IN-DEPTH ANALYSIS OF THE PHYTOCHEMICAL AND BIOACTIVE PROFILE OF ENDEMIC BROWN MACROALGA *FUCUS VIRSOIDES*

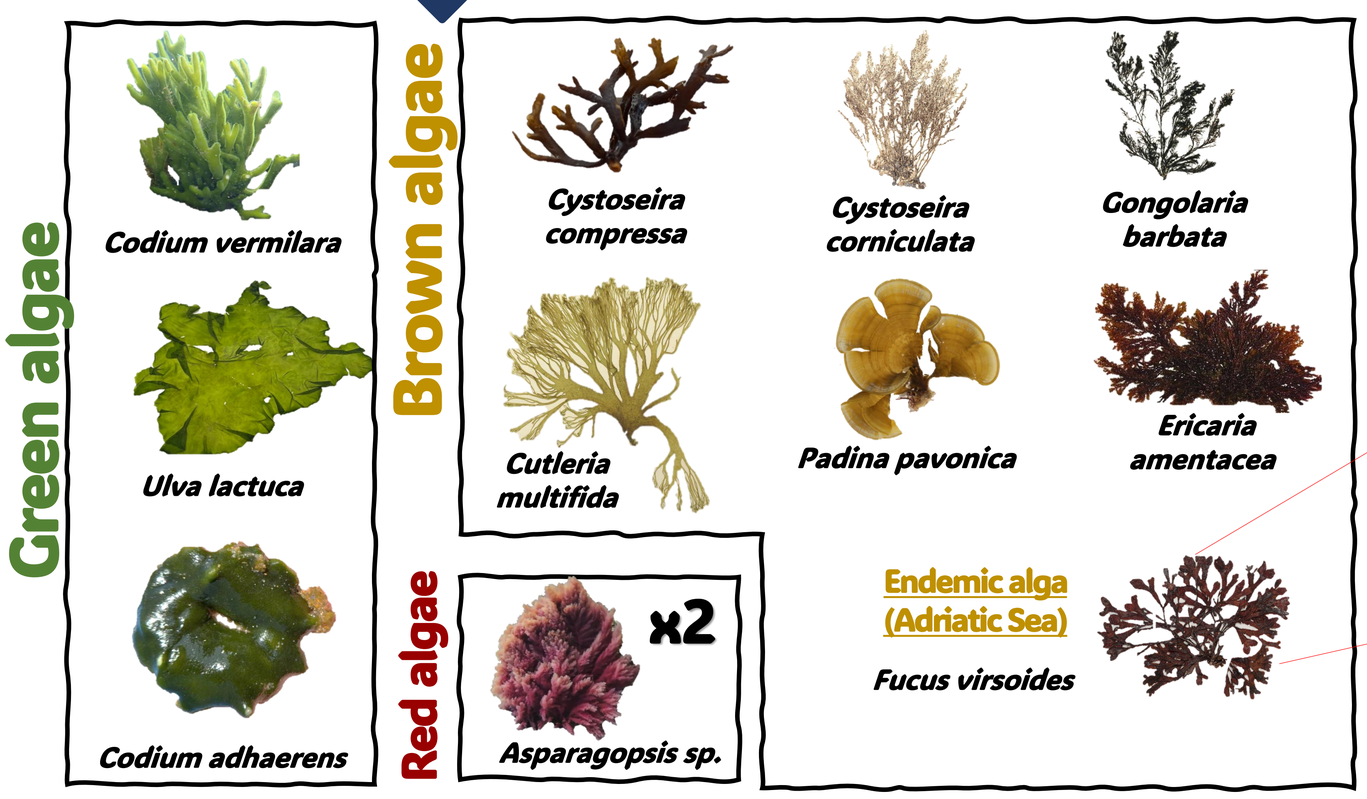
Kristina Perišić

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

ABSTRACT

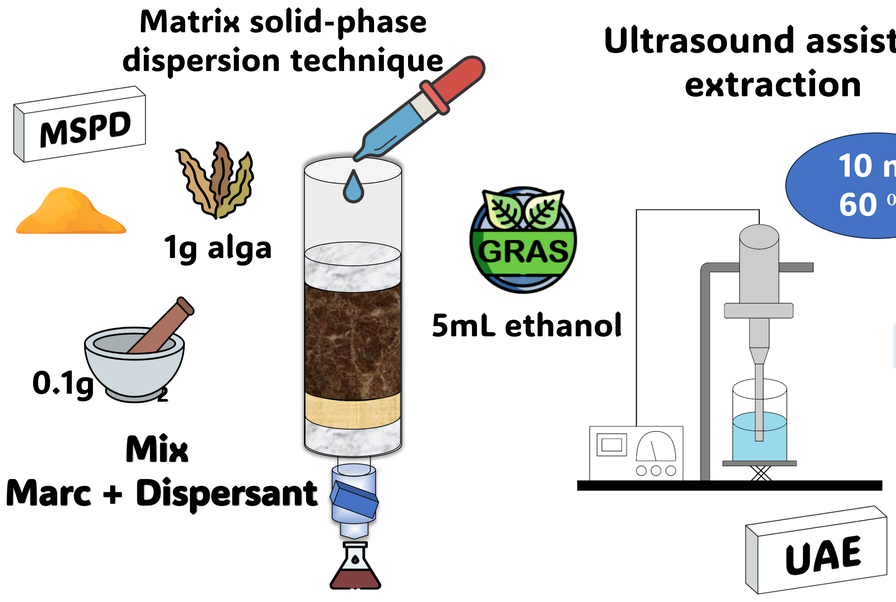
This study focuses on the endemic macroalga of the Adriatic Sea, *Fucus virsoides*, which, despite its biological importance, remains insufficiently studied. As a representative of brown algae, *F. virsoides* is a valuable source of various bioactive compounds, including complex polysaccharides, polyphenols, fatty acids, and vitamins, which have been associated with numerous potential biological effects. For the isolation of bioactive compounds, the green solvent ethanol/water in a 1:1 volume ratio was used, along with two environmentally friendly extraction methods: ultrasound-assisted extraction (UAE) and matrix solid-phase dispersion (MSPD). Spectrophotometric methods were employed to determine the total phenolic content (TPC) and antioxidant activity of the extracts using the ABTS assay. The phenolic profile was analyzed by liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS). Furthermore, UHPLC-QToF was used to identify additional compounds, providing a detailed insight into the chemical composition of the alga. The isolated bioactive compounds, particularly polyphenols and polysaccharides, exhibit various potential biological properties, including antioxidant, anti-inflammatory, and antimicrobial activities. Owing to these properties, these compounds represent promising constituents for applications in the pharmaceutical, food, and cosmetic industries, particularly in the development of natural dietary supplements, functional ingredients, and dermocosmetic products.

GREEN, BROWN AND RED ALGAE

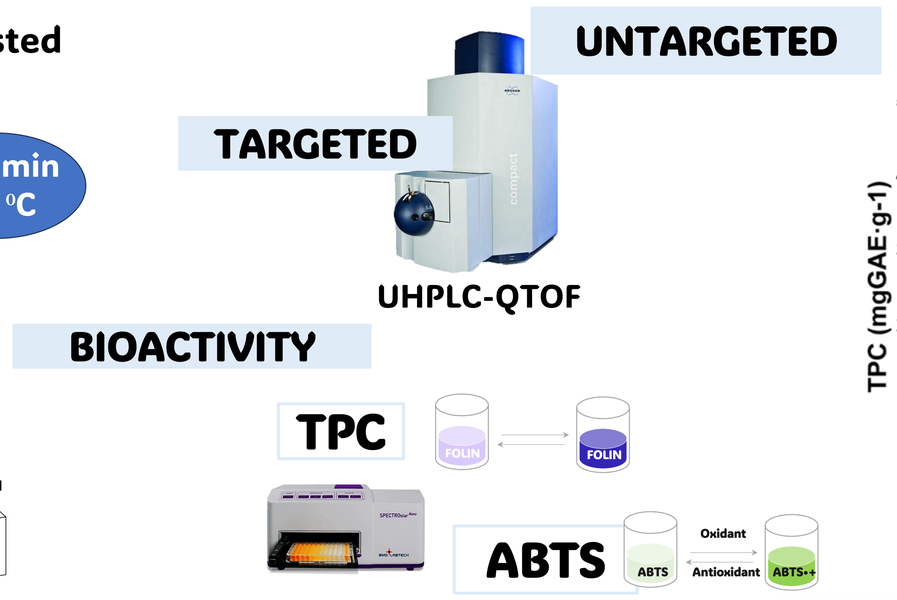


***Fucus virsoides*, Jadranski bračić**

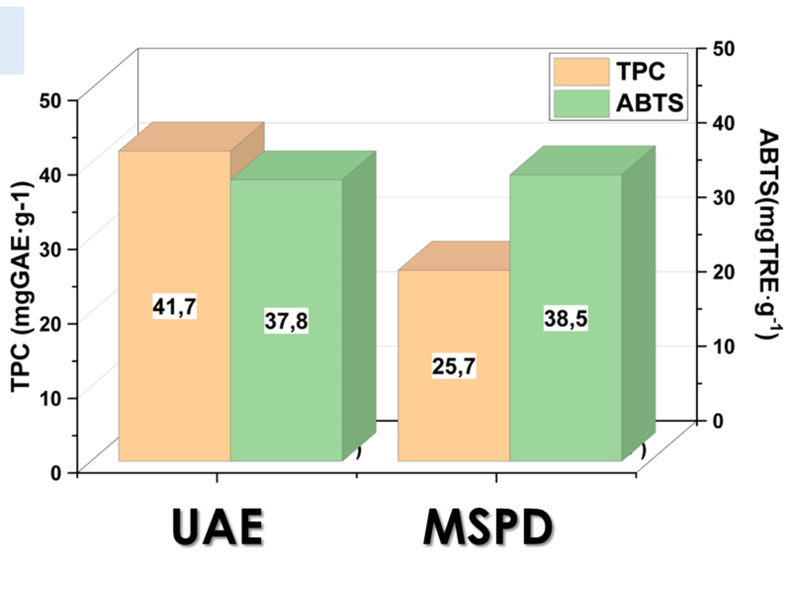
EXPERIMENTAL PROCEDURE



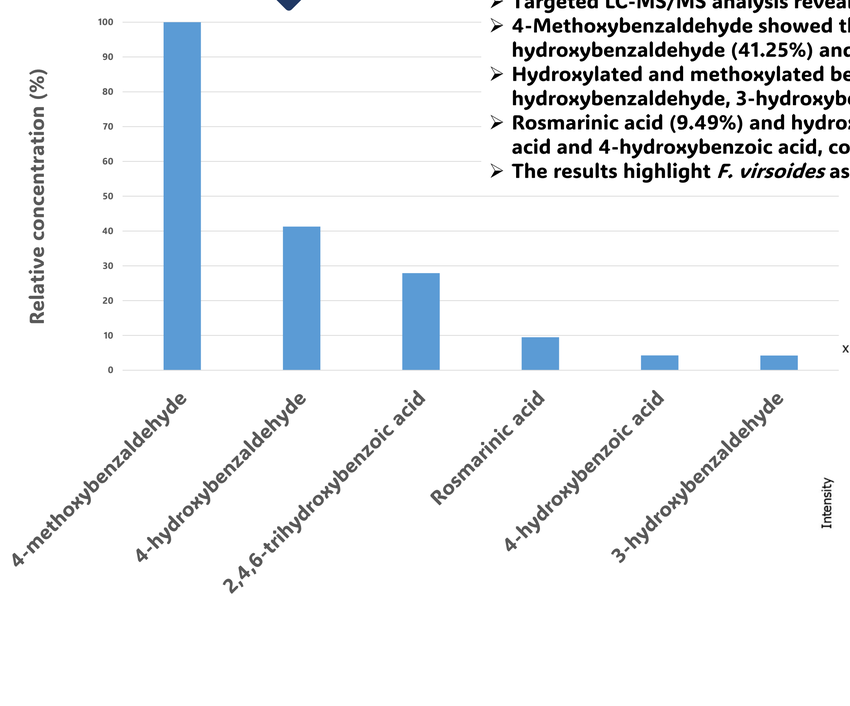
ANALYSIS



BIOACTIVE RESPONSE



POLYPHENOLIC PROFILE



- Targeted LC-MS/MS analysis revealed six phenolic compounds in *Fucus virsoides*
- 4-Methoxybenzaldehyde showed the highest relative response (100%), followed by 4-hydroxybenzaldehyde (41.25%) and 2,4,6-trihydroxybenzoic acid (27.89%)
- Hydroxylated and methoxylated benzaldehyde derivatives were identified: 4-hydroxybenzaldehyde, 3-hydroxybenzaldehyde, and 4-methoxybenzaldehyde
- Rosmarinic acid (9.49%) and hydroxybenzoic acid derivatives, including 2,4,6-trihydroxybenzoic acid and 4-hydroxybenzoic acid, contributed to the phenolic profile
- The results highlight *F. virsoides* as a potential source of diverse bioactive phenolic metabolites

UNTERGETED ANALYSIS

- UHPLC-QToF-MS analysis revealed a diverse metabolomic profile of *Fucus virsoides*.
- 20 metabolites were identified, belonging to the following chemical families: organic acids, lipid and lipid-related derivatives, amino acid derivatives, phenolic derivatives, polyols, sterol derivatives, and sulphated compounds.
- Organic acids represented the most abundant group, including dicarboxylic, hydroxylic, sugar and tricarboxylic acids, as well as polyunsaturated fatty acids (PUFAs). Lipid-related metabolites included hydroxylated fatty acids, oxylipins and sulfoquinovosyl monoacylglycerols (SQMGs).
- The most prominent chromatographic signals were attributed to citric acid, 2,4-dihydroxyacetophenone 5-sulfate, FA 9:2+1O, and SQMG 16:0/0:0.

CONCLUSIONS

- *Fucus virsoides showed high bioactive potential and a diverse chemical profile.*
- *UAE resulted in a higher total phenolic content (TPC) than MSPD (41.7 ± 0.8 vs. 26.0 ± 3.0 mg GAE/g), while both extracts showed similar ABTS antioxidant activity (38 mg TE/g).*
- *Targeted LC-MS/MS confirmed several phenolic compounds, with 4-hydroxybenzaldehyde and 2,4,6-trihydroxybenzoic acid showing the highest relative responses, while rosmarinic acid further highlights the diversity of the phenolic profile.*
- *UHPLC-QToF-MS identified 19 metabolites from several chemical groups, including organic acids, fatty acids and their hydroxylated derivatives, oxylipins, SQMGs, phenolic sulfates, sterol derivatives, polyols, amino acids and sulphated compounds.*
- *Among the most prominent metabolites were SQMG 16:0/0:0, FA 9:2+1O, 2,4-dihydroxyacetophenone 5-sulfate, and citric acid.*
- *The presence of linoleic acid, EPA and 12-HETE, together with diverse phenolic and sulphated compounds, highlights the metabolic diversity and potential of F. virsoides as a source of natural bioactive compounds. Further studies are needed to quantify individual metabolites, confirm their structures, and investigate their specific biological activities.*

ACKNOWLEDGEMENTS

BIOPROSPECTING JADRANSKOG MORA
Projekt sufinancira Europska unija iz Europskog fonda za regionalni razvoj
Republika Hrvatska Ministarstvo znanosti i obrazovanja
Europska unija Zajedno do fondova EU
Republika Hrvatska Ministarstvo regionalnoga razvoja i fondova Europske unije
EUROPSKI STRUKTURNI I INVESTICIJSKI FONDOVI
Operativni program KONKURENTNOST I KOHEZIJA

This research was conducted within the framework of the Scientific Centre of Excellence for Marine Bioprospecting (BioProCro), as part of the Adriatic Sea Bioprospecting project (KK.01.1.1.01.0002), funded by the European Union, and the project Sustainable Bioprospecting of Adriatic Sea Organisms for Innovative Natural Products – BioProCro (PK.1.1.10.0001).