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# Emerging and New Technologies in Food Science and Technology

During the final three decades of the last century consumer demands for natural, minimally processed, fresh like and safe foods led to the search for gentle processing and to the development of new ("emerging") processing concepts. Examples for these developments are the emergence of the hurdle concept (Gould, 1995) and of food biotechnology (Shetty et al, 2006; Knorr, 1987).

Within the last decade the request and necessity to provide - in addition to gentle processing and fresh like products - nutritional and sensory benefits, to integrate the food chain to achieve this and to aim for sustainability throughout the food chain (ETP, 2007) was added and increased the complexity of process development.

Generally, high intensity electric pulses can be generated by the switched discharge of a suitable capacitor bank. The characteristics of the discharge circuit determine the shape of the time dependent potential at the treatment chamber where the product is exposed to the electric field (Raso & Heinz, 2006). Depending on the product and application, parallel plate electrode treatment chamber configuration or co-linear type treatment chambers are most commonly used. A comprehensive review on treatment chamber configurations can be found in (Huang & Wang, 2009).

In pulsed electric field systems for preservation of liquid food working at higher treatment intensities, electrochemical reactions can occur in the treatment chamber at the electrode surface (Morren, Roodenburg & de Haan, 2003). PEF is affecting the cell membranes and thus can be expected to influence the texture of products in which the structure is largely dependent on the integrity of cells. Applied to plant or animal raw material, it can be used for tissue softening and improvement of extraction processes (Vorobiev & Lebovka, 2008). In contrast to heat treatments applied for pasteurisation, PEF does not cause protein coagulation or gelatinization of starch. Covalent chemical bonds are not affected so that nutrients remain intact.

The pressures currently used range from tens of MPa in common homogenizers or supercritical fluid extractors to up to 350 or 800 MPa in ultra HP homogenizers or HP pasteurization units, respectively. These HP units are principally used for the inactivation of vegetative microorganisms to extend shelf life of the treated food, which was first reported by Hite (1899) for a pressure treatment of bovine milk.

Ultrasound is the energy generated by sound waves of frequencies above the human hearing and is roughly defined by a frequency range from 18 kHz up to 1GHz.

In terms of food safety ultrasound can contribute to higher hygienic standards in food production. Cavitation and associated phenomena can loosen impurities and improve cleaning processes with shortened application times and reduced use of chemicals. In respect of microorganism inactivation the singular use of ultrasound is generally rated insufficient for food industry standards (FDA, 2000). However, ultrasound application is rated promising in combination with other preservation processes, such as heat, mild pressure or ozone, as sonication induced cell damage leads to a higher sensitivity towards other treatments (IFT, 2006).

Atmospheric-pressure plasma is commonly generated by corona discharge, dielectric barrier discharge or plasma jet. For the treatment of non-uniformly shaped products, the application of plasma jets offers advantages due to various options regarding design and construction. Radio-frequency (rf)-driven plasma jets can be used for studies on treatment of food related materials. Such a plasma source consists of a needle electrode in the centre of a ceramic nozzle and a grounded outer electrode. The generated plasma contains chemical species, charged species, radicals, heat, and UV in different concentrations. The concentrations of the reagents are depending on the process parameters and the gas used. To operate plasmas in this pressure regime, several generation methods are available. Most commonly used are radio frequency (rf) or microwave (mw) excited plasma sources.

The presence of UV emitting species, charged particles, and free radicals is associated with the antimicrobial effect of the plasma (Moisan et al., 2002; Laroussi, 2005). The capability of non-thermal atmospheric plasmas to inactivate vegetative cells, including gram-negative and gram-positive bacteria, yeast, fungi, biofilm

formers, and endospores was shown in various studies (Moreau, 2008). Recent interest is mainly focused on the inactivation efficiency of cold plasma with respect to contaminated pericarps of mangos, melons (Perni et al., 2008), bell pepper (Vleugels et al., 2005), fresh cut fruit surfaces (Perni et al., 2008a) or almonds (Deng et al., 2007). However, the inactivation mechanisms of different plasmas are not yet fully understood. Depending on the plasma source, process parameters and process gases the reactive species vary within the plasma, which makes inactivation mechanisms difficult to compare.

Recent research activities focus mainly on inactivation of microbes but little is known about the effect of plasma on food matrices. Since emitted reactive species do not only react with bacteria, they may also affect food components such as water, lipids, proteins, and carbohydrates (Keener, 2008). Grzegorzewski et al. (2010) presented results on plasma effects on phenolic compounds. Recently, a joint research project has been launched in Germany to further elucidate the effects of plasma on heat sensitive food matrices (FISA database, 2010).

The emerging and new technologies presented are at different stages of development with high hydrostatic pressure technology for food preservation and quality retention being the most advanced. Pulsed electric field applications are on the verge of industrial use. Ultrasound has some non-food safety applications and supercritical water and low temperature plasma treatment are in their developmental stage.

Literature:

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