EFFECT OF COLD STORAGE ON PROTEINASE AND CHORISMATE MUTASE ACTIVITIES IN SOLANUM TUBEROSUM L. GENOTYPES DIFFERING IN BLACKSPOT SUSCEPTIBILITY

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Abstract

Potato tubers (Solanum tuberosum) from genotypes differing in chemical susceptibility to the physiological disorder blackspot bruise (TXA 763-5, Atlantic, Ranger Russet, Russet Burbank, and Lemhi Russet) were stored for eight months at 3°C. Protein extracts from each cultivar were assayed for proteinase and chorismate mutase (CM) activities. During cold storage, three of five genotypes tested increased in their ability to develop melanin-type pigments responsible for blackspot. Concurrent with this were increases in either endopeptidase, aminopeptidase, or CM activities or combinations of enzyme activities specific to genotypes. These increases in enzyme activity may be responsible for the increase in levels of the melanin precursor tyrosine, associated with cold storage of potato tubers.

Compendio

Tubérculos de papa (Solanum tuberosum) que provienen de genotipos que difieren en la susceptibilidad química a la enfermedad fisiológica de la mancha negra causada por golpes (TXA 763-5, Atlantic, Ranger Russet, Russet Burbank y Lemhi Russet) fueron almacenados durante ocho meses a 3°C. Los extractos de proteínas de cada cultivar fueron sometidos a las pruebas de actividad de la proteinasa y chorismata mutasa (CM). Durante el almacenamiento en frío, tres de los cinco genotipos probados aumentaron su habilidad para desarrollar pigmentos del tipo de la melanina, que son los responsables de la mancha negra no infecciosa. Concurrente con ello hubo un incremento en las actividades de la endopeptidasa, aminopeptidasa o CM, o en las combinaciones de las actividades enzimáticas específicas de los genotipos. Estos incrementos en la actividad enzimática, asociados con el almacenamiento en frío de los tubérculos de papa, pueden ser responsables del aumento de los niveles de la tirosina precursora de la melanina.

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Introduction

*Solanum tuberosum* cultivars grown commercially in the United States are generally susceptible to the physiological disorder, blackspot bruise. When tubers are damaged during harvesting or handling, dark pigments (melanin) may develop in the damaged cells forming blackspot bruises. These melanin pigments result from the oxidation of phenolic substrates such as tyrosine and chlorogenic acid catalyzed by polyphenol oxidase (PPO) (3, 9, 13, 19). The susceptibility of tubers from different cultivars to blackspot has been shown to be unrelated to total PPO activity (18, 21). Tyrosine levels usually correlate with blackspot susceptibility, while chlorogenic acid and other phenolics may not (2, 5, 12). The levels of free tyrosine in the tuber are determined by protein turnover and by *de novo* synthesis via the shikimic acid pathway (6). One of the important enzymes on the tyrosine synthesis pathway is chorismate mutase (CM). This enzyme, with its two isozyme forms, catalyzes the conversion of chorismate into prephenate, which is a precursor for both tyrosine and phenylalanine. The CMI isozyme is regulated by tyrosine and phenylalanine by feed-back inhibition and is activated by tryptophan. The CMII isozyme, however, is not regulated by any amino acid (7). Changes in total phenolics of potato tubers have been compared to changes in PPO and cytochrome oxidase during storage (11). However, detailed analysis of the changes in specific phenolics and the metabolic pathway from which they come as they relate to blackspot bruise susceptibility has been lacking.

We have previously shown that the quantity of free tyrosine was correlated with blackspot susceptibility and that differences in susceptibility between cultivars at harvest was related to proteinase activity, but not to CM activity (14). We have also demonstrated that increases in chemical susceptibility to blackspot during cold storage of tubers is related to an increase in free tyrosine (5). The purpose of this study was to determine if the increase in chemical susceptibility of tubers to blackspot during cold storage is associated with increases in the activity of either endopeptidases, aminopeptidases, Chorismate mutase I or II, or combinations of these.

Materials and Methods

*Potato Tuber Production*

Five genotypes were selected to represent blackspot resistant and susceptible types. These were the biochemically susceptible cultivars, Russet Burbank, Lemhi Russet, and Ranger Russet and the biochemically resistant genotype and cultivar, TXA 763-5 and Atlantic. They were planted in early April, 1992 at the Washington State University, Irrigated Agriculture Research and Extension Center (IAREC), Prosser, WA and grown using standard commercial production practices (10). All plants were harvested in