NEW PRE-PROCESSING TECHNOLOGIES FOR FRUITS AND VEGETABLES

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ABSTRACT

Horticultural products constitute one of the most perishable foods and its availability throughout the year requires the application of preservation methods. Traditionally, horticultural products are preserved by freezing, allowing these products to reach longer shelf-life periods. Until nowadays, freezing has been preceded by a blanching step, which has been considered as an efficient and safe food preservation method. However, besides its reliable efficiency in terms of food safety, blanching normally induces various chemical reactions, leading to quality deterioration by producing undesirable changes in sensory and nutritional qualities, affecting the balance between high quality and safety.

The increasing consumer quality demanding standards has spurred the search for new and gently processing technologies that prolong shelf-life without the detrimental effects caused by severe heating. Non-thermal methods have emerged as attractive alternatives to conventional methods of thermal processing. There are several new non-thermal technologies of potential interest to the industry, such as ozone, UV-C irradiation, ultrasound, high pressure, and electrical pulses. The application of non-thermal technologies to food processing and preservation may yield processed foods with minor losses of colour, flavour, texture and nutrients, while retaining the desired shelf-life and safety.

Ozone, UV-C irradiation, and ultrasound treatments are promising techniques for the fruits and vegetables industry. However, their efficiency depends on the product/microorganism under consideration.

Keywords: non-thermal methods, innovative technologies, ozone, ultrasound, ultraviolet

INTRODUCTION

Fruits and vegetables are very perishable and present a very short shelf-life. The availability of these products throughout the year is traditionally achieved by the application of preservation methods, such as modified or controlled atmospheres, freezing and heat preservation (pasteurisation, sterilization), among others.

The freezing of fruits and vegetables is as one of the most used preservation processes, resulting in foodstuffs of increased stability and higher nutritional and sensorial quality, compared with the same products processed by other ways, such as dehydration or heat preservation (Fennema *et al.*, 1973; Ibanez *et al.*, 1996). However, the freezing process has currently been facing some difficulties in assuring this quality, mainly in the blanching operations and storage, which constitute the most critical steps for the quality warranty (Reid, 1990; Ibanez *et al.*, 1996, Martins and Silva, 2001).

The increasing consumer quality demanding standards has spurred the search for new and gently processing technologies that prolong shelf-life without the detrimental effects caused by blanching, a severe thermal process. Non-thermal methods have emerged as attractive alternatives to conventional methods of thermal processing, and constitute challenging methods aiming at reducing pernicious effects of thermal methods, by preserving quality and nutritional attributes of fruits and vegetables, and yielding safe and less-perishable products.

THERMAL *vs.* NON-THERMAL METHODS

Conventional thermal processing methods, such as blanching, pasteurisation or sterilization, play a very important role in the food industry, as they allow high food safety levels. Blanching is a conventional preservation technique, and is very used in the fruits and vegetables industry. This process is characterized by the use of heat, at temperatures usually between 85ºC and 100ºC, during a short interval of time, around 2-3 minutes. The definition of blanching time/temperature to which the product must be submitted, depends on the size, shape, thermal diffusivity and natural levels of enzymes (Fennema *et al.*, 1973; Knorr, 1995). This technique is applied essentially to vegetables, since they present a great enzymatic activity. The enzymatic activity is speeded up during the post-harvest period, and is responsible for the alteration of quality parameters, as flavour, colour, texture and nutritional parameters, such as vitamins and minerals. The inactivation of enzymes is essential before freezing of fruits and vegetables, as this operation only slows down enzyme activity. Its does not destroy or completely stop it (Fennema *et al*, 1973).

Although blanching is considered to be an essential treatment in some food industries, nowadays, it has come across with some limitations. Being a thermal treatment, the relatively high temperatures to which the products are normally subjected give rise to undesirable sensorial and nutritional changes, such as colour change, softening of tissues, vitamin losses and development of cooked flavours (Qi *et al*., 1995; Martins and Silva, 2001). This fact promoted the search and the development of other methods, so efficient as blanching concerning the reduction of the enzyme activity and the microbial load of the products, and at the same time capable to retain the organoleptic and nutritional characteristics, so much demanded by today's consumers (Radanna *et al.*, 1995; Rice, 2001; Patau *et al*., 2001; Piyasena *et al*., 2003; Knorr *et al*., 2004)

The application of ozone, ultrasounds and ultraviolet (UV-C) irradiation are examples of non-thermal technologies that may have potential applications in the food industry. Because they do not use heat, these technologies are commonly assigned as non-thermal technologies. As the conventional, these new technologies intend to increase the shelf-life of products, though eliminating the disadvantages that the thermal methods cause. Moreover, they require a minor consumption of energy, for what they appear as much more economic and environmental friendly technologies (Piyasena *et al*., 2003).

INNOVATIVE NON-THERMAL METHODS

Ozone

The ozone is a gas whose molecules are formed by three oxygen atoms. In nature, this triatomic molecule is formed by sun UV light (185 nm). Commercially, this molecule is obtained by submitting oxygen molecules to electrical discharges. This molecule is very unstable, and it rapidly dissociates, returning to its former oxygen form (Butz and Tauscher, 2002).

The ozone is considered as a potent disinfecting agent, due to its high oxidation power (Guzel-Seydim *et al.*, 2004). Studies show that ozone enables a fast inactivation of microorganisms through the reaction with intracellular enzymes, nucleic material or membrane components, destructing the coating of spores or viral capsules (Victorin, 1992; Kim *et al.*, 1999).

The disinfection is the most usual and known application of ozone. Some applications of ozone in the food industry include food preservation, surface hygienisation, sanitation, water disinfection and wastewater reutilization (Graham *et al.*, 1969; Schneider *et al*., 1991; Sheldon and Brown, 1986; Guzel-Seydim, 1996; Dosti, 1998).

The ozone, applied as a gas or in dissolved water, has been tested for the post-harvest treatments of fruits and vegetables, such as apples, oranges, berries, grapes, onions, lettuce and spices (Norton *et* al, 1968; Beuchat, 1992; Zao and Craston, 1995; Kim *et al*., 1999; Perez *et* al., 1999; Song *et al*., 2002; Suslow, 2004). However, its uses still rise some controversies, and its efficacy, concerning its application in foods, still needs to be further studied.

Ultraviolet light

Ultraviolet (UV) light occupies a wide band of wavelengths in the non-ionising region of the electromagnetic spectrum, between X-rays (200 nm) and visible light (400 nm) (Hollósy, 2002). The germicidal range is in the region of short-wave UV (UV-C), with wavelenghts between 200 and 280 nm, being the 254 nm the most lethal (Summerfelt, 2003). Exposure to low doses of UV-C has been reported to reduce post-harvest decay of fruits and vegetables (Lu *et al.*, 1987; Erkán *et al.*, 2001; Marquenie *et al.*, 2002; Allende and Artés, 2003), which accredits prospective application of UV-C in the postharvest industry.

Ultrasound

Ultrasound is defined as pressure waves with a frequency of 20 kHz or more (Butz and Tauscher, 2002). Ultrasound may be used at frequencies between 20 kHz and 10 MHz. Higher-power ultrasound at lower frequencies (20-100 kHz) has the ability to cause cavitation, which has the capacity to inactivate microbes and enzymes (Knorr *et al.*, 2002, 2004; Piyasena *et al.*, 2003).

The ultrasounds technology has been more and more used in the food industry, either for analysis or for the modification of foods (Knorr *et al.*, 2002). Low intensity ultrasounds provide information about physical-chemical properties, and high intensity ultrasounds are normally used to physically and chemically change the properties of foods, such as emulsification, cell disruption, chemical reaction promotion, enzyme inhibition, meat softening and modification of crystallisation processes (McClements, 1995).

The use of ultrasounds just as is, seems not to be effective in the microorganisms inactivation in foods. However, the conjoint application of mild temperatures may enhance the ultrasonication effect (thermosonication), especially in terms of product's safety (Mason *et al.*, 1996, Lopéz-Malo *et al.*, 2005), with minor changes in terms of quality parameters, when compared to conventional thermal methods. Other combinations that seem to be also successful in terms of microbial and enzymatic inactivation are the manosonication and thermomanosonication, which combine the use of pressure, and pressure + temperature together with ultrasounds, respectively (McClements, 1995; Mason *et al.*, 1996; Zenker *et al.*, 2001).

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