Chapter 8
Non-Thermal Preservation of Dairy Products: Principles, Recent Advances, and Future Prospects

Alperen Koker
Middle East Technical University, Turkey

İlhami Okur
https://orcid.org/0000-0002-2541-7123
Middle East Technical University, Turkey

Sebnem Ozturkoglu-Budak
Ankara University, Turkey

Hami Alpas
https://orcid.org/0000-0002-7683-8796
Middle East Technical University, Turkey

ABSTRACT

Dairy products include carbohydrates, protein, fatty acids, and different micronutrients, such as minerals and vitamins. Thermal treatment is generally used in dairy products to provide product safety and increase shelf life. But it can also lead to undesirable effects on dairy products such as protein denaturation, maillard reaction, and loss of vitamins. Non-thermal technology is an alternative method in the preservation of food products due to improving product safety and shelf life without any negative effects on food nutritional content. High hydrostatic pressure (HHP), pulsed electric field (PEF), ultrasound, cold plasma (CP), and pulsed light (PL) are the main non-thermal techniques that are used in the food industry. This chapter gives general principles of the non-thermal techniques, current applications in the dairy products, and recent advances in the dairy industry.

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INTRODUCTION

Mammals secrete milk from their mammary glands and the primary function of milk is the nutrition of the mammalian neonates. Throughout history, milk and dairy products have been acknowledged as an important source of nutrition and humans domesticated variety of dairy animals such as cow, buffalo, goat, sheep, camel, and many other mammalian species. The major purpose was the production of an adequate amount of milk for the nutritional needs of a human i.e. higher amount of milk that is required for the nourishment of the dairy animal's offspring. Milk is available as a liquid form as pasteurized milk, sterilized milk, and milk of modified composition. Additionally, evaporated milk products, sweetened condensed milk products, and powdered milk products are available in the market. Another milk component, milk cream, is available in the market such as sterilized cream and whipping cream. Cheese, yogurt, butter, kefir, sour cream, fermented buttermilk, and many other fermented dairy products have been important for humans due to their longer shelf life compared with raw and heat-treated milk and nutritious properties developed during the fermentation process. In the class of dairy products, cheeses have the most number of varieties depending on milk type, starter culture, processing, and aging.

Non-thermal technologies are alternative methods in terms of preservation of food products to a certain shelf-life and providing both a healthy and quality product. These technologies have shown not to have any negative effects on the food nutritional content and other quality factors during the process stage (Putnik et al., 2019). Unlike heat treatment applications, non-thermal techniques are known as energy-efficient processes. For these reasons, in recent years non-thermal technologies have gained popularity in the food industry (Santhirasegaram et al., 2016) and there has been much research related to this subject. High hydrostatic pressure (HHP), pulsed electric field (PEF), ultrasound, cold plasma (CP), and pulsed UV-light are the main non-thermal techniques that are used in the industry. They have different microbial inactivation mechanisms and different effects on the physicochemical properties of foods. However, the effects of non-thermal techniques on foods and microorganisms are related to processing parameters, microorganism type and load, and properties of food. In recent years, there has been much research on non-thermal technology applications on milk and other dairy products such as cheese, yogurt, butter, kefir, ice-cream, sour cream, fermented buttermilk, and other fermented dairy products.

This chapter aims to give information about general principles of the non-thermal techniques, current applications in the milk and dairy products industry, recent advances, investigated novel approaches and future expectations from these technologies.

HIGH HYDROSTATIC PRESSURE (HHP)

High Hydrostatic Pressure (HHP), also known as a cold pasteurization technique or pascalization, is a non-thermal technique in which extremely high pressures (between 200 MPa and 800 MPa) are applied to foods that are submerged in a liquid -mostly water- for a desirable period of time (t) and at a desirable temperature (T) (Doona, Kustin, & Feeherry, 2010). It can be said that HHP is a 3-Dimensional process because of having three different parameters as pressure, time and temperature. HHP can destroy vegetative cells of microorganisms, and enzymes (Alpas et al., 1999; Alpas, Lee, Bozoglu, & Kaletunç, 2003). This technique can be applied to all solid and liquid foods except for porous and dry products (Morales-de la Peña, Welti-Chanes, & Martín-Belloso, 2019). Classic heat treatments usually cause the formation of undesirable compounds and caramelization of products due to Maillard reaction and