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A modified form of Myzithra cheese produced by substituting the fresh cheese whey by dried whey protein concentrate and ovine milk and cream

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ABSTRACT

A modified form of Myzithra cheese (M) was produced by substituting the fresh cheese whey by dried whey protein concentrate 65% (WPC 65%). The proportion of the materials used in the production of the modified Myzithra cheese blend was: 16.1% WPC, 49.9% water, 8.0% ovine milk and 26.0% ovine cream. The mixture was placed in polyethylene package before being subjected to heat treatment at 90 °C for 30 min. A control Myzithra cheese (C) was also produced in the traditional way. Both cheeses were submitted to microbiological, physicochemical and rheological analyses as well as organoleptic tests 1 day after production and following 25 days in cold storage. The modified Myzithra cheese (M) had a higher lactose, potassium and sodium content and lower total bacteria, protein, ash, calcium, hardness and adhesiveness than C-Myzithra cheese, while yeasts and moulds were absent. Also, M-Myzithra cheese remained unchanged organoleptically and texturally during cold storage, whereas C-Myzithra cheese deteriorated. Sensory evaluation revealed that M-Myzithra cheese was of good quality and can cover the annual consumption demand for Myzithra cheese, thus helping to resolve the problem of seasonal production of C-Myzithra cheese while simultaneously exploiting the WPC.

1. Introduction

Whey is the watery portion of milk remaining after milk coagulation and removal of the curd. The consumption and manufacture of cheeses is increasing worldwide at a rate of about 2% per year. As a result, the amount of cheese whey is also increasing and it is estimated to be approximately 120 million tons per annum. The major whey producers are the EU and the US (FAO, 1999; Stiles, 2012). In most cases, it is not utilized, resulting in a loss of nutritionally valuable milk constituents and causing serious environmental pollution due to its high content of organic substances with a high Biological Oxygen Demand (Gonzalez, 1996). The chemical composition of whey differs according to the types of cheese produced and especially the kind of milk used for cheese production (Gonzalez, 1996; Silanikove et al., 2010). In fact, cheese whey contains 5–8% solids, more than half of the solids of the original milk, including about 20% of the protein, and most of the lactose, minerals, water-soluble vitamins, lactic acid and trace elements (Gonzalez, 1996; Koutinas et al., 2009). Total essential amino acids are 37.6% of the total amino acids in sheep whey proteins (Hejtmánková et al., 2012). Whey is commercially exploited by the production of whey cheeses or by the isolation of whey ingredients, such as Whey Protein Concentrates (WPCs). WPCs are widespread, as they contain essential amino acids, e.g. branched chain amino acids (leucine, isoleucine, and valine) and sulphur amino acids (methionine, cysteine) and they have antioxidant properties (Smithers, 2008). WPCs are whey protein powder preparations which contain 35–80% total protein and variable quantities of moisture, lactose, ash, fat, K, Cl, Ca, P, Na, Mg and non protein nitrogen, while the total microorganism is influenced by the following processing steps: pasteurization, ultrafiltration, spray-drying and packaging.

Of all Greek whey cheeses, Myzithra is the one that is produced in the largest quantity throughout the country. It is a soft cheese, usually made from the whey of hard or semi-hard cheeses derived from either ewe or a mixture of ewe and goat milk; for this reason it does not cover annual demand. Myzithra has a fat content in dry matter of about 50% and a moisture content that is not greater than 70% (Anifantakis, 1991). Due to the high moisture content, low concentration of salt and pH close to 6, Myzithra, like other Greek whey cheeses, is susceptible to microbial spoilage and consequently has a

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limited shelf-life (Kalogridou-Vassiliadou et al., 1994; Lioliou et al., 2001).

Taking into account the economic and environmental importance of utilizing whey, and the year round demand for Myzithra cheese in the market, the objective of this work was to develop a modified Myzithra cheese that would contain whey protein concentrate (WPC-65) prepared from ovine and caprine wheys and a fat and moisture content standardized by adding appropriate quantities of ovine milk and cream or water, respectively.

The microbiological, physicochemical, rheological, and organoleptic characteristics of the two types of Myzithra cheese were determined and evaluated after 1 day and 25 days of cold storage at 4 °C.

2. Materials and methods

2.1. Whey

Whey was derived from ovine milk after the production of Halloumi cheese (Anifantakis and Kaminarides, 1983). The mean values (±) the standard errors of the mean of the whey used, as determined by the Milkoscan apparatus (model 255 A/B, type 25,700, Fosselectric, Denmark) were: 0.54% ± 0.02 fat, 1.67% ± 0.05 total protein and 5.35% ± 0.09 lactose. The mean pH of the whey used was 6.4 ± 0.02.

2.2. Whey protein concentrate 65% (WPC-65)

The whey Protein Concentrate 65% (WPC-65) was supplied by "Epirus Protein Company" and prepared from mixture ovine and caprine Feta cheese wheys and contained according of producer 65% serum proteins, 22% lactose, 3,8% fat, 3.6%, ash 3.5%, moisture 3.3%, Ca 3.6 g/kg, P 3.3 g/kg, Na 2.8 g/kg, K 6.5 g/kg and Mg 0.8 g/kg.

2.3. Ovine cream

The ovine cream used was pasteurized and its fat content was 70%. Cream was used to adjust the fat content of the blends so that the modified Myzithra cheese contained 50% fat in dry matter.

2.4. Ovine milk

Ovine milk was obtained from the farm of the Agricultural University of Athens and had the following chemical composition as determined by the Milkoscan apparatus: pH 6.38 ± 0.01, fat 4.4% ± 0.06, total protein 4.76% ± 0.03 and lactose 5.09% ± 0.04

2.5. Water

Distilled water was used to adjust the moisture content of the blends, so that the modified Myzithra cheese contained 67% moisture.

2.6. Production of Myzithra cheeses

2.6.1. Production of traditional Myzithra cheese

Control Myzithra cheese (C) was produced from the whey after the production of ovine Halloumi cheese using the traditional technology described by Anifantakis (1991). In order to improve the quality of the Myzithra cheese, 10% ovine milk was also incorporated into the whey, when it reached a temperature of 65–70 °C during the manufacturing process. The whey mixture was heated under constant stirring up to 90 °C; the resulting curd remained at 90 °C for 30 min and was then transferred by a ladle into a cheese cloth, tightened and hung on a pole to drain for 3 h at 20–22 °C. The cheese was wrapped in paper and maintained refrigerated at 4 °C for 25 days.

2.6.2. Production of modified Myzithra cheese

The modified Myzithra cheese (M) was prepared so as to adjust the fat in dry matter to about 50% and moisture content to about 67%, as in Myzithra cheese. The proportion of material used in the production of the modified Myzithra cheese blend was: (1) 49.9% distilled water, (2) 16 .1% Whey Protein Concentrate 65% (WPC-65) from mixture ovine and caprine Feta cheese whey, (3) 8% ovine milk and (4) 26% ovine cream.

WPC was mixed thoroughly in the water, under stirring and heating. At 65 °C, ovine milk and ovine cream were added. The mixture was placed in cylindrical 200 mL polyethylene packages, tied firmly with string at each end and heated in a water bath under stirring at 90 °C for 30 min. Then it was cooled under running tap water to room temperature and maintained refrigerated at 4 °C for 25 days.

2.7. Experimental planning and sampling

Five replicates of each type of Myzithra cheese were prepared. The cheeses were analyzed 1 day after production and after 25 days at 4 °C. All analyses were performed in triplicate. All reagents and chemicals were of analytical grade (Merck, Darmstadt, Germany).

2.8. Physicochemical analyses

Samples of cheese were analyzed for total proteins by the Kjeldahl method according to the International Dairy Federation -IDF-(25/1964), total solids according to, fat according to the volumetric method of Gerber—Van Gulic (Schneider, 1954), lactose and lactic acid were analyzed by high-performance liquid chromatography using the method of Kaminarides et al. (2007), ash as specified by the AOAC (1975) and minerals according to IDF (119/2007). The pH was measured by a pH meter (model 632, Metrohm, Herisau, Switzerland). All analyses were performed three times for each sample.

2.9. Enumeration of micro-organisms

The enumeration of total bacteria, yeasts and moulds and coliforms was performed on cheese after 1 and 25 days storage at 4 °C. 10 g of each cheese sample were diluted in 2% sterile sodium citrate (90 mL) (Merck, Darmstadt, Germany) and homogenized for 2 min in a Stomacher Lab Blender 400 (Seward Medical, London, UK). Serial decimal dilutions were prepared with 0.1% (w/v) Ringer solution (Oxoid, Hampshire, England) and plated in duplicate onto the appropriate media. Total bacteria were enumerated on Plate Count Agar (Difco, Michigan, USA) and the plates were incubated aerobically at 30 °C for 72 h (IDF, 100B:1991). The enumeration of yeasts and moulds was carried out on Yeast Extract Glucose Chloramphenicol Agar (Merck, Darmstadt, Germany) by incubation at 25 °C for 5 days (IDF 94B:1991). For the count of coliforms, Violet Red Bile Agar (Oxoid, Hampshire, England) was used and the plates were incubated at 37 °C for 1 day (IDF 73A:1985). All the counts were expressed as colony forming units per gram of cheese (cfu g^{-1}).

2.10. Rheological evaluation

The rheological properties of the cheese were measured with a Shimadzu testing instrument, model AGS-500 NG (Shimadzu Corporation, Kyoto, Japan), as described by Kaminarides and Stachtiaris (2000).