PROGRESS IN ENGINEERING APPLICATION AND TECHNOLOGY
e-ISSN: 2773-5303

PEAT

Vol. 6 No. 1 (2025) p. 607-613
https://publisher.uthm.edu.my/periodicals/index.php/peat

Comparative Study of Pomegranate (*Punica Granatum*) Peel and Banana (*Musa Paradisiaca L.*) Peel Extracts as Natural Preservative and its Antioxidant Effect on Homemade Cake

Nur Hidayah Zulkapli[1], Nor Faizah Razali[1*]

[1] *Department of Chemical Engineering Technology, Faculty of Engineering Technology, University Tun Hussein Onn Malaysia (UTHM), Pagoh Education Hub, KM1, Jalan Panchor, 86400, Muar, Johor Malaysia*

*Corresponding Author: faizahr@uthm.edu.my
DOI: https://doi.org/10.30880/peat.2025.06.01.064

Article Info

Received: 18 January 2025
Accepted: 05 February 2025
Available online: 30 April 2025

Keywords

Pomegranate *(Punica granatum)*, Banana *(Musa Paradisiaca L.)*, antioxidant, natural preservatives

Abstract

This study explores the potential of pomegranate (Punica granatum) peel and banana (Musa paradisiaca L.) peel extracts as natural preservatives, emphasizing their antioxidant properties and food preservation effects. Fruit peel, often considered waste, is rich in bioactive compounds like phenolics, making them viable alternatives to synthetic preservatives. This study aimed to extract and compare the total phenolic content (TPC), antioxidant activity, and antimicrobial effects of these peels using ultrasonic-assisted extraction (UAE). This study also aimed to evaluate the function of antimicrobial activity of synthetic preservatives, pomegranate peel and banana peel as natural preservatives on homemade cake. The TPC and antioxidant activity were measured using the Folin-Ciocalteu reagent and DPPH radical scavenging assays, while antimicrobial activity was assessed via the disc diffusion method. Pomegranate peels demonstrated superior TPC (2.669 mg GAE/g), and antioxidant activity (41.51% inhibition) compared to banana peels (1.925 mg GAE/g, 23.67% inhibition). Antimicrobial tests revealed limitations such as lack of clear antimicrobial activity observed in the disc diffusion method under the experimental condition. Application of the extracts to homemade cakes demonstrated the potential of pomegranate peel to extend shelf life up to 14 days without mold formation, outperforming banana peel and synthetic preservative BHA. The findings suggest that pomegranate peel, enriched with phenolic compounds, serves as a promising natural alternative for synthetic food preservatives, aligning with consumer demand for safer and eco-friendly options.

1. Introduction

Interest in natural food preservation methods has increased because of the growing need for safer and more environmentally friendly substitutes for artificial preservatives. Despite their effectiveness, synthetic preservatives are frequently linked to negative health and environmental effects, which makes consumers prefer natural, plant-based alternatives [1]. Fruit peels, which are frequently discarded, are a rich source of bioactive substances such tannins, flavonoids, and phenolics [2]. Due to their antibacterial and antioxidant qualities, these substances have the potential to replace chemical preservatives in the food industry. Examining the application

of fruit peel extracts supports international initiatives to cut down on food waste while advancing sustainability and public health.

Fruit peels antibacterial and antioxidant qualities have been the subject of several investigations, with pomegranate (Punica granatum) and banana (Musa paradisiaca L.) peels receiving particular attention. Banana peels include alkaloids and flavonoids that have antioxidant qualities, while pomegranate peels are abundant in phenolic compounds such punicalagin and ellagic acid [3]. These bioactive substances have demonstrated the ability to prolong the shelf life of a few food items. Research comparing these fruit peels' effectiveness with synthetic preservatives in actual food applications is still few, nevertheless. Furthermore, more research is needed to determine whether these extracts can function as natural preservatives in intricate food matrices like homemade cakes.

In addition to meeting customer demand, the shift to natural preservatives is a crucial first step in tackling more significant environmental and public health issues. Fruit peels and other agricultural trash can be used by enterprises to promote circular economy principles and cut down on organic waste. Furthermore, using natural preservatives is consistent with green chemistry concepts, which emphasize lowering the amount of artificial chemicals in food items. This change offers a way to create healthier food items while reducing the environmental impact of food production, which has practical consequences for public health, sustainability, and food safety. This research highlights the importance of incorporating environmentally friendly solutions into food technology by concentrating on the untapped potential of banana and pomegranate peels.

By examining the antibacterial and antioxidant qualities of pomegranate and banana peel extracts as well as their efficacy as natural preservatives in prolonging the shelf life of baked cakes, this study seeks to close the gap. According to the research, pomegranate peel extracts will have better antioxidant activity and preservation effects than banana peels and artificial preservatives like butylated hydroxyanisole (BHA) because of their higher total phenolic content. The goal of this research is to aid in the creation of natural, sustainable substitutes for synthetic food preservatives.

2. Methodology

2.1 Extraction of Pomegranate peel and Banana peel using Ultrasonic Assisted Extraction (UAE)

Pomegranate and banana were obtained from the local supermarket. The peels from pomegranate and banana were separated from the fruits and were cut into small pieces by using a knife. Fruit peels were dried for 24 hours at 40°C in the oven. After that, all the fruit peels that had dried were grounded into a fine powder. 150 ml of 90% ethanol solvent were used to extract 10 g of pomegranate and banana peel powder by using Ultrasonic assisted extraction (UAE). 120 watts of power for 30 minutes of extraction time was used. Then, a Whatman No. 1 filter paper were used to separate the extracted sample from its solid residue. The filtered extract was then centrifuged for fifteen minutes at 5,000 rpm around 4°C. The filtrates were concentrated using a rotary evaporator at 40°C.

2.2 Total Phenolic Content

The total phenolic content presented in pomegranate and banana were determined by using Folin-Ciocalteu reagent method. 0.2 mL of the Folin-Ciocalteu phenol reagent was added to 40 µL of extract. To the mixture, 0.6 mL of 7.5% sodium carbonate were added. 3.16 mL of distilled water was then added to the mixture. The mixture was gently vortexed to homogeneously mix the mixture. The absorbance of the blue-coloured complex was measured using a UV-VIS spectrophotometer at 765 nm after two hours of incubation at room temperature around 24°C. Gallic acid was used to plot the standard calibration curve, and the total polyphenol concentration was reported as gallic acid equivalents.

2.3 DPPH Radical Scavenging Assay

1 ml of the extract were combined with 5 ml of 0.1 mM DPPH which were prepared in ethanol. The test tubes were wrapped in foil aluminium and incubated at 37°C in the dark for 30 minutes. The absorbance of the reaction mixture was then measured at 517 nm by using a UV- VIS spectrophotometer. The scavenging activity is calculated as:

$$DPPH\ scavenging\ activity\ (\%) = \frac{OD\ Control - OD\ Sample}{OD\ Control} \quad (1)$$

Progress in Engineering Application and Technology Vol. 6 No. 1 (2025) p. 607-613

OD control = the absorbance of DPPH + ethanol
OD sample = the absorbance of DPPH + sample

2.4 Antimicrobial Test

For the antimicrobial activity, disc diffusion methods were used. The bacteria lawn was prepared by streaking the *Escherichia coli* on the prepared Mueller-Hinton agar (MHA). 5 μL of extract were spotted on the paper discs alternately on both sides and was allowed to dry before the next 5 μL was spotted. The concentration for both peel extracts used is 6.67%. Ampicillin disc was used as positive control. All discs were dried before applied on the bacterial lawn. Antimicrobial activity was evaluated by measuring the diameter of the inhibition zone (IZ) around the discs. Antibacterial activities were expressed as the mean zone of inhibition diameters (mm) produced by the peel extract.

2.5 Application of Extracted Peels and BHA on Homemade Cake

Pomegranate and Banana extract were applied to the homemade cake using common cake-making recipes with some modifications. One spoonful of baking powder, 1.5 grams of salt, and 100 grams of all-purpose flour were placed in a bowl. The butter and sugar were creamed in a mixer with a whisk attachment until they were light and creamy. The flour mixtures were added in and were mixed until combined. Then, the batter was poured into a baking cup, and the peels extract was added separately and stirred thoroughly. After that, the batter mixture will be baked for 40 minutes at 180 °C in the oven. There are 4 types of cake that were baked. The cake without any addition of peel extract or chemical preservative was the first type. The other three cakes were cakes with the addition of pomegranate extract, banana extract and BHA. After all the cakes was baked, the cakes were stored at room temperature around 24°C and were observed for its mold formation throughout each day of the 14 days of storage.

3. Results and Discussion

3.1 Total Phenolic Content

The Folin-Ciocalteu reagent method demonstrated its suitability for quantifying the phenolic content in both pomegranate and banana peel extracts. The results of this study indicated that pomegranate peels exhibited higher total phenolic content (2.669 mg GAE/g) compared to banana peels (1.925 mg GAE/g) as illustrated in Fig. 1. In this study, due to the existence of phospho molybdic-phosphotungstic-phenol complex, the active extracts will react with the Folin-Ciocalteu reagent in an alkaline medium, resulting in a blue-colored solution [4]. Due to this, the blue color complex solution in pomegranate peels is darker than in banana solutions. This indicates that the darker the blue color solutions, the higher phenolic content in those solutions. This difference aligns with prior literature emphasizing the richness of pomegranate peels in phenolic compounds, such as ellagic acid, punicalagin, gallotannins, anthocyanins, and flavonoids [5]. These compounds will react efficiently with the Follin-Ciocalteu Reagent, yielding higher phenolic content values. Phenolics have a redox characteristic, enabling them to function as reducing agents, hydrogen donors, and singlet oxygen quenchers, responsible for their scavenging activity [6]. Variations in phenolic content brought on by environmental variables or variations in extraction efficiency were not taken into consideration in this investigation. These finding results suggest that pomegranate peel extracts may be utilized as sustainable substitutes for artificial preservatives in food products.

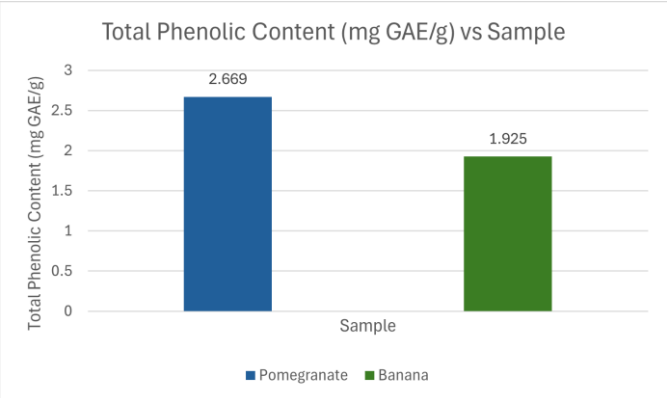

Fig. 1: Graph of Total Phenolic Content (mg GAE/g) against Sample

3.2 DPPH Radical Scavenging Assay

The assay is based on the extract capacity to scavenge free radicals by donating hydrogen [7]. The result obtained shows that the antioxidant activity which was extracted from pomegranate peel extracts is higher compared to antioxidant activity from banana peel extracts as shown in Fig. 2. Pomegranate has higher antioxidants compared to banana which might be due to the chemical structure of pomegranate, as it contains high levels of flavonoid and phenolic content. The findings of the current study also confirmed that, pomegranate peel extracts contain higher phenolic and flavonoid content [8]. Pomegranates contain a variety of polyphenols, such as anthocyanins, quercetin, kaempferol, luteolin glycosides, ellagitannins, gallotannins, and ellagic acid [9]. However, the results may differ based on the fruit peels' ripeness and origin, as well as the extraction techniques used. These results suggest that extracts from pomegranate peels may be used in food products as a natural antioxidant.

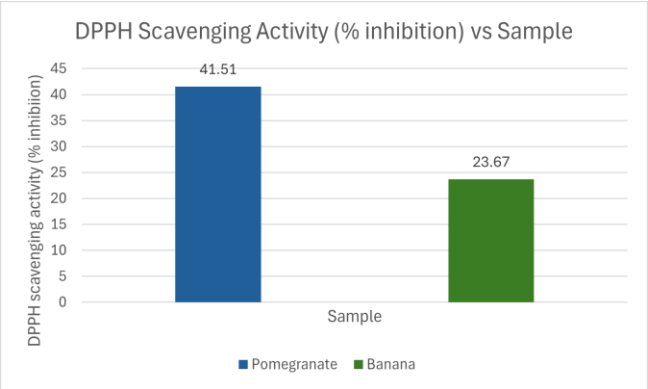

***Fig. 2*:** Graph of DPPH scavenging activity (% Inhibition) against sample

3.3 Antimicrobial Test

Fig. 3 shows the result obtained from the antimicrobial test for both peel extracts by using disc diffusion method. Bacterial susceptibility is assessed by measuring the inhibition zones in bacterial growth that are produced by the gradient that the antibiotics create when they diffuse radially into the agar [10]. However, the result obtained as illustrated in Fig. 3 does not align with the expected result where the inhibition zone cannot be calculated as there are no clear inhibition zones observed around the peel extract discs and ampicillin disc.

(a) (b)

***Fig. 3*:** The result of antimicrobial test of the peel extracts (a) Pomegranate extract; (b) Banana extract

The result obtained does not align with the expected result might be due to several factors affecting the result, including an inadequate concentration of bioactive chemicals. Plant material such as fruit peels, which might vary depending on the environment, harvest season, extraction technique, solvent employed, and stability of contents, determines the quality of plant extracts [11]. It might be because the extracts levels of phenolic compounds or other bioactive ingredients are below what is required for them to have antibacterial activity. This could stem from the extraction method or the inherent composition of the fruit peels. The length, pH, temperature, particle size, and solvent-to-sample ratio of extraction methods typically vary, which also has an impact on the amount

Progress in Engineering Application and Technology Vol. 6 No. 1 (2025) p. 607-613

and quality of compounds that are extracted [12]. For increased efficacy, future research should think about refining the extraction techniques by experimenting with various solvents such as methanol, acetone, or ethanol-water combinations and optimizing extraction parameters such as temperature, sonication time, and solvent ratio [13]. The extracts antimicrobial efficacy may have been diminished by the degradation of bioactive components during the extraction, storage, or application processes. Phenolic compounds, for instance, are sensitive to environmental factors such as light, temperature, and pH. According to recent studies, temperature, light, oxygen, and pH are all environmental factors that might affect bioactive compounds such as flavonoids [14]. Inconsistent outcomes may also arise from uneven extract applications or inadequate disc drying prior to agar installation. Future research could solve this by using the agar well diffusion approach, which may improve diffusion and enable a higher volume of extract application. Test reliability can be improved by making sure that extract is evenly impregnated on discs, drying them appropriately, and applying more volume [10]. This surprising result implies that, in the experimental setup used, the extracts did not demonstrate measurable antibacterial activity.

3.4 Application of Extracted Peels and BHA on Homemade Cake

The peel extracts are applied to the homemade cake to observe the ability of the extracts to act as natural preservatives for the cake. The mold formation is observed for a duration of 14 days. The blank sample was the first to have mold formation on day 9 of the observation as shown in the circled-on in Fig. 4(a). On day 11 of the observation, the cakes incorporated with banana peels start to have the formation of mold as illustrated in Fig. 4(b). Fig. 4(c) shows the cakes with BHA preservatives could only last long for 12 days longer than banana peel extracts before the mold could form. On day 14, the cake with pomegranate extracts sample does not display any mold formation as shown in Fig. 4(d). This might be due to pomegranate is rich in phenolic content which enhances the antioxidant properties that can extend the shelf life of cake.

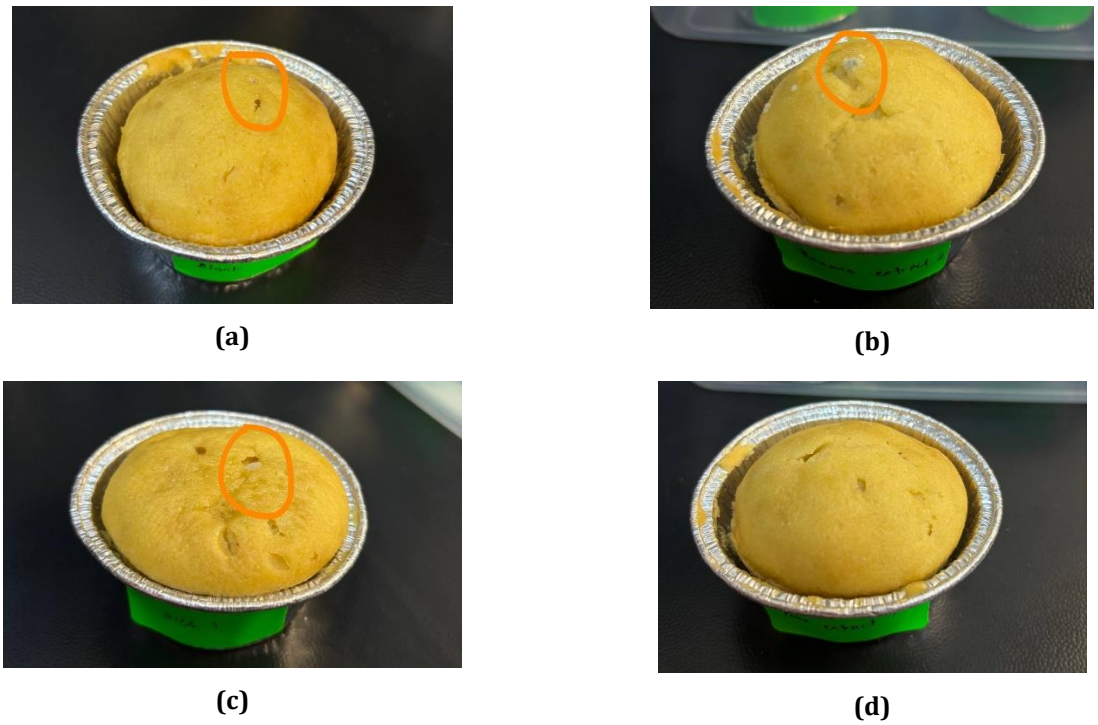

***Fig. 4*:** Observation of cakes throughout 14 days (a) Blank sample of cake on day 9 of the observation (b)Banana peel extracts sample of cake on day 11 of observation (c) BHA sample of cake on day 12 of the observation (d) Pomegranate peel extracts sample of cake on 14 days of observation

4. Conclusions

The study investigates the potential of banana (Musa paradisiaca L.) and pomegranate (Punica granatum) peel extracts as natural preservatives with antioxidant qualities. In line with their rich bioactive compound, the results showed that pomegranate peel extracts had much higher antioxidant activity and total phenolic content than banana peel extracts. These qualities were assessed utilizing cutting-edge techniques including the Folin-Ciocalteu reagent method and the DPPH radical scavenging assay, demonstrating their effectiveness in prolonging the shelf life of food items like handmade cakes. In contrast to banana extracts and artificial preservatives, the use of pomegranate extracts on cakes showed greater preservation benefits, delaying mold development for up to 14 days, even if antimicrobial tests did not produce distinct inhibitory zones. Additionally, the goal of this project is

to identify safer and healthier alternatives to synthetic preservatives, such as fruit-based natural preservatives. Therefore, the successful completion of this study would greatly improve the disciplines of food preservation by providing a sustainable way to replace synthetic preservatives with natural preservatives while also improving the nutritional and preservative aspects of food products. The study has several limitations, including the lack of significant antimicrobial activity observed in the disc diffusion method, which may be due to insufficient concentrations of bioactive compounds. Furthermore, variations in extraction efficiency and ambient conditions were not considered, which could have an impact on the antioxidant qualities and overall phenolic content. The research was also limited to homemade cakes, restricting their applicability to other food products, and did not include sensory evaluations to assess the impact of the extracts on taste, texture, or aroma when incorporated in cakes.

Future research should concentrate on refining the extraction techniques to optimize the quantity of bioactive components to further investigate the antioxidant and preservative capabilities of banana and pomegranate peels. Experimenting with various solvents, concentrations, and extraction times may be part of this. To improve the process's sustainability and efficiency, more sophisticated extraction methods like microwave-assisted extraction or supercritical fluid extraction could be investigated. Pomegranate and banana peel extracts can be used in a variety of food matrices outside of homemade desserts for practical purposes. Their adaptability as natural preservatives would be revealed by testing how well they preserve meat, dairy, or beverage goods. To make sure that the inclusion of these extracts does not negatively impact the food products flavor, texture, or scent, consumer sensory assessments should also be carried out. Lastly, to pinpoint the precise chemicals causing the extracts preservative and antioxidant qualities, a more thorough chemical profile of the extracts is advised. This might make it easier to create focused applications for the food, medicine, and cosmetics sectors. The viability of increasing the use of these natural preservatives in commercial manufacturing should also be assessed from an economic and environmental standpoint.

Acknowledgement

The authors would like to thank the Faculty of Engineering Technology (FTK) University Tun Hussein Onn Malaysia (UTHM) for the financial support to carry out the project and extend the support to use the lab facilities.

Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Hidayah, Nor Faizah Razali;* ***data collection:*** *Nur Hidayah;* ***analysis and interpretation of results:*** *Nur Hidayah, Nor Faizah Razali;* ***draft manuscript preparation:*** *Nur Hidayah. All authors reviewed the results and approved the final version of the manuscript.*

References

[1] Campêlo, M. C. S., Medeiros, J. M. S., & Silva, J. B. A. (2019). Natural products in food preservation. International Food Research Journal, 26(1).

[2] Munekata, P. E. S., Pateiro, M., Domínguez, R., Nieto, G., Kumar, M., Dhama, K., & Lorenzo, J. M. (2023). Bioactive Compounds from Fruits as Preservatives. Foods, 12(2), 343. https://doi.org/10.3390/foods12020343

[3] Ariani N, Akhmad R. Aktivitas ekstrak etanol kulit buah pisang kepok mentah (Musa Paradisiaca Forma Typica) terhadap pertumbuhan Candida Albicans secara in vitro. Jurnal Pharmascience. 2018;05(01):39-44.

[4] Hatami, T., Emami, S. A., Miraghaee, S. S., & Mojarrab, M. (2014). Total Phenolic Contents and Antioxidant Activities of Different Extracts and Fractions from the Aerial Parts of Artemisia biennis Willd. *PubMed*, *13*(2), 551–559. https://pubmed.ncbi.nlm.nih.gov/25237350

[5] Santana, R. J., De C Batista, T., Valença, C. A., Zielińska, A., Severino, P., Souto, E. B., Marques, M. N., & Cardoso, J. C. (2024). Design of experiment for a sustainable extraction of phenolic compounds from

pomegranate peels and proof of antioxidant and antimicrobial properties. *Sustainable Chemistry and Pharmacy*, *42*, 101860. https://doi.org/10.1016/j.scp.2024.101860

[6] Babbar, N., Oberoi, H. S., Uppal, D. S., & Patil, R. T. (2010). Total phenolic content and antioxidant capacity of extracts obtained from six important fruit residues. *Food Research International*, *44*(1), 391–396. https://doi.org/10.1016/j.foodres.2010.10.001

[7] Afsharnezhad, M., Shahangian, S., Panahi, E., & Sariri, R. (2017). Evaluation of the antioxidant activity of extracts from some fruit peels. *journals.guilan.ac.ir*. https://doi.org/10.22124/cjes.2017.2463

[8] Abodahb, S., Nizay, M., & ElKorashy, M. (2022). Effect of pomegranate and banana extracts on microshear bond strength of resin composite to bleached bovine enamel: an In-Vitro study. *Al-Azhar Dental Journal for Girls*, *9*(2), 251–263. https://doi.org/10.21608/adjg.2022.103255.1430

[9] Barnossi, A. E., Moussaid, F., & Housseini, A. I. (2020). Tangerine, banana and pomegranate peels valorisation for sustainable environment: A review. *Biotechnology Reports*, *29*, e00574. https://doi.org/10.1016/j.btre.2020.e00574

[10] Yu, G., Lee, G., Hung, Y., Li, S., Ma, Y., Chen, Z., & Hsuan, S. (2024). Ai-driven identification and analysis of inhibition zones in disk diffusion tests with the hue contrast method. *Microchemical Journal*, 112459. https://doi.org/10.1016/j.microc.2024.112459

[11] Garcia-Salas, P., Morales-Soto, A., Segura-Carretero, A., & Fernández-Gutiérrez, A. (2010). Phenolic-Compound-Extraction systems for fruit and vegetable samples. *Molecules*, *15*(12), 8813–8826. https://doi.org/10.3390/molecules15128813

[12] Bubonja-Šonje, M., Knežević, S., & Abram, M. (2020). Challenges to antimicrobial susceptibility testing of plant-derived polyphenolic compounds. *Archives of Industrial Hygiene and Toxicology*, *71*(4), 300–311. https://doi.org/10.2478/aiht-2020-71-3396

[13] Oroian, M., Ursachi, F., & Dranca, F. (2020). Influence of ultrasonic amplitude, temperature, time and solvent concentration on bioactive compounds extraction from propolis. *Ultrasonics Sonochemistry*, *64*, 105021. https://doi.org/10.1016/j.ultsonch.2020.105021

[14] Ioannou, I., Hafsa, I., Hamdi, S., Charbonnel, C., & Ghoul, M. (2012). Review of the effects of food processing and formulation on flavonol and anthocyanin behaviour. *Journal of Food Engineering*, *111*(2), 208–217. https://doi.org/10.1016/j.jfoodeng.2012.02.006