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Effect of blending Jersey and Holstein-Friesian milk on Cheddar cheese processing, composition, and quality

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ABSTRACT

The effect of Jersey milk use solely or at different inclusion rates in Holstein-Friesian milk on Cheddar cheese production was investigated. Cheese was produced every month over a year using nonstandardized milk consisting of 0, 25, 50, 75, and 100% Jersey milk in Holstein-Friesian milk in a 100-L vat. Actual, theoretical, and moisture-adjusted yield increased linearly with percentage of Jersey milk. This was also associated with increased fat and protein recoveries and lower yield of whey. The composition of whey was also affected by the percentage of Jersey milk, with lower whey protein and higher whey lactose and solids. Cutting time was lower when Jersey milk was used, but the cutting to milling time was higher because of slower acidity development. Hence, overall cheesemaking time was not affected by the use of Jersey milk. Using Jersey milk increased cheese fat content in autumn, winter, and spring and decreased cheese moisture in spring and summer. Cheese protein, salt, and pH levels were not affected. Cheese was analyzed for texture and color, and it was professionally graded at 3 and 8 mo. The effect of Jersey on cheese sensory quality was an increase in cheese yellowness during summer and a higher total grading score at 3 mo in winter; no other difference in cheese quality was found. The study indicates that using Jersey milk is a valid method of improving Cheddar cheese yield.
Key words: Jersey, Cheddar, cheese yield, cheese quality

INTRODUCTION

Milk composition has an important influence on the technical and economic efficiency of cheesemaking (Storry et al., 1983; Sundekilde et al., 2011). Milk suitability is modified by many factors such as diet, breed, protein genetic variant, health, season, and rearing condition. The effects of breed and protein genetic variants, which are interrelated, have been subject to increased interest (Barlowska et al., 2006). The Jersey, Brown Swiss, Montbéliarde, and other high milk solids–yielding breeds have been shown to have a positive effect on cheesemaking (Lucey and Kelly, 1994).

The Jersey (**J**) breed is the second-most-important dairy breed in the world, and it has been suggested that using J milk would improve the efficiency of the cheesemaking sector in Canada (Thompson, 1980), Wales (Hayes, 1983), and the United States (Capper and Cady, 2012) because of improved longevity, superior udder health, higher cheese yield, reduced feed and water requirement, and an overall reduction in the carbon footprint of Cheddar cheese production.

However, the use of J milk for Cheddar cheese production, although common, is still limited both in terms of the quantity used by individual cheesemakers and the number of cheesemakers using it. This could be linked to the lack of information available to cheesemakers on the effects of using J milk on the cheesemaking process and cheese yield.

Estimates of cheese yield from J were based mainly on theoretical cheese-yield equations, and theoretical increases ranged from 21 to 32% compared with Holstein-Friesian (**H-F**; Lundstedt, 1979; Geary et al., 2010; Capper and Cady, 2012). The only practical study measuring the actual improvement in yield did so using standardized milk and showed an increase of only 10% (Auldist et al., 2004).

There also appears to be a presumption in the industry that J milk has a negative effect on cheese quality. Cheese quality can be first defined as the compliance to legislation (International Food Standards, 2003), which specifies a minimum level of fat and maximum moisture. Second, quality can be defined as the cheese having the desirable organoleptic properties at the time of consumption, which is commonly assessed using grading at the cheese factories. In the case of J cheese, it is believed to have a higher moisture content due to the lower protein-to-fat ratio, resulting in lower syneresis (Bliss, 1988) and a buttery, weaker texture and rancid taste due to the higher fat content and larger, more fragile fat globules, causing early lipolysis (Cooper et al., 1911). However, these fears of negative effect

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were not supported by past data. Auldist et al. (2004) found that the moisture content and composition of J and H-F Cheddar cheeses made with standardized milk were not different, with the exception of a higher salt concentration and lower pH and ash concentration for J cheese. On the other hand, Whitehead (1948) found that Cheddar cheese from nonstandardized J milk had a lower moisture content and the cheese was also firmer. However, the cheesemaking process also had to be adapted to account for differences in acidity development and syneresis. Unfortunately, no information regarding yield was provided. Thus, information is lacking on the effect of J milk on Cheddar cheesemaking, composition, and sensory properties limiting its use on a commercial scale.

This study, therefore, investigated the effect of J milk, and blends of J and H-F, on Cheddar cheese production with the objective of finding the optimal inclusion rate of J milk in H-F milk for improving yield without reducing the quality of the cheese.

MATERIALS AND METHODS

Experimental Design

The experiment was carried out 3 times each season between September 2012 and November 2013. The seasons were defined as autumn (September, October, and November), winter (December, January, and February), spring (March, April, and May), and summer (June, July, and August).

Samples from the combined evening and morning milking were obtained from the university herd of H-F cows (CEDAR, Reading, UK) and 2 J farms (Brackley and Slough, UK) and transported to the pilot-scale cheesemaking facility at the University of Reading. Jersey milk was blended with H-F milk at 0, 25, 50, 75, and 100% J in H-F milk. Because of time limits, the ratios 25 and 75% were performed on alternate repeats. Thus, 4 samples were analyzed on each repeat, giving a total of 48 observations.

Milk Composition

Analysis for fat, protein, lactose, casein, urea content, and freezing-point depression and SCC were performed by the National Milk Laboratory (Glasgow, UK) using an infrared milk analyzer. The ratios of protein to fat and casein to protein were calculated from this data. Size of casein micelles and size of fat globules, expressed as volume moment mean D(4.3), surface area moment mean D(3.2), and volume mean diameter D(0.5) and span, were determined using a Zetasizer 500 (Malvern Instruments Ltd., Worcestershire, UK) and a Mastersizer S 2000 (Malvern Instruments Ltd.), respectively. Calcium ion concentration (Ca^{2+}) was determined using a Ciba Corning 634 ISE Ca^{2+}/pH Analyzer (Bayer Ltd., Newbury, UK) using the method of Lin (2002). Milk pH was measured using a FE20 desktop pH meter (Mettler-Toledo Ltd., Leicester, UK), and titratable acidity (**TA**) was measured using an acid-base titration with a Titralab automatic titrator (Radiometer Analytical, Villeurbanne, France) titrated with 0.1 *M* NaOH until pH 8.70 was reached, and expressed as Dornic acid (°D). All analyses were performed within 24 h of milk collection.

Cheesemaking Process

On each occasion 4 vats of cheese were made over 2 d. Bulk milk was pasteurized but not standardized, because standardization was not carried out by the large commercial cheese plant on which the cheesemaking process is based. Approximately 80 kg of milk was placed into each vat and warmed to 33°C. Starter (RSF 638, Chr. Hansen Laboratories A/S, Hørsholm, Denmark) was added at 0.0269 g/kg of milk and left to ripen for 35 min. Coagulant Marzyme 15 PF (Danisco, DuPont Company, Hertfordshire, UK) was then added at 0.2566 mL/ kg after being diluted 5-fold with water. Curd was cut at the cheesemaker's judgment. The curd and whey was heated to 39°C in 45 min and then left to scald at this temperature for 50 min. Whey was then drained, and the cheddaring process started when the TA reached 0.20 ± 0.05 °D. Curd was milled at TA 0.30 ± 0.05 °D and salt added at 24 g/kg of curd. Salted curds were left to cool and then filled into round molds of 5 kg and prepressed at 3 Pa up to 7 Pa, and left to press overnight at 7 Pa.

The yield and composition of the whey was determined from the whey collected between drainage until milling (Lactoscope, Advanced Instruments Inc., Drachten, the Netherlands). Yield was calculated from the weight of milk placed in the vat and the weight of cheese after pressing and vacuum packing. Yield was expressed both in actual yield, kilograms of cheese per 100 kg of milk, and adjusted yield using a fixed moisture content of 37%. Theoretical yield was also calculated using milk-composition data and the Van Slyke equation (Van Slyke and Price, 1949). Finally, cheese-yield efficiency was calculated using the actual yield as percentage of theoretical yield.

Additionally, fat and protein recoveries and losses were calculated using the composition and quantity of milk and whey based on the principle described by Banks et al. (1981). Time of addition of rennet to cutting, cutting to milling, and starter to milling was recorded.