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Unconventional Treatments of Food: Microwave vs. Radiofrequency

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Abstract

Food spoilage causes considerable economic losses and constitutes a health risk for consumers due to the potential for some microorganisms to produce toxins. In the last ten years, there are limitations in the microbial decontamination of foods by current methods and the development of novel techniques in this area would be advantageous. Conventional cooking and heating techniques produce the degradation of the product's quality attributes and nutritional properties due to the intense heat treatment and subsequent destruction of proteins and vitamins, including undesirable changes to other characteristics such as flavor and color. Dielectric heating has been studied in many experiments for microbial and pest reduction and for the ability to heat the product without making undesirable changes. The aim of this study is to make a short review in respect to unconventional treatments of food, which are already implemented in industry or are in the research and development phase.

The paper presents similarities and differences between two novel treatments: microwave (MW) and radiofrequency (RF) in terms of equipment required, mechanism of action and applications in food industry.

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Keywords: food spoilage, microwave treatment, radiofrequency treatment, food preservation

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1. Introduction

The market pressure to produce ever-tastier, ever-cheaper, low- and no-fat, chemical-free, safe products is one of the strongest trends in the food industry (Orsat and Raghavan, 2014).

Consumers now expect food products of superior sensory quality and increased functional and nutritional properties, combined with a traditional, wholesome image and guaranteed safety (Nychas and Panagou, 2011).

Chemical treatment of foods, beverages and water is becoming less popular with consumers, with concerns over chemical residues and toxicity. Similarly, the public has rejected gamma radiation treatment of foods. Heat treatment of foods at high temperature can affect texture, flavour and appearance of the product whereas less severe thermal treatment may not achieve adequate decontamination (Maktabi et al., 2011).

Nowadays, terminology such as `novel processing' or `emerging technologies in food science' has become quite common within the food science community. However, for consumers, such phrases are not commonly heard, nor are the terminology describing some food products as being processed by sound waves, microwaves, light or electricity (Barbosa- Canovas and Bermudez-Aguirre, 2010). Innovative non- thermal processes for food preservation have attracted the attention of many food manufacturers (Tao et al. 2014). Some novel technologies have been tested in model systems, for example oscillating magnetic fields; the technology was tested a long time ago but results were unfavourable, and further research has yet to be reported.

On the other hand, ultrasound, radio frequency and ultraviolet light are all under research in laboratories today in model and real food systems, while other novel technologies (e.g. cold plasma) are still undergoing initial testing (Barbosa-Canovas and Bermudez-Aguirre, 2010). In microwave and radio-frequency processing, the electromagnetic waves of certain frequency are used to heat food products. Generally two frequencies (915 and 2,450 MHz) for microwave food processing and three frequencies (13.56, 27.12, and 40.68 MHz) for radio-frequency processing are used (Tewari and Juneja, 2007). Electromagnetic waves are waves of electrical and magnetic energy moving together through space (FEHD, 2005). The paper presents similarities and differences between two novel treatments: microwave (MW) and radiofrequency (RF) in terms of equipment required, mechanism of action and applications in food industry.

2. Equipment required for MW and RF heating

In Figure 1 a schematic arrangement for MW heating is compared with a typical RF heating parallel plate electrode configuration.

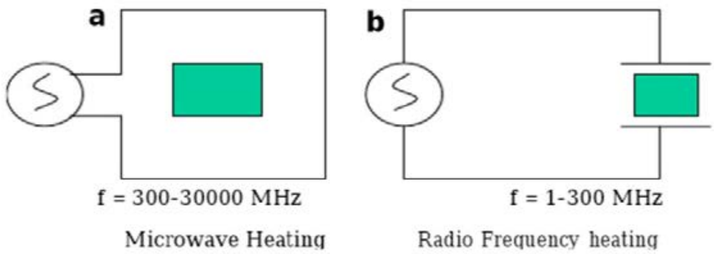

Figure 1. Schematic arrangement for (a) MW and (b) RF heating (Marra et al., 2009)

A typical MW system consists of a magnetron, a waveguide and an applicator cavity (figure 2). The magnetron generates MW and the waveguide carries the waves to the applicator cavity. The material is kept in the applicator cavity (Dev et al., 2012). When an absorptive material is exposed to a microwave source, its temperature increases mainly due to the interaction of waves with the matter. Two main processes of interaction take place, depending on the characteristics of ions and solvents in the material composition: ionic conduction and dipolar rotation. As a result of both processes, a molecular movement in the liquid is promoted causing the heating of the material (Mello et al., 2014).