



Effects of low-pressure homogenisation on the sensory and chemical properties of Emmental cheese

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ABSTRACT

The study investigated the effects of a pre-processing routine on the sensory and chemical properties of Emmental cheese and the suitability of temporal dominance of sensations (TDS) in analysing dynamic sensory changes during mastication. Cheeses were produced with milk homogenised at various pressures (0, 5 and 10 MPa and a control), incubated at 37 °C for 1 h and pasteurised. Homogenised milk cheeses were less yellow, more consistent in colour, had smaller eyes, were higher in taste intensity, salty and sour tastes, less elastic and more crumbly, fatty, sticky and smooth. TDS curves showed dramatic changes in textural attributes. Cheese produced with homogenised milk had higher concentrations of FFA, higher moisture and salt contents and lower protein and fat contents. Positive consequences of the routine on the characteristics of the cheeses were found. TDS was beneficial as an addition to traditional sensory profiling methods and as a stand-alone method. *Industrial relevance:* The application of a novel low pressure homogenisation routine in cheesemaking leads to desirable changes in sensory and chemical properties of the resultant cheese. This process could be used on an industrial scale. This study also shows the potential of TDS as a tool in assessing dynamic sensory changes in cheese and encourages its use as an aid in product development of cheeses.

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1. Introduction

Although cheese is an established product, technological modifications to cheesemaking processes continue to be investigated to improve chemical, physical, nutritional, sensory and safety properties of the finished product (Jana & Upadhyay, 1992; Kelly, Huppertz, & Sheehan, 2008). Homogenisation has been used as part of the cheesemaking process, for prevention of creaming of fat globules or in control of fat loss and development of free fat (Kelly et al., 2008). Homogenisation has been incorporated into cheesemaking in various ways, for example; by direct homogenisation of the milk before cheesemaking (Peters & Moore, 1958), by separation, homogenisation of the cream and incorporation into the skim (Collins, McSweeney, & Wilkinson, 2003) or by using high-pressure homogenisation (Voigt, Donaghy, Patterson, Stephan, & Kelly, 2010). However, homogenisation can cause deleterious changes to milk and cheese, for instance; uncontrollable lipolysis, changes to characteristic textures, lightening of colour etc. (for an extensive review of changes see: Jana & Upadhyay, 1992).

Low-pressure homogenisation, as part of a pre-processing routine in Cheddar cheesemaking has previously been investigated by Deegan and McSweeney (in press). The authors found that by using low-pressure homogenisation as part of a controlled pre-processing routine, subsequent lipolysis in resultant Cheddar-cheese ripening could be effectively controlled. Extensive chemical analyses were completed to track release of free fatty acids (FFA) and effects on cheesemaking parameters and resultant cheese properties, bringing interesting information which should be followed up. The study lacked investigation into the sensory consequences of such a process on the resultant cheese, which is especially warranted, given the changes which occurred to the lipolytic processes.

Many studies have used descriptive analysis for evaluation of attributes in cheese and in particular, for Swiss cheese (Lawlor, Delahunty, Wilkinson, & Sheehan, 2002; Liggett, Drake, & Delwiche, 2008; Ritvanen et al., 2005). Appearance is of critical importance to consumer acceptability and visual appeal in Swiss-type cheeses due to the characteristic eyes produced by the action of propionibacteria during the warm-room phase of ripening (Cakir & Clark, 2009). The present study investigates the effects of a pre-processing routine involving low-pressure homogenisation on Emmental cheese with a particular emphasis on sensory aspects of the ripened cheese. Descriptive analysis is static in nature, whereas temporal dominance

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of sensations (TDS) investigates the dynamic perceptual changes during mastication and after swallowing (Pineau, de Bouillé, Lepage, Schlich, & Rytz, 2012). Assessors are presented with a list of attributes and indicate the attribute which they consider to be dominant from that list during mastication. The TDS method has improved differentiation of overall dynamic perception between samples and highlighting of interactions between attributes (Labbe, Schlich, Pineau, Gilbert, & Martin, 2009). To date the TDS method has been used to investigate properties of a variety of products, for example; breakfast cereals (Lenfant, Loret, Pineau, Hartmann, & Martin, 2009), candies (Saint-Eve et al., 2011), wine (Meillon et al., 2010) and fish sticks (Albert, Salvador, Schlich, & Fiszman, 2012).

The objective of this study was to investigate the sensory and chemical consequences of Emmental cheese made using a pre-processing routine involving homogenisation. The secondary aim was to investigate the potential of TDS as a sensory tool in the evaluation of cheeses made with the pre-processing routine.

2. Materials and methods

2.1. Pre-treatment of milk and cheese production

The pre-treatment used is shown in Fig. 1. Raw milk (obtained from Valio Ltd, Finland) was standardised (Seital Separator, Santorso, Italy) to a protein to fat ratio of 0.86, with a final fat percentage of 3%. The milk was heated to 55 °C and immediately homogenised in a two

stage homogeniser (HPM Srl, Parma, Italy) at pressures of 0, 5 or 10 MPa, followed by cooling to 37 °C and transfer to a 150 L insulated stainless steel vessel (Pro Ruchti, Uttigen, Switzerland). The milk was incubated with gentle stirring at 37 °C for 1 h, pasteurised at 75 °C × 15 s in a plate heat exchanger (Fischer Maschinen- und Apparatebau AG, Ebreichsdorf, Austria) and passed directly to cheese vats (Pro Ruchti, Uttigen, Switzerland). 100 L of pre-treated milk was used in each vat. A control milk sample was subjected to the same treatment without passing through the homogeniser.

Emmental cheese was produced according to the general protocol described by Mato Rodriguez, Ritvanen, Joutsjoki, Rekonen, and Alatosava (2011). Concentrated starters (*Streptococcus thermophilus* T101, *Lactobacillus helveticus* K16, and *Propionibacterium freudenreichii* ssp. *freudenreichii* P131) and a protective strain (*Lactobacillus rhamnosus* Lc705) were obtained from Valio Ltd and chymosin (600 international clotting units/mL) from Chr Hansen (Hørsholm, Denmark). Two circular test cheeses (approx. 5 kg) were produced from each 100 L cheese vat, one for sensory evaluation at 90 d ripening and the other for microbiological and chemical analyses. Cheesemaking was carried out in triplicate, over 3 weeks. Ripening consisted of 14 d at 12 °C, 25 d at 23 °C and 51 d at 5 °C. The cheeses produced are coded as C (control) and H0, H5 and H10 for cheeses produced from milk homogenised at 0, 5 and 10 MPa, respectively.

2.2. Sensory methodology

Panel members (n = 15, 11 females, 4 males, ages ranging from 20 to 54) were recruited from students and staff of the Department of Food and Environmental Sciences, University of Helsinki. Training of panel members took place over a two week period and consisted of four three-hour sessions. During training, assessors were presented with commercial Emmental cheeses and were encouraged to describe their taste, odour, appearance and texture. The vocabulary generated by the assessors was discussed and modified until a distinct group of 22 attributes remained (see Table 1). For each attribute, reference samples were developed with the group and use of scales was discussed. Sensory profiling was performed at 90 d of ripening. Presentation conditions of samples are shown in Table 2. Appearance attributes were evaluated under white light, prior to evaluation of odour, taste and texture. Remaining attributes were evaluated in individual booths under red light to avoid any effect of colour differences on odour and taste evaluation (Sipahioglu, Alvarez, & Solano-Lopez, 1999). All samples were cut 24 h before evaluation, placed into the evaluation containers and refrigerated overnight. Samples were removed from refrigeration 1 h prior to evaluation to allow equilibration to room temperature. Between evaluating each sample, assessors were instructed to cleanse their palate with an extruded flavourless corn snack and to rinse their mouth with water, before continuing to the next sample. All attributes were rated on a 10 cm unstructured line scale with ends representing 'no intensity' at 0 and 'very high intensity' at 10. Evaluations were replicated once.

Assessors were trained in the use of TDS. Panel discussion and pretesting resulted in two subsets representing flavour and texture attributes. The flavour subset consisted of 6 attributes; *salty*, *sweet*, *sour*, *bitter*, *nutty* and *buttery*, while the texture subset consisted of 4 attributes; *elastic*, *crumbly*, *fatty* and *smooth*. Attribute order was randomised to prevent bias by assessors in choice based on order. Assessors placed the sample in their mouth and, when perceived, clicked the most dominant attribute on the list. As the perceived dominant attribute changed during mastication, assessors were free to select and change according to their perception (Labbe et al., 2009). The assessor clicked the 'stop' button on swallowing the sample. Assessors cleansed their palate by eating an extruded flavourless corn snack and rinsed their mouth with water, before continuing to the next sample. Both sensory profiling and TDS were carried out using Fizz Sensory Evaluation Software Version 2.45 (Biosystemes, Couternon, France).

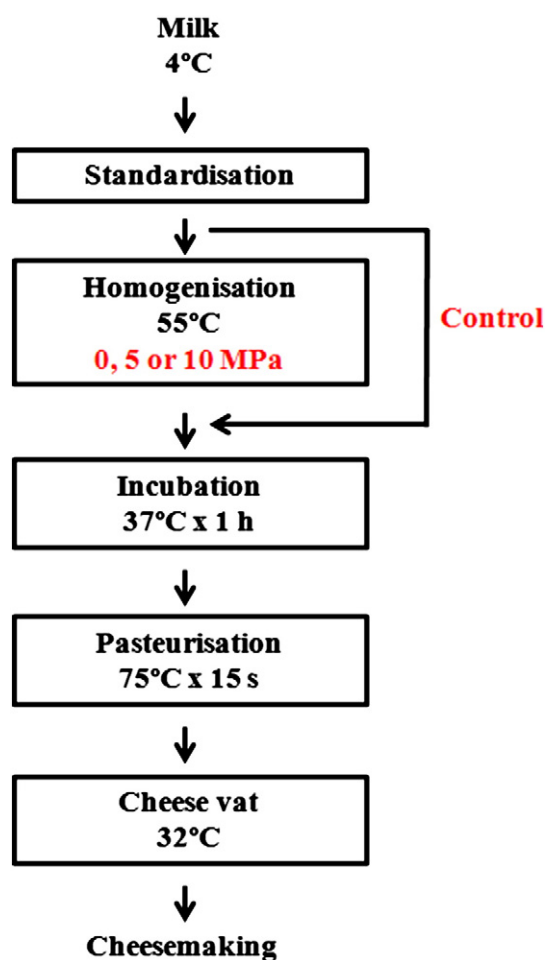


Fig. 1. Schematic representation of milk pre-treatment.

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