

# Fresh Produce

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**Scope and target readership:** *Fresh Produce* only publishes original papers and review articles on biotech research in the areas of postharvest storage, treatment, quality evaluation, packaging, handling and distribution of agronomic (including forage) and horticultural crops. Research results spanning from harvest to consumer will be considered.

Postharvest treatments of fresh product (but not food processing) as affecting the quality of processed product will be included. Interdisciplinary (ecology, entomology, plant physiology, plant pathology, molecular biology, chemistry, engineering, technology, economics) research is encouraged.

Market analyses, consumer trends, novel quarantine measures and legislature pertaining to the handling, marketing or distribution of fresh produce also fall into the scope of this journal.

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**Cover photo:** Top: Shiitake mushrooms in an early stage, with their caps closed (more details in Ares *et al.*, pp 32-40); bottom: Symptoms of postharvest diseases in chayote fruits. Clockwise from top left fruit: Anthracnose or freckles (initial symptom) (*Colletotrichum orbiculare*); Reddish-purple mould (*Fusarium oxysporum*); White mould (*Phytophthora capsici*); Acid rot (*Geotrichum* sp.) (more details in Cadena-Iñiguez *et al.*, pp 41-53).

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**Ernesto A. Brovelli, Luis Cisneros-Zevallos (USA)** Horticultural Maturity Revisited: From Peaches to *Echinacea* (pp 1-3)

**ABSTRACT**

**Opinion Paper:** A considerable amount of research has been conducted on defining maturity indices for horticultural products that ensure that these are harvested at their horticultural maturity. It is at this stage of development when a plant or plant part has met the conditions for utilization *for a particular purpose*. For fresh-market produce, horticultural maturity is based on the final assessment by the consumer based on the product's sensory characteristics. For produce that is to undergo processing, horticultural maturity is set based on how produce at various stages of development will tolerate extreme conditions during processing. Horticultural maturity for both fresh-market and processing commodities relies heavily on the consumer's quality judgment and that is why sensory evaluation constitutes the most powerful way of defining maturity indices for these two market venues. With a growing body of evidence supporting the role of plants in human disease prevention or intervention, it becomes critical to define valid models for establishing maturity indices for plants harvested for these purposes. In the present manuscript, we report the use of phytochemical markers as well human gene expression as parameters that help establish appropriate harvest windows.

**Susan Lurie (Israel)** 1-MCP in Post-Harvest: Physiological Mechanisms of Action and Applications (pp 4-15)

**ABSTRACT**

**Invited Review:** 1-Methylcyclopropene (1-MCP) is an inhibitor of ethylene perception. It binds irreversibly to the ethylene receptors and inhibits downstream processes that are controlled by ethylene. In the area of postharvest this means many ripening processes of climacteric fruits, such as softening, color and aroma development, respiration increase and organic acid decrease are inhibited. However, beyond these processes, ethylene also has a role to play in responses to pathogen attack and to wounding, such as occurs during preparation of fresh-cut commodities. 1-MCP has effects on biochemical responses to these occurrences as well. In addition, 1-MCP has been used on non-climacteric commodities to determine what maturation and senescence processes are under the control of ethylene. This review will describe the current knowledge of the effect of 1-MCP on ripening and senescence, on the responses of harvested produce to pathogen infection, and responses of fresh-cut commodities.

**Valérie Orsat, G.S. Vijaya Raghavan (Canada)** Microwaves in Postharvest Applications with Fresh Fruits and Vegetables (pp 16-22)

**ABSTRACT**

**Invited Mini-Review:** Fruits and vegetables are an increasing part of our diets as they are a recognized source of health enhancing nutrients. The use of microwaves to ensure product quality for minimally processed fruits and vegetables is gaining popularity. Microwaves are electromagnetic waves with frequencies between 300 MHz and 300 GHz. In this review we concentrated on research conducted at the 2450 MHz frequency. The special microwave-matter interaction mechanisms make microwaves a special format of energy that can bring many advantages to various applications in post-harvest handling of horticultural crops. The principal advantage in the use of microwave energy is the great reduction in processing time which often yields higher end-product quality. Microwave power has been used for high-temperature-short time thermal treatments of fresh commodities for disinfection, disinfestations, control of ripening, to impede on senescence and for the retention of phytochemicals. The study of the microwave permittivity of the produce can provide information on its quality, maturity and moisture content and can be used in sensing as a process control measure.

**Griffiths Gregory Atungulu (Japan/Kenya)** High Electric Field Technology in Post Harvest Drying (pp 23-31)

**ABSTRACT**

**Invited Mini-Review:** The diversity of drying processes and equipment used in agricultural product processing reflects difficulty of handling and processing solid materials and the special requirements for various products. Undesirable product deteriorations in addition to economics of investment and operation costs involved in thermal processing have initiated the

quest for alternative methods. Several studies on improvement of drying processes have been published recently. Research has identified application of high electric fields in drying as one such promising technology. The application of high electric fields as a non-thermal drying process is reviewed within this paper. In the reviewed literature are found a range of researches that utilize electric fields and their pulses to facilitate water removal from agricultural products. The merits of reduced energy consumption, quality sustenance particularly of heat sensitive products, augmentative effect on convective mass transfer during the drying of agricultural product and the synergism accorded by electrohydrodynamic (EHD) as a pretreatment measure in osmotic dehydration are herein described. Greater efforts perhaps need to be made to develop standard dryers based on this technology at industrial level. Scale up and transfer of laboratory- and pilot-scale experiments to prove industrial applicability and educating the diverse users of agricultural product drying equipment as to the potential benefits of this technique are necessary future directions in realizing the benefits associated with high electric field drying technology. Realizing industrial application of the non-thermal high electric field technology in drying is a priority due to the overwhelming worldwide concern over global warming attributed in large measure to greenhouse gases produced by the combustion of fossil fuels.

**Gastón Ares, Claudia Lareo, Patricia Lema (Uruguay)** Modified Atmosphere Packaging for Postharvest Storage of Mushrooms: A Review (pp 32-40)

#### ABSTRACT

**Invited Review:** Production and consumption of edible mushrooms have grown continuously in the last fifteen years, particularly due to interest in their nutritional and health benefits. The three most cultivated mushrooms worldwide are *Agaricus bisporus* (common mushrooms), *Lentinus edodes* (shiitake) and *Pleurotus* spp. (oyster mushroom). Mushrooms are highly perishable. They tend to lose quality right after harvest, mainly because of their high respiration rate and the fact that they have no barrier to protect them from water loss. Mushrooms' shelf-life is limited to a few days under normal refrigeration conditions, which is a constraint on the distribution and marketing of fresh product, making extension of mushroom's shelf life a constant quest. Modified atmosphere packaging has been used for postharvest storage and commercialization of mushrooms. This technology alters the normal composition of air to provide an appropriate atmosphere in order to decrease product's respiration rate, microbial growth and physiological disorders, which leads to preservation of product's quality and an increased shelf life. However, modified atmosphere packaging conditions should be carefully designed. Inappropriate modified atmosphere conditions may be ineffective or even shorten the shelf life of the product due to damage of tissues. Reported results for modified atmosphere packaging of mushrooms depend on the mushroom species considered. In this paper, the use of modified atmosphere packaging for mushrooms, specifically for *Agaricus*, *Lentinus edodes* and *Pleurotus*, is reviewed.

**Jorge Cadena-Iñiguez, Lourdes Arévalo-Galarza, Carlos H. Avendaño-Arrazate, Marcos Soto-Hernández, Lucero del Mar Ruiz-Posadas, Edelmiro Santiago-Osorio, Marcelo Acosta-Ramos, Víctor M. Cisneros-Solano, Juan Francisco Aguirre-Medina, Daniel Ochoa-Martínez (Mexico)** Production, Genetics, Postharvest Management and Pharmacological Characteristics of *Sechium edule* (Jacq.) Sw. (pp 41-53)

#### ABSTRACT

**Invited Review:** The Cucurbitaceae family represents an important group of domesticated plants including the genera *Cucumis*, *Momordica*, *Luffa*, *Lageraria*, *Citrullus*, and in Central America *Cucurbita* and *Sechium* stand out because of their nutritious and economic value. *Sechium edule* (Jacq.) Sw., commonly called chayote, is highlighted in this review. The importance of chayote is based on the growing commercial demand of the fruit and its large-scale production in Mexico and Costa Rica, and to a lesser extent, in Guatemala, Brazil, Puerto Rico, Algeria, India, New Zealand, and Australia. Chayote comes from the cloud forest of Mexico and Central America, the central region being the State of Veracruz, Mexico, where the largest infraspecific variation has been identified, recently classified in botanical varieties with different shape, color, and flavor. Despite the large variety, only the chayote called smooth green (*Virens levis*) has been utilized for large-scale commercial exploitation. For this variety, research has been carried out with respect to traditional and commercial production systems, ecophysiological behavior, disease identification and diagnosis (under field and storage conditions), postharvest technology, medicinal and nutraceutical use, and regulations for international trade, topics referred to in this review.

**Víctor H. Escalona, Encarna Aguayo, Francisco Artés (Spain)** Improving Quality and Extending Shelf Life of Intact and Minimally Fresh Processed Kohlrabi (pp 54-58)

#### ABSTRACT

**Invited Mini-Review:** In recent years the increased demand of kohlrabi from European Nordic countries has induced an expansion of their cultivated area in Spain. Commonly, at the retail sale level kohlrabi stems are mainly commercialized in ambient air under non-refrigerated conditions. For that reason, weight loss, development of diseases, and an increase in toughening are the most important causes of kohlrabi deterioration. The storage life of kohlrabi stems stored with leaves is only 2 weeks at 0°C and 95% relative humidity (RH). Nevertheless, when the stems are stored without leaves the storage life could be prolonged up to 2 months at 0°C and 95% RH. On the other hand, the minimal fresh processing of kohlrabi stems to produce ready-to-eat slices, dices and sticks increases the deterioration rate. The use of controlled and modified atmospheres (CA and MA) benefits the overall quality and shelf life of whole intact and minimally fresh processed or fresh-cut kohlrabi, mainly by reducing water loss, the respiration rate and the ethylene production, retarding microbial growth and decay, and inhibiting some disorders like enzymatic browning. According to our studies the range of 2 to 5 kPa O<sub>2</sub> combined with 5 to 20 kPa CO<sub>2</sub> at 0 to 5°C and 95% RH are the most appropriate conditions for lowering the metabolic activity and microbial growth. This review describes the effect of low O<sub>2</sub> combined with different CO<sub>2</sub> levels on the respiration rate, ethylene production, sugars and organic acids content, microbial growth, physiological disorders and shelf life of intact and minimally fresh processed kohlrabi.

**Anastasios S. Siomos, Athanasios Koukounaras (Greece)** Quality and Postharvest Physiology of Rocket Leaves (pp 59-65)

#### ABSTRACT

**Invited Mini-Review:** Rocket is a collective name of three main vegetable species [*Eruca sativa* Mill., *Diplotaxis tenuifolia* (L.) DC and *Diplotaxis muralis* (L.) DC] used for human consumption, in several countries of the Mediterranean region. It is a popular leafy vegetable consumed in raw salads, either alone or in a mixture with other vegetables; it is usually marketed as leaf bunches or as fresh-cut individual leaves in modified atmosphere packages. Color is the most important quality characteristic of the rocket leaves and any change of the normal green color could be a limiting factor for their marketability. The major postharvest problem of this vegetable is its rapid senescence, which is expressed primarily as yellowing, associated with chlorophyll degradation, but wilting is also a serious problem. The high perishability of rocket is a consequence of its extremely high respiration rate. Since it is a minor vegetable, very few research data are available about its postharvest features or regarding the best methods of handling, transporting and storage. A temperature of 0°C and a close to 100% relative humidity are effective storage tools, but currently the application of the above conditions is limited, since rocket usually is shipped and stored at 10°C without maintaining relative humidity at the optimum levels. Modified atmosphere packaging could be a promising postharvest handling alternative, but more research is required to answer basic questions for the postharvest physiology of this vegetable, including the further investigation of the role of ethylene. This review compiles the existed knowledge regarding the effect of the commonly applied postharvest handling procedures of rocket leaves on its quality and postharvest physiology and additionally it proposes areas requiring further study.

**Dharini Sivakumar, Lise Korsten, Karin Zeeman (South Africa)** Postharvest Management on Quality Retention of Litchi during Storage (pp 66-75)

#### ABSTRACT

**Invited Mini-Review:** The litchi (*Litchi chinensis* Sonn.) is a tropical to subtropical fruit. It is a popular export commodity due to its attractive skin colour and exotic flavour. The fruit has a rough indehiscent pericarp (skin) surrounding the succulent, edible aril and a seed in the centre. Pericarp browning, postharvest decay and micro-cracking are identified as major constraints affecting the commercial quality of litchi during storage, transportation or at the consumer shelf. Desiccation or moisture loss from the pericarp and mechanical injury due to improper postharvest handling practices during the fruit export chain ultimately result in browning. Micro-cracking was also observed in preharvest during fruit developmental stages, and in postharvest due to poor handling practices and packing line operations. The micro-cracks on the pericarp act as ports of entry for the invasion of postharvest pathogens during cold storage and transportation. Although pericarp browning caused by desiccation does not severely affect the sensory attributes of litchis, mechanical injury and postharvest decay can cause deleterious effects on the sensory attributes of litchi fruit. Pericarp browning and postharvest decay during storage and transportation are currently controlled by adopting sulphur dioxide fumigation in many litchi exporting countries. However, sulphur dioxide fumigation leaves undesirable residues, alters the fruit taste and results in health hazards for consumers and packhouse workers. This review

summarises the latest developments in developing alternative treatments to replace sulphur dioxide fumigation in the litchi postharvest management chain to retain overall fruit quality.

**Shiping Tian, Boqiang Li, Zhansheng Ding (China)** Physiological Properties and Storage Technologies of Loquat Fruit (pp 76-81)

#### **ABSTRACT**

**Invited Mini-Review:** Loquat usually has a high market value with a relatively short postharvest life, because the fruit are perishable, easily damaged and lose commercial quality after harvest and in storage. The general characteristics, quality properties, physiological disorders and decay of loquat fruit after harvest have been chiefly evaluated, and the advances in beneficial treatments, decay control and storage technologies are also introduced in this review.