9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

The Impact of Plasma Activated Seawater on Postharvest Sea Grapes *Caulerpa lentillifera*

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Sea grapes (*Caulerpa lentillifera*) are a highly nutritious and commercially valuable macroalga. However, their significant perishability due to microbial contamination poses a major postharvest challenge [1, 2]. Conventional preservation methods often compromise quality, highlighting the need for alternative treatments require further investigation. Cold plasma technology, particularly plasma-activated water containing reactive oxygen and nitrogen species (RONS), has shown potential for microbial inactivation and quality preservation of fresh produce. Despite this, the effects of plasma-activated seawater (PASW) on *C. lentillifera* remain inexplored.

In this present study, we evaluate the impact of PASW on the quality of sea grapes during storage. Key parameters, including microbial density, weight loss, total phenolic content (TPC), ascorbic acid content, malondialdehyde (MDA) levels, and pigment content, were analyzed. Additionally, the physicochemical properties of the PASW were also characterized to better understand the underlying mechanisms.

Fresh *C. lentillifera* samples were harvested and submerged in seawater for 24 hours. Plasma was generated using a Dielectric Barrier Discharge with air, N_2, or N_2-O_2 gas mixtures as the working gas, which then passed through 150 mL of sterilized seawater for durations of 5–30 min. PASW properties including pH and RONS (H_2O_2, NO_3^-, NO_2^-) concentrations were measured. *C. lentillifera* samples were then treated with PASW generated at each duration to determine the optimal activation time required for complete bacterial inactivation. This optimal duration was subsequently applied to evaluate the quality of sea grapes at 0-, 24-, and 48-hours post-treatment.

The physicochemical properties of PASW, including pH and RONS concentrations were found to correlate with plasma activation time. Specifically, an increase in RONS concentrations corresponding to decrease in pH were observed. These findings suggest that the generation of these RONS during gas-liquid interaction may contribute to both the observed pH reduction and the enhanced antimicrobial properties of PASW [3, 4, 5].

Complete bacterial inactivation of sea grapes was achieved as the activation time of PASW increased (Fig. 1), demonstrating its potential for microbial control. Post-treatment quality analysis revealed minimal changes in key quality parameters within the first 24 hours. However, during extended storage, slight increases in MDA content and weight loss, as well as reductions in TPC, chlorophyll, and carotenoid content, were observed. Despite these changes, the overall quality and visual appearance of the PASW-treated sea grapes remained largely preserved.

These findings highlight the potential of PASW as an effective tool for postharvest preservation of sea grapes. Further research is necessary to optimize long-term preservation strategies and explore the feasibility of large-scale applications.

References

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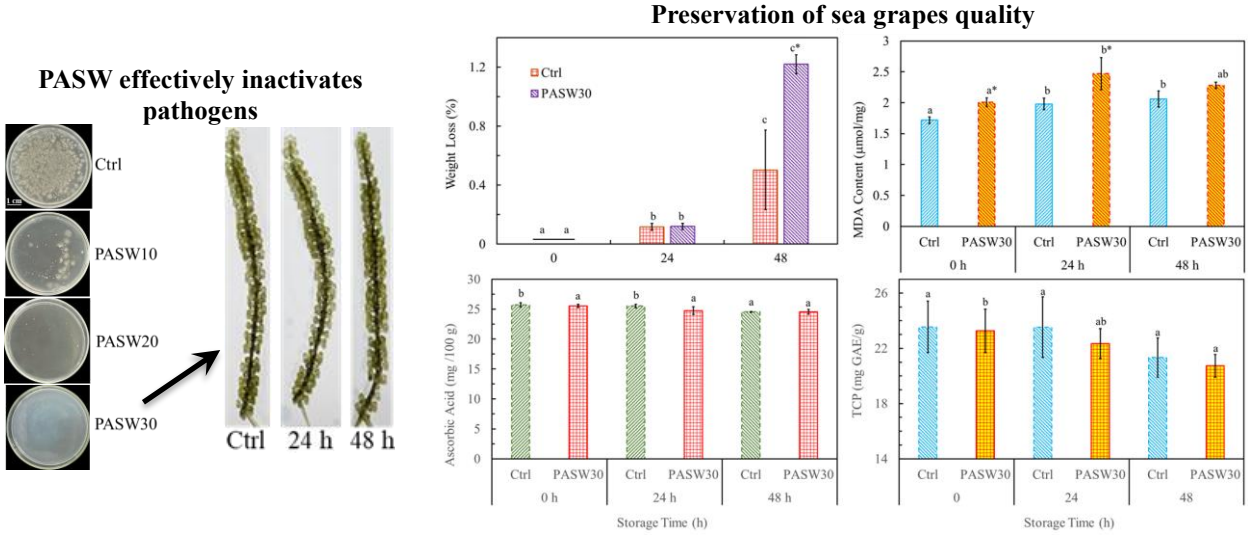

Figure 1. Bactericidal efficacy of PASW, and its impact on sea grapes quality and appearance within 48 h of storage