

Managing Epiphytic Microorganisms on Harvested Fruits and Vegetables to Extend Storage-and Shelf-life

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Abstract

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The surfaces of roots and aerial parts of plants support epiphytic microorganisms some of which are antagonistic to plant pathogens. Harvested fruits and vegetables probably support similar microbial epiphytes. It may be possible to manage such populations to extend the storage-and shelf-life of fruits and vegetables. Antagonistic microorganisms have been applied artificially to harvested fruits and vegetables to control certain postharvest diseases. Such procedures may

provide alternatives to synthetic fungicides for the control of postharvest decay and attempts are being made to commercialize them. Evidence exists that certain epiphytic antagonists may be under the genetic control of the host. It may be possible to select plants genetically that support antagonists on their surfaces which will reduce postharvest diseases.

Key words: Antagonistic microorganisms, Biological control, post-harvest diseases.

Introduction

Heavy reliance has been placed on refrigeration and fungicides to extend the life of fruits and vegetables after they are harvested (6). Also, controlled atmosphere storage is being used increasingly (10). The use of these methods is limited in some countries because they are expensive.

Key fungicides (eg. benlate, captan, botran) used to control postharvest diseases in the United States have recently been withdrawn from the market. A critical need exists worldwide for alternatives to present methods to control postharvest diseases of fruits and vegetables.

Researchers have identified an epiphytic population on the surface of plants which may influence and in some cases control foliar and root diseases (5, 7). We have just begun to appreciate that organisms on the surfaces of harvested commodities may have a similar effect (20). This paper explores how we might manage epiphytic organisms on the surface of fruits and vegetables as an alternative method for postharvest disease control. Because of the paucity of information in this area, much of what will be presented is speculation.

Microecology of Fruit and Vegetable Surfaces

An ecological succession of microorganisms has been followed on the surfaces of the above-ground parts of plants (3). Seasonal changes influence these microbial populations as does the application of pesticides (1). In general, epiphytic bacteria are dominant during the early part of the growing season with yeast and filamentous fungi increasing as the season progresses. Our understanding of the microbial populations which inhabit the surfaces of fruits and vegetables is much more rudimentary.

Antagonistic microorganisms to postharvest pathogens are part of the natural microflora on the surface of fruits and vegetables (19). Do such populations naturally compete with

postharvest pathogens and reduce disease development? If so, perhaps we could manage them to reduce postharvest losses from postharvest pathogens.

Chalutz and Wilson (4) found that when concentrated washings from citrus fruit surfaces were placed on nutrient agar, only yeasts and bacteria grew out. Filamentous fungi, which cause rots, grew out only after the washings were diluted, suggesting they may have been suppressed on the citrus surface by yeasts and bacteria. It is a common experience with citrus and other fruit that they rot more rapidly if washed than if they are not. The removal of antagonists which suppress rot pathogens may contribute to this phenomenon.

Preharvest treatment of plants prior to harvest should influence the microflora that occurs on the surfaces of harvested fruits and vegetables. Such practices as pesticide application are known to modify existing epiphytic populations on leaf surfaces (1) and would be expected to affect fruit and vegetable epiphytes as well. Other practices such as fertilization, irrigation, and harvesting and processing should impact on the epiphytic microbes on fruit and vegetable surfaces (15). If we are to manage the existing epiphytic microflora on fruits and vegetables, a more basic understanding of the microecology of these organisms is needed.

Artificially Introducing Antagonistic Microorganisms

Postharvest diseases of fruits and vegetables have been controlled by artificially placing antagonists on their surfaces (17,18). Some of these organisms are normal inhabitants of fruits and vegetables (19). Pusey (12) has proposed that we look for antagonists to control postharvest diseases among the microorganisms that are normally associated with our food to insure their safety when consumed.

Diseases of harvested peaches, apples, citrus, and other fruits and vegetables have been controlled by the artificial introduction of antagonists. A patented bacterium *Bacillus*

subtilis (B-3) has been used to control brown rot of peaches caused by *Monilinia fructicola* (13). It has been applied successfully in pilot tests under commercial conditions and attempts are being made to develop it commercially (14).

Yeast antagonist which normally inhabit fruit and vegetable surfaces have proven very effective in controlling postharvest rots (17). Some of these yeasts have been patented (16) and are being tested under commercial conditions for the control of rots of citrus, apple, and peach (9).

Genetic Control of Epiphytic Microorganisms

Evidence exists that some of the microflora which occurs on the surfaces of plants may be under the genetic control of the host. This raises the possibility that plants could be bred and/or selected to support epiphytic microorganisms on their surfaces which would make them resistant to pathogens and other stresses.

Bird (2) at Texas A & M University has developed a number of cotton cultivars which are highly resistant to a wide range of pests (insects, pathogens, nematodes), as well as, drought stress. He has termed this resistance Multi-Adversity Resistance (MAR). The epiphytic populations associated with the root system and above-ground parts of MAR plants were found to support a higher population of antagonistic microorganism than more susceptible plants (Bird, personal communication). Gaugh et al. (8) found that if they sprayed

resistant wheat plants with the antibiotic streptomycin they lost their single-gene resistance to *Septoria tritici*. Kloepper et al. (11) found that plants resistant to nematodes supported a characteristic antagonistic microbial population associated with their root systems. All these studies suggest that some plant epiphytes may be under the genetic control of the host.

Conclusion

The utilization of existing and introduced epiphytic antagonistic microorganisms as alternatives to synthetic fungicides holds real promise. Such practices will have to be based on a thorough understanding of the microecology and biology of these organisms. In utilizing artificially introduced antagonists, effective formulations and application methods will have to be developed. Also, the potential risks presented by such organisms cannot be ignored. Since they will be consumed by humans, their safety will have to be established.

The postharvest environment provides an especially favorable milieu for the utilization of antagonistic microorganism to control diseases. Harvested commodity are concentrated during processing which makes targeting antagonists for disease control agents easier. Also, temperature and humidity are less variable in the postharvest environment than in the field. This makes the application of biological control agents more controllable and predictable than in the field.

الملخص

ويلسون، شارل. 1992. إدارة الكائنات الدقيقة النباتية على ثمار الفاكهة ونباتات الخضر المقطوفة لإطالة فترة تخزينها وبقائها. مجلة وقاية النبات العربية 10 (1): 44 - 46

مثل هذه الكائنات على نحو تجاري. وقد تضحي هذه التقنية بديلاً عن مبيدات الفطور المصنعة لمكافحة اعفان ما بعد الحصاد. هذا وتوجد بينات تشير إلى تحكم العائل وراثياً ببعض هذه الكائنات المضادة. ومن الممكن إجراء انتخاب وراثي للنبات لصفة دعم المضادات الموجودة على سطوحها والتي من شأنها تقليل أمراض ما بعد الحصاد. كلمات مفتاحية: أمراض ما بعد الحصاد، مكافحة حيائية، كائنات دقيقة مضادة.

تدعم سطوح الجذور والأجزاء الهوائية لبعض النباتات نمو كائنات دقيقة، يمارس بعضها فعلاً مضاداً للممرضات النباتية. ويحتمل أن تدعم ثمار الفاكهة ونباتات الخضر المقطوفة نباتاً دقيقاً مماثلاً. ومن الممكن إدارة مجتمعات هذه الكائنات بحيث يفاد منها في إطالة فترة تخزين ثمار الفواكه والخضار المقطوفة وبقائها. وقد تم استخدام هذه الكائنات الدقيقة المضادة اصطناعياً على ثمار الفاكهة والخضار المقطوفة لمكافحة امراض ما بعد الحصاد. كما جرت محاولات لإنتاج

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