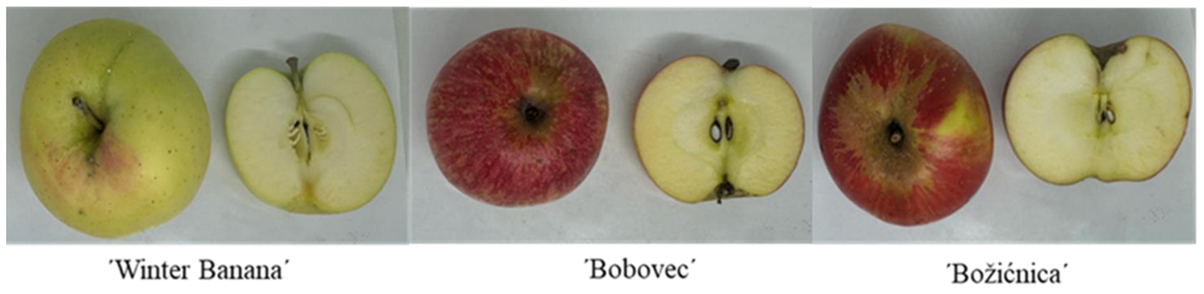
TRADITIONAL APPLE CULTIVARS: A PROMISING RESOURCE FOR BY-PRODUCT VALORIZATION

Ana-Marija Gotal Skoko[1], Antun Jozinović[1], Jurislav Babić[1], Drago Šubarić[1], Ante Lončarić[1,2]
[1] Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, 31000 Osijek, Croatia
[2] Josip Juraj Strossmayer University of Osijek, Faculty of Tourism and Rural Development in Požega, Vukovarska 17, 34000 Požega

1 INTRODUCTION

The growing interest in sustainable food production has underscored the importance of agro-industrial by-product valorization as a source of valuable bioactive compounds. Because the composition of apple processing by-products depends on the fruit's chemical composition, characterizing apple cultivars is essential for identifying raw materials with high valorization potential. Therefore, this study compared three traditional (´Winter Banana´, ´Bobovec´, and ´Božićnica´) and three commercial (´Jonagold´, ´Idared´, and ´Golden Delicious´) apple cultivars for their chemical composition and bioactive properties.



2 METHODOLOGY

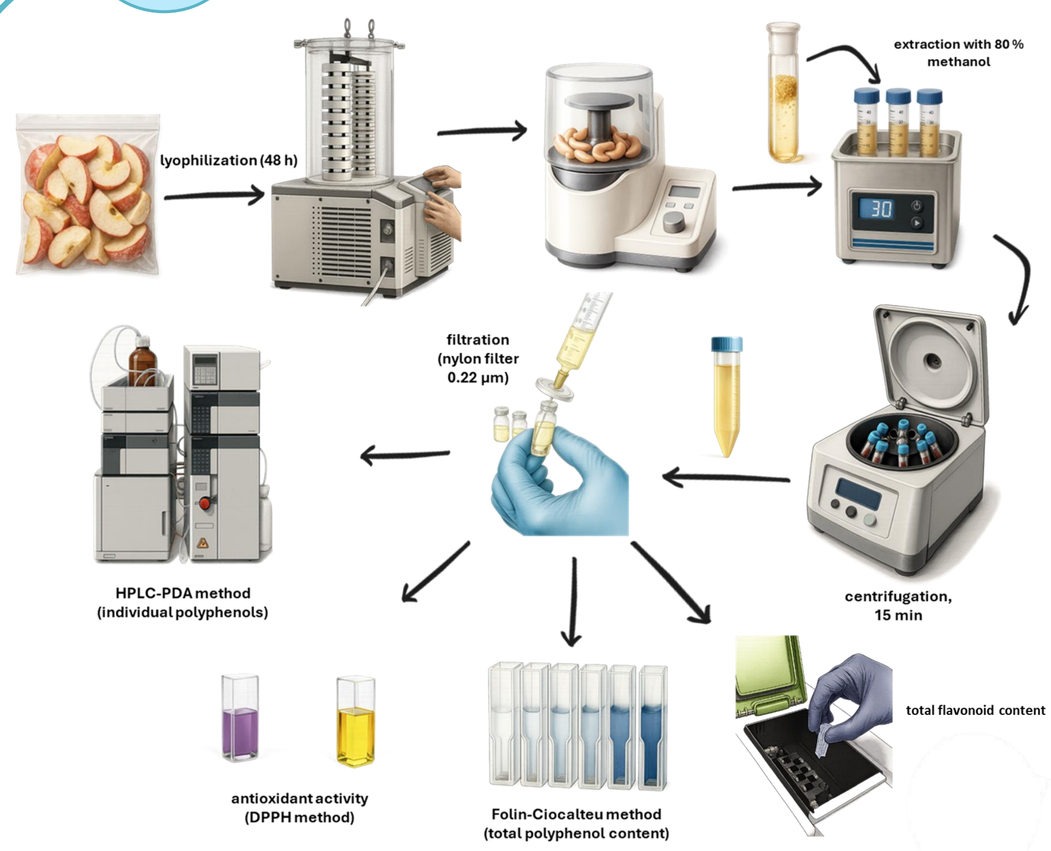


Figure 1. Experimental procedure for determining the polyphenol profile, antioxidant activity, and total polyphenol and flavonoid content.

3 RESULTS

Table 1. Polyphenol profile of traditional and commercial cultivars [µg/g]

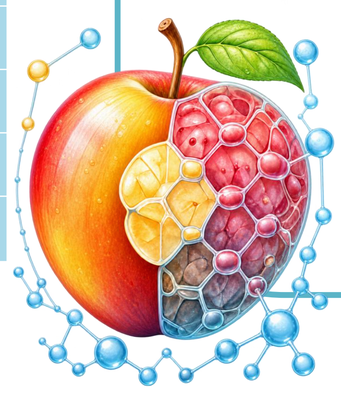
	´Winter Banana´	´Bobovec´	´Božićnica´	´Jonagold´	´Idared´	´Golden Delicious´
Idaein chloride	0.00 ± 0.00	42.09 ± 0.41	84.20 ± 0.78	50.66 ± 0.99	204.74 ± 0.54	0.00 ± 0.00
Gallic acid	6.33 ± 0.53	1.88 ± 0.91	0.00 ± 0.00	1.76 ± 0.09	1.22 ± 1.54	0.00 ± 0.00
***Trans*-ferulic acid**	0.18 ± 0.02	0.15 ± 0.01	0.42 ± 0.03	0.08 ± 0.00	0.45 ± 0.02	0.32 ± 0.01
Chlorogenic acid	1481.59 ± 83.30	1247.38 ± 3.82	1099.00 ± 7.62	494.79 ± 7.46	754.48 ± 230.04	490.03 ± 0.36
Epigallocatechin	39.17 ± 4.10	661.80 ± 19.15	649.27 ± 47.95	30.60 ± 2.97	36.40 ± 3.05	24.57 ± 3.46
Caffeic acid	1.47 ± 0.06	0.39 ± 0.01	0.90 ± 0.02	1.00 ± 0.01	0.68 ± 0.01	0.76 ± 0.00
Procyanidin A2	0.76 ± 0.02	1.55 ± 0.05	2.84 ± 0.15	1.00 ± 0.04	1.20 ± 0.17	0.00 ± 0.00
Catechin	19.98 ± 1.11	49.17 ± 1.12	73.93 ± 2.42	7.71 ± 0.35	26.31 ± 0.14	8.83 ± 0.13
***p*-coumaric acid**	0.21 ± 0.03	0.48 ± 0.02	0.43 ± 0.01	0.25 ± 0.01	0.11 ± 0.01	0.31 ± 0.01
Phloridzin	75.45 ± 6.26	86.71 ± 0.20	186.04 ± 1.48	40.15 ± 0.29	95.63 ± 0.18	68.12 ± 2.59
Epicatechin	413.74 ± 18.40	298.87 ± 3.09	284.65 ± 19.41	92.09 ± 2.16	82.09 ± 0.43	81.23 ± 4.64
Myricetin	15.39 ± 1.23	35.98 ± 0.14	25.76 ± 0.17	12.11 ± 0.05	41.76 ± 0.06	16.87 ± 0.01
Quercetin-3-rutinoside	41.81 ± 3.95	84.37 ± 0.87	122.00 ± 1.93	17.51 ± 0.38	140.78 ± 2.17	44.78 ± 0.18
Quercetin-3-D-glucoside	30.00 ± 2.89	26.01 ± 1.23	65.29 ± 1.06	5.65 ± 0.10	32.43 ± 2.14	17.05 ± 0.18
Procyanidin B1	232.59 ± 22.58	396.12 ± 91.86	1079.20 ± 104.37	31.37 ± 4.83	36.30 ± 12.85	372.61 ± 13.27
Oenin chloride	0.00 ± 0.00	0.00 ± 0.00	0.85 ± 0.02	0.45 ± 0.02	1.43 ± 0.02	0.00 ± 0.00
Quercetin	0.11 ± 0.03	0.73 ± 0.08	0.32 ± 0.02	1.54 ± 0.01	0.11 ± 0.02	0.16 ± 0.02
Procyanidin B2	519.84 ± 21.42	754.53 ± 7.78	559.79 ± 6.03	251.12 ± 7.51	850.62 ± 0.76	280.55 ± 1.56
Pelargonidine-3-glucoside	0.00 ± 0.00	0.00 ± 0.00	2.91 ± 0.17	0.94 ± 0.10	4.33 ± 0.06	0.00 ± 0.00

Table 2. The content of total polyphenols, flavonoids and antioxidant activity in traditional and commercial apple cultivars

	´Winter Banana´	´Bobovec´	´Božićnica´	´Jonagold´	´Idared´	´Golden Delicious´
DPPH [mmolTE/g]	0.60 ± 0.07	0.92 ± 0.07	1.24 ± 0.04	0.56 ± 0.04	0.65 ± 0.01	0.54 ± 0.03
Total polyphenols [mg/kg]	519.86 ± 14.00	682.26 ± 11.42	857.98 ± 11.30	509.26 ± 5.06	494.91 ± 12.32	463.11 ± 9.53
Total flavonoid content [g CE/kg]	466.59 ± 23.17	468.94 ± 15.43	572.47 ± 12.45	286.98 ± 23.09	287.76 ± 22.69	276.78 ± 5.43

4 DISCUSSION AND CONCLUSION

The results indicate that both traditional and commercial apple cultivars can be considered valuable sources of bioactive compounds for by-product valorization. The high concentrations of phenolic compounds, particularly chlorogenic acid, epicatechin, catechin, procyanidin B1 and B2, and quercetin derivatives, demonstrate that apples have potential beyond their primary use as fresh fruit or juice. Traditional cultivars showed high levels of several phenolic compounds (chlorogenic acid, procyanidin B1, catechin, epicatechin, phloridzin, epigallocatechin) and therefore may represent promising cultivar sources for the recovery of phenolic compounds from apple processing by-products, such as peels, pomace, and seeds. Among the commercial cultivars, ´Idared´ also demonstrated considerable potential due to its high levels of procyanidin B2 and quercetin-3-rutinoside. Moreover, the results showed that the traditional apple cultivar ´Božićnica´ exhibited the highest total polyphenol content (857.98 ± 11.30 mg/kg), total flavonoid content (572.47 ± 12.45 g CE/kg), and antioxidant activity.



From a by-product valorization perspective, these compounds could be recovered and used as natural antioxidants or functional ingredients in food, cosmetic, and other value-added applications. Therefore, apple processing residues should not be regarded simply as waste, but rather as potential sources of high-value phytochemicals.

This research was conducted as part of the project „From food industry by-products to new functional products (NUS-PRO-FUN, 581-UNIOS-94)" funded by National Recovery and Resilience Plan (funded by the European Union, NextGenerationEU)

Sufinancira Europska unija

21 Ružičkini dani
DANAS ZNANOST – SUTRA INDUSTRIJA
9. – 11. rujna 2026. • Vukovar • Hrvatska