An overview concerning methodologies applied to guarantee fruits and vegetables safety

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INTRODUCTION

The incidence of foodborne outbreaks caused by contaminated fresh fruit and vegetables has increased in recent years. The pathogens most frequently linked to minimally processed produce-related outbreaks include bacteria (*Salmonella* spp., *Listeria monocytogenes*, *Escherichia coli; Shigella* spp.), viruses (Norwalk-like, hepatitis A), and parasites (*Cryptosporidium*, *Cyclospora*). There are many and very different technologies to reduce/eliminate the microorganisms present in food however some can´t be used in fruit and vegetables without compromising the fresh character of these products.

OBJECTIVE

In attempt to improve the microbial status of these valuable foods, a number of chemical and physical methods are in use.

The objective of this work is to gathered information concerning the effectiveness and advantages/limitations of these methods and possible alternative methodologies.

METHODS

Minimal processing describes non-thermal technologies to process food in a manner to guarantee the food safety and preservation as well as to maintain as much as possible the fresh-like characteristics of fruits and vegetables.

Physical methods

Removes bacteria from plant surfaces by use of shear forces (see Table 1).

Chemical methods

Application of mechanical washing with sanitizers to fruit and vegetables surface, followed by rinsing with potable water (see Table 2).

Hurdle technology

Is a combination of different mentioned preservation techniques as a preservation strategy. Commonly are based on storage temperatures, water activity, pH, redox potential, modified atmosphere, and addition of preservatives. Consists on use of a sequence of mild treatments (low intensity) to inhibit or inactivate the factors responsible of food spoilage, avoiding the use of single treatments at more severe conditions.

Hurdles need to be chosen in function of the quality attributes of a product. At the most important trend is to use preservation techniques that prolong storage stability and do not have detrimental effects on the quality of the food product .

Table 1. Physical methods (advantages/ limitations) used for the preservation off minimally processed vegetables and fruits

Method	Advantages	Limitations
Modified atmosphere packing (MAP)	•Extends storage life of the fresh produce •In general, fresh-cut products are more tolerant to higher CO2 concentrations than intact product	•Produces high levels of CO2 with potential development of off-flavours •May create opportunities for slower growing pathogenic bacteria •Controlled atmosphere depends on the product
Irradiation	•No chemical treatment •High efficiency for inactivation of foodborne pathogens •Can be conducted after packaging .and at room temperature •Extends shelf life of produce	•Image of irradiation by consumers •Quality may be affected •Texture alteration
Ultraviolet light	•Absence of residual toxicity •Relatively inexpensive and easy to use •Can reduce deterioration of the produce •Synthesis of health-promoting compounds (anthocyanins and stilbenoids)	•Pre-treatment normally necessary •Increasing costs •Difficulties in accurately the UV dose •Increases the stress, respiration rate, and induce a lignification-like process

Table 2. Chemical methods (advantages/ limitations) used for the preservation off minimally processed vegetables and fruits

Method	Advantages	Limitations
Chlorine (hypochlorite)	•Low cost •Easily available •Long history of use	•Hazardous DBPs (chlorinated by-products) at high levels •Corrosive •Efficacy is affected by the presence of organic matter and pH
Chlorine dioxide	•Efficacy at neutral pH •Effectiveness less pH dependant •Fewer hazardous DBP formation •Less corrosive	•Not efficient at permitted levels for fresh produce •Requires on-site generation •Explosive •Not permitted for cut produce
Organic acids	•Easy to use •Economical •No toxicity	•Interferes with the sensory quality •Relatively lower antimicrobial efficacy •Disinfection have an impact on the wastewater quality
Hydrogen peroxide (H_2O_2)	•No harmful DBP formation •No residue production •Not corrosive at permitted levels	•Negative impact on overall quality •Phytotoxicity against some products (lettuce and berries) •Low antimicrobial efficacy at permitted levels for vegetables •Requires the removal of residual H_2O_2 after processing
Peroxyacetic acid	•No harmful DBP formation •Efficacy is not affected by the organic load of water •Efficacy unaffected by temperature •Not corrosive at permitted levels	•Low antimicrobial efficacy at permitted levels for vegetables (<80 ppm)
Calcium-based solutions	•Increase of product calcium content •Delays aging or ripening of fruits and vegetables •Reduces post-harvest decay	•Bitterness and off-flavours associated with calcium chloride •Limited efficacy as antimicrobial
Ozone	•Extends storage life of fresh non-cut products. •Effective at low concentrations and short contact time •Broad spectrum •Generally recognized as safe (GRAS) •Decomposes to nontoxic products •Lower running cost	•Possible deterioration of produce flavour and colour •Possible physiological injury and loss of antioxidant constituents of produce •Unstable, very highly reactive, corrosive to equipment •Possible human toxic effects in processing facilities •Requires on-site generation and monitoring in indoor applications •Higher initial investment cost
Electrolysed water (EW)	•Inactivates several pathogenic and spoilage microorganisms •Neutralises harmful substances such as cyanides, ammonium	•Reduces quality on fresh-cut vegetables

CONCLUSIONS

Most of the techniques referred have not yet been adopted by the fresh-cut and minimally processed fruit and vegetables industry. Chlorine continues being the most commonly used sanitizer due to its efficacy, cost-effectiveness ratio and simple use. None of these methods alone can control all the parameters that maintain the quality and shelf-life of the product. Further research is needed to improve these methods and apply potential alternatives, like biopreservation.

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