Ohmic Heating: A Novel Technique for processing Berries

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Berries consist of an extensive amount of bioactive chemicals like flavonoids, anthocyanins and phenolic acids. These compounds are proven to offer a number of health advantages, including anti-inflammatory, anticancer, antioxidant characteristics. Because berries are very delicate and in short supply owing to the season, they are typically processed into a puree, juice beverage, and jam using different techniques of processing, which may affect the bioactive compounds and bioactivities (Li et al., 2017).Traditional thermal processing is one of the most essential methods used in food processing to inactivate microbes and enzymes, but it has been proven to have a negative impact on heat-sensitive polyphenols and nutritional properties (Salari & Jafari, 2020). One of the most difficult difficulties in the food processing business is minimising the degradation of bioactive chemicals undergoing traditional heat treatments. Ohmic heating (OH) is gaining popularity among researchers as an alternative to traditional thermal approaches.

Ohmic Heating: Principle

Ohmic heating (also known as electrical conduction or electrical resistance heating) works on the principle that an alternating or changing electric current travels through particles of food, causing ions to migrate in the direction of electrodes with opposite charges. Then, ions collide with each other as they move, causing resistance to ion movement along with a rise in kinetic energy. The heating of product is done by converting the food into electrical resistance which generates instantaneous and volumetric heat in it because of the ions in motion. The quantity of heat produced is estimated by various factors like electric field, current, voltage along with electrical conductivity of the food particles (Alkanan et al., 2021).

Benefits of Ohmic Heating

The time it takes to raise the temperature at this cold point with traditional heating may overprocess the residual particles and the surrounding liquid. This much processing destroys nutrients and reduces flavour(Varghese et al., 2014). While in case of ohmic heating, heat is generated within the food particles, and the inside-out heating pattern allows for uniform and quick heating (Tian et al., 2018). Due to this ohmic heating preserves the colour and nutritional characteristics of food while also allowing for faster processing times and larger yields in contrast to traditional heating methods. Moreover, Ohmic heating has low investment costs, high energetic efficiency and is considered technically simple (Kaur et al., 2016)

Factors Affecting Ohmic Heating

Factors like time and temperature of treatment, electric field strength and frequency have a significant impact on Ohmic heating (Sakr & Liu, 2014).The larger the strength of the electric field, quicker is the heating rate. Ohmic heating is commonly done with alternating current (AC) because the fast variations in the direction of the electric field cause ions to vibrate. The longer the heating period and higher the temperature of ohmic heating, the greater the microbial inactivation is achieved (Tian et al., 2018). But increasing the heating time and temperature will degrade the bioactive compounds. So, all the parameters must be considered according to the requirement in the process design.

Application of Ohmic Heating for Processing Berries

Recently, the novel and emerging technology of ohmic heating has been applied for processing berries. In an investigation by Sarkis et al., (2013), the pasteurization of pulp of blueberry using ohmic heating showed 5.7-14.7% degradation of anthocyanin, while traditional thermal heating showed a degradation of 7.2%. The results of the study showed that deterioration enhanced with both raising voltage from 160 to 240 V and increasing solids content from 4 to 16 g/100g.These findings might be explained by electrochemical processes catalysed by high voltages. For the blueberry pulp with a solid content of 10 g/100 g, the anthocyanin degradation was observed lower for lower voltage (160V) than the reported for conventional heating. During the osmo-dehydration (OD) of blueberries, the mass transfer was intensified by combination it with ohmic heating and pulsed vacuum (PV) treatments. PVOD/OH method of treatment at 50 °C, reaching a loss of nearly 50% of the over-all polyphenol content equated with the fresh sample and a loss of 70–80% of the flavonoids and non-flavonoids. The polyphenol retention was more at less temperatures; hence, the application of an intermediate process temperature (40 °C) was selected as a pre-treatment for 240 min prior to further drying at 60°C. The OH application shortens the drying time, thus favouring bioactive component retention and producing higher-quality products than conventional heating (Moreno et al., 2016). Another study by Hardinasinta et al., (2021)evaluated the applicability or use of ohmic technology for sterilizing purees and juices from three types of berry-like fruits grown in Indonesia, namely, jambolana, bignay, and mulberry. The results of the study showed that ohmic heating is a appropriate technology to sterilize juices of these fruits. The electrical conductivities of the juices ranged from 0.128 to 0.430 $S.m^{-1}$ and rose linearly with temperature rise. Heating rates ranged from 0.57 to 0.66 °C/s, with system performance coefficients (SPC) ranging from 0.64 to 0.81. According to the findings of this research, ohmic heating is appropriate for the sterilization of juices of these fruits thus it has a quick heating time and a high coefficient of performance.

Conclusion

The preservation of bioactive substances under heat treatment is a difficult problem for the food business. Ohmic heating, a new thermal technology, has the potential to lessen the degradation or loss of bioactive chemicals. Ohmic heating is an advancing method to process berries due to its rapid, efficient, and scalable nature. However, optimizing the time, temperature, and voltage of the extraction process is crucial to achieving the highest retention of bioactive compounds. Higher temperatures, longer extraction times and higher voltages generally result in higher yields, but only up to a certain point, beyond which degradation becomes more significant. Overall, because Ohmic heating has a much shorter processing time than conventional procedures, bioactive compounds happen to be better retained.

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