Enhancing Antioxidant Properties of Lettuce through Nutritional Deficiency in Aquaponic Systems with Aeroponic Cultivation

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Abstract

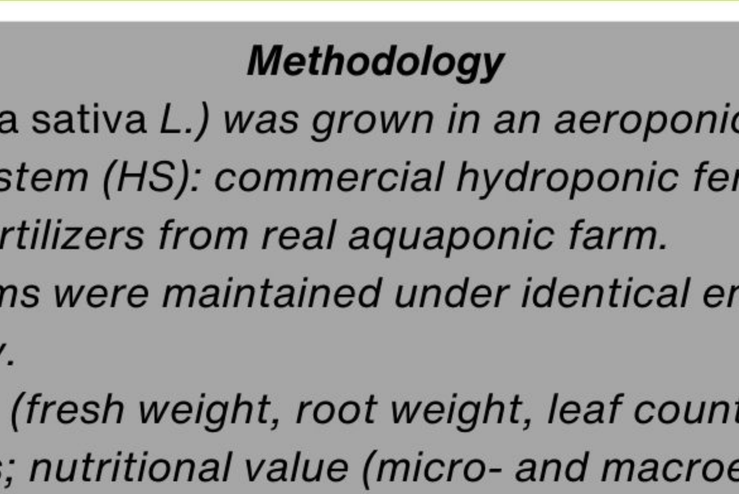
This study contrasts the yield and nutrient quality of lettuce (Lactuca sativa L.) grown in aeroponic systems using commercial hydroponic fertilizers and fertilizer-free aquaponic water. Under identical conditions, hydroponics yielded superior fresh weight, leaf count, and area, whereas aquaponics led to greater lettuce head dry weight and root-to-shoot ratio. Hydroponics showed increased NO3–, P, NH4+, and K levels, while aquaponics had elevated S, Cl–, Na, and Mg. Nutritional assessment revealed higher K, S, P, Zn, Fe, Mn, and vitamin B2 in hydroponic lettuce, with aquaponics outperforming in Ca, Na, Mg, Al, B, and Si. Notably, aquaponically grown lettuce exhibited enhanced flavonoid, phenol content, and antioxidant capacity.

Methodology

- ***Cultivation Setup:*** *Lettuce (*Lactuca sativa *L.) was grown in an aeroponic system for 30 days.*
- ***Nutrient Solutions:*** *Hydroponic System (HS): commercial hydroponic fertilizers; Aquaponic System (AS): aquaponic water without added fertilizers from real aquaponic farm.*
- ***Controlled Conditions:*** *Both systems were maintained under identical environmental and operational conditions to ensure comparability.*
- ***Assessments:*** *Growth parameters (fresh weight, root weight, leaf count, and leaf area); nutrient concentration in nutrient solutions; nutritional value (micro- and macroelements); bioactive compounds (total flavonoid and phenol content); antioxidant capacity.*

Hydroponic lettuce

- *sufficient nutrients amount*
- *higher water intake*

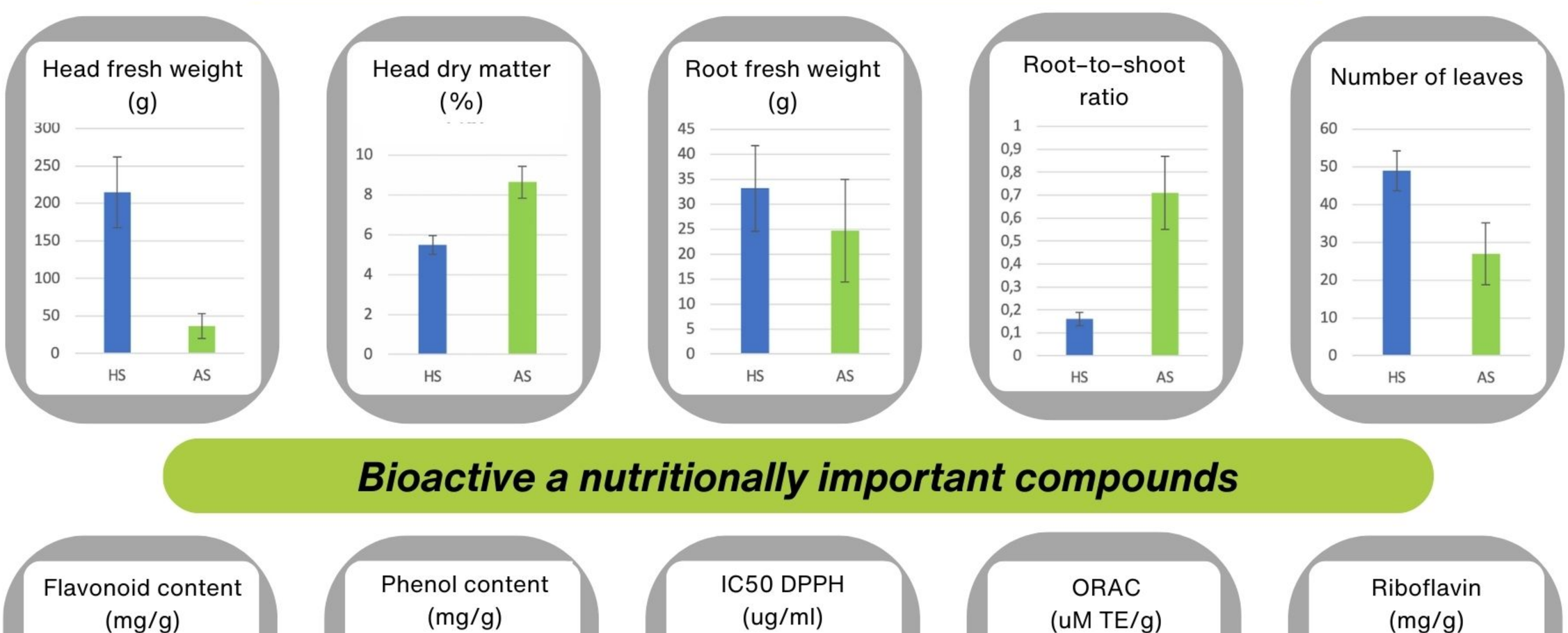


Aquaponic lettuce

- *nutrient deficiency*
- *higher salinity*
- *lower water intake*

Growth parameters

Bioactive a nutritionally important compounds



Conclusion

This study highlights the efficacy of AS in sustainable agriculture. Despite its lower nutrient profile compared to HS, AS consistently produced sustainable lettuce yields without traditional fertilizers. Furthermore, AS lettuce exhibited increased flavonoids, phenolic compounds, antioxidant activity, and notably, silicon content in lettuce leaves. While AS yields were lower, its benefits in resource recycling and enhanced nutrition underscore the importance of further research into aquaponics' potential in modern agriculture.

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