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"Competing pathways for equitable food systems transformation: Trade-offs and synergies"

Could pigmented rice be an alternative variety for increased nutritional security and mitigation of salinity stress?

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Abstract

Black rice, known for its antioxidant properties, is grown by resource-poor farmers in unfavourable conditions. Salinity stress is a significant problem for rice production, but black rice's antioxidant properties improve plant tolerance to stress. The hypothesis is that black rice's high antioxidant levels will help it adapt better to salinity stress, maintain high yield, and improve grain nutrient parameters. In a pot experiment, black rice (Asamurasaki) had a small yield reduction (12 %) under moderate salt stress (6 dS m^{-1}) compared to white rice (Hitomebore) (20 %). Under high salt stress (12 dS m^{-1}), black rice and white rice had a larger yield reduction of 58 % and 64 %, respectively. While high grain yield was maintained under salt stress, black rice showed significant increases in grain flavonoid and phenolic content, with higher levels of these antioxidants under higher salt stress. Black rice produced under salt stress had a significantly reduced lightness L* value, which improved visual grain quality, particularly due to the high levels of antioxidants in the grain under salt stress. Two-year field trials using simulated frequent saltwater intrusion showed that the rate of yield reduction in black and white rice was similar, ranging from 8.5 % to 8.7 % in year 1 (3 dS m^{-1}) and increased to 25.9 % and 26.8 % in year 2 (5 dS m^{-1}) due to increased salt stress. Salt stress substantially increased grain flavonoid and crude protein content in black rice, and the effect was more pronounced in year 2. In contrast, no difference in grain antioxidant content was observed between the control and salt stress in white rice. Black rice exhibits moderate salt stress tolerance, causing only a slight yield reduction and increased phenolic and flavonoid compounds. Severe salt stress leads to yield losses but also increases antioxidant levels. Therefore, black rice is a suitable option for cultivation in areas with moderate salt stress, sustaining production while improving the nutritional value of grains for human consumption.

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