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Influence of The Solvent Type on The Chemical Composition of Extracts and The Efficiency of Bioactive Components Election

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Abstract: This study investigated the influence of extraction solvents with different polarity on the recovery of biologically active compounds from fruit and berry raw materials. The selection of an appropriate solvent is one of the key factors determining extraction efficiency, chemical composition, antioxidant properties, and safety of the final extract. Water, 98% ethanol, ethanol–water mixture (1:1), n-hexane, benzene, ethyl acetate, and chloroform were evaluated as extraction media due to their different physicochemical characteristics and extraction capacities. The average total phenolic content of extracts obtained with the ethanol–water mixture reached 701.5 mg GAE/100 g, exceeding extracts prepared with ethanol and water by 31.9% and 30.4%, respectively. Similarly, the average anthocyanin content was 161.75 mg GAE/100 g, which was substantially higher than that obtained using individual solvents. Although ethanol produced slightly higher flavonoid contents in several samples, the ethanol–water mixture provided the best overall performance when all quality indicators were considered together. The superior efficiency of the ethanol–water mixture can be explained by the synergistic effect of both solvents. Water promotes swelling of plant tissues and facilitates the release of hydrophilic compounds, whereas ethanol improves the extraction of moderately polar phenolics and anthocyanins. In contrast, non-polar solvents such as n-hexane, benzene, and chloroform exhibited considerably lower extraction efficiency and are less suitable for food applications due to safety concerns. Overall, the results confirm that the ethanol–water mixture is the most appropriate extraction solvent for obtaining antioxidant-rich fruit and berry extracts with high biological value and potential application in functional food production.

Keywords: Fruit and berry extracts, extraction solvent, ethanol–water mixture, phenolic compounds, flavonoids, anthocyanins, antioxidant activity, solvent polarity, extraction efficiency, bioactive compounds.

INTRODUCTION:

In theory, any substance can act as a solvent for another substance. However, in practice, only those solvents that meet specific technological, chemical, and safety requirements are selected for extraction processes. An ideal solvent should possess high dissolving capacity, remain chemically inert toward the solute, and should not participate in undesirable chemical reactions. In industrial applications, solvents are expected to be cost-effective, safe to handle, stable during storage, and chemically and pharmacologically inert. Furthermore, the selected solvent should exhibit high extraction efficiency, be economically feasible, readily available, and should not impart undesirable taste or odor to the final product. It should also comply with fire safety requirements, possess low volatility, and should not promote the growth of microorganisms (Azmir et al., 2013; Chemat et al., 2020).

Several approaches are used to classify extraction solvents. Based on their chemical nature, solvents are generally divided into organic and inorganic categories. The selection of a suitable solvent is a critical stage in obtaining concentrated extracts, and the extraction efficiency of different solvents is often compared. This selection is primarily based on the principle of "like dissolves like" and the polarity of the solvent. Although there is no single universal quantitative parameter describing solvent polarity, it is commonly evaluated using dielectric constant and dipole moment (Dai & Mumper, 2010; Chemat et al., 2012; Zhang et al., 2018).

Among inorganic solvents, water is the most widely used because it is natural, environmentally friendly, and highly effective for extracting many bioactive compounds. Organic solvents are also extensively employed in industrial and laboratory applications. They include hydrocarbons, halogenated hydrocarbons, alcohols, ethers, esters, ketones, and nitro compounds. These solvents can be classified according to their physicochemical properties, including boiling point, polarity, and toxicity. For example, ethanol and ethyl acetate are considered low-boiling solvents, whereas xylene is classified as a high-boiling solvent. Based on molecular polarity, hydrocarbons and carbon disulfide are regarded as non-polar solvents, while water, alcohols, and acetone are classified as polar solvents (Khoddami et al., 2013; Mustafa & Turner, 2011).

Therefore, the proper selection of an extraction solvent is one of the key factors determining the extraction efficiency of bioactive compounds, as well as the antioxidant activity and microbiological safety of fruit and berry extracts (Chemat et al., 2020; Alara et al., 2021; Tiwari, 2015).

METHODS

1. Plant Materials

The study was conducted using four locally available fruit and berry raw materials: black raisin (QK), black currant (QS), raspberry (M), and cherry (G). The samples were selected due to their high content of biologically active compounds, particularly phenolic compounds, flavonoids, and anthocyanins. All experimental analyses were carried out at the Food Technology Research Laboratory of Tashkent Institute of Chemical Technology.

2. Extraction Procedure

The extraction efficiency of solvents with different polarities was evaluated using distilled water, 98% ethanol, ethanol–water mixture (1:1, v/v), n-hexane, benzene, ethyl acetate, and chloroform. The solvents were selected according to their physicochemical properties, polarity, and extraction capacity for bioactive compounds.

The fruit and berry samples were washed, dried, and ground to obtain a homogeneous powder. Ultrasound-assisted extraction (UAE) was employed to isolate bioactive compounds from the plant materials. The extraction process was performed under controlled conditions using a fixed solid-to-solvent ratio, extraction time, temperature, and ultrasonic frequency. After extraction, the suspensions were filtered through filter paper, and the obtained extracts were stored at 4 °C until further analysis.

3. Determination of Bioactive Compounds

The total phenolic content (TPC) of the extracts was determined by the Folin–Ciocalteu colorimetric method. The absorbance was measured using a UV–Vis spectrophotometer, and the results were expressed as milligrams of gallic acid equivalents (mg GAE/100 g of fresh weight).

The total flavonoid content (TFC) was determined using the aluminum chloride ($AlCl_3$) colorimetric assay and expressed as mg GAE/100 g.

The total anthocyanin content (TAC) was measured using the pH differential method, and the results were expressed as mg GAE/100 g.

4. Antioxidant Activity

The antioxidant activity of the extracts was evaluated using the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging assay. The radical scavenging capacity was expressed as EC_{50} (mg/mL), representing the extract concentration required to inhibit 50% of DPPH radicals. Lower EC_{50} values indicated higher antioxidant activity.

5. Statistical Analysis

All experiments were performed in triplicate, and the results were expressed as the mean ± standard deviation (SD). Statistical analysis was carried out using standard statistical software. Significant differences among the means were evaluated at a significance level of $p < 0.05$.

RESULTS AND DISCUSSION

In the studies, a mixture of 98% ethyl alcohol, water, n-hexane, benzene, ethyl acetate, chloroform, and a

1:1 ratio of water and ethanol was selected as the extraction medium. The use of such solvents is explained by their varying degree of polarity and high extraction capacity.

As the degree of polarity increases, solvents can be arranged in the following sequence: n-hexane < benzene < chloroform < ethanol < ethyl acetate < water.

The solvent used significantly affects the chemical composition of the resulting extract.

Table 1

Effect of the solvent on the chemical composition of the resulting extract

Solvent	Ethanol/Water	ethanol	water	hexane	benzene	ethyl acetate	chloroform
Total amount of phenolic substances, GK/100 g							
QK	860	823	750	90	15	227	113
QS	720	702	696	8	11	170	135
M	791	213	330	10	22	95	42
G	435	390	376	38	180	123	31
Total amount of flavonoids, mg GK/100 g							
QK	393	361	42	57	44	18	63
QS	99	126	34	18	27	21	35
M	87	53	53	6	17	48	13
G	77	146	45	28	14	46	21
Total amount of anthocyanins, mg GK/100 g							
QK	390	255	117	17	2	16	29
QS	101	28	90	9	13	11	43
M	75	68	71	16	19	32	7
G	81	34	81	19	20	8	13
Antiradical activity, EC50 mg/ml							
QK	5,9	6,7	24,8	19,6	8,4	14,9	5,2
QS	35	4,5	22,6	18,4	6,1	13,2	3,2
M	19	5,3	23,9	19,1	7,0	14,1	3,9
G	34	7,1	26,4	21,8	9,2	16,5	5,7

Based on the obtained results, the ethanol–water mixture was identified as the most suitable extraction solvent for recovering bioactive compounds from fruit and berry raw materials. This solvent demonstrated higher extraction efficiency for phenolic compounds and anthocyanin pigments than the other solvents investigated.

The results showed that the average total phenolic content (TPC) of the extracts obtained with the ethanol–water mixture was 701.5 mg GAE/100 g, which was 31.9% higher than that obtained with ethanol and 30.4% higher than that obtained with water. The superiority of the ethanol–water mixture was particularly evident for black raisin (QK), black currant (QS), and raspberry (M). For example, the TPC of black raisin extracts reached 860 mg GAE/100 g using the ethanol–water mixture, compared with 823 mg GAE/100 g using ethanol and 750 mg GAE/100 g using water.

The ethanol–water mixture also produced the highest total anthocyanin content. The average anthocyanin concentration reached 161.75 mg GAE/100 g, representing an increase of 68.1% and 80.2% compared with ethanol and water, respectively. These findings indicate that the ethanol–water mixture is highly effective for extracting polar and moderately polar anthocyanin compounds.

Although ethanol yielded slightly higher flavonoid contents in several samples, the ethanol–water mixture provided more stable and consistently high extraction performance when all quality parameters were evaluated simultaneously. The average total flavonoid content (TFC) was 164.0 mg GAE/100 g for the ethanol–water mixture and 171.5 mg GAE/100 g for ethanol. Since this difference was relatively small, solvent selection was based not only on flavonoid recovery but also on total phenolic content, anthocyanin content, antioxidant activity, and food safety considerations.

The superior extraction performance of the ethanol–water mixture can be explained by its intermediate polarity. Water promotes the swelling of plant cell walls and facilitates the release of hydrophilic phenolic compounds, whereas ethanol decreases the overall polarity of the extraction medium, thereby enhancing the solubility of moderately polar flavonoids, anthocyanins, and other polyphenolic compounds. Consequently, the ethanol–water mixture enables the simultaneous extraction of a broader spectrum of bioactive compounds than either water or ethanol used individually.

In contrast, extracts obtained with n-hexane, benzene, ethyl acetate, and chloroform contained considerably lower concentrations of phenolic compounds, flavonoids, and anthocyanins. Furthermore, benzene and chloroform are unsuitable for food applications because of their toxicity and safety concerns. Likewise, n-hexane, being a non-polar solvent, exhibited poor extraction efficiency for phenolic compounds due to their predominantly polar nature.

CONCLUSION

Due to the high yield of phenolic compounds and anthocyanins, stable results for flavonoids, and relative safety for food technology, the ethanol/water mixture was selected as the most optimal solvent for obtaining fruit and berry extracts. According to the experimental results, the use of water, ethyl alcohol, and their mixtures in various ratios among the studied extractants made it possible to obtain extracts with a rich chemical composition. A similar pattern was observed in the antioxidant activity of the resulting extracts. While the aqueous medium primarily ensures the removal of polar and hydrophilic compounds from the raw material composition, ethanol facilitates the transition of relatively low-polar and certain lipophilic components into the solution. The combined use of water and ethanol allows for the complex isolation of biologically active substances with different polarities. Therefore, these extractants were evaluated as the most effective among the studied solvents. Their selection was based not only on their high extraction properties but also on their safety from the perspective of food production.

REFERENCES

1. Alara, O. R., Abdurahman, N. H., & Ukaegbu, C. I. (2021). Extraction of phenolic compounds: A review on conventional and emerging techniques. Journal of Food Measurement and Characterization, 15, 3899–3927.
2. Azmir, J., Zaidul, I. S. M., Rahman, M. M., Sharif, K. M., Mohamed, A., Sahena, F., Jahurul, M. H. A., Ghafoor, K., Norulaini, N. A. N., & Omar, A. K. M. (2013). Techniques for extraction of bioactive compounds from plant materials: A review. Journal of Food Engineering, 117(4), 426–436. https://doi.org/10.1016/j.jfoodeng.2013.01.014
3. Chemat, F., Vian, M. A., & Cravotto, G. (2012). Green extraction of natural products: Concept and principles. International Journal of Molecular Sciences, 13(7), 8615–8627. https://doi.org/10.3390/ijms13078615
4. Chemat, F., Vian, M. A., Fabiano-Tixier, A. S., Nutrizio, M., Režek Jambrak, A., Munekata, P. E. S., Lorenzo, J. M., Barba, F. J., Binello, A., & Cravotto, G. (2020). A review of sustainable and intensified techniques for extraction of food and natural products. Green Chemistry, 22(8), 2325–2353. https://doi.org/10.1039/C9GC03878G

5. Dai, J., & Mumper, R. J. (2010). Plant phenolics: Extraction, analysis and their antioxidant and anticancer properties. Molecules, 15(10), 7313–7352. https://doi.org/10.3390/molecules15107313
6. Khoddami, A., Wilkes, M. A., & Roberts, T. H. (2013). Techniques for analysis of plant phenolic compounds. Molecules, 18(2), 2328–2375. https://doi.org/10.3390/molecules18022328
7. Mustafa, A., & Turner, C. (2011). Pressurized liquid extraction as a green approach in food and herbal plants extraction: A review. Analytica Chimica Acta, 703(1), 8–18. https://doi.org/10.1016/j.aca.2011.07.018
8. Tiwari, B. K. (2015). Ultrasound: A clean, green extraction technology. TrAC Trends in Analytical Chemistry, 71, 100–109. https://doi.org/10.1016/j.trac.2015.04.013
9. Zhang, Q. W., Lin, L. G., & Ye, W. C. (2018). Techniques for extraction and isolation of natural products: A comprehensive review. Chinese Medicine, 13, 20. https://doi.org/10.1186/s13020-018-0177-x