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The influence of brine concentration on chemical composition and texture of Iranian White cheese

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Abstract

The effect of brine concentration on composition, proteolysis development measured by free tyrosine–tryptophan content, microstructure monitored using scanning electron micrographs, and rheological behavior measured in uniaxial compression test and small amplitude oscillatory shear were studied. Three treatments of Iranian White cheese were made by immersing cheese curds in brines with different salt concentrations (9%, 13%, and 17%). The higher the brine concentration, the higher were the salt, fat and protein contents and lower was the moisture content. The treatment; therefore, led to a significant increase in salt-in-moisture and a decrease in the ratio of moisture to protein. It also increased the values of fracture stress and storage modulus. The concentration of free tyrosine–tryptophan decreased as salt-in-moisture of cheese increased. When the moisture content of the treatments decreased, fat did not replace the moisture on an equal basis, so the total filler volume (fat and moisture) was decreased. The decrease in the ratio of filler to protein in treatments ripened at stronger brines could mainly account for the increased firmness. The cheeses ripened in weaker brines (9% and 13%) especially that in the weakest had a dense microstructure with large protein aggregates; while, the cheese ripened in the strongest brine (17%) had a casein network with more homogenous protein aggregates permeated by holes and fissures corresponding to discrete fat globules and/or pools of coalesced fat globules.

Keywords: Iranian White cheese; Microstructure; Rheology

1. Introduction

Iranian White cheese is a close textured brined cheese (Madadlou, Khosrowshahi, Mousavi, & Djome, 2006) made from cow's milk, sheep's milk or mixtures of them. The main flavor characteristics are acidity and saltiness (Erdem, 2005). It resembles Beyaz peynir (Turkish White cheese) and Feta but differs from Feta in the way it is made. It is, for example, manufactured without dry salting of curd and slime formation on the curd surface before brining (Madadlou et al., 2006) which are essential for the development of the characteristic Feta flavor during ripening (Carić, 1993). It is widely consumed all over Iran as a major diet in breakfast and manufacturing of other domestic cheese varieties such as jug cheese (Madadlou et al., 2006) and also processed cheese. At the industrial level, the ripening period is 40–90 days, but the cheeses made from raw milk in small rural production units may be ripened for 6–8 months (Azarnia, Ehsani, & Mirhadi, 1997). It is during ripening that the individual and unique characteristics of each cheese variety develops (Fox, Law, McSweeny, & Wallace, 1993) due to an extremely complex set of biochemical changes occur (Fox, 1993). Khosrowshahi, Madadlou, Mousavi, and Emam-Djome (2006) reported that the texture

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(rheology and microstructure), chemical and biochemical composition, and opacity of Iranian White cheese changed markedly during 50 days aging in brine at 5 °C. As the ripening progressed, moisture and protein contents of the treatments continuously decreased; while, their total ash, salt, and salt in moisture contents increased. Fat content and pH of the cheeses remained stable during ripening.

In addition to enhancing cheese taste (Gunasekaran & Mehmet Ak, 2003) the concentration and distribution of salt in cheese have a major influence on various aspects of cheese quality (Fox, Guinee, Cogan, & McSweeny, 2000) including texture (Guinee & Fox, 1993). It alters the water-binding capacity of casein within the cheese matrix and, thus, influences the physical properties of cheese (Paulson, McMahon, & Oberg, 1998). Brined-cheese manufacturing plants in Iran work with different levels of processing variables. For example, brine concentration varies from 8% to around 16% (Alizadeh, Hamedi, & Khosroshahi, 2005) or even 18% w/v. Alizadeh et al. (2005) used response surface methodology to evaluate the effects of some of processing variables on the sensorial quality of Iranian White cheese. Those researchers found that optimum conditions were ripening time of 32 days, ripening temperature of 8.3 °C, rennet concentration of 1.6 g kg^{-1} of milk, and brine concentration of 11%. There was; however, no report on the effect of brine concentration on chemical characteristics and texture (rheology and microstructure) of Iranian White cheese.

Textural properties of cheese are influenced by numerous factors (Gunasekaran & Mehmet Ak, 2003) including both processing and formulation variables. The objective of the present paper was to study the influence of brine concentration on the rheology (measured in uniaxial compression, and small amplitude oscillatory shear), microstructure (monitored using scanning electron micrographs), proteolysis rate (measured by quantification of free tyrosine–tryptophan in cheese curd) and chemical characteristics of Iranian White cheese at the 8th week of ripening in brine.

2. Materials and methods

2.1. Treatments, cultures, and rennet

Three treatments of cheese that ripened at 9%, 13% or 17% brine concentrations were made. Cheeses were manufactured in triplicate, each replicate in 1 day using 7 kg of milk for each treatment. One lyophilized direct-to-vat mesophilic mixed culture (R-704, Chr, Hansens Dairy Cultures, Denmark) containing *Lactococcus lactis* subsp. *cremoris* and *Lactococcus lactis* subsp. *lactis* was used as starter. As coagulant, chymosin derived by fermentation of *Aspergillus niger* var. *awamori* [Standard rennet, Chy-Max, Chr, Hansen Inc., Denmark: 183 International Milk Clotting Units (IMCU)/ml (International Dairy Federation, 1997)] was used at a concentration of 4.5 IMCU kg^{-1} of milk. Rennet was diluted 30-fold with cold water then added to each 7 kg batch of milk.

2.2. Cheese-making procedure

Fresh raw milk obtained from Animal Husbandry of Urmia University, was batch-pasteurized at 65 °C for 5 min (Hayaloglu, Guven, & Fox, 2002; Khosrowshahi et al., 2006) in a stainless steel container placed in a water bath, cooled to 35 °C and transported carefully to a cheese vat (FT20-MkII CHEESE VAT, Armfield Ltd., Ringwood, Hampshire, UK). The milk was supplemented with 0.15 g of $CaCl_2$ kg^{-1} of milk and held at 35 °C for approximately 60 min after inoculation of culture for starter maturation before the addition of rennet. The curd was cut crossways in cubes of 2 cm^3 when firm (approximately after 55 min). After being cut, the curd was allowed to settle for 3–5 min and then gently agitated at a gradually increasing rate for 10 min to avoid fusion of freshly cut curd cubes and facilitate whey expulsion. This was followed by whey draining and pressing the transferred curd into molds (25 (length) × 12 (width) × 10 (height)) for 2.5 h (under the initial pressure of 0.3 kPa which gradually increased up to approximately 2.9 kPa at the first hour and held constant to the end of pressing) to complete draining. After pressing, the curd was divided into six equal portions which were stored at 23–25 °C for 19–20 h, placed in air-tight plastic containers, and covered with 9%, 13%, or 17% (w/v) brine (brine was beforehand pasteurized at 80 °C for 10 min and filtered through a clean cloth after rapid cooling) in a random order. After sealing, the containers were stored first at 23–25 °C for 24 h and then refrigerated at 5–6 °C for the ripening period of 8 weeks.

2.3. Chemical analysis

Titrable acidity of milk was determined by the Dornic method and its total solids were determined by drying 8–11 g of milk at 100 °C for 5 h. The pH of milk and cheese samples was measured using a digital pH-meter (microprocessor pH meter, model pH 537 WTW, Germany). Cheese was analyzed for moisture content by vacuum-oven [(Association of Official Analytical Chemists, 1997); method number 926.08], salt content by Volhard (James, 1995) and for ash content by dry ash method (Association of Official Analytical Chemists, 1997). The fat content of milk and cheese samples was determined by the Gerber method (James, 1995) and their total protein contents were determined by measuring total nitrogen using the Kjeldahl method (Association of Official Analytical Chemists, 1997) and converting it to protein content by multiplying by 6.38. All chemical measurements were done in triplicate. Cheese samples were chemically analyzed at the 8th week of ripening.