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REVIEW

Effects of infrared heating as an emerging thermal technology on physicochemical properties of foods

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ABSTRACT

Infrared (IR) radiation is part of an electromagnetic spectrum between the ultraviolet and microwave regions. IR radiation impacts the surface of the food, generating heat that can be used as an efficient drying technique. Apart from drying, IR heating is an emerging food processing technology with applications in baking, roasting, microbial inactivation, insect control, extraction for antioxidant recovery, peeling, and blanching. Physicochemical properties such as texture, color, hardness, total phenols, and antioxidants capability of foods are essential quality attributes that affect the food quality. In this regard, the main objective of this review study was to highlight and discuss the effects of IR heating on food quality to expand its food applications and commercial adoption. The fundamental mechanisms, type of emitters, and IR processing parameters are discussed in this review to explore their impacts on food quality. Infrared heating has been shown that the appropriate operating conditions (distance, exposure time, IR power, and temperature) with high heat transfer, thus leading to a shorter drying time. Besides, IR heating used in food processing to improve food-surface color and flavor, it also enhances hardness, firmness, shrinkage, crispiness, and viscosity. Meanwhile, antioxidant activity is enhanced, and some nutrients are retained.

KEYWORDS

Infrared heating; emerging technologies; color; texture; rheology

1. Introduction

Infrared (IR) radiation is a non-ionizing electromagnetic spectrum at the wavelength ranges of 0.75 to 1000 µm, found between the ultraviolet and microwave regions. The IR radiation spectral ranges are classified as near-infrared (NIR: 0.75 – 1.4 µm), mid-infrared (MIR: 1.4 – 3 µm), and far-infrared (FIR: 3 – 1000 µm) (Tsai and Hamblin 2017). IR heating technology has been declared by the Food and Drug Administration (FDA) to be safely used in food processing; hence it has been applied in drying, pasteurization, roasting, peeling, blanching, baking, antioxidant recovery, and microbial inhibition (Aboud et al., 2019; Pawar and Pratape 2017; Piatti, Graeff-Hönninger, and Khajehei 2019). Moreover, this emerging food processing technology has prominent applications in a couple of agricultural products (Pan, Venkitasamy, and Li 2016), especially for post-harvest and storage treatment. For instance, IR pretreatment of rice, wheat, and other cereal crops during the storage has been found to completely eradicate insects and preserve grain microstructure (Ding et al. 2018; Duangkhamchan et al. 2017). The significant benefits of using IR technology include shortened drying time, good reproducibility, and reduced energy consumption (Campos et al. 2021).

Thermal processing is a common practice in the food industry which is commonly used with critical environmental conditions such as heat sources or temperature control systems. However, extreme conditions may cause significant damage to the quality parameters of the product (Lee, Choi, and Jun 2016). Infrared radiation is a promising thermal food processing technology that can address the drawbacks of traditional heating methods conventionally used in the food industry. However, it is reported that the thermal energy generated by this technology can penetrate only a short distance (Pawar and Pratape 2017), while the standard smaller equipment can limit the production capacity. As a result, there is a possibility of undesired firmer and harder texture for some products, with more considerable weight losses (Ozkahraman, Sumnu, and Sahin 2016). In addition, there are several drawbacks to IR heating, including low penetration depth of radiation, making it unsuitable for large and dense foods (Lao et al. 2019). In addition, food quality including texture, structure, and nutritional value can be negatively impacted by IR when there is a lack of careful process control (Li et al. 2014; Pan 2020).

Nevertheless, IR radiations on food processing possess several advantages compared to conventional heating methods:

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