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Research Article

Impact of Drying Methods on The Bioactive Compounds and Antioxidant Capacity of Pomegranate (*Punica granatum* L.) Peel

Sengul Uysal[a,b,1*], Dilek Efe Arslan[a,2]

[a] *Erciyes University Halil Bayraktar Health Services Vocational College, Kayseri, Turkey*
[b] *Drug Application and Research Center, Erciyes University, Kayseri, Turkey*

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ABSTRACT

Pomegranate peel, a fruit by-product, is a rich source bioactive compound. This study evaluated the effects of shade (SD) and oven drying (OD) on the bioactive content and antioxidant properties of pomegranate peel. The antioxidant capacity was evaluated by reducing power activity, radical scavenging, and metal chelating assays. Results showed that total bioactive compounds and antioxidant capacity were influenced by drying methods. The study indicated that pomegranate peel could be utilized in food and pharmaceutical industries.

Araştırma Makalesi

Kurutma Yöntemin Nar (*Punica granatum* L.) Kabuğunun Biyoaktif Bileşikleri ve Antioksidan Kapasitesi Üzerine Etkisi

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Biyoaktif bileşikler
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ÖZ

Bir meyve yan ürünü olan nar kabuğu zengin bir biyoaktif bileşik kaynağıdır. Bu çalışma nar kabuğunun biyoaktif içeriğine ve antioksidan özellikleri üzerine gölgede ve fırında kurutmanın etkileri değerlendirilmiştir. Antioksidan kapasite indirgeme gücü aktivitesi, radikal süpürme ve metal şelatlama testleri tarafından değerlendirilmiştir. Sonuçlar toplam biyoaktif bileşiklerin ve antioksidan kapasitenin kurutma metotları tarafından etkilendiğini gösterdi. Araştırma nar kabuğunun gıda ve ilaç endüstrilerinde kullanılabileceğini gösterdi.

* Sorumlu Yazar
E-posta adresleri: senguluysal@erciyes.edu.tr (S. Uysal), dilekea@erciyes.edu.tr (D. Efe Arslan)
[1] ORCID: 0000-0003-4562-1719
[2] ORCID: 0000-0003-1115-303X
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Etik Beyan **Ethical Statement**

Bu çalışmanın hazırlanma sürecinde bilimsel ve etik ilkelere uyulduğu ve yararlanılan tüm çalışmaların kaynakçada belirtildiği beyan olunur (S. Uysal).

It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited (S. Uysal).

İntihal Kontrolü **Plagiarism Check**

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Çıkar Çatışması **Conflict of Interest**

Yazarlar, bu makalede bildirilen çalışmayı etkiliyor gibi görünebilecek bilinen hiçbir rakip mali çıkarları veya kişisel ilişkileri olmadığını beyan ederler.

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1. Introduction

In recent years, there has been increasing global interest in food by-products (such as peel, seed, and leaves). These non-edible parts contain higher content of bioactive compounds when compared to the edible parts (Osorio et al., 2021). Food by-products had significant biological activity including anti-inflammatory, antioxidant, antidiabetic, antimicrobial, and anticancer (Mateus et al., 2023).

Punica granatum L. (Pomegranate), which belongs to the Punicaceae family, is a significant fruit with medicinal properties (Elfalleh et al., 2012; Jurenka, 2008). Pomegranate, mainly the peel, contain various phenolic compounds like gallic acid, punicalagin, ellagic acid, caffeic acid (Kazemi et al., 2016). The previous phytochemical studies of pomegranate peel established the presence of phenolic compounds. Yenil et al. (2023) were the determined phenolic compounds from different varieties of pomegranate peels, identifying ellagic acid, as the most abundant polyphenolic compounds. Phenolic compounds such as gallic acid, chlorogenic acid, caffeic acid, and quercetin have been identified in peel of *P. granatum* by Kafeel et al. (2023).

Many studies have demonstrated that pomegranate peel extracts have been used to treat Alzheimer's, diabetes, arthritis, and cardiovascular diseases due to its antioxidant potential (Gullon et al., 2016; Wasila et al., 2013). In addition, pomegranate peel can be used as source for food, cosmetic and pharmaceutical applications.

Drying methods is an important factor affecting biological activity and bioactive compounds (Belwal et al., 2022; Wojdylo et al., 2020). Akther et al. (2023) evaluated the antioxidant properties and phytochemical profile of mango powder by different drying methods. The results demonsrated that the drying methods affected bioactive compounds and antioxidant activity. Another study has reported the effects of different drying methods on the quality of brocade orange peels (Wang et al., 2023). Conventional extraction methods, such as soxhlet, infusion, and decoction extraction, are widely used extraction of bioactive compounds. However, these methods have some deficiencies including low extraction rates and long extraction time (Meng et al., 2024). Modern extraction techniques such as ultrasound-assisted and supercritical fluid extraction address drawbacks these shortcomings (Fang et al., 2018; Ray et al., 2023). Ultrasound-assisted extraction has nowadays gained prominence as green technology, cost-effectiveness, fast, and low-energy (Kumar et al., 2021).

The present research aimed to evaluate the possible effects of two drying methods (shade and oven drying) on the phytochemical content and antioxidant capacity of pomegranate peel.

2. Material and Methods

2.1. Plant materials

The pomegranate samples were purchased a company. The peels were dried by oven drying and shade drying methods. Oven drying (OD): the peels dried in oven at 75 C° for 20 h. Shade drying (SD): the peels were dried in the dark at the temperature of 25 C°. The peels were powdered by a laboratory mill.

2.2. Preparation of the extraction

The plant materials were extracted by Ultrasonication assisted extraction (UAE). 5 g plant samples were sonicated with 100 ml water for 1 h at 30 °C. The extracts were filtered and then were lyophilized. The extracts were kept at +4 °C until future analysis.

2.3. Total bioactive contents

The total phenolics and flavonoid content were evaluated using the Folin-Ciocalteu and $AlCl_3$ methods (Uysal et al., 2017).

2.4. Antioxidant assays

The antioxidant properties were performed by different assays including ABTS, DPPH, FRAP, metal chelating assays and CUPRAC. The details about the antioxidant methods can be found in our previous research (Uysal et al., 2017).

3. Results and Discussion

3.1. Total bioactive compounds

The total phenolic and flavonoid content obtained by two drying methods are shown in Figure 1 and 2. Shade drying contained higher levels of total phenolics content compared to oven drying. Oven drying procuded had the highest flavonoid content than shade drying. Higher drying temperatures resulted in a higher bioactive content of pomegranate extracts (Tontul & Topuz, 2017). Ozay-Arancioglu et al. (2022) reported the effect of drying methods on the bioactivite and bioaccesssibility in pomegranate arils. Total phenolic content of arils extracts ranged from 6.13 to 7.88 mgGAE/g extract. In the same study, the total flavonoid content varied from 0.33 to 0.49 mgCE/g and extracts displayed very low flavonoid content. Compared with our results, pomegranate peel contained higher levels of total phenolic content compared to pomegranate arils. Hamid et al. (2020) found that the total phenolics of different parts obtained from wild pomegranate fruits were determined. Calín-Sánchez et al. (2013) demonstrated that total polyphenols in pomegranate rind at different drying methods ranged between 57.3 mgGAE/g – 118 mgGAE/g.

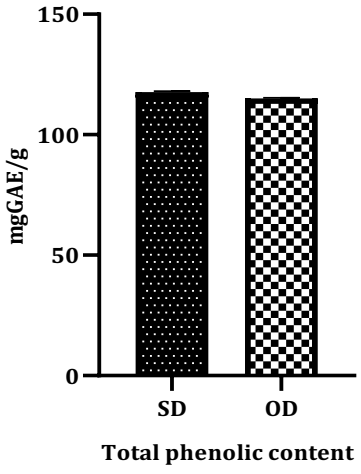

Figure 1. Total phenolics of Pomegranate peel extracts, SD: Shade drying, OD: Oven drying.

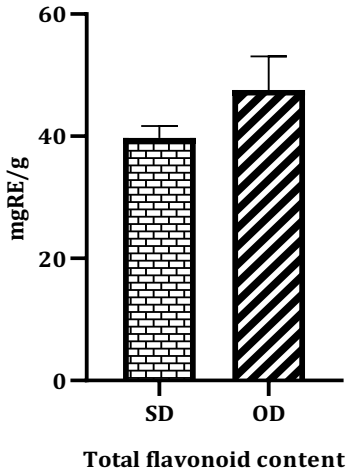

Figure 2. Total flavonoids of Pomegranate peel extracts, SD: Shade drying, OD: Oven drying.

3.2. Antioxidant capacity

The antioxidant properties of extracts derived from pomegranate peel was determined using the ABTS, DPPH, FRAP, CUPRAC, and metal chelating activity. The extracts displayed significant scavenging activity on DPPH and ABTS. Oven drying exhibited higher scavenging activity than shade drying. Fig 3 presents the antioxidant results of pomegranate extracts. The reducing power activity was determined by CUPRAC and FRAP assays. The shade drying showed higher CUPRAC activity with value of 795.97 mgTE/g as compared to oven drying (733.67 mgTE/g). In the FRAP assay, oven drying exhibited the highest activity. Similarly, oven drying (30.29±8.97 mgEDTAE/g) presented the highest metal chelating activity as compared to the shade drying (21.38±3.12 mgEDTAE/g). Several studied indicated that oven drying technique for pomegranate peel considered potential technique for quality of dried pomegranate peel (El-Said et al., 2014; Mphahlele et al., 2016).

Our findings are supported by the previous studies (John et al., 2017; Mphahlele et al., 2016; Sarkar et al., 2024). They reported the drying method impacted the bioactive compounds and biological actvity of pomegranate peel.

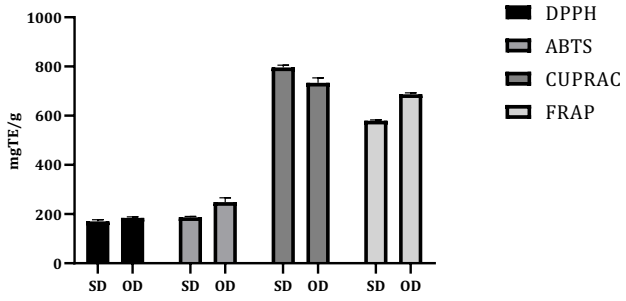

Figure 3. Antioxidant capacity of Pomegranate peel extracts, SD: Shade drying, OD: Oven drying.

According to Hamid et al. (2020) the antioxdiant activity of different part of wild pomegranate fruits affected by their drying methods. Ozay-Arancioglu et al. (2022) also found the antioxidant properties could significantly affected the drying methods. In investigation by Muhammad et al. (2023), the radical scavenging activity of pomegranate peel dried by different methods against the DPPH radical was determined. The obtained results showed solar drying method showed the highest activity than oven drying and sun drying method. Also, Setlhodi et al. (2024), indicated extraction of pomegranate peel at 78 °C displayed the most potent antioxidant capacity. Sarkar et al. (2024) reported the effect of four drying technigues on the bioactive compounds and antioxidant activity of pomegranate peels. According to the results, the freeze-drying method exhibited the highest total phenolic content and DPPH activity.

4. Conclusion

This study concluded that pomegranate peel, which is a by-product, is major source of bioactive compounds. Pomegranate peel extract displayed good antioxidant capacity. The drying methods affected total bioactive compounds and antioxidant capacity. Pomegranate peel can be a potential candidate for food and pharmaceutical fields.

CRediT author statement

SU: Methodology, Original Draft, Investigation, Writing - review & editing
DEA: Investigation, Original Draft, Writing - review & editing

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