Influence of UV-C irradiation dose on quality attributes of Thai jasmine milled and brown rice

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Abstract

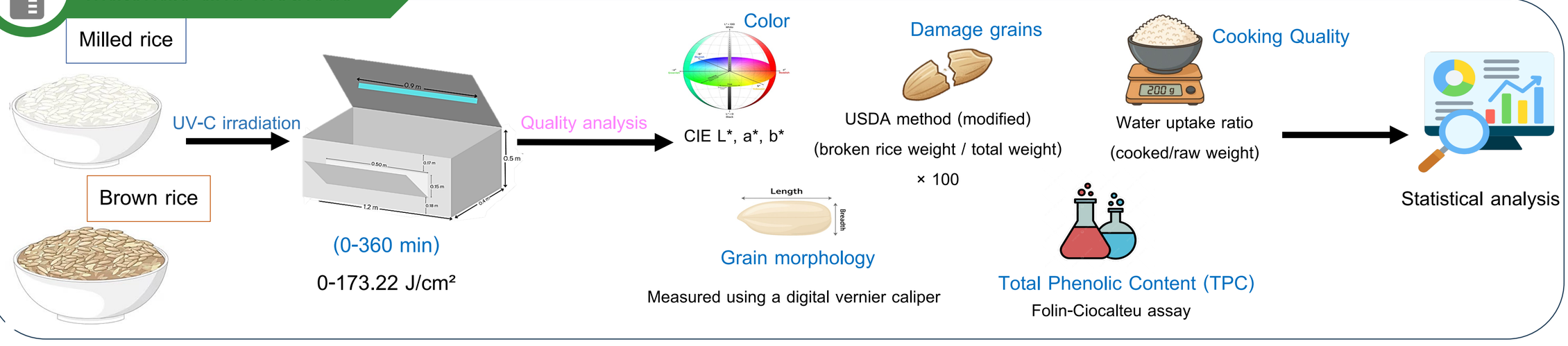
Ultraviolet-C (UV-C) irradiation has gained interest as a non-thermal postharvest technology for cereal grains; however, its effects on rice quality are dose-dependent and influenced by processing state. This study examined the impact of UV-C doses ranging from 0–173.22 J/cm² on the physicochemical and cooking qualities of Thai jasmine milled and brown rice. Evaluated parameters included color attributes, grain integrity, cooking-related morphological changes, water uptake, and total phenolic content. Overall, UV-C treatment produced measurable but moderate changes in rice quality. Milled rice showed greater sensitivity to irradiation, reflected by reductions in lightness (L*), higher proportions of damaged grains, and slight decreases in water uptake ratio. Brown rice exhibited greater stability, likely due to the protective bran layer. Grain morphology—length-to-width ratio, grain elongation, and width expansion—was minimally affected in both rice types. Total phenolic content displayed minor fluctuations without substantial degradation across treatments. These findings indicate that UV-C dose critically shapes quality responses and that milled and brown rice differ in tolerance to irradiation. Low to moderate doses preserved key quality attributes, whereas higher doses increased grain damage, particularly in milled rice. The results offer practical guidance for optimizing UV-C treatment to maintain the quality of premium aromatic rice.

Introduction

- Rice quality is critical for consumer acceptance of Thai jasmine rice.
- Postharvest contamination by molds can lead to mycotoxin formation, posing food safety concerns.
- UV-C irradiation is a promising non-thermal technology for microbial control, but it may also alter grain quality.

This study investigates the dose-dependent effects of UV-C irradiation on the physicochemical and cooking properties of milled and brown jasmine rice.

Materials and Methods



Results and Discussion

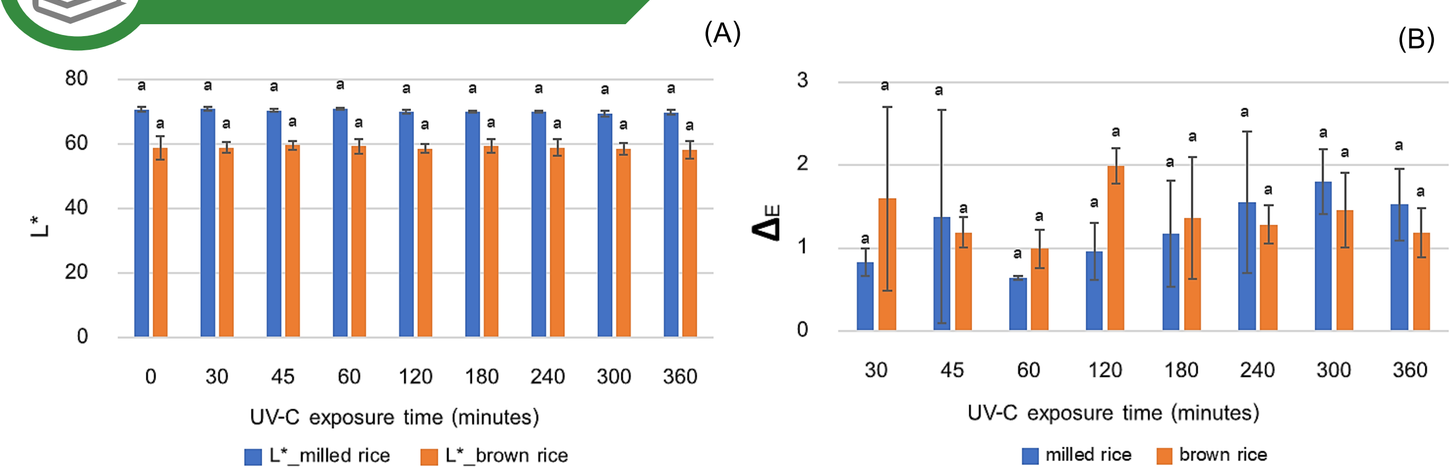


Fig. 1 L values (A) and total color difference (ΔE) (B) of milled and brown rice treated with UV-C treatments.

Color parameters (L* and ΔE) were measured separately in raw milled and raw brown rice. UV-C irradiation did not cause significant changes in color values within each rice type ($p \leq 0.05$), although minor numerical variations were observed. However, clear differences were found between rice types, with brown rice showing lower L* values due to the presence of the bran layer. These results indicate that the processing state plays an important role in determining rice color characteristics. [1]

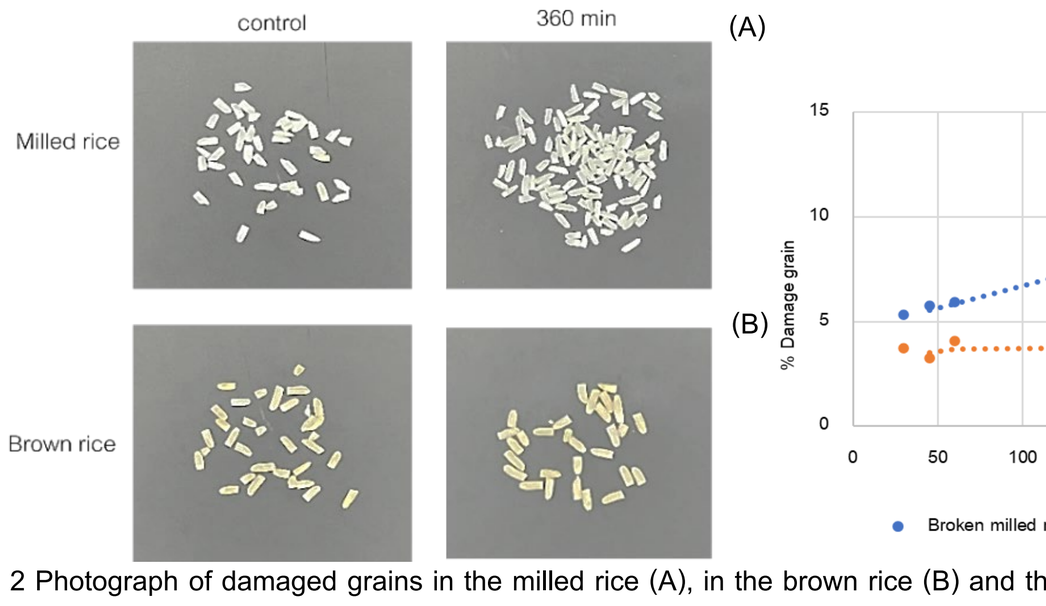


Fig. 2 Photograph of damaged grains in the milled rice (A), in the brown rice (B) and the graph shows percentage of damaged grains at different UV-C exposure time (C).

Damaged grains increased in milled rice (5.32–8.79%), while only slight changes were observed in brown rice (3.75–4.10%). This suggests that milled rice is more sensitive to UV-C irradiation, whereas the bran layer in brown rice likely provides protective effects. [1]

Grain morphology

- L/W ratio showed only minor variation across UV-C doses.
- Some significant differences occurred at specific exposure times.

Cooking qualities

- Water uptake ratio slightly decreased with UV-C exposure.
- Changes were small in both rice types.
- Grain elongation and width expansion were largely preserved.
- Cooking-related hydration properties were largely maintained.

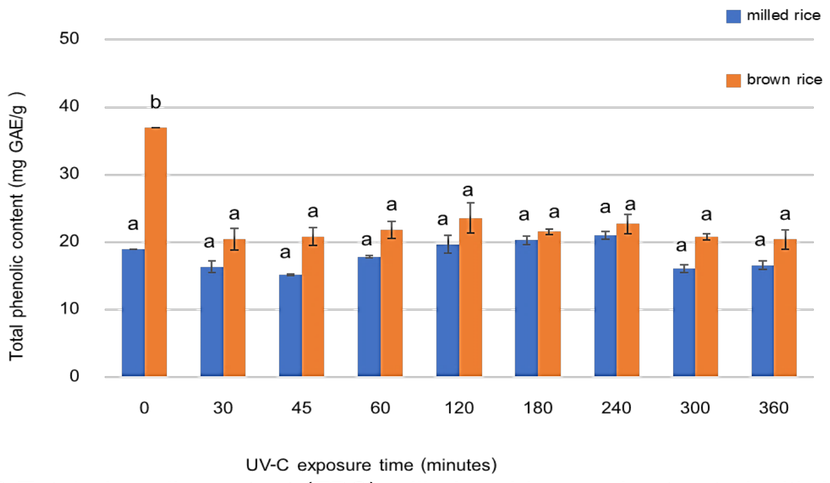


Fig. 3 Total phenolic content (TPC) milled and brown rice treated with UV-C treatments.

Total phenolic content (TPC) showed minor fluctuations in milled rice and a slight decline in brown rice, indicating that UV-C irradiation did not cause substantial phenolic degradation. Brown rice exhibited higher baseline TPC due to the presence of the bran layer. Overall, the relatively stable TPC suggests that UV-C treatment largely preserved the chemical quality of rice. [2]

Conclusion

UV-C irradiation caused dose-dependent but moderate changes in the physicochemical and cooking qualities of Thai jasmine rice. Milled rice was more sensitive than brown rice due to the absence of the bran layer. Low to moderate UV-C doses preserved key quality attributes, suggesting potential as a non-thermal postharvest treatment. However, further studies under industrial-scale conditions are needed due to limited UV-C penetration.

References: [1] Dittgen, C.L., M.M.d. Silveira, D.P. Kroning, V. Ziegler, M.d. Oliveira, C.D. Ferreira. 2020. Chemical, physical, and sensory changes in rice subjected to UV-C radiation and its acceptability to rice weevil Sitophilus oryzae (L.) (Coleoptera: curculionidae) and humans. Journal of Stored Products Research 90: 101760. doi.org/10.1016/j.jspr.2020.101760

[2] Butsat, S., Siriamornpun, S. 2010. Antioxidant capacities and phenolic compounds of the husk, bran and endosperm of Thai rice. Food Chemistry 119(2): 606–613. doi.org/10.1016/j.foodchem.2009.07.001

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