The Austrian Journal of Technical and Natural Sciences, No 11–12
ISSN 2310-5607

PREMIER Publishing
ppublishing.org

DOI:10.29013/AJT-23-11.12-29-32

STUDY OF PHYTOCHEMICAL COMPOSITION OF FROZEN APPLES AND THEIR HEALTH BENEFITS

Shakhlo Niyazova [1], Shermanov Beknazar [2], Shukhrat Khasanov [3]

[1] Shakhrisabz branch of Tashkent chemical-technological institute

[2] Alfraganus University

[3] Yu. Yunusov Institute of the Chemistry of Plant Substances

Cite: *Niyazova S., Shermanov B. Khasanov Sh. (2023). Study of Phytochemical Composition of Frozen Apples and Their Health Benefits. Austrian Journal of Technical and Natural Sciences 2023, No 11-12*. https://doi.org/10.29013/AJT-23-11.12-29-32

Abstract

Apples are widely consumed fruits known for their nutritional value and health benefits. Freezing is a common preservation method used for apples to extend their shelf life and maintain their quality. In recent years, there has been a growing interest in studying the phytochemical composition of frozen apples and understanding the potential health benefits they offer. In this article, we will explore the research conducted on the phytochemical composition of frozen apples and discuss the associated health benefits.

Keywords: *phytochemicals, phenolic, flavonoids, carotenoids, Golden spur*

Introduction

Freezing preservation of food has been used for thousands of years because of high product quality (Phoon, P.Y., Galindo, F.G., Vicente, A., Dejmek, P. 2008; Kutsakova, V.E., Frolov, S.V., Yakovleva, M.I., 1997). Generally speaking, the quality of frozen food is closely related to freezing and thawing processes. Biotechnological studies provide valuable information about the changes that occur in fruits when they are frozen. By analyzing the biochemical composition, nutritional content, and sensory attributes of frozen fruits, researchers can assess their quality and potential shelf life. These studies are essential for ensuring that exported fruits reach consumers in optimal condition, with minimal loss of nutritional value.

Apples are a widely consumed fruit and are known to be a rich source of phytochemicals. These phytochemicals, including phenolic, flavonoids, and carotenoids, have been associated with various health benefits and may play a key role in reducing the risk of chronic diseases such as cardiovascular disease and cancer (Jeanelle, Boyer, Rui Hai, Liu, 2004).

Health Benefits of Apples:

Reduced Risk of Chronic Diseases: Epidemiological studies have linked the consumption of apples with a reduced risk of certain cancers, cardiovascular disease, asthma, and diabetes. Antioxidant Activity: Apples have been found to have strong antioxidant activity, which helps protect the body against oxidative stress and damage caused by free radicals.

Inhibition of Cancer Cell Proliferation: Laboratory studies have shown that apples can inhibit the proliferation of cancer cells.

Decreased Lipid Oxidation: Apples have been found to decrease lipid oxidation, which is beneficial for cardiovascular health. Lowered Cholesterol: Consumption of apples has been associated with lower cholesterol levels.

Phytochemical Composition of Apples:

Apples contain a variety of phytochemicals, including quercetin, catechin, phloridzin, and chlorogenic acid, all of which are strong antioxidants. The phytochemical composition of apples can vary between different varieties and may also change during the maturation and ripening of the fruit. Storage has little to no effect on apple phytochemicals, but processing can greatly affect their composition (Jeanelle, Boyer, Rui Hai, Liu, 2004).

Based on the above, it is important to study the content of phytochemicals, including phenolics, flavonoids, and carotenoids in frozen apple fruit.

In this study, we investigated the antioxidant content of frozen apples (Golden spur) and analyzed their health benefits.

Materials and methods

The study used the following materials:

Frozen Apples, Laboratory Equipment: Various laboratory equipment was used to extract and analyze the phytochemicals present in the frozen apple samples. This equipment included a blender, centrifuge, analytical balance, spectrophotometer, and HPLC (high-performance liquid chromatography) system.

Chemicals and Reagents: Several chemicals and reagents were used during the analysis process. These included solvents like methanol, acetonitrile, and water, as well as standards of known phytochemical compounds for identification and quantification purposes.

The following methods were employed to analyze the phytochemical composition of frozen apples:

Sample Preparation: Frozen apple samples were thawed, and the cores were removed. The samples were then homogenized using a blender to obtain a uniform mixture for analysis.

Extraction of Phytochemicals: The extraction of phytochemicals from the frozen apple samples was carried out using a suitable solvent, such as methanol or a mixture of methanol and water. The extraction process involved shaking the samples for a specific duration to ensure efficient extraction of the targeted compounds.

Centrifugation: After the extraction process, the samples were centrifuged to separate the solid particles from the liquid extract. The supernatant obtained after centrifugation contained the phytochemicals of interest.

Quantification of Total Phenolic Content: The total phenolic content of the frozen apple samples was determined using a spectrophotometric method, such as the Folin-Ciocalteu assay. This method involves the reaction of phenolic compounds with Folin-Ciocalteu reagent, resulting in the formation of a blue-colored complex that can be quantified using a spectrophotometer.

Identification and Quantification of Individual Phytochemicals: High-performance liquid chromatography (HPLC) was used to identify and quantify individual phytochemical compounds present in the frozen apple samples. HPLC is a powerful analytical technique that allows for the separation, identification, and quantification of various compounds based on their chemical properties and retention times.

Results and discussion

Apples have gained special attention due to their chemical composition, especially for their antioxidant characteristics. Among different groups of natural antioxidants, phenolic compounds are the main constituents responsible for the antioxidant properties of apples (Arias, A., Feijoo, G., Moreira, M.T. 2022; Al Daccache, M., Koubaa, M., Maroun, R.G., Salameh, D., Louka, N., Vorobiev, E. 2020; Skinner, R.C., Gigliotti, J.C., Ku, K.M., Tou, J.C., 2004).

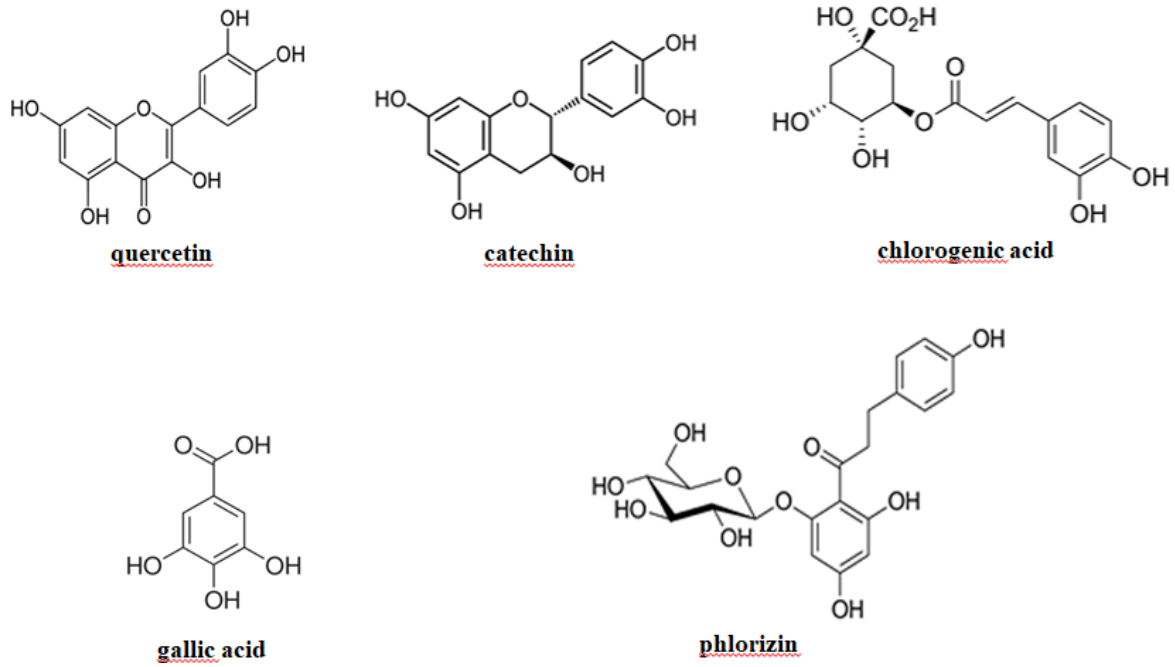
Apples contain high concentrations of flavonoids as well as other phytochemicals, and the concentration of these phytochemicals can depend on many factors, such as apple variety, apple picking and storage, and apple processing. Phytochemical concentrations also differ greatly between apple skin and apple flesh.

As a result of our research, the following antioxidant compounds were found in fro-

zen apples. quercetin-3-galactoside, quercetin-3-glucoside, quercetin-3-rhamnoside (https://pubchem.ncbi.nlm.nih.gov/compound/Quercetin), catechin (Kríz, Z., Koca, J., Imberty, A., Charlot, A., Auzély-Velty, R., (July 2003), chlorogenic acid (Clifford, M. N., (1999), gallic acid (Haslam, E., Cai, Y., (1994), and Phlorizin (Makarova, Elina; Górnaś, Paweł; Konrade, Ilze; Tirzite, Dace; Cirule, Helena; Gulbe, Anita; Pugajeva, Iveta; et al. (2015). (Figure 1). It was found that these substances have the following concentrations in 100 g of fruit: quercetin glycosides, 12.8 mg; vitamin C, 11.6 mg; procyanidin B, 7.23 mg; chlorogenic acid, 8.12 mg; epicatechin, 9.18 mg and phloretin glycosides, 6.21 mg.

In addition, a frozen apple sample was found to contain 120 mg of gallic acid equivalent (GAE) per 100 grams of fresh weight. It stands out as an important phenolic compound with antioxidant health benefits.

Figure 1. *Chemical structure of phytochemicals in frozen apples*



The results of this study highlight the nutritional value of frozen apples, particularly in terms of their phytochemical composition. The high total phenolic content indicates that frozen apples can be a rich source of antioxidants, which play a crucial role in protecting the body against oxidative stress and reducing the risk of chronic diseases.

The presence of flavonoids, such as quercetin and kaempferol, in frozen apples is noteworthy. These compounds have been extensively studied for their potential anti-inflammatory and anti-cancer effects. Quercetin, in particular, has been shown to have anti-allergic, anti-viral, and cardiovascular protective properties.

Hydroxycinnamic acids like caffeic acid and p-coumaric acid are also present in frozen apples. These compounds have been linked to various health benefits, including anti-inflammatory and anti-microbial activities. They may contribute to the overall antioxidant capacity of frozen apples.

It is important to note that the phytochemical composition of apples can vary depending on several factors, including the apple variety, ripeness, and storage conditions. Frozen apples, in particular, may undergo certain changes in their phytochemical profile due to the freezing and thawing process. However, this study provides valuable insights into the general composition of frozen apples and highlights their potential health benefits.

Conclusions

In conclusion, the research on the phytochemical composition of frozen apples demonstrates that they contain a significant amount of phenolic compounds, including flavonoids and hydroxycinnamic acids.

These compounds have been associated with various health benefits, including antioxidant, anti-inflammatory, and anti-cancer properties. Incorporating frozen apples into the diet can be a convenient and nutritious way to reap the benefits of these phytochemicals. However, further studies are needed to explore the impact of freezing and thawing on the phytochemical stability and bioavailability of apples.

References

Phoon, P.Y., Galindo, F.G., Vicente, A., Dejmek, P. Pulsed electric field in combination with vacuum impregnation with trehalose improves the freezing tolerance of spinach leaves. Journal of Food Engineering, 2008.– Vol. 88.– No. 1.– P. 144–148. DOI: 10.1016/j.jfoodeng.2007.12.016

Kutsakova, V.E., Frolov, S.V., Yakovleva, M.I. Mass transfer during freezing. Russian journal of applied chemistry. 1997.– Vol. 70.– No. 12.– P. 2061–2063.

Jeanelle, Boyer, Rui Hai Liu. Apple phytochemicals and their health benefits Nutr J. 2004; 3: 5. Published online 2004. May 12. Doi: 10.1186/1475–2891–3–5

Arias, A., Feijoo, G., Moreira, M.T. Exploring the Potential of Antioxidants from Fruits and Vegetables and Strategies for Their Recovery. Innov. Food Sci. Emerg. Technol. 2022; 77: 102974. Doi: 10.1016/j.ifset.2022.102974. [CrossRef] [Google Scholar]

Al Daccache, M., Koubaa, M., Maroun, R.G., Salameh, D., Louka, N., Vorobiev, E. Impact of the Physicochemical Composition and Microbial Diversity in Apple Juice Fermentation Process: A Review. Molecules. 2020; 25: 3698. Doi: 10.3390/molecules25163698. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

Skinner, R.C., Gigliotti, J.C., Ku, K.M., Tou, J.C. A Comprehensive Analysis of the Composition, Health Benefits, and Safety of Apple Pomace. *Nutr. Rev.* 2018; 76: 893–909. Doi: 10.1093/nutrit/nuy033. [PubMed] [CrossRef] [Google Scholar]

URL: https://pubchem.ncbi.nlm.nih.gov/compound/Quercetin

Kríz, Z., Koca, J., Imberty, A., Charlot, A., Auzély-Velty, R. (July 2003). "Investigation of the complexation of (+)-catechin by beta-cyclodextrin by a combination of NMR, microcalorimetry and molecular modeling techniques". Organic & Biomolecular Chemistry.– 1 (14): 2590–2595. Doi:10.1039/B302935M. PMID12956082.

Clifford, M.N. (1999). "Chlorogenic acids and other cinnamates – nature, occurrence and dietary burden". *Journal of the Science of Food and Agriculture*.– 79 (3): 362–372. Doi:10.1002/(SICI)1097-0010(19990301)79:3<362: AID-JSFA256>3.0.CO;2-D

Haslam, E., Cai, Y. (1994). "Plant polyphenols (vegetable tannins): Gallic acid metabolism". Natural Product Reports.– 11 (1): 41–66. Doi:10.1039/NP9941100041. PMID15206456

Makarova, Elina, Górnaś, Paweł, Konrade, Ilze, Tirzite, Dace, Cirule, Helena, Gulbe, Anita; Pugajeva, Iveta, et al. (2015). "Acute anti-hyperglycaemic effects of an unripe apple preparation containing phlorizin in healthy volunteers: A preliminary study". *Journal of the Science of Food and Agriculture*.– 95 (3): 560–568. Doi:10.1002/jsfa.6779. PMID24917557.

submitted 29.11.2023;
accepted for publication 20.12.2023;
published 24.01.2024

Contact: shuhrat.hasanov.0305@gmail.com