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The value of food waste: *Citrus reticulata* (mandarin) peel as potent biological agent

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pharmaceuticals



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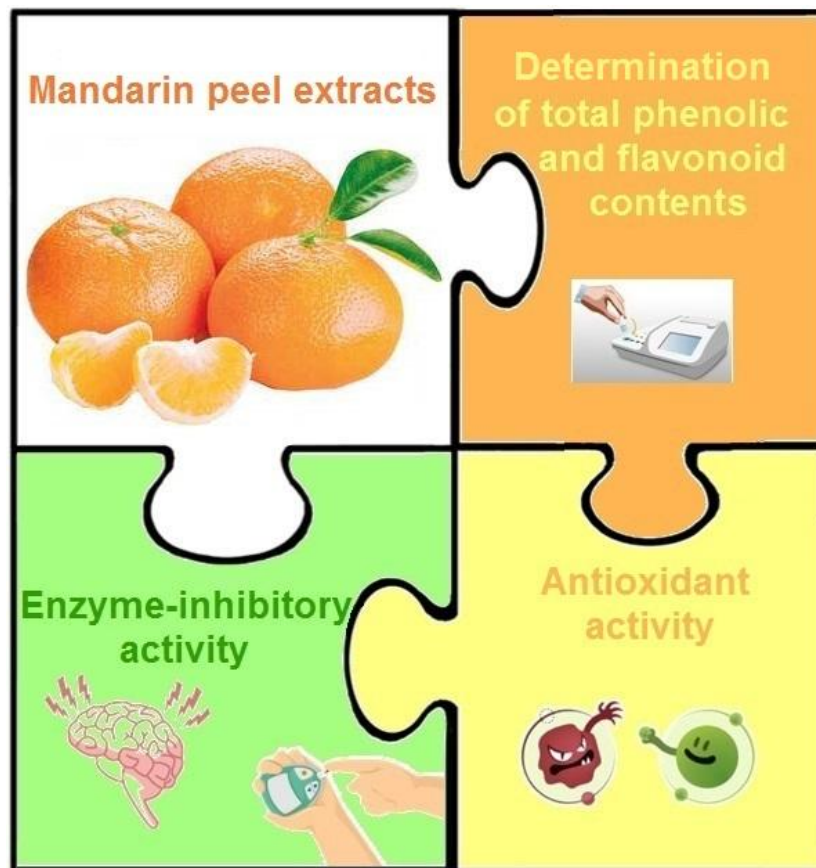


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Graphical Abstract



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Abstract

Citrus reticulata (mandarin) is used in the food industry mainly for juice production, while its peel represents a byproduct with high content of miscellaneous biologically active compounds. This research aimed to **assess the antioxidant and enzyme-inhibitory activities** of different peel extracts of mandarin cultivated under natural conditions in the Montenegrin coastal region (Lastva Grbaljska). Mandarin fruits were collected in November 2017, and their extracts were prepared using acetone, methanol, and boiling distilled water as solvents. Total phenolic (TPC) and flavonoid (TFC) contents were determined at the concentration of 0.5 mg/mL, as well as the extracts' antioxidant (using DPPH and total reducing power assays) and enzyme-inhibitory activities (using acetylcholinesterase (AChE) and α -glucosidase inhibition assays). The results indicated that the acetonic extract exhibited the highest radical scavenging activity (12.70%), while also showing the highest TPC (52.40 mg GAE/g) and TFC (13.05 mg QE/g), which is not surprising since acetone is known to extract biologically highly active flavonoid aglycones from plants. Although the aqueous extract had the lowest TPC and TFC, it exerted the highest reducing power (199.06 μ mol AAE/g), as well as AChE inhibition activity (22.44%), indicating that other groups of phytochemicals besides phenolics, such as various classes of glycosides, are responsible for the displayed bioactivity. Moreover, none of the extracts inhibited the activity of α -glucosidase. Finally, this study suggests that **mandarin peel should not be dismissed in food processing since it possesses a valuable medicinal potential that remains to be further investigated.**

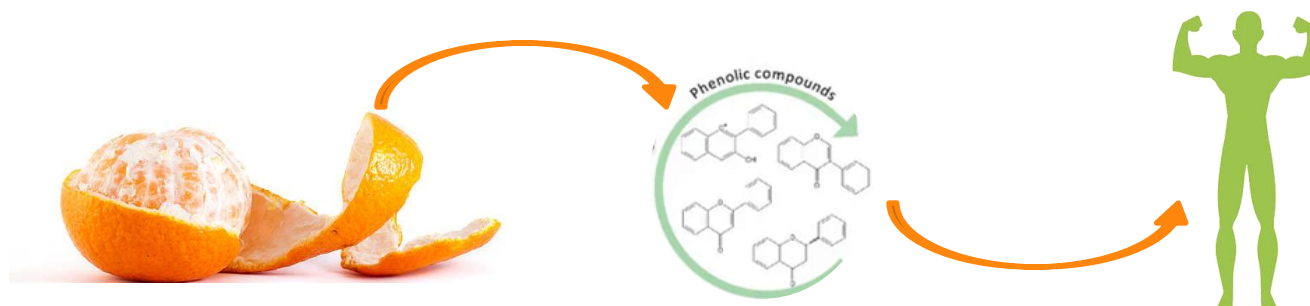
Keywords: biological activities; *Citrus reticulata*; extracts; phenolics

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Introduction

- **Free radicals**, highly reactive species with unpaired electrons in their outermost shell → **oxidative stress** → tissue damage → a **large number of diseases**, among others, **Alzheimer's disease** (AD) and **diabetes mellitus** (DM).
- **Natural products** are being extensively studied due to their ability to act as antioxidants and suppress the reactive oxygen species production.
- A number of **natural products** inhibit the activity of enzymes associated with AD and DM, such as acetylcholinesterase (AChE) and α -glucosidase, respectively.
- The **peel of different citrus fruits** have been widely studied because of high content of diverse **biologically active compounds** including natural antioxidants, such as phenolic acids and flavonoids.



Results and discussion

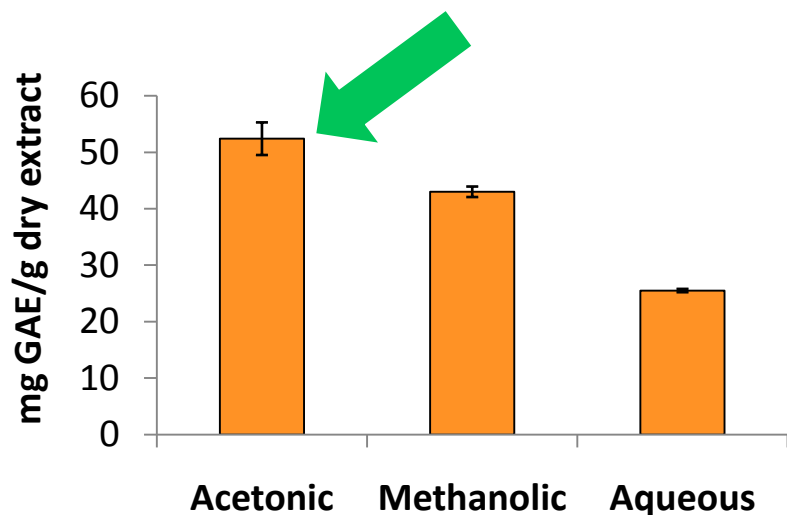


Fig. 1. Total phenolic content (TPC)
*GAE – gallic acid equivalents

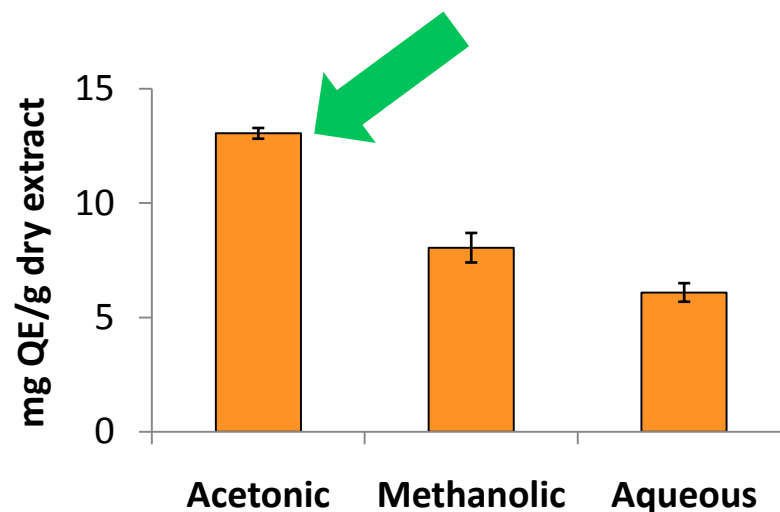


Fig. 2. Total flavonoid content (TFC)
*QE – quercetin equivalents

The acetonic extract had the highest TPC (52.40 mg GAE/g) (Fig. 1) and TFC (13.05 mg QE/g) (Fig. 2).

The aqueous extract had the lowest TPC and TFC (Figs. 1 and 2).

Results and discussion

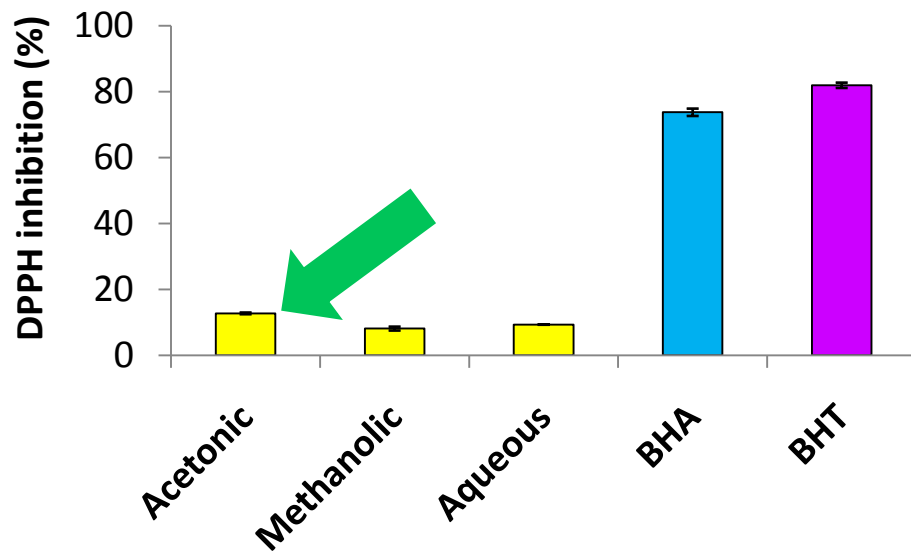


Fig. 3. DPPH inhibition

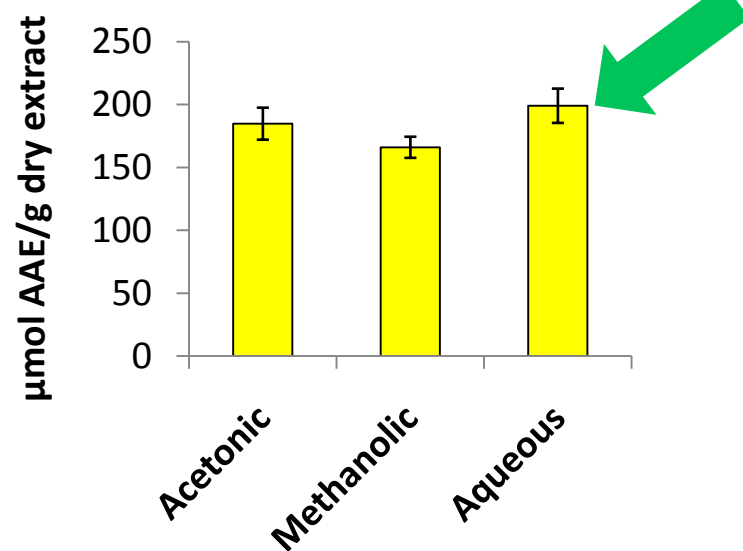


Fig. 4. Total reducing power (TRP)
*AAE – ascorbic acid equivalents

The acetonic extract exhibited the highest DPPH scavenging potential (12.70%), however this activity was significantly lower compared to the positive controls, BHA and BHT, tested at the same concentration (Fig. 3).

The aqueous extract exerted the highest total reducing power (Fig. 4).

Results and discussion

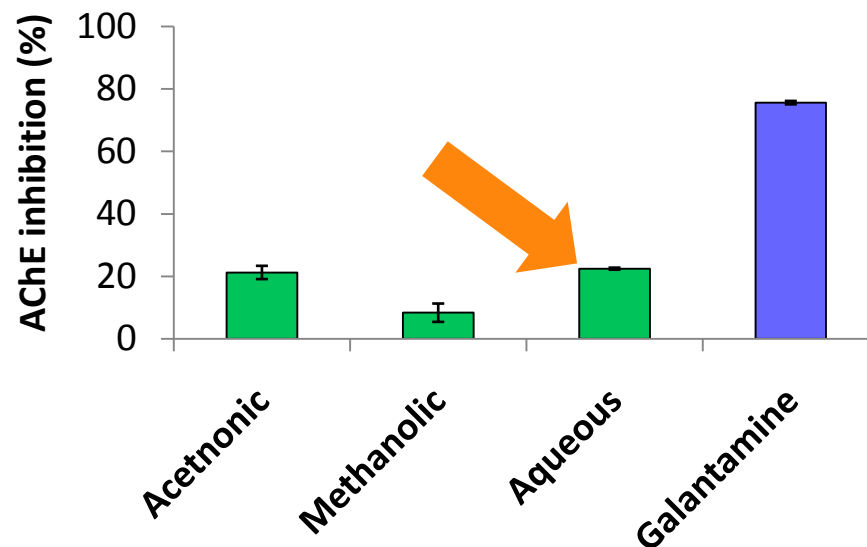


Fig. 5. AChE inhibition

The aqueous extract exhibited the highest AChE inhibition activity (22.44%), however this activity was significantly lower compared to the positive control, **galantamine**, tested at the same concentration (Fig. 5).

None of the extracts inhibited the activity of α -glucosidase at the tested concentration.

Conclusions

- Even though the tested concentration of the mandarin peel extracts was not high (0.5 mg/mL), they exerted **noticeable biological potential**.
- The DPPH scavenging activity of the **acetonc extract** might be attributed to the fact that these extracts are usually rich in **biologically highly active flavonoid aglycones**.
- The **aqueous extract** exhibited the highest reducing power and AChE inhibition activity, indicating that other groups of phytochemicals besides phenolics, such as **various classes of glycosides**, might be responsible for the displayed bioactivity.

Mandarin peel should not be dismissed in food processing since it possesses a valuable medicinal potential that remains to be further investigated.



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