



Cyprus
University of
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Faculty of Geotechnical
Sciences and
Environmental
Management

Doctoral Dissertation

**Alternative ways of managing fresh produce and effects on
safety and quality**

Panayiota Xylia

Limassol, December 2020

CYPRUS UNIVERSITY OF TECHNOLOGY
FACULTY OF GEOTECHNICAL SCIENCES AND ENVIRONMENTAL
MANAGEMENT
DEPARTMENT OF AGRICULTURAL SCIENCES, BIOTECHNOLOGY
AND FOOD SCIENCE

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Approval Form

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*Dedicated to,
my family*

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‘It adds to the joy of discovery to know that your work may make a difference in people’s lives.’

Flossie Wong-Staal

Abstract

Vegetables are an important component of a balanced diet and dietary guidelines suggest the increase consumption of vegetables as an important source of phytonutrients. However food poisoning outbreaks have been linked with the consumption of these commodities, since the risk of contamination of fresh produce with foodborne pathogens throughout the food chain is high if sanitary and precautionary measures are not taken. Moreover, there is a current trend towards the use of natural, eco-friendly products for the preservation of fresh produce quality and safety, as alternatives to synthetic compounds (i.e. chlorine) commonly used in the food industry. The purpose of this thesis was to investigate i) the microbiological and physicochemical attributes of ready-to-eat salads as affected by season, producer, type of salad and expiring date, ii) the effects of plant age, inoculum level and nutrient solution pH of hydroponically grown lettuce inoculated with *Salmonella* Enteritidis and iii) the effects of natural products on the quality and safety of ready-to-eat vegetables (minimally processed lettuce and shredded carrot). Results indicate that season, type of vegetable and expiring date greatly affected the microbial load and plant-tissue related parameters of ready-to-eat salads. More specific, higher microbial load of samples was observed during spring. Interestingly *Salmonella enterica* was not found in any of the tested samples, whilst 3.70% of samples were found to harbor *Listeria monocytogenes*. A correlation of phenolics and antioxidants with the presence of *Escherichia coli*, *Staphylococcus* spp., *Pseudomonas* spp. and *Bacillus cereus* was reported. Furthermore, spoilage microorganisms (i.e. *Pseudomonas* spp., yeasts and molds), CO₂ production and damage index were found in increased levels at the end of products shelf-life (expiring date). Furthermore, during hydroponic cultivation of lettuce (one of the main vegetables consumed and used for ready-to-eat salad preparations), plant age, greatly affected the internalization of *S. Enteritidis* on plant tissues, whilst the presence of the bacterium initiated plant defense mechanisms and damage index markers. Interestingly, the colonization and internalization of *S. Enteritidis* in root was more frequent in younger plants compared to older plants at higher pH values. It was evident that the presence of *S. Enteritidis* in nutrient solution, root rinse and internally of roots increased plant defenses and damage index. Examining different natural products (i.e. marjoram essential oil-EO and hydrosol, ascorbic acid-AA, and chitosan) but also their combination in postharvest management, seem to be remarkable alternatives for the preservation of minimally processed vegetables safety and quality. It is noteworthy, that the combination of marjoram EO+AA application enhanced nutritional attributes (phenols, carotenoids) on both commodities examined, while chitosan, EO, chitosan+EO and chitosan+AA resulted to decreased Total viable count (TVC) and yeast and molds counts on minimally processed lettuce. Further exploitation of different products and optimized methods of application (i.e. EOs encapsulation) are important to be considered for safer and more nutritive fresh products that will meet consumer's demands and acceptability.

Keywords: Food safety, foodborne pathogens, food quality, hydroponics, natural products, vegetables, processed products