Innovative Food Science and Emerging Technologies 22 (2014) 81–88

Contents lists available at ScienceDirect

Innovative Food Science and Emerging Technologies

journal homepage: www.elsevier.com/locate/ifset

Sterilization and aseptic packaging of soymilk treated by ultra high pressure homogenization

Fábio Henrique Poliseli-Scopel *, Manuela Hernández-Herrero, Buenaventura Guamis, Victoria Ferragut

Centre Especial de Recerca Planta de Tecnologia dels Aliments (CERPTA), XaRTA, TECNIO, MALTA-Consolider, Departament de Ciència Animal i dels Aliments, Facultat de Veterinària, Universitat Autònoma de Barcelona, 08193-Bellaterra (Cerdanyola del Vallès), Barcelona, Spain

ARTICLE INFO

Article history:
Received 15 August 2013
Accepted 2 January 2014
Available online 11 January 2014

Editor Proof Receive Date 3 February 2014

Keywords:
Ultra high pressure homogenization (UHPH)
Soymilk
Aseptic packaging
Physical–chemical analysis
Sensory analysis

ABSTRACT

Ultra high pressure homogenization (UHPH) was applied on soymilk to produce an aseptically packaged beverage. UHPH-treated soymilk (300 MPa, 80 °C inlet temperature and 144 °C/0.7 s at the homogenization valve) was compared with samples treated by ultra high temperature (UHT) at 142 °C for 6 s. After treatment, soymilk samples were aseptically packaged in coated paperboard cartons of 200 mL Tetra Brik containers. Tetra Brik containers were stored for 6 months at room temperature and analyzed at different days. Microbiological (total mesophilic aerobic bacteria, aerobic spores, *Bacillus cereus*, and enterobacteria counts), physical (dispersion stability and particle size distribution), chemical (hydroperoxide index and volatile profile evolution) and sensory analyses were performed on soymilks. Both UHPH and UHT soymilks did not present microbiological growth during storage. UHPH soymilk presented high colloidal stability and relevant decrease in hydroperoxide index during storage. On the other hand, almost all of the compounds associated to off-flavors were detected in the volatile profile of soymilk. Sensory results indicated that UHPH treatment did not produce changes in soymilk which could affect the panel perception for different UHT and UHPH soymilks and for selecting their preference.

Industrial relevance: Soymilk constitutes one of the food industry sectors with the highest worldwide growth and its consumption has experienced a noticeable increase in the last years. The growing consumer demand for safe products, environmentally friendly processes and high quality nutritional foods has challenged the food industry to adapt the technological processes. This tendency impacts directly on traditional technologies, like heat treatments. In this sense, UHPH technology has been applied as an alternative to those thermal treatments. This research paper presents a comparative study between soymilk treated by UHPH and by UHT to produce a product stored at room temperature for 6 months. Results showed stable levels of oxidation, high physical stability, no microbial growth and a positive trend of sensory response during the period analyzed for UHPH soymilk. Moreover, the UHPH system was designed to work at continuous flow, allowing its application in several industrial food processes.

1. Introduction

Worldwide soymilk consumption, particularly in Western countries, has increased rapidly mainly due to the potential benefits of soybean nutritive properties. Soymilk is considered to be an inexpensive source of protein and unsaturated fatty acids for human consumption. Other relevant aspects of soymilk are it is free of cholesterol, gluten and lactose, thus, it is also a suitable food for lactose-intolerant consumers, vegetarians and persons allergic to milk (Chou & Hou, 2000). Despite its health benefits, a decisive factor to soymilk acceptance by Western consumers is its sensory perception, due to its particular beany flavor and other aromas.

In order to extend the shelf-life and facilitate distribution, soymilk is usually subjected to intense heat treatment and commercialized in aseptic packaging conditions with an unrefrigerated shelf-life of at least a year (Kwok & Niranjan, 1995). For this purpose, ultra high temperature (UHT) technology is widely used in food industries, mainly in Western countries. Although UHT treatment can produce a microbiologically stable soymilk, it may change the quality aspects that may compromise shelf-life and nutritional value (Kwok & Niranjan, 1995; Wang, Xiong, & Wang, 2001).

Several aspects define the quality characteristics of soymilk such as colloidal stability, chemical changes and potential microbial growth, especially from the germination of the occasional presence of resistant spores. All of them are crucial factors to take into account in the shelf-life determination of products packaged under aseptic conditions. In addition to shelf-life determination, volatile profile could be considered as an important factor related to consumer acceptance, for compromising aroma and possibly taste quality due to the typical beany flavor generated by the compounds. Volatile compounds are derived from oxidation process and include chemical families such as aldehydes, ketones, furans, alcohols, esters and acids (Poliseli-Scopel, Gallardo-Chacón, Juan, Guamis, & Ferragut, 2013). Of these chemical groups, hexanal

* Corresponding author. Tel.: +34 55 4236358650; fax: +34 55 4236358668.
E-mail address: fapelpr@gmail.com (F.H. Poliseli-Scopel).

1466-8564/$ – see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.ifset.2014.01.001

compound is detected in low sensory threshold, so it is the most studied and the major off-flavor in soy products (Hashim & Chaveron, 1995; Yuan & Chang, 2007).

Sensory analysis allows the evaluation of the impact of volatile compounds by analyzing general sensory attributes during storage of the treated soymilk. In addition, panelist opinion contributes in the physical stability evaluation and oxidation degree determination during storage for long period. In general, acceptance of the product, appropriate terminologies as well as appropriate standard to evaluate objectionable flavors are essentials to achieve reliable results (Torres-Penaranda & Reitmeier, 2001).

In order to minimize loss of quality and find out an alternative to heat treatments for long shelf-life products, a great interest has been given to ultra high pressure homogenization (UHPH). UHPH is an emerging technology which combines high pressure with minimal temperature effect during processing. In addition, it produces fine and stable emulsions, and depending on UHPH conditions applied to foods, microbial and enzymatic inactivation may be compared to some thermal treatments (Cruz et al., 2007; Poliseli-Scopel, Hernández-Herrero, Guamis, & Ferragut, 2012, 2013).

The goal of this study was to compare UHT and UHPH treatments on changes in quality parameters, focusing on producing a UHPH soymilk with extended shelf-life stored at room temperature similar to those achieved by conventional UHT treatments.

2. Material and methods

2.1. Soymilk elaboration

Soymilk was elaborated following the method described by Poliseli-Scopel et al. (2012). Briefly, soybeans (Majesta variety) were soaked overnight and then were ground in a crushing machine (adapted from Frigomat, Milan, Italy) for 20 min at 80 °C. The pulp was separated by filtration, leaving what is considered to be the soymilk base product: 2.72 ± 0.30 protein; 1.74 ± 0.14 fat; 5.96 ± 0.60 dry matter; 1.47 ± 0.22 carbohydrate; and 0.22 ± 0.03 ash. pH measurements were monitored using a pH meter (model GLP 21+ Crison, Spain) during the storage period.

2.2. UHPH and UHT treatments

To obtain UHT soymilk, the base product was subjected to homogenization of two stages (18 MPa and 4 MPa) performed in a homogenizer (X68IE + X68P, Niro Soavi, Parma, Italy) before UHT treatment (142 °C for 6 s) with an indirect system equipment (6500/010, GEA Finnah GmbH, Ahaus, Germany).

Soymilk base product was UHPH-treated using an ultra high pressure homogenizer (model: FPG 11300, Stansted Fluid Power Ltd., Essex, UK) at a flow rate of 120 L/h. The UHPH system was described by Poliseli-Scopel et al. (2012). Briefly, inlet temperature of the product was achieved quickly (approximately 1 s) by using a multi-tubular heat exchanger (Garvía, Barcelona, Spain) located before the machine entrance. The temperature at the homogenization valve was monitored by a sensor (PT100) located just at the exit of a high pressure valve. A total of 130 L of soymilk base product were subjected to 300 MPa and 80 °C of inlet temperature. This condition was selected based on previous results published by our own group (Poliseli-Scopel et al., 2013; Poliseli-Scopel, Gallardo-Chacón et al., 2013; Poliseli-Scopel, Hernández-Herrero et al., 2013). The temperature reached after the homogenization valve was 144 °C for 0.7 s, and was cooled at 25 ± 2 °C by means of heat exchange (Garvía, Barcelona, Spain) located after the homogenization valve.

UHPH and UHT-treated soymilks were stored in an aseptic tank (Tetra Alsafe LA Mk II, Lund, Sweden) at 7 °C until the end of the treatment process. After that, all treated soymilk was aseptically packaged. The experiments were carried out in duplicate for UHPH and UHT treatments.

2.2.1. Cleaning procedure

To guarantee the sterilization condition of the UHPH and UHT processes, all processing circuit was submitted to a cleaning procedure.

UHT system was sterilized by means of superheated water in all process circuit at 136 °C for 45 min prior to treatment. After treatment, the equipment was cleaned following the CIP procedure (cleaning-in-place). First of all, it was passed through UHT circuit alkaline solution (3% NaOH) at 95 °C for 30 min and acid solution (2% HNO_3) at 45–50 °C for 20 min. Finally, a disinfecting solution (0.3%) prepared with acetic and peracetic acids and hydrogen peroxide was used.

UHPH system was sterilized by means of vapor at 140 °C for 50 min in all circuit process prior to treatment. After soymilk processing, the equipment was cleaned by using silicate alkaline detergent solution at 70 °C for 30 min followed by nitric acid solution at 45–50 °C for 20 min only through the heat exchangers. Finally the same disinfecting solution of UHT procedure was applied.

Aseptic tank was sterilized at 130 °C (minimum temperature) for 50 min prior to use by UHPH and UHT treatments. After that, the cleaning procedure was that used by UHT system.

2.3. Storage conditions

UHT and UHPH soymilks were aseptically packaged in coated paperboard cartons (200 mL Tetra Brik containers) by using a Tetra Pak (TBA/9 200 Slim Line, Lund, Sweden) aseptic technology. The Tetra Brik containers were stored at room temperature (18–25 °C) for 180 days. Samples were analyzed in specific days, as indicated in each determination. For each day, 3 briks were randomly selected and then mixed in a glass prepared for this purpose. For microbiological analysis, 3 extra briks were selected and mixed in sterile bottles in a laminar flow cabin adapted for this purpose.

2.4. Microbiological analysis

Microbiological quality was assessed by enumerating the mesophilic aerobic bacteria, mesophilic aerobic spore, *Bacillus cereus* and enterobacteria counts. The analysis was performed as described by Poliseli-Scopel et al. (2012) at 1, 20, 40, 60, 90, 120, 150 and 180 days of storage. To evaluate mesophilic aerobic bacteria growth, about 10 briks at day 1 of each treatment were placed at 30 °C for 20 days. For thermophilic aerobic bacteria growth, such as *Geobacillus stearothermophilus*, 10 briks of each treatment at day 1 and at day 130 of storage were placed at 55 °C for 10 days. Total mesophilic aerobic bacteria were determined on PCA medium (Oxoid Ltd., Basingstoke, Hampshire, UK) and total thermophilic aerobic bacteria on TSA medium (Oxoid).

2.5. Physical stability

Soymilk samples were transferred into borosilicate glass tubes of 27.5 × 70.0 mm up to 40 mm of height and two drops of sodium azide (0.04%) were added. Three tubes of each treatment (UHT and UHPH) and untreated soymilk were prepared and stored at 4 °C. On each day of analysis (1, 20, 40, 60, 90, 120, 150 and 180 days of storage) samples were carefully placed in the Turbiscan equipment (LAB expert Formulaction, France) and a near infrared light from the top to bottom measured the percentage of light backscattered through the sample at 25 °C. Results were expressed by the determination of the height of solid layers that settled during the period of storage. For that purpose, a tool of the software provided by the manufacturer named “sediment phase thickness” was used.