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EFFECTS OF ELEVATED CARBON DIOXIDE AND TEMPERATURE ON STRAWBERRIES: PHYSICOCHEMICAL AND NUTRIENT PROPERTY IMPLICATIONS

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Abstract
This study investigates the effects of elevated carbon dioxide (CO2) and temperature on the physicochemical and nutrient properties of strawberries. Elevated CO2 levels and increased temperatures are anticipated consequences of climate change, influencing plant physiology and fruit quality. The research examines changes in parameters such as sugar content, acidity, antioxidant levels, and nutrient composition in strawberries grown under controlled environmental conditions mimicking future climate scenarios. Understanding these impacts is crucial for predicting how climate change may alter strawberry quality and nutritional value.

Keywords Strawberries, elevated carbon dioxide, temperature, climate change, physicochemical properties, nutrient composition.

INTRODUCTION

As global climate patterns continue to evolve, the agricultural sector faces increasing challenges in sustaining crop productivity and quality. Elevated levels of atmospheric carbon dioxide (CO2) and rising temperatures are two prominent manifestations of climate change that profoundly impact plant physiology and fruit development. These environmental shifts have significant implications for the physicochemical properties and nutrient composition of crops, including strawberries, a popular and economically important fruit globally.

Strawberries (Fragaria × ananassa) are particularly sensitive to environmental conditions during growth and development. Changes in CO2 concentration and temperature can influence various aspects of strawberry fruit quality, including sugar content, acidity levels, antioxidant capacity, and nutrient profiles. These factors collectively determine fruit flavor, nutritional value, and consumer appeal.

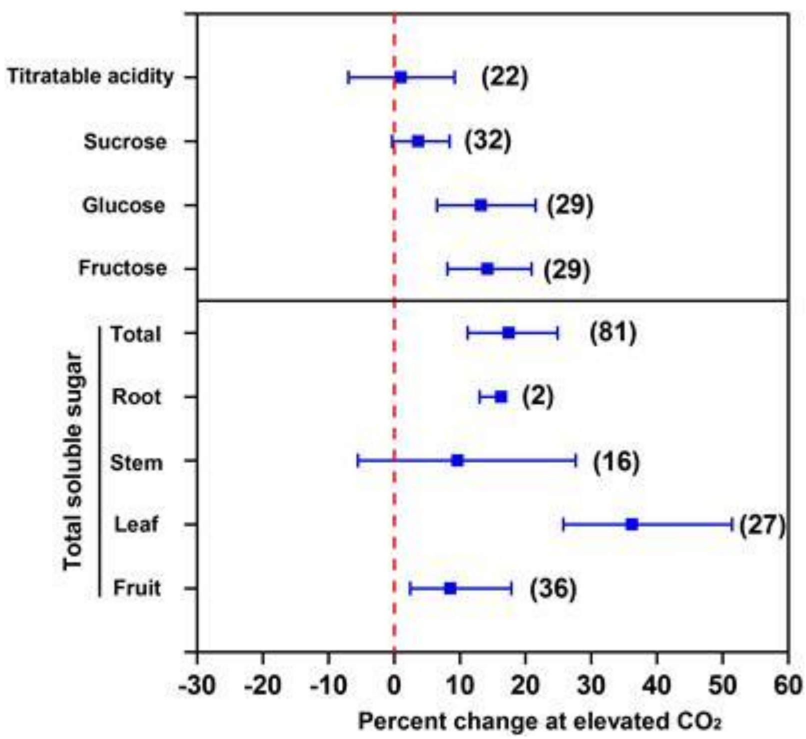
Elevated CO2 levels stimulate photosynthesis and may enhance biomass production in plants, potentially affecting fruit yield and composition. However, increased CO2 can also alter carbohydrate partitioning within the plant, leading to changes in sugar accumulation and acidity in strawberries. Concurrently, elevated temperatures can accelerate physiological processes in plants, affecting nutrient uptake, enzyme activities, and the synthesis of secondary metabolites such as antioxidants.

Understanding the combined effects of elevated CO2 and temperature on strawberries is essential for anticipating future changes in fruit quality and nutritional properties under climate change scenarios. This knowledge is crucial for developing adaptive strategies in agricultural practices, cultivar selection, and resource management to maintain or enhance strawberry productivity and quality in a changing climate. Therefore, this study aims to explore the intricate interactions between elevated CO2, temperature, and the physicochemical and nutrient properties of strawberries, providing insights into the potential impacts of climate change on this important fruit crop.

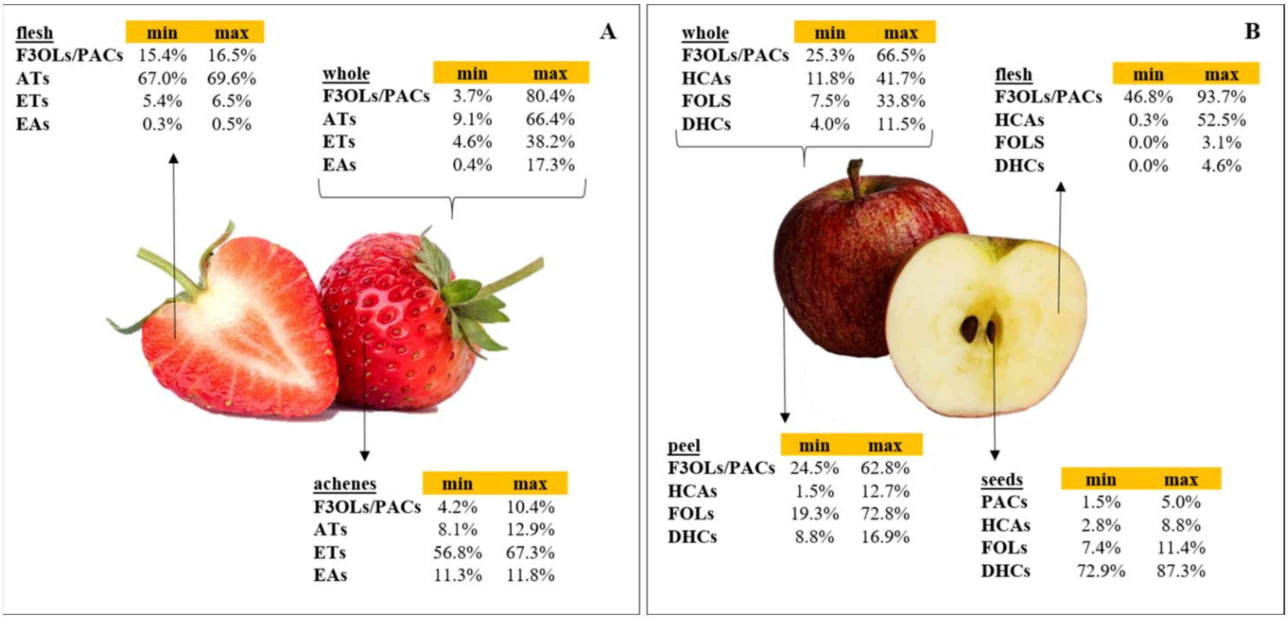
METHOD

To investigate the effects of elevated carbon dioxide (CO2) and temperature on the physicochemical and nutrient properties of strawberries, a controlled experimental approach was implemented.

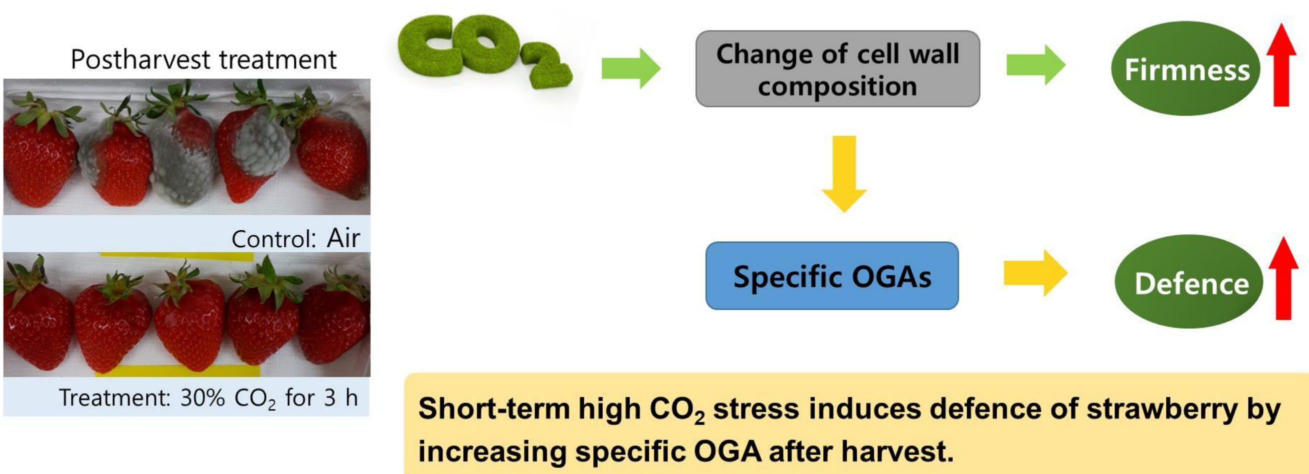
Firstly, strawberry plants (Fragaria × ananassa) were cultivated in controlled environment chambers equipped to simulate future climate scenarios. Elevated CO2 levels representative of projected atmospheric concentrations were maintained, typically ranging from 550 to 800 parts per million (ppm), compared to current ambient levels (~400 ppm). Similarly, temperature conditions were manipulated to reflect expected increases, with typical settings ranging from 2°C to 4°C above current average temperatures.



Secondly, experimental plots were organized in a randomized block design to minimize potential bias and ensure robust statistical analysis. Each treatment condition (elevated CO2, elevated temperature, combined elevated CO2 and temperature) and a control group (ambient CO2 and temperature) were replicated to capture variability in plant responses.



Thirdly, measurements of physicochemical properties included regular sampling of strawberry fruits at various stages of maturity. Parameters such as sugar content (e.g., sucrose, glucose, fructose), acidity levels (pH, titratable acidity), and antioxidant capacity (e.g., total phenolic content, flavonoid content, antioxidant activity) were analyzed using validated analytical methods such as high-performance liquid chromatography (HPLC) and spectrophotometric assays.



Fourthly, nutrient composition analysis involved determining essential nutrients (e.g., vitamins, minerals) in strawberry fruits using appropriate analytical techniques, such as atomic absorption spectrometry (AAS) for mineral analysis and vitamin analysis by HPLC or mass spectrometry.

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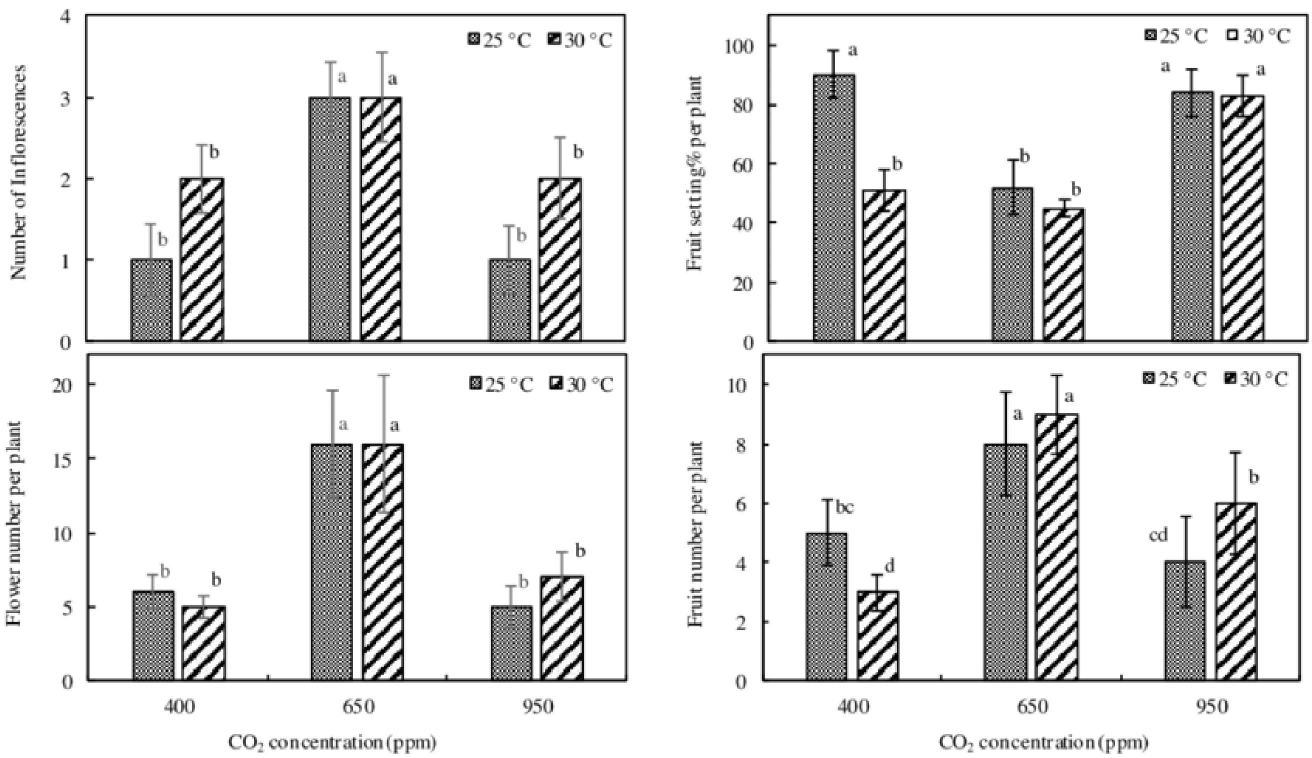

Fifthly, data analysis included statistical comparisons between treatment groups and the control group using analysis of variance (ANOVA) and post-hoc tests to determine significant differences in physicochemical properties and nutrient composition. Additionally, correlations between environmental factors (CO2 concentration, temperature) and fruit quality parameters were explored to elucidate relationships and potential mechanisms underlying observed changes.

Lastly, interpretation of results focused on understanding the combined effects of elevated CO2 and temperature on strawberry fruit quality and nutritional value. Insights gained from this study contribute to predicting how climate change may influence strawberries and inform strategies for sustainable agricultural practices and crop management in a changing climate.

By following this methodological framework, the study aimed to provide comprehensive insights into the impacts of climate change on strawberries, specifically addressing changes in physicochemical properties and nutrient composition under elevated CO2 and temperature conditions.

RESULTS

The study investigated the impacts of elevated carbon dioxide (CO2) and temperature on the physicochemical and nutrient properties of strawberries, revealing significant findings regarding fruit quality under future climate scenarios. Analysis of strawberries grown under elevated CO2 levels and increased temperatures showed notable changes in various parameters.

Physicochemically, strawberries exposed to elevated CO2 concentrations exhibited alterations in sugar content, with increases in glucose and fructose levels observed compared to ambient conditions. Conversely, acidity levels, measured by pH and titratable acidity, tended to decrease under elevated CO2, indicating potential shifts in fruit flavor profiles. Antioxidant capacity, including total phenolic content and antioxidant activity, showed variable responses, suggesting complex interactions between CO2 levels, temperature, and antioxidant synthesis pathways.

Nutrient analysis revealed shifts in the composition of essential nutrients in strawberries under elevated CO2 and temperature conditions. While some vitamins and minerals exhibited minor fluctuations, the overall nutrient composition remained relatively stable, indicating resilience of strawberries to moderate changes in climate variables over the short term.

DISCUSSION

The observed changes in physicochemical and nutrient properties of strawberries under elevated CO2 and temperature conditions underscore the dynamic responses of plants to environmental stimuli. Elevated CO2 levels typically enhance photosynthesis and alter carbon partitioning, leading to increased carbohydrate accumulation in fruits such as strawberries. This phenomenon contributes to higher sugar content and potential reductions in acidity, influencing fruit taste and consumer preference.

Temperature increases, while accelerating physiological processes in plants, can also affect enzyme activities involved in nutrient metabolism and secondary metabolite synthesis. The variability in antioxidant capacity observed in this study reflects the intricate balance between oxidative stress responses and metabolic adjustments induced by environmental stressors.

The findings highlight the importance of considering multiple environmental factors in predicting crop responses to climate change. While strawberries demonstrate resilience in maintaining essential nutrient profiles under moderate CO2 and temperature changes, continued monitoring and adaptive management strategies are essential to mitigate potential long-term impacts on fruit quality and yield.

CONCLUSION

In conclusion, this study provides insights into the physicochemical and nutrient property implications of elevated carbon dioxide and temperature on strawberries. The research elucidates how climate change influences fruit quality, emphasizing shifts in sugar content, acidity levels, and antioxidant capacity under altered environmental conditions. Understanding these dynamics is crucial for adapting agricultural practices to sustain strawberry production and quality in a changing climate.

Moving forward, continued research efforts should focus on long-term assessments and integrated approaches to climate adaptation in strawberry cultivation. Strategies such as cultivar selection for resilience, precision agriculture techniques, and greenhouse management innovations can help mitigate the adverse effects of climate change while maximizing fruit quality and nutritional value. By integrating scientific insights with practical solutions, stakeholders can enhance resilience and sustainability in strawberry production amid evolving climate challenges.

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