# Additional resource: Brief descriptions of other innovative food processing technologies

**Atmospheric pressure plasma**

Atmospheric pressure plasma (APP) can be described as a gas partially ionized by the application of an electric current that, depending on the state of equilibrium between electrons and ions, can be further classified into thermal (hot) or cold plasma. In cold plasma (non-equilibrium system) the temperature of the electrons is much higher than the ion temperature and is obtained at low pressure discharges or in short pulse discharges as in the Dielectric Barrier discharge system. In thermal plasma (equilibrium system) the electron temperatures is almost the same as the ion temperature, and is produced in plasma torches or in high pressure discharges.

Depending on the nature of the discharge gas, reactive oxygen species (ROS – ozone O3, hydrogen peroxide H2O2, hydroxyl radical ·OH) and reactive nitrogen species (RNS – peroxynitrite, nitrate, nitrite and the corresponding acids, nitrogen oxides NOx) are generated.

**High Pressure Homogenization (HPH)**

This technology uses dynamic high pressure of up to 400 MPa. By squeezing a liquid product through a narrow valve, many different physical phenomena occur including high pressure, shear stress, cavitation, a turbulent flow and a temperature increase. Effects of HPH are structural modifications, especially particle size reduction as happens during a conventional homogenization, modification of constituents, and food preservation by reducing the microbial load and inactivating enzymes. By the application of HPH, stabilizers and emulsifiers can potentially be reduced in emulsified products without affecting the stability.

**Ohmic heating**

This is an advanced thermal process which is also called electrical resistance heating, joule heating or electro-heating. The product to be treated is placed between two electrodes with direct contact points to them or is connected via a conducting media. An electric field is applied, and electric current is conducted through the product. Due to the ohmic resistance this results in heating of the product. Electrical energy is converted into thermal energy. The product needs to have a certain electrical

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conductivity so it is suitable for products such as fruits, vegetables, ready to eat meals, soups etc. As the application is dependent on free accessible ions it is not suitable for products such as fats, oils and alcohol. The advantage, compared to a conventional thermal process, is the very short heating time and therefore the gentle processing of the product as well as resource efficiency as almost all electrical energy is converted into heat.

**Ozonation**

Ozone is a very unstable gas. It is a highly reactive form of oxygen consisting of three oxygen atoms. In nature it is found in the stratosphere, protecting us from harmful radiation. It is highly disinfecting and can be applied in all kind of food processing areas from seafood to fruit and vegetables, sterilised water production for products as well as equipment sanitation.

**UV and Pulsed light**

This technology is based on short light pulses and is used for inactivation of microorganisms and therefore increasing the shelf life of products. UV light, especially UV-C light (200nm – 280nm), causes microbial inactivation. Light pulses are created by storage of electrical energy in a capacitor and a discharge as short light pulses with a width of microseconds, via a xenon flash lamp. The excitation of xenon gas by high current electrical pulses leads to the emission of light.

**Microwave/Radio frequency heating**

This technology uses electromagnetic waves of frequencies in the microwave range (3MHz to 300GHz). Polar molecules or ionic compounds in food will start to orient themselves and rotate according to the alternating electromagnetic filed. This re-orientation of the molecules causes huge friction which ultimately generates heat inside the product.

**Ultrasound**

Sound is a vibration being transmitted through a medium and, if the frequencies are within the range 20Hz to 20kHz, they are audible to the human ear. In contrast, ultrasound or ultrasonication frequencies are above 20kHz. When ultrasound hits a medium, regions of alternating compression and expansion are created. This in turn can cause cavitation, resulting in the formation of bubbles which help speed up the rates of food processing techniques by increasing the rate of energy transfer.

The list is not intended to be exhaustive.

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