

## Article

# Investigation into the Phytochemical Composition, Antioxidant Properties, and In-Vitro Anti-Diabetic Efficacy of *Ulva lactuca* Extracts

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**Abstract:** In this research, the chemical compositions of various extracts obtained from *Ulva lactuca*, a type of green seaweed collected from the Nador lagoon in the northern region of Morocco, were compared. Their antioxidant and anti-diabetic properties were also studied. Using GC-MS technology, the fatty acid content of the samples was analyzed, revealing that palmitic acid, eicosenoic acid, and linoleic acid were the most abundant unsaturated fatty acids present in all samples. The HPLC analysis indicated that sinapic acid, naringin, rutin, quercetin, cinnamic acid, salicylic acid, apigenin, flavone, and flavanone were the most prevalent phenolic compounds. The aqueous extract obtained by maceration showed high levels of polyphenols and flavonoids, with values of  $379.67 \pm 0.09$  mg GAE/g and  $212.11 \pm 0.11$  mg QE/g, respectively. This extract also exhibited an impressive ability to scavenge DPPH radicals, as indicated by its IC<sub>50</sub> value of  $0.095 \pm 0.12$  mg/mL. Additionally, the methanolic extract obtained using the Soxhlet method demonstrated antioxidant properties by preventing  $\beta$ -carotene discoloration, with an IC<sub>50</sub> of  $0.087 \pm 0.14$  mg/mL. Results from in-vitro studies showed that extracts from *U. lactuca* were able to significantly inhibit the enzymatic activity of  $\alpha$ -amylase and  $\alpha$ -glucosidase. Among the various extracts, methanolic extract (S) has been identified as the most potent inhibitor, exhibiting a statistically similar effect to that of acarbose. Furthermore, molecular docking models were used to evaluate the interaction between the primary phytochemicals found in these extracts and the human pancreatic  $\alpha$ -amylase and  $\alpha$ -glucosidase enzymes. These findings suggest that *U. lactuca* extracts contain bioactive substances that are capable of reducing enzyme activity more effectively than the commercially available drug, acarbose.

**Keywords:** *Ulva lactuca*; fatty acids; phenolic compounds; antioxidant activity; enzyme inhibition; anti-diabetic properties; molecular docking

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