Effect of *PSY 2* and *SFSR* Genes on the Organic Tomato Fruit Quality

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Impact on California Agriculture: Tomatoes are one of California's most significant agricultural commodities, with the state being the largest producer in the United States. The cultivation of tomatoes not only supports the state's economy but also plays a vital role in food security. However, the tomato industry faces several challenges, including issues related to food waste, climate change, and the increasing demand for organic produce. Enhancing the quality and shelf-life of tomatoes is critical in addressing these challenges, as it could reduce food spoilage, increase marketability, and improve sustainability. The discovery of tomato-specific genes, such as the fruit shelf-life regulator gene (*SlFSR*), offers promising opportunities to improve tomato traits crucial for California's agriculture, including both conventional and organic tomato production.

Rationale/Introduction: Tomatoes (*Solanum lycopersicum*) are an economically valuable crop due to their versatility in culinary uses and nutritional benefits. They are rich in vitamins, minerals, and antioxidants, particularly lycopene, which contributes to their red color and has various health benefits. While many tomato, varieties are bred for flavor, size, and color, extending the shelf-life of tomatoes without compromising their quality remains a significant challenge. Recent research has identified key genes such as *SlFSR*, which regulate fruit shelf-life by modulating cell wall-modification genes without affecting the ripening process. Additionally, the synthesis of lycopene, which is essential for color and health benefits, is regulated by phytoene synthase (*PSY1*). Understanding how these genes interact and their expression levels across generations can provide valuable insights into improving both the shelf-life and nutritional quality of tomatoes, particularly for organic farming, where fewer chemical interventions are used.

Experimental Approach: To explore the genetic basis of shelf-life extension and carotenoid production in tomatoes, this study used two organic tomato breeding lines, CPP 46 Black and CPP 65, to produce hybrid lines (CPP 46 Black x CPP 65 and CPP 65 x CPP 46 Black). These lines were selected due to their distinct characteristics, including differences in fruit size, shape, and carotenoid content. The primary focus was on the expression of two genes: the fruit shelf-life regulator gene (*SlFSR*) and phytoene synthase (*PSY1*). The F_1 and F_2 generations of hybrid crosses, as well as the parent lines, were grown in a certified organic field setting. Phenotypic data were collected, and tissue samples were taken for analysis. Real-time PCR (qRT-PCR) was used to measure the expression levels of *PSY1* and *SlFSR* genes across the generations. This experimental approach aimed to determine whether hybridization leads to an increase in the expression of these genes, thereby improving the shelf-life and carotenoid content of the tomatoes.

Major Conclusion: Preliminary results suggest that hybridization significantly affects the expression of both *SlFSR* and *PSY1* genes. In the F_1 generation, there was an observable increase in the expression of both genes, which is expected to result in extended shelf-life and enhanced carotenoid accumulation in the fruit. The F_2 generation showed a broader distribution of gene expression, indicating the inheritance pattern and the potential for further improvement in subsequent breeding cycles. These findings provide promising insights for organic tomato production in California, as they suggest that traditional breeding techniques, supported by molecular expression-based selection, can be used to enhance shelf-life and carotenoid content. This approach offers a sustainable solution to reducing food waste while improving the nutritional quality of tomatoes, which could lead to more efficient crop production systems in the face of climate change and increasing consumer demand for organic produce.

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