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Physico-chemical parameters and antioxidant activity of baked product fortified with fruit waste powder

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Abstract

Fruit wastes are naturally enriched with vitamins, minerals and other bioactive compounds. Compelling evidences justify and designate peels and relative extracts of numerous fruits as nutraceuticals and functional food. Pomegranate (Punica granatum L.) rind is known as a good source of biologically active food components, and in this paper the potential use of pomegranate rind powder in cookies was studied. Cookies were produced by substituting 8, 16, 23, 31, and 39% of wheat flour with pomegranate rind powder. Chemical parameters (total acidity, ash, total phenolic and flavonoid content, as well as antioxidant activity (using ABTS method), were evaluated in cookies through the comparison to the control sample with no added pomegranate rind powder. Total ash content increased from 0.65% for cookies S0 (0% PoR) to 1.57% for sample S5 (39% PoR), while moisture content decreased from 6.65% to 4.86% for sample S0 and S5 respectively. Total phenolic content ranged from 294.67 mgGAE/100g to 2180.6 mgGAE/100g and flavonoid content from 118.8 mgCE/100g to 1088 mgCE/100g for S1 (8%) and S5 (39%), respectively. All cookies supplemented with PoR powder exhibited higher total phenolic, flavonoid content, and antioxidant activities compare to control sample.

Keywords: Cookie, Chemical analysis, Pomegranate rind powder, Aantioxidant activity

1 Introduction

Pomegranate (Punica granatum L.), a member of the family Punicaceae, is a deciduous

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shrub or small tree widely cultivated in the Middle East, European, and Southeast Asian countries (El-Hadary and Taha, 2020). Each and every part of pomegranate plant (leaves, stem, fruits, bark and roots) possess numerous bioactive compounds like phenolic compounds, including hydrolysable tannins (pedunculagin, punicalin, punicalagin, and ellagic and gallic acids), flavonoids (catechins, anthocyanins, and other complex flavonoids) and complex polysaccharides (Smaoui et al., 2019; Quideau et al., 2011). It is a fruit, commonly known as "seeded apple" or "granular apple", highly valued and consumed worldwide for its pleasant taste, nutritional values, and medicinal properties (Pathak et al., 2017). A mature pomegranate fruit measures about 6–10 cm in diameter, weighs 200 g on an average, and usually contains 50% peel, 40% arils and 10% seeds. Pomegranate fruit is used in fruit processing and beverage industry for preparation of juice and soft drinks, and during the production process, a large quantity of fruit-derived low-cost non-edible waste (mostly peel and seed) is generated. These wastes are valuable sources of bioactive compounds and could either be used as functional food ingredients or as food additives, nutraceuticals, and supplements to enrich phenolic content in diets (Pathak et al., 2017; Gullon et al., 2020). These bioactive compounds, apart from being natural, exert antioxidant and antimicrobial activity and are reported to improve the quality, safety, and extend the shelf life of different types of food products such as oils (El-Hadary and Taha, 2020), meat (Hygreeva et al., 2014; Morsy et al., 2018), fish (Zhuang et al., 2019), and dairy products like cheese, curd, fermented milk (Kandylis and Kokkinomagoulos, 2020), cereal based cookies (Kaderides et al., 2020).

It has been described that pomegranate rind is an excellent source of valuable biocompounds, including phenolic acids (hydroxycinnamic and hydroxybenzoic acids), flavonoids (anthocyanins, catechins and other complex flavonoids) and hydrolyzable tannins (ellagic and gallic acids, pedunculagin, punicalin and punicalagin), all of them with proven beneficial health effects (Singh et al., 2018). Besides, pomegranate by-products also contain organic acids, minerals (calcium, phosphorus, magnesium, potassium and sodium), protein and fatty acids (mainly punicic, linoleic and oleic acids present in the seeds) (Pirzadeh et al., 2021; Bar-Ya'akov et al., 2019). Several studies have reported that the phenolic content of pomegranate rind was 10 times higher than that found in the pulp (Li et al., 2006). In addition to their nutraceutical relevance, pomegranate rind and rind extract exhibit important technical functions (antioxidant, antimicrobial, colorant and flavouring) and may also act as excellent natural additives for food preservation and quality enhancement. As a consequence, on account of these whole properties the use of rind's fractionated compounds in food and nutraceutical industry is on the rise (Ismail et al., 2012; Kanatt et al., 2010; Naveena et al., 2008; Qu et al., 2012). Mounting evidence suggest that hydrolysable polyphenols in pomegranate rind, especially ellagitannins, are the most active antioxidants amongst the tannins contained therein. These compounds (ellagic acid, punicalagin, punicalin and gallagic acid) have been shown to hold heightened antioxidant and pleitropic biological activities and notably, to act synergistically together (Seeram and Heber, 2011).

The aim of this paper is to highlight the importance of pomegranate rind powder as food bulking agent and as a valuable substitutes of common synthetic food additives, providing information on their potential application on baked product with regard to issues of food safety, preservation, enrichment and quality enhancement.

2 Materials and Methods

Pomegranate fruits were collected from the local farmers in Tirana area. After cleaning the fruit and separation of rind from other parts of pomegranate fruit, rinds were placed in a tray and dried at 650C for 20 hours. Than the dried rind were crushed by food grinder into a powder form to completely pass through 0.5 mm size sieve. Cookies were prepared from wheat flour (control) and blends (wheat flour substituted with 8, 16, 23, 31 and 39% pomegranate rind powder) using the traditional recipe for cookies. Dough was rolled into a sheet of uniform thickness, cut into round shape pieces and placed in oven at 2000C and baked for 10 – 12 min.

The pH values of the samples were determined by suspending 10g of each sample in 100ml of distilled water in 250ml beaker (Matthew et al., 2015). The moisture and ash content in the sample was estimated according to the method of AOAC (1984) (Williams, 1984). 5g of sample was taken in pre-weighed moisture box, dried at 105oC for 24 hrs in hot air oven, cooled in desiccators and weighed again up to a constant weight. For ash determination the samples were heated in a muffle furnace for 6 -8 hours at 600-700oC. To ensure completion of ashing, the crucible was again heated in a muffle furnace for 1-2 hour, cooled and weighed. This was repeated till the consecutive weights were the same and the ash was almost grayish-white in color.

Measurement of total polyphenols was performed in accordance with the colorimetric method of Folin-Ciocalteu (Singleton and Rossi, 1965). 125 µL extract were mixed with 125 µL Folin-Ciocalteu reagent and after 6 min was added sodium carbonate 7.5%. After 2 hours at room temperature in the dark the absorbance was measured spectrophotometrically at 760nm using UV/Vis spectrophotometer (Libra S22 Bichrom, UK). The total phenolic content is expressed as mg gallic acid equivalents/100g sample using a gallic acid standard curve.

An aliquot (0.5mL) of methanolic extract sample was added to 10mL volumetric flask containing distilled water. Total flavonoid content was measured using aluminum chloride colorimetric assay (Zhishen et al., 1999). Then 0.15mL NaNO2 was added to the flask and after 6 min, 0.15mL AlCl3. At 6th min, 2mL NaOH was added and the solution was mixed completely. The absorbance level was measured versus prepared reagent blank at 510 nm and total flavonoid content is expressed as mg catechin equivalents/100g sample (mg/100g CE).

Antioxidant activity was determined using ABTS radical scavenging assay (Re et al., 1999). ABTS and potassium persulfate mixture was kept in the dark at room temperature for 16 h before use. 40µl of each sample extract was mixed with 1.96mL of ABTS reagent. The percentage inhibition of absorbance at 765nm after 6min at room temperature was calculated and plotted as a function of antioxidant concentration.

3 Results and Discussions

Figure 1a presents the data on the moisture content expressed in percentage. There is a decrease in the moisture content with the increase of the percentage of pomegranate rind powder. Cookies with an addition of 8% PoR have a slight difference of moisture content compare to control sample, value which is further reduced by increasing percentage of PoR.

The lowest value of moisture is observed in sample S5 with 39% of PoR. Akoja and Coker (2018) reported that the moisture content was an indicator of shelf stability, thus an increase in moisture content can enhance microbial growth which leads to deterioration in foods. The moisture content (4.86% in cookies with 39% PoR) was lower than the range recommended by USDA National Nutrient Database for Standard Reference which is 11.5%. The low moisture content of cookies enriched with PoR reduced the possibility of microbial attack. High moisture content is not a desirable in a product such as cookies, because it has an inverse relationship with texture of the product, which is an important attribute with consumer preference (Akoja and Coker, 2018). Rind as a non-edible part of pomegranate has been previously referred as a good source of minerals like Ca, K, Mg, Fe and Zn (Fawole and Opara, 2012). Incorporation of PoR powder in wheat flour presented a significant increase in ash contents of cookies from 0.82% to 1.57%, thereby improving micro-elemental concentration of baked products. 8% PoR powder supplementation increased ash level of cookies with 26% while 39% PoR powder supplementation increased with 141% ash content in cookie sample.

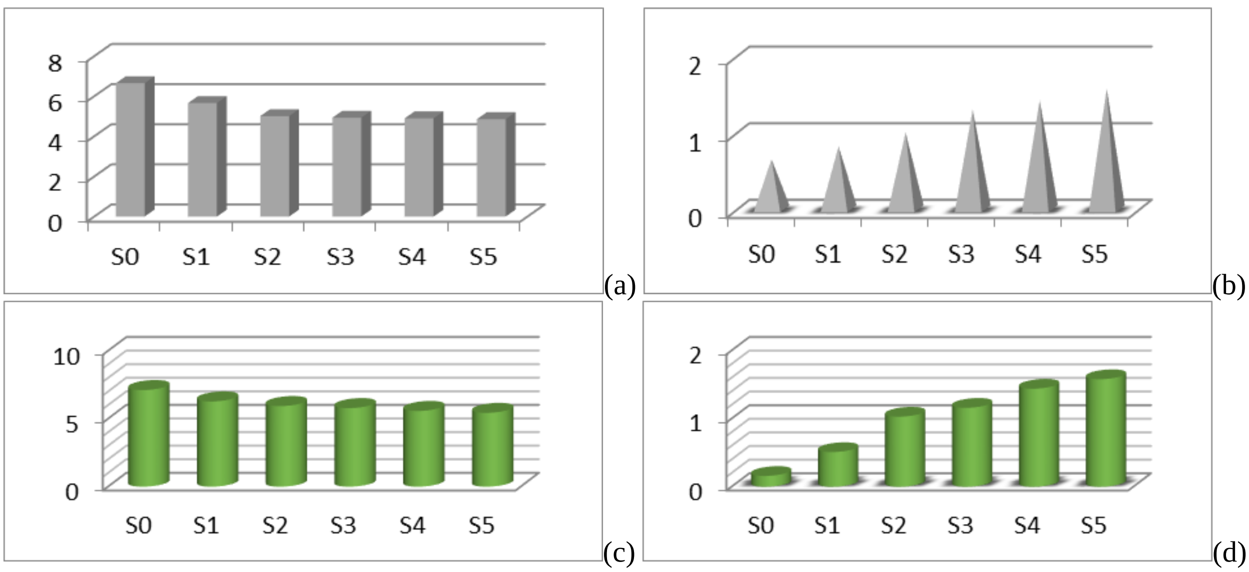

Figure 1. (a) moisture content expressed in percentage; (b) ash content expressed in percentage; (c) pH level; (d) total acidity of control sample (S0), cookie with 8% PoR (S1), 16% PoR (S2), 23% PoR (S3), 31% PoR (S4) and 39% PoR (S5).

Figure 1(b) shows that the ash content ranged from 0.65% to 1.57% for cookies with minimum of 8% PoR and maximum of 39% PoR respectively. All these are in agreement to the findings of Al-Sayed and Ahmed (2013), Ismail et al. (2014) and Youssef and Mousa (2012) for enriched cookies with fruit waste supplementation. The pH is an important parameter in the formulation of cookies. The result of pH and total acidity of cookies supplemented with PoR powder are presented in Figure 1c and 1d. The pH of control sample was 7.12 and decreased considerable with addition of different levels of PoR.

Addition of 8% PoR caused a reduction of pH level to 6.28, which is further reduced to a minimum level 5.44 for cookies with 39% PoR powder. Acidic products are more shelf stable than non-acidic counterparts and an acidic pH is associated with the development of a pleasant taste (Peter Ikechukwu et al., 2017). Total acidity value ranged from 0.16% for control sample to 1.58% for cookies enriched with 39% of PoR powder.

Higher concentration of total phenolics (2180.6 mg GAE/100g) and flavonoids (1088 mg CE/100g) and associated antioxidant activity (6891.36 mg/100g) were exhibited from cookies sample with 39% PoR (Table 1). Total phenolic contents of cookies were increased from 294.67 - 2180.6 GAE mg/100g expressing a linear trend with gradual increments of PoR concentration in cookies from 8 – 39%. Flavonoid content follow the same trend that range from 118.8 - 1088 CEmg/100g for cookies supplemented with PoR compare to control sample. A dose dependent response was recorded in antioxidant activity of cookies with PoR identifying a correlation among antioxidant activity and polyphenolic content. The lowest and the highest antioxidant ABTS scavenging activity values ranged from 167.9 (S0) to 6891.36 mg/100g (S5).

Table 1. Total phenolic and flavonoid contents of control and PoR supplemented cookies, along with their radical scavenging activities; control sample cookie (S0), cookie with 8% PoR (S1), 16% PoR(S2), 23% PoR (S3), 31% PoR (S4) and 39% PoR (S5).

Sample	**Phenolic content (GAE mg/100g)**	**Flavonoid content (CE mg/100g)**	**ABTS scavenging activity (Ascorbate equivalent mg/100g)**
S0	73.88 ± 1.54	21.46 ± 0.07	167.9 ± 0.04
S1	294.67 ± 0.62	118.83 ± 0.95	887.65 ± 0.18
S2	823.80 ± 2.01	294.06 ± 1.03	2570.99 ± 0.61
S3	1070.00 ± 1.11	441.83 ± 0.65	3417.90 ± 0.49
S4	1862.84 ± 0.82	668.11 ± 0.71	5761.11 ± 0.08
S5	2180.59 ± 1.37	1088.11 ± 0.26	6891.36 ± 0.43

4 Conclusion

The results of this study revealed that the incorporation of pomegranate rind powder in wheat flour improved physic-chemical parameters of cookies, phenolic and flavonoid content, along with their antioxidant activity, compare to the traditional wheat flour cookies. Based on value of pH, total acidity and moisture, cookies supplemented with pomegranate rind powder tend to be more shelf-stable. Intensified health problems of the society resulted in a change of human attitude to the quality of consumed products. The nutritive value of foods particularly baked products like cookies can be improved by fortification of wheat flour with pomegranate rind powder as they are rich source of polyphenols.

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Conflict of interests

The authors declare that there are no competing interests.

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