus peel had much better DPPH radical scavenging activity ($81.00 \pm 0.13\%$) than the plain dark chocolate (77.75 ± 0.13) and this difference was statistically significant ($p < 0.05$). This means that the dark chocolate with passion fruit and citrus peel can give more antioxidants and dietary fiber to the consumers, which are good for their health. The customers also liked the taste and texture of the dark chocolate with passion fruit and citrus peel. Therefore, this product has a good chance of being successful in the confectionery business.

Keywords: Confectionery business, antioxidant activity, beneficiary

1. Introduction

Pomegranate fruit leaves belong to the Punicaceae family and have a lot of antioxidants like tannins and flavonoids. These antioxidants can help with many health issues such as aging, inflammation and hardening of the arteries (Khan *et al.*, 2016) ^[20]. They can also prevent free radicals from harming our cells and DNA. Free radicals are unstable chemicals that can cause cancer, heart diseases, aging, and inflammation. Our bodies have natural ways to fight free radicals, such as enzymes and compounds. But sometimes these ways are not enough, and we need extra antioxidants to protect our cells from damage. Many people are interested in using traditional drugs that have strong antioxidants (Khan *et al.*, 2016) ^[20]. We were interested in how well pomegranate fruit peel powder combated free radicals. Free radicals can cause a wide range of illnesses and are harmful to human health. Free radicals can be stopped by some synthetic antioxidants, but they can also be harmful. Plant-based natural antioxidants are better and healthier for us. Vitamins C, E, carotenoids, and flavonoids are just a few of the numerous antioxidants found in plants. Flavonoids are particularly powerful antioxidants that can save us from cancer and heart disease. Fruit peels contain more flavonoids, which we can use as additives. Free radicals can be stopped in several ways by flavonoids, which can also improve the efficiency of other antioxidants. A rich source of flavonoids and other antioxidants is the pomegranate plant. Traditional medicine is also used to treat a variety of problems, including cataracts, parasites, and diarrhea. More antioxidants are found in the pomegranate fruit's peel than in its bloom, leaf, or seed. (Khan *et al.*, 2016) ^[20]. It has been claimed that the polyphenols (tannins, ellagic, and gallic acids) found in pomegranate peel extracts give its *in vitro* antioxidant and anti-mutagenic qualities. These elements have been employed in the creation of cosmetics, tinctures, cuisine recipes, and even therapeutic formulas⁵. On the other hand, pomegranate syrup has been shown to have antioxidant and anti-sclerotic benefits on animal models when studied *in vitro*.

Corresponding Author:
Karanam Siva Sai Srinivas
 M.Sc. Student, Department of
 Food Technology and Nutrition,
 School of Agriculture, Lovely
 Professional University,
 Phagwara, Punjab, India

Additionally, research on humans has demonstrated that pomegranate juice consumption regularly lowers blood pressure in hypertensive people, delays the atherosclerotic process, and boosts the blood's overall antioxidant status 5, 6, 7. Pomegranate juice has the extraordinary ability to enhance antioxidant enzymes serum PON1 and macrophage PON2 by 50–100% while reducing oxidative stress by 40–80%.⁸ (Khan *et al.*, 2016)^[20]

Table 1: Nutrient content of pomegranate peel per 100g

Composition	Content
Total solid	94.50
Moisture	5.40
Total sugars	17.70
Reducing sugars	4.34
Protein	4.90
Crude fiber	16.20
Fat content	1.26
Ash	3.40

(Khan *et al.*, 2016)^[20]

Many individuals love chocolate as a snack because they like how sweet and delicious it is. In comparison to other chocolates, dark chocolate contains more cocoa and less sugar. Cocoa contains flavonoids, which are organic substances having antioxidant properties. Antioxidants can stop or lessen the effects of free radicals, which are harmful substances that can lead to disease and ageing. Flavonoids can also enhance brain function and mood by increasing blood flow and stimulating neurotransmitters. The benefits of flavonoids for health and wellbeing can be enjoyed by eating dark chocolate. (Yeo *et al.* 2022)^[21] Food businesses need to improve quality, reduce safety mistakes, and keep up with market developments if they want to compete in the food market. Many individuals enjoy the popular commodity known as chocolate. The global market is anticipated to sell about 9500 thousand tons of chocolate in 2024. With a market value of \$45.6 billion in 2018 dark chocolate is highly well-liked. (IMARC *et al.*, 2019)^[3].

2. Materials and Methods

The raw materials required for the present work like pomegranates, cocoa powder, cocoa mass, butter, sugar, etc. were obtained from the local market of Jalandhar.

2.1 Chemicals required

BSA (Bovine Serum Albumin), NaOH, HCl, Methanol, BHA (butylated hydroxyl anisole), DPPH solution, etc. were the chemical solutions obtained from department of Food Science and Nutrition, school of Agriculture, Lovely Professional University, Phagwara. These chemicals were purchased from reputed companies in India.

2.2 Equipment

The equipment's and sophisticated machineries such as Tray drier, Spectrophotometer (Sytronics Visible spectrophotometer), centrifuge machine, hydro-distillation Apparatus, Muffle furnace, etc. were required in the present investigation used from the department of department of Food Science and Nutrition, school of Agriculture, Lovely Professional University, Phagwara, Punjab.

2.3 Packaging material

The various packaging materials like LDPE for packaging of

the chocolate was purchased from Phagwara, Punjab.

2.4 Preparation of pomegranate peel powder

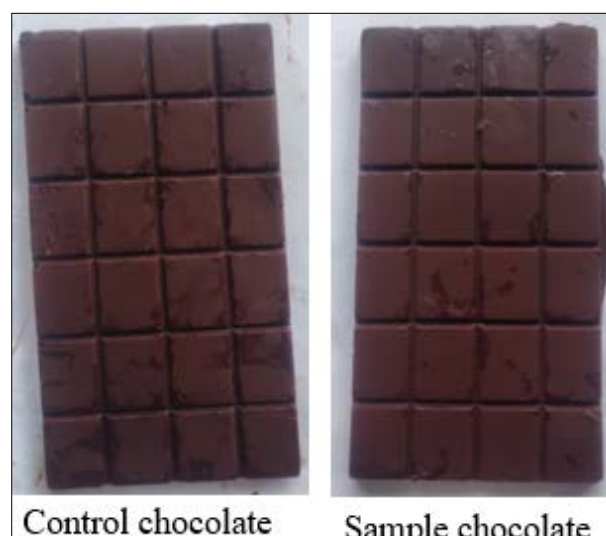
The pomegranates were washed with running water, and then the peels were removed with a knife. Pomegranate peels were dehydrated in a cabinet dryer for 8 hours at 65 degrees.

2.5 Preparation of dark chocolate

Table 2 details our process for making dark chocolate. We melted cocoa butter over a pan of boiling water (double boiling method). When it reached 50 °C, we whisked in unsweetened cocoa powder. Additionally, icing sugar, passion fruit powder, and pomegranate peel powder were progressively added. The chocolate was then tempered by cooling it to 26 °C and then heating it to 31 °C. The cocoa butter crystals were stabilized by this. The chocolate was piled into a mound and left to cool at room temperature for 20 minutes to solidify. After that, we put it in the fridge. The chocolate was taken off the mound and kept at 4 °C for storage. In the same way as before, we made regular dark chocolate, but without the pomegranate peel powder.

Table 2: Formulation of dark chocolate (Control) and pomegranate peel powder dark chocolate (Sample)

Ingredients	Control	Sample
Cocoa butter	20g	20g
Unsweetened cocoa powder	25g	25g
Milk powder	25g	23g
Icing sugar	30g	28g
Pomegranate peel powder	-	5g
Total	100g	100g



2.6 Proximate analysis

According to the AOAC technique, proximate analysis was carried out in duplicate for the following factors: moisture (Hot air oven method), protein (Kjeldahl method), ash, total dietary fiber (Fibertec method), and fat levels (Soxhlet method) (William and George, 2005)^[5].

2.7 Antioxidant test

Chocolate samples were defatted following the procedure of (Övet 2015). Chocolate extracts were obtained as described by (Cerit *et al.* 2016)^[4]. The antioxidant activity was measured using the DPPH (2,2-diphenyl-1-picrylhydrazyl) method based on (Cerit *et al.* 2016)^[4].

2.8 Sensory evaluation

Ten panellists evaluated the control and sample using a nine-point hedonic scale (1 = highly dislike to 9 = extremely like). The panellists were asked to rank their preferences for the various sensory qualities of dark chocolate, including their surface smoothness, texture, scent, melting characteristics, and overall acceptability. All samples were placed on trays in accordance with a random permutation table and coded with three-digit random numbers. Additionally, a preference test was run. The formula below was used to calculate the acceptance index of the control and sample.

$$\text{Acceptance Index} = (\text{Mean overall acceptability score}/9) \times 100$$

2.9 Data analysis: The IBM SPSS ® programme was used to

organize and analyze all of the acquired data. Calculating the mean and standard deviation (xSD) values, while testing for significant differences using a t-test with a confidence level of 99.99%.

3. Result and Discussion

The pomegranate peel powder had the following proximate composition as shown in Table 1. The moisture (%) content was 3.9 ± 0.25 , the ash (%) content was 5.1 ± 0.14 . the fat (%) content was 9.3 ± 0.12 similarly the pH, TSS, acidity was found 3.8 ± 0.22 , 0.8 ± 0.05 and 4.9 ± 0.6 respectively. Crude fiber was calculated (20.8 ± 0.7) the second higher amount after total sugar composition (31.5 ± 0.4). The reducing and non-reducing sugar was 30.6 ± 0.13 and 1 ± 0.11 nitrogen was 1.4 ± 0.32 and protein was 8.7 ± 0.12 respectively.

Table 3: Proximate composition of pomegranate peel powder

S#	Proximate Analysis	Results
1	Moisture (%)	3.9 ± 0.25 (%)
2	Ash (%)	5.1 ± 0.14 (%)
3	Fat (%)	9.3 ± 0.1 (%)
4	pH (%)	3.8 ± 0.22 (%)
5	TSS (%)	0.8 ± 0.05 (%)
6	Acidity (%)	4.9 ± 0.6 (%)
7	Crude Fiber (%)	20.8 ± 0.7 (%)
8	Total sugar (%)	31.5 ± 0.4 (%)
9	Reducing sugar (%)	30.6 ± 0.13 (%)
10	Non-Reducing sugar (%)	1 ± 0.11 (%)
11	Nitrogen (%)	1.4 ± 0.32 (%)
12	Protein (%)	8.7 ± 0.12 (%)

Table 2 displays the approximate composition of the sample and the control. The sample was different from the control in that it included higher fat (51.15%) and dietary fiber (3.06%) but less moisture (9.55%), protein (8.04%), and ash (3.56%). Pomegranate peels were added, which boosted the sample's dietary fiber content. According to (Yeo *et al.* 2022) [12] pomegranate peels contain 64.8 g of dietary fiber per 100 g.

Table 4: Proximate composition of control and sample chocolate

	Control	Sample
Moisture content (%)	5.26 ± 0.67^a	3.8 ± 0.06^a
Crude fat (%)	64.5 ± 0.33^b	70.5 ± 0.23^b
Dietary fiber (%)	0.92 ± 0.10^a	3.05 ± 0.02^a
Crude protein (%)	10.43 ± 0.03^a	8.03 ± 0.51^a
Ash (%)	80 ± 3.89^a	97 ± 4.08^b

Values are presented as mean \pm SD. Values with different superscript within the same row are significantly different ($p < 0.05$)

Table 5 demonstrates that the sample had a much higher DPPH radical scavenging activity ($86.10 \pm 0.13\%$) than the control ($61.10 \pm 0.13\%$). This indicates that compared to regular dark chocolate, the dark chocolate with orange peel powder and passion fruit powder exhibited more antioxidant activity. The primary antioxidants in the sample are the polyphenols found in orange and passion fruit peels. These include proanthocyanidins, which are polymers of flavan3-ols like catechin and epicatechin, which are flavan3-ols present in cocoa and chocolate (Steinberg *et al.*, 2003) [11]. In addition, the citrus peels include flavonoids such hesperidin, naringin, and nobiletin, which are O-methylated flavones, as well as glycosides. (Steinberg *et al.*, 2003) [11]

Table 5: Antioxidant activity of control and sample

Type of assay	Control	Sample
DPPH (%)	77.75 ± 0.13^a	81.00 ± 0.13^a

The data are shown as mean \pm SD. If the values in the same row have different superscript letters, they are significantly different ($p < 0.05$).

A test was used to analyze the mean sensory scores. The sample had better color, surface smoothness, pomegranate peel aroma, and overall acceptability, and worse texture and melting property than the control (Table 4). However, the sensory quality of the control and the sample did not differ significantly. Figure 1 compares the overall acceptance of the control and sample. The sample had a higher acceptance index (82%) than the control (78%).

Table 6: Mean scores for different sensory attributes of control and sample

	Control	Sample
Color and appearance	8.20 ^a	8.50 ^a
Pomegranate peel aroma	7.75 ^a	7.22 ^a
Texture, smoothness	8.20 ^a	7.80 ^a
Flavor	7.30 ^a	7.90 ^a
Taste	7.30 ^a	7.90 ^a
Overall acceptability	7.80 ^a	8.20 ^a

The mean \pm SD (n = 10) of the values are shown. Values that have different superscript in the same row differ significantly ($p < 0.05$).

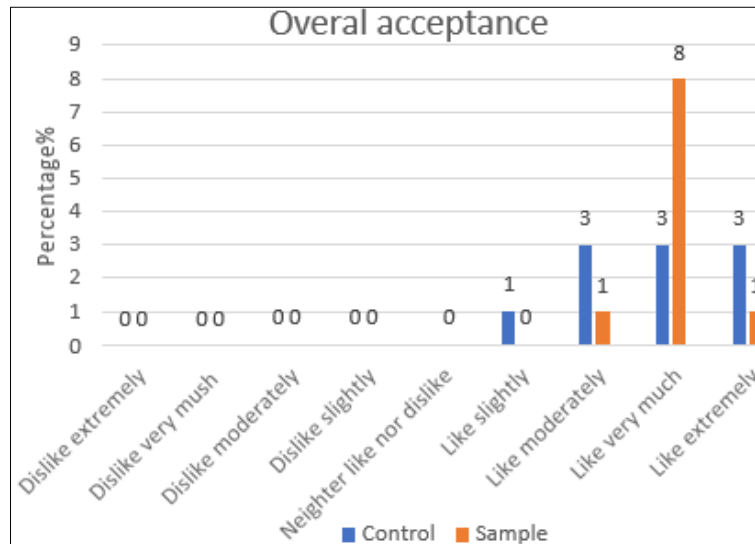


Fig 1: Comparison on the overall acceptance of control and sample

4. Conclusion

Fruit peels from pomegranates are leftovers from the food business. These wastes might be used to create goods with added value. Pomegranate peel powder in aqueous solution shown strong antioxidant activity when tested using the DPPH radical scavenging technique. Pomegranate peel's phenolic content is what gives it its strong antioxidant properties. Humans may benefit from pomegranate peel's raw extracts and purified fraction, which may also be used for medicinal and food preservation purposes. It has a high sensory quality with an Acceptance Index of 82%. By using agricultural waste such as peels, this functional food can also contribute to environmental protection. Moreover, this chocolate can help patients with various types of cancers as an indirect medicine.

4. Conflict of interests

The authors declare no conflict of interest.

5. Reference

- Khan S, Patel A, Bhise KS. Antioxidant activity of pomegranate peel powder. *Journal of Drug Delivery and Therapeutics*. 2017;7(2):81-84.
- Yeo Y, Thed S. Product development of passion fruit and citrus peel dark chocolate. *Food Res*. 2022;6:41-44.
- IMARC Group. Dark chocolate market: global industry trends, share, size, growth, opportunity and forecast 2019-2024 Research and Markets; c2019.
- Cerit İ, Şenkaya S, Tulukoğlu B, Kurtuluş M, Seçilmişoğlu Ü, Demirkol O. 2016.
- William H, George L. Official Methods of Analysis of AOAC International. 18th ed. Gaithersburg, USA: AOAC International; c2005.
- Topkaya C, Isik F. Effects of pomegranate peel supplementation on chemical, physical, and nutritional properties of muffin cakes. *Journal of Food Processing and Preservation*. 2019;43(6):e13868.
- Chau C, Huang Y. Characterization of passion fruit seed fibresa potential fibre source; c2004.
- Ibrahim UK, Kamarrudin N, Suzihaque MUH, Abd Hashib S. 2017.
- López JAS, Li Q, Thompson IP. 2010.
- Rafiq S, Kaul R, Sofi S, Bashir N, Nazir F, Nayik GA. 2018.
- Steinberg F, Bearden M, Keen C. Cocoa and chocolate flavonoids; c2003.
- William H, George L. Official Methods of Analysis of AOAC International. 18th ed. Gaithersburg, USA: AOAC International; c2005.
- Ullah N, Ali J, Khan FA, Khurram M, Hussain A, Rahman IU, *et al*. Proximate composition, minerals content, antibacterial and antifungal activity evaluation of pomegranate (*Punica granatum* L.) peels powder. *Middle East J Sci Res*. 2012;11(3):396-401.
- AACC. Approved Methods of the American Association of Cereal Chemists (9th ed.). St. Paul, MN: Author. Method: 32-07. Determination of Soluble, Insoluble and Total Dietary Fiber in Foods and Food Products; c1995.
- AACC. Approved methods of the American Association of Cereal Chemists (10th ed.). St. Paul, MN: Author. Methods; c2000. 10-91, 44-19, 46-13, 55-30, 56-11.
- Ahmed ST, Islam MM, Bostami ABMR, Mun HS, Kim YJ, Yang CJ. Meat composition, fatty acid profile and oxidative stability of meat from broilers supplemented with pomegranate (*Punica granatum* L.) by-products. *Food Chemistry*. 2015;188:481-488.
- Ajayi IA, Oderinde RA, Kajogbola DO, Uponi JI. Oil content and fatty acid composition of some underutilized legumes from Nigeria. *Food Chemistry*. 2006;99(1):115-120. <https://doi.org/10.1016/j.foodchem.2005.06.045>
- Al-Rawahi AS, Rahman MS, Guizani N, Essa MM. Chemical composition, water sorption isotherm, and phenolic contents in fresh and dried pomegranate peels. *Drying Technology*. 2013;31;257-263.
- AOAC. International: Official methods of analysis (15th ed.). Washington, DC: AOAC International; c1990.
- Khan MA, Ngo HH, Guo WS, Liu Y, Nghiem LD, Hai FI, *et al*. Optimization of process parameters for production of volatile fatty acid, biohydrogen and methane from anaerobic digestion. *Bioresource technology*. 2016 Nov 1;219:738-48.