T E X N İ K A E L M L Ə R İ

UDC 663.26

POMEGRANATE PEEL AS A SOURCE OF BIOACTIVE FATTY ACIDS: ANALYSIS AND POTENTIAL APPLICATIONS

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DOI: 10.30546/2958-8111.2025.2.101

Abstract

This investigation is conducted research to obtain bioactive compounds from the peels of the Bala Mursal, Azerbaijan Guloyshe, and Nazik gabıg pomegranate varieties obtained during processing from wine factories located in the Aghsu and Goychay districts and to study their health benefits for the purpose of food supplement applications. Pomegranate peels contain many fatty acids. The antioxidant properties of these acids further contribute to their broad functions such as protection against oxidative stress and reducing the risk of chronic diseases, including anti-cancer, antibacterial, and cardiovascular protection. For this purpose, fatty acids composition analyses of the research samples were carried out using modern equipment in accordance with the relevant methodology in the "Complex Studies" laboratory of the Azerbaijan Food Safety Institute, in the "Food Technologies" laboratory named after Aziz Sancar of the Azerbaijan State University of Economics. During the study, significant differences were observed in the analysis results depending on the growing conditions and characteristics of the varieties. The high content of fatty acids in the composition of pomegranate peel makes it possible to use it both as a food additive and as a substitute for chemical preventive agents.
The aim of the research is to better reuse waste sources for physiological applications by revealing the health benefits of the waste sources through a deeper understanding of the fatty acids in pomegranate peels obtained during processing in the winery industry in Azerbaijan.
Keywords: cultivated varieties, crude oil, fatty acids, varietal characteristics, growing conditions

İntroduction

Approximately one-third of the food produced globally for human consumption is lost or wasted. In quantitative terms, this includes both food processing by-products and food losses, amounting to approximately 1.3 billion tons, with an estimated value of around 990 billion USD [1, 2]. Among these, the fruit and vegetable processing industry is one of the major producers of by-products, accounting for approximately 45% [3]. Another significant contributor in this regard is the wine industry, where pomegranate peels generated during processing constitute a substantial portion of waste, representing approximately 26–30% of the total fruit weight [4]. Globally, the pomegranate juice industry produces an average of 1.9 million metric tons of pomegranate peels annually. The composition of the fruit is approximately 46% juice, 43% peel, and 11% seeds [5, 6].

The improper utilization of these by-products not only leads to resource wastage but also contributes to environmental pollution. Pomegranate peels are rich in various bioactive compounds, including fatty acids, catechins, antioxidants, minerals, vitamins, polyphenols, dietary fiber, flavonoids,

punicalagins, anthocyanins, and ellagic acid, which offer numerous potential health benefits [7,8]. These bioactive constituents play a crucial role in promoting human health, providing protective effects against serious conditions such as cardiovascular diseases, oxidative stress, inflammation, diabetes, obesity, and certain types of cancer [9].

The multiple applications of pomegranate peels in food bioprotection and their potential use as functional food additives have been extensively studied. The presence of these bioactive compounds provides a basis for their utilization as value-added resources and functional ingredients. Considering that there are approximately 500 pomegranate varieties worldwide, with over 60 variaties cultivated in Azerbaijan, there exsists a favorable framework for the rational use of pomegranatw peels generated during wine production.

The present study aims to analyze the fatty acids composition of pomegranate peels obtained during wine processing, highlighting their potential health benefits when used as food additives and adding value to the pomegranate industry.

Material and methods

In the initial stage, the pomegranate peels (a rich source of natural compounds), which were the object of our research, were washed and cleaned, then cut into small pieces and dried in a drying device in 2 stages at a specified temperature and moisture. The moisture content of pomegranate peels varied by variety, and was 61% in Azerbaijan Guloyshe, 60% in Bala Mursal, and 59% in Nazik gabıg. Thus, in the first stage, the pomegranate peels, which we conducted the research with 4400 grams for each variety, were cleaned and placed in a drying device for 50 minutes at a temperature of 60 degrees, depending on the variety, until they reached 14-16% moisture content. The first stage of the drying process was completed with a mass of 2624-2620 g for each variety and a moisture content of 35-37%. In the second stage of the process, the shells with a mass of 2624-2620 g were placed in a drying device for 2 hours at 55 degrees Celsius for each variety until the moisture content reached 7-9%. After the drying process was completed, the mass of pomegranate peels was determined by variety - in the range of 1.026 - 1.019 g and the moisture content was determined as 9% for Azerbaijan Guloyshe, 7% for Nazik gabıg, and 8% for Bala Mursal. Then, the pomegranate peels were ground.

The determination of crude oil method

First, extraction pouchs were prepared. Filter paper measuring 110×90 mm was used for prepare the pouchs. The filter paper was made in the form of a pouch, then was kept in a soxhlet in ether for 1 hour, then was put into a weighing bottle. With the weighing bottle lid open was dried in an oven at 105°C for 1 hour, then was placed in a desiccator, cooled, and weighed on an analytical balance with an accuracy of ±0.001 grams.

1.0 gram of sample was dried and placed into the weighed pouch on an analytical balance to an accuracy of ±0.001 grams, the mouth of the pouch was closed, the pouch was placed into the used weighing bootle during drying and kept in a drying oven at 105 °C for 3 hours, then was cooled in a desiccator and weighed on an analytical balance to an accuracy of ±0.001 grams. The weighed pouch was placed into the extractor of the Soxhlet apparatus vertically. The feed particles were extracted with diethyl ether. The ether appropriate for the feed type was poured into the flask of the Soxhlet apparatus. At this time, ether is poured into the flask of the Soxhlet apparatus in such an amount that the total volume of solvent after draining from the extractor does not exceed 2/3 of the volume of the flask. The sample was kept in the apparatus with ether overnight, and extraction was continued the next day. The next day, extraction was carried out in a Soxhlet apparatus for 5–8 hours. At the end of the extraction, the pouchs were removed from the Soxhlet apparatus and the ether was allowed until evaporate.

The determination of fatty acids method

Oil samples obtained from the peels of Bala Mursal, Azerbaijan Guloyshe, and Nazik gabıg pomegranate varieties using the Soxhlet method were individually weighed into a 0.5 g centrifuge tube, then 5 ml of n-hexane was added and mixed. Then 200 µl of KOH-methanol solution was added. It was mixed in a vortex device for 1 minute and allowed to stand for 5 minutes. 0.5 g of Na_2SO_4 was added and centrifuged at room temperature for 3 minutes. Then the sample oils were placed in a gas chromatography device and the fatty acid composition was determined.

The devices

Drying process: Chinese-made “Heat Pump Dehydrator” model “AGHD-15ELC”; grinding process: 2020 Turkish-made “Model SM 108 Super Mixer Grinder”; crude oil: by the Socs plus-SCS-6AS instrument based on the Soxhlet method according to the GOST13496.15 2016 standard; fatty acid composition: “Agilent technologies 7820A” model gas chromatography with ISO 12966-4, ISO 15884 IDF 182 standards;

Results and their discussion

Oils were extracted from different varieties of pomegranate peels (Bala Mursal, Azerbaijan Guloyshe, and Nazik gabıg) by the Soxhlet method and the fatty acid composition of the oils was studied. Thus, during the analysis of fatty acids, 19 fatty acids were detected in the peels of the Bala Mursal, Azerbaijan Guloyshe, Nazik gabıg varieties (Table 1).

Thus, myristic acid was found in the amount of 3.33725% in Azerbaijan Guloyshe, 3.17332% in Nazik gabıg, and 2.98725% in Bala Mursal.

Trace amounts of pentadecanoic acid were also found in the pomegranate peel oils studied. Thus, this fatty acid accumulated in the amount of 0.37894% in Azerbaijan Guloyshe, 0.32114% in Nazik gabıg, and 0.31912% in Bala Mursal.

It was clarified that the palmitic acid amount in pomegranate peel oils is slightly higher. Thus, this fatty acid accumulated in Azerbaijan Guloyshe - 17.25311%, in Nazik gabıg - 17.13674%, in Bala Mursal - 16.93512%.

Later, it was found that palmitoleic acid was present in small amounts in the oils. Thus, it was found in Azerbaijan Guloyshe - 0.70263%, in Nazik gabıg - 0.68447%, in Bala Mursal - 0.67972%.

Stearic acid, which belongs to the group of saturated fatty acids, was also found in small amounts in the studied pomegranate peel oils. Thus, this fatty acid constituted 9.90530% in Azerbaijan Guloyshe, 9.62831% in Nazik gabıg, and 9.56436% in Bala Mursal.

Cis and trans isomers of oleic acid were also found in pomegranate peel oils. Thus, the cis isomer of oleic acid was 20.98883% in Azerbaijan Guloyshe, 20.80446% in Nazik gabıg, and 20.97265% in Bala Mursal. The trans isomer of oleic acid (elaidic) was 0.75470% in Azerbaijan Guloyshe, 0.75226% in Nazik gabıg, and 0.74964% in Bala Mursal.

Linoleic acid was also found in significant amounts in pomegranate peel oils. Thus, this fatty acid was found in the amount of 19.99353% in Azerbaijan Guloyshe, 19.98575% in Nazik gabıg, and 19.12647% in Bala Mursal.

Trans-linoleic acid was also found in trace amounts in pomegranate peel oils. Thus, this fatty acid was found in the amount of 0.30361% in Azerbaijan Guloyshe, 0.29968% in Nazik gabıg, and 0.28947% in Bala Mursal.

During the analysis, arachidic acid was found in small amounts in pomegranate peel oils. Thus, it was detected in the amount of 1.05148% in Azerbaijan Guloyshe, 1.04996% in Nazik gabıg, and 1.04993% in Bala Mursal.

During the study, α-linolenic fatty acid was also found in significant amounts in the oils. Thus, this fatty acid was found in the amount of 7.91444% in Azerbaijan Guloyshe, 7.78012% in Nazik gabıg, and 7.27364% in Bala Mursal.

Eicosenoic fatty acid, which is one of the valuable indicators for oils, was found in significant amounts. Thus, this fatty acid was found in the amount of 7.14878% in Azerbaijan Guloyshe, 7.12317% in Nazik gabıg, and 7.11576% in Bala Mursal.

During the study, γ - linolenic fatty acid was also found in the oils. Thus, this fatty acid was found in the amount of 0.42199% in Azerbaijan Guloyshe, 0.42114% in Nazik gabıg, and 0.40178% in Bala Mursal.

During the analysis, it was found that pomegranate peel oil also contains a small amount of behenic acid. Thus, this acid was detected in the amount of 1.74832% in Azerbaijan Guloyshe, 1.67236% in Nazik gabıg, and 1.65785% in Bala Mursal.

Docosadienoic fatty acid was found in certain amounts in the oils. It was clarified that this fatty acid was in Azerbaijan Guloyshe - 2.33762%, in Nazik gabıg - 2.32639%, in Bala Mursal - 2.17826%.

Lignoceric acid was also found in trace amounts in pomegranate peel oils. Thus, this fatty acid was in Azerbaijan Guloyshe - 0.56868%, in Nazik gabıg - 0.53972%, in Bala Mursal - 0.52654%.

Eicosapentaenoic acid was also found in insignificant amounts in the oil samples. It was detected in the amount of 1.20275% in Azerbaijan Guloyshe, 1.16538% in Nazik gabıg, and 1.16483% in Bala Mursal.

Nervonic acid was also found in trace amounts in pomegranate peel oils. It was determined that this fatty acid was in Azerbaijan Guloyshe - 1.62729%, in Nazik gabıg - 1.62521%, and in Bala Mursal - 1.61912%.

During the analysis, docosahexaenoic fatty acid was also found in a small amount in the oils. It was clarified that this fatty acid was in Azerbaijan Guloyshe – 2.34575%, in Nazik gabıg - 2.34118%, and in Bala Mursal - 2.32112%.

The results of the analysis showed that the highest fatty acid amount was found in Azerbaijani Guloyshe (Figure 1). It was clarified that unsaturated fatty acids predominated in the composition of pomegranate peels. Thus, saturated fatty acids were 34.24308% in Azerbaijan Guloyshe, 33.52155% in Nazik gabıg, and 33.04017% in Bala Mursal. Unsaturated fatty acids were found 65.69692% in Azerbaijan Guloyshe, 65.30921% in Nazik gabıg, and 64.89246% in Bala Mursal. The high content of unsaturated fatty acids compared to saturated fatty acids in pomegranate peels also indicates a nutritionally favorable lipid profile and the potential for beneficial applications for health [10]. The diversity of the composition and amount of fatty acids in the peels depends on their genotypic characteristics and growing conditions [11].

Table 1. Fatty acids in pomegranate peels

Fatty acids, %		**Pomegranate peel**		
		Varieties		
		Bala Mursal	**Azerbaijan Guloyshe**	**Nazik gabıg**
C14:0	myristic	2.98725	3,33725	3.17332
C15:0	pentadecanoic	0.31912	0.37894	0.32114
C16:0	palmitic	16.93512	17.25311	17.13674
C16:1	palmitoleic	0.67972	0.68763	0.68447
C18:0	stearic	9.56436	9.90530	9.62831
C18:1c	oleic	20.97265	20.98883	20.80446
C18:1t	elaidic	0.74964	0.75470	0.75226
C18:2c	linoleic	19.12647	19.99353	19.98575
C18:2t	trans isomers of linoleic	0.28947	0.30361	0.29968
C20:0	arachidic	1.04993	1.05148	1.04996
C18:3n3	alpha-linolenic	7.27364	7.91444	7.78012
C20:1	eicosenoic	7.11576	7.14878	7.12317
C18:3n6	gamma-linolenic	0.40178	0.42199	0.42114
C22:0	behenic	1.65785	1.74832	1.67236
C22:2	docosadienoic	2.17826	2.33762	2.32639
C24:0	lignoceric	0.52654	0.56868	0.53972
C20:5	eicosapentaenoic	1.16483	1.17275	1.16538
C24:1	nervonic	1.61912	1.62729	1.62521
C22:6	docosahexaenoic	2.32112	2.34575	2.34118
Amount of saturated fatty acids, %		33.04017	34.24308	33.52155
Amount of unsaturated fatty acids, %		64.89246	65.69692	65.30921

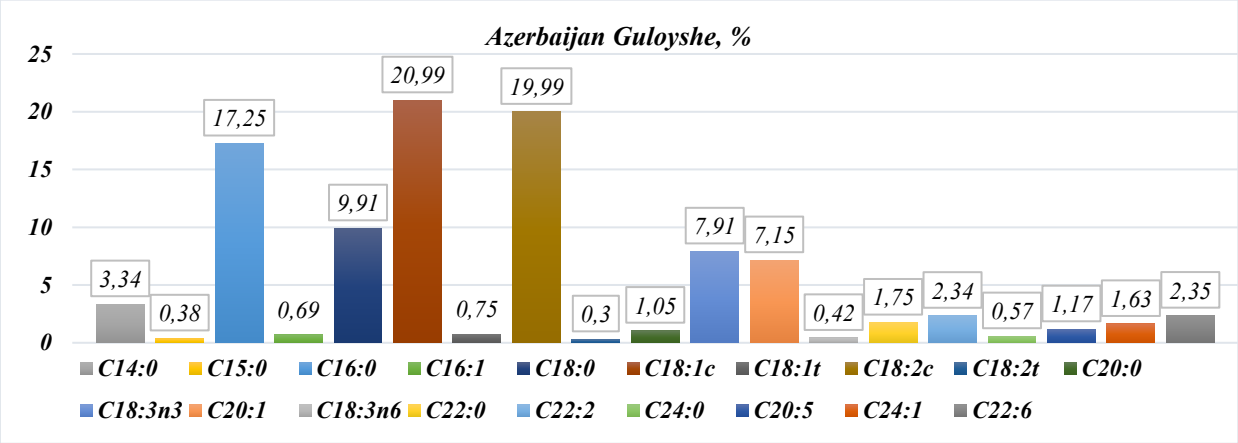

Figure 1. The fatty acid amounts in peels of Azerbaijan Guloyshe pomegranate

Conclusion and Suggestions

The fatty acids composition of pomegranate peels, which are obtained as waste from the winery industry in Azerbaijan was analyzed in detail for the first time. The conducted research on pomegranate peels has proven the richness of many important fatty acids in their composition. By determining the fatty acid composition of pomegranate peels, 19 fatty acids were detected. The highest fatty acid amounts were found in linoleic – 19.12647-19.99353%, oleic acid - 20.80446-20.98883%, α-linolenic - 7.27364-7.91444%, palmitic 16.93512-17.25311%. It should be especially emphasized that the highest amount of fatty acids was found in Azerbaijan Guloyshe.

The results of the study clearly showed that the diversity of the composition and amount of fatty acids in pomegranate peels depends on their variety (genotypic characteristics) and growing conditions (climate, soil, region).

It can be concluded from the results of the study that environmentally safe, balanced in terms of composition and technologically convenient this pomegranate peels indicates the possibility of its use as a food supplement with its fatty acids. The obtained pomegranate peel powder is intended to be used as a functional food by adding it to yogurts and teas in the future. This research work, which is being carried out for the first time in Azerbaijan, is expected to be the result of further investigation of the therapeutic potential of new nutrients and ongoing research activities.

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NAR QABIĞI BİOAKTİV YAĞ TURŞULARININ MƏNBƏYİ KİMİ: TƏHLİL VƏ POTENSİAL TƏTBİQLƏR

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Xülasə

Bu tədqiqat Ağsu və Göyçay rayonlarında yerləşən şərab zavodlarından emal zamanı əldə edilən Bala Mürsəl, Azərbaycan Gülöyşəsi və Nazik qabıq nar sortlarının qabıqlarından bioaktiv birləşmələrin əldə edilməsi və qida əlavələrinin istifadəsi məqsədi ilə onların sağlamlığa faydalarının öyrənilməsi məqsədilə tədqiqat aparılır. Nar qabığının tərkibində çoxlu yağ turşuları var. Bu turşuların antioksidan xüsusiyyətləri oksidləşdirici stressdən qorunmaq və xərçəng əleyhinə, antibakterial və ürək-damar sistemi də daxil olmaqla xroniki xəstəliklərin riskini azaltmaq kimi geniş funksiyalarına kömək edir. Bu məqsədlə Azərbaycan Qida Təhlükəsizliyi İnstitutunun “Kompleks Tədqiqatlar” laboratoriyasında, Azərbaycan Dövlət İqtisad Universitetinin Əziz Sancar adına “Qida texnologiyaları” laboratoriyasında müvafiq metodologiyaya uyğun müasir avadanlıqdan istifadə edilməklə tədqiqat nümunələrinin yağ turşularının tərkibinin təhlili aparılmışdır. Tədqiqat zamanı sortların böyümə şəraitindən və xüsusiyyətlərindən asılı olaraq analiz nəticələrində əhəmiyyətli fərqlər müşahidə edilmişdir. Nar qabığının tərkibindəki yağ turşularının yüksək olması ondan həm qida əlavəsi, həm də kimyəvi profilaktik vasitələrin əvəzi kimi istifadə etməyə imkan verir.
Tədqiqatın məqsədi Azərbaycanda şərabçılıq sənayesində emal zamanı əldə edilən nar qabıqlarının tərkibindəki yağ turşularını daha dərindən başa düşmək yolu ilə tullantı mənbələrinin sağlamlıq faydalarını üzə çıxarmaqla tullantı mənbələrindən fizioloji məqsədlər üçün daha yaxşı təkrar istifadə etməkdir.

Açar sözlər: yetişdirilən sortlar, xam yağ, yağ turşuları, sort xüsusiyyətləri, yetişdirmə şəraiti

КОЖУРА ГРАНАТА КАК ИСТОЧНИК БИОАКТИВНЫХ ЖИРНЫХ КИСЛОТ: АНАЛИЗ И ВОЗМОЖНОСТИ ПРИМЕНЕНИЯ

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Резюме

Данное исследование проведено с целью получения биоактивных соединений из кожуры граната сортов Бала Мурсель, Азербайджан Гюльёйше и Назик Габыг, полученных в процессе переработки на винодельнях Агсуинского и Гейчайского районов, а также изучения их пользы для здоровья с целью использования в качестве пищевых добавок. Кожура граната содержит множество жирных кислот. Антиоксидантные свойства этих кислот обуславливают их широкий спектр функций, таких как защита от окислительного стресса, противораковые, антибактериальные свойства и снижение риска хронических заболеваний, в том числе сердечно-сосудистых. С этой целью жирно-кислотный состав исследуемых образцов был проанализирован с использованием современного оборудования по соответствующей методике в лабораториях «Комплексные исследования» Азербайджанского института безопасности пищевых продуктов и «Пищевые технологии» имени Азиза Санджара Азербайджанского государственного экономического университета. В ходе исследования были выявлены существенные различия в результатах анализа в зависимости от условий выращивания и особенностей сортов. Высокое содержание жирных кислот в кожуре граната позволяет использовать её как в качестве пищевой добавки, так и в качестве замены химическим профилактическим средствам. Цель исследования — повышение эффективности повторного использования отходов в физиологических целях путём выявления их пользы для здоровья посредством более глубокого изучения жирных кислот, содержащихся в кожуре граната, полученной в процессе переработки в винодельческой промышленности Азербайджана.

Ключевые слова: возделываемые сорта, сырое масло, жирные кислоты, сортовые характеристики, условия выращивания

Məqalə daxil olub: 01 sentyabr 2025-ci il
Təkrar işlənməyə göndərilib: 10 sentyabr 2025-ci il
Çapa qəbul olunub: 30 sentyabr 2025-ci il