LWT - Food Science and Technology 77 (2017) 30–38

Contents lists available at ScienceDirect

LWT - Food Science and Technology

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

Properties of spreadable processed Mozzarella cheese with divergent compositions of emulsifying salts in relation to the applied cheese storage period

Richardos Nikolaos Salek, Michaela Černíková, Vendula Pachlová, Zuzana Bubelová, Veronika Konečná, František Buňka*

Department of Food Technology, Faculty of Technology, Tomas Bata University in Zlín, T.G. Masaryka 5555, 760 01, Zlín, Czechia

ARTICLE INFO

Article history:
Received 6 August 2016
Received in revised form
9 November 2016
Accepted 10 November 2016
Available online 12 November 2016

Keywords:
Processed cheese
Mozzarella
Emulsifying salts
Texture
Rheology

ABSTRACT

The study was focused on selected textural and viscoelastic characteristics of spreadable processed cheese (35 g/100 g dry matter; 50 g/100 g fat in dry matter) manufactured with different ternary mixtures of emulsifying salts (ES) and from Mozzarella-type cheese (MC) with different storage periods (0, 2 and 4 weeks) over the course of a 60-day storage period (6 ± 2 °C). The ES utilized consisted of disodium hydrogenphosphate (DSP), tetrasodium diphosphate (TSPP), sodium salt of polyphosphate with mean length n ≈ 20 (P20), and trisodium citrate (TSC). Furthermore, the hardest samples were those manufactured from DSP and TSPP in a ratio 1:1. This ratio resulted in processed cheese with the highest values of gel strength and interaction factor. When TSC was utilized in the mixtures, the hardness of the samples rose with the increase of P20 (≥50%). Additionally, when DSP, TSC, TSPP, and P20 were added as sole ingredients, hardness decreased in the following order: P20 > TSPP ≈ TSC > DSP. This trend was also observed with the values of gel strength and interaction factor. The hardness of all samples increased with increased storage periods. However, the hardness values dropped in relation to an increase in the storage period of the MC.

1. Introduction

Processed cheese (**PC**) is manufactured by mixing cheese, water, emulsifying salts (**ES**), and other dairy/non-dairy ingredients, commonly under vacuum, in the presence of heat and shear. Furthermore, the desired compact structure of PC is obtained by the addition of ES. Their ability to sequester calcium from the casein matrix (exchanging Na^+ for Ca^{2+}) and the pH adjustment cause protein hydration and dispersion, and the casein present acts as the "true" emulsifier within the matrix (Awad, Abdel-Hamid, El-Shabrawy, & Singh, 2004; El-Bakry, Duggan, O'Riordan, & O'Sullivan, 2011; Kapoor & Metzger, 2008; Lee, Buwalda, Euston, Foegeding, & McKennan, 2003; Lee & Klostermeyer, 2001). The ion-exchange ability is not identical for all ES. Therefore, the phosphate ion-exchange ability increases with the increasing content of P_2O_5 (Buňka et al., 2014; Shirashoji, Jaeggi, & Lucey, 2006).

Traditional Mozzarella is a soft/semi-soft, unripened, pasta-filata cheese, originally manufactured from water buffalo (*Bubalus* sp.) milk, with high levels of moisture (50–60%) and a relatively high pH (>5.5), typically immersed in a hot liquid (mainly a combination of water, brine or whey) preserving the soft-springy texture, whereas the high amounts of expressible serum contribute to its flavor and physicochemical characteristics. Additionally, most Mozzarella cheese (**MC**) is manufactured from pasteurized, partly skimmed cow's milk. The immersion of the cheese-curd in the hot liquid is a specific process enhancing its plasticization and stretching properties. Mozzarella is packaged in a conditioning liquid and stored under refrigeration conditions (6 ± 2 °C). Moreover, MC is one of the most-consumed cheeses worldwide, is used as an ingredient in a series of food products (including PC), and is a high volume product supporting the food service industries (Francolino, Locci, Ghigliettti, Iezzi, & Mucchetti, 2010; Luo, Pan, Guo, & Ren, 2013; Segat et al., 2014; Zhu, Brown, Guo, & Ren, 2015).

During the storage of MC, complex biochemical events determine its final quality and acceptance. Proteolysis is the major phenomenon that occurs during cheese aging (besides glycolysis

* Corresponding author.
E-mail address: bunka@ft.utb.cz (F. Buňka).

http://dx.doi.org/10.1016/j.lwt.2016.11.019
0023-6438/

and lipolysis) that greatly affects the physical characteristics of nearly all cheeses. Generally, cheeses show similar proteolytic trends. On the other hand, differences in cheese nature and manufacturing processes influence the proteolytic pattern. In comparison to Cheddar and Dutch-type cheeses, pasta-filata cheeses represent a special case (in terms of proteolytic pattern). Particularly, the casein molecules ("fibres" or "strings") are arranged distinctly after the stretching process (Costabel, Pauletti, & Hynes, 2007; Sousa, Ardö, & McSweeney, 2001). In the case of PC, rheological and textural properties are influenced by the age of the applied cheese and/or also by specific technological operation during cheese manufacturing. Hence, more intensive proteolytic reactions result from an increasing cheese maturity level. However, the above-mentioned properties are also affected by factors such as: dry matter (**DM**), fat in DM content, pH value, type and amount of ES added, processing, and storage conditions (Brickley, Auty, Piraino, & McSweeney, 2007; Pachlová et al., 2011; Piska & Štětina, 2004).

To the best of our knowledge, there are only a few publications dealing with PC properties produced only from MC, particularly the works of Chavhan, Kanawjia, Khetra, and Puri (2015), Chen and Liu (2012), and Khetra, Chavhan, Kanawjia, and Puri (2015). Nevertheless, the combined effect of MC storage period and different ES (type and composition) on the textural and rheological characteristics of spread-type PC during its storage has not found in the literature.

The present work was undertaken with the primary objective of analyzing the dependence of selected textural properties (hardness) and viscoelastic properties of PC made from MC on the composition of ES ternary mixtures [composed of disodium hydrogenphosphate (**DSP**), tetrasodium diphosphate (**TSPP**), sodium salt of polyphosphate with mean length n ≈ 20 (**P20**), and trisodium citrate (**TSC**)] during a 60-day storage period. This dependence was observed in samples with adjusted pH (target values within the interval of 5.60–5.80, corresponding to the standard pH values of spreadable PC). A supplementary aim was to evaluate the effect of MC (basic raw material) age on the above-mentioned dependence.

2. Materials and methods

2.1. Materials

Mozzarella-type cheese [42 g/100 g DM content; 35 g/100 g fat in DM content; 0, 2, 4-weeks of maturity (storage at 6 ± 2 °C) – the same batch of cheese was applied during the whole experiment] was supplied by NET PLASY s.r.o. (Bystřice pod Hostýnem, Czech Republic). Butter (84 g/100 g, DM content; 82 g/100 g, fat content) was obtained from Sachsenmilch Leppensdorf, GmbH (Wachau, Germany). In addition, DSP (Na_2HPO_4), TSPP ($Na_4P_2O_7$), and P20 (sodium salt of polyphosphate with mean length n ≈ 20) were supplied by Fosfa PLC Company (Břeclav, Czech Republic); TSC ($C_6H_5Na_3O_7$), HCl, and NaOH were purchased from SigmaAldrich Inc. (Schnelldorf, Germany).

2.2. Preparation of the processed cheese samples

The production of the samples was designed in order to achieve end-products with 35 g/100 g DM content and 50 g/100 g fat in DM content. Furthermore, the ES were utilized in 4 types of ternary mixtures (TSC:TSPP:P20; DSP:TSC:P20; DSP:TSPP:TSC; DSP:TSPP:P20) and their total concentration was 3 g/100 g (calculated based on the total weight of the melt). In addition, 12 percentage ratios of each type of ternary mixture (100:0:0; 50:50:0; 0:100:0; 40:40:20; 40:20:40; 20:40:40; 50:0:50; 0:50:50; 40:0:60; 20:20:60; 0:40:60; 0:0:100 – the percentage of the substances was calculated on the basis of the total weight of the ES) were evaluated. Fig. 1 illustrates the schematic description of the experimental

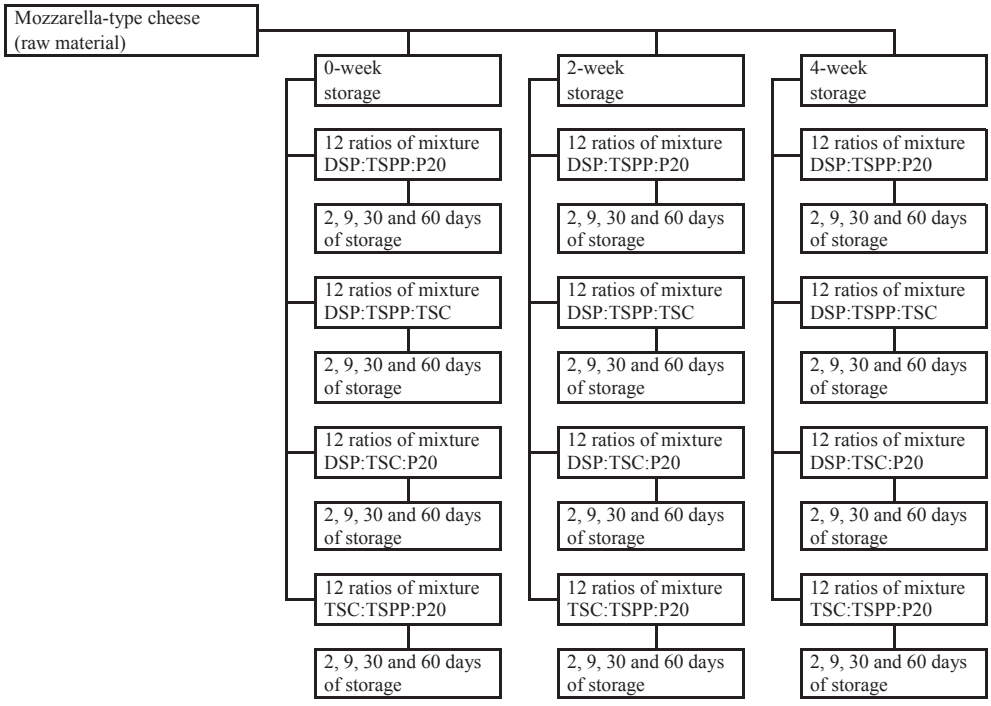

Fig. 1. Scheme of the experimental design with model processed cheeses manufactured using Mozzarella-type cheese (in various time of storage) and the different percentage ratios of the four types of ternary mixtures comprising DSP:TSPP:P20, DSP:TSPP:TSC, DSP:TSC:P20 and TSC:TSPP:P20 (DSP – Na_2HPO_4, TSPP – $Na_4P_2O_7$, P20 – sodium salt of polyphosphate with mean length n ≈ 20 (P20) and TSC – trisodium citrate). The model samples were tested after 2, 9, 30 and 60 days of storage.