J. Dairy Sci. 92:4745–4755
doi:10.3168/jds.2009-2146

Seasonal variation in the Dutch bovine raw milk composition

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ABSTRACT

In this study, we determined the detailed composition of and seasonal variation in Dutch dairy milk. Raw milk samples representative of the complete Dutch milk supply were collected weekly from February 2005 until February 2006. Large seasonal variation exists in the concentrations of the main components and milk fatty acid composition. Milk lactose concentration was rather constant throughout the season. Milk true protein content was somewhat more responsive to season, with the lowest content in June (3.21 g/100 g) and the highest content in December (3.38 g/100 g). Milk fat concentration increased from a minimum of 4.10 g/100 g in June to a maximum of 4.57 g/100 g in January. The largest (up to 2-fold) seasonal changes in the fatty acid composition were found for *trans* fatty acids, including conjugated linoleic acid. Milk protein composition was rather constant throughout the season. Milk unsaturation indices, which were used as an indication of desaturase activity, were lowest in spring and highest in autumn. Compared with a previous investigation of Dutch dairy milk in 1992, the fatty acid composition of Dutch raw milk has changed considerably, in particular with a higher content of saturated fatty acids in 2005 milk.
Key words: seasonal variation, milk composition, fatty acid, protein

INTRODUCTION

Milk and dairy products are important components of western diets. The composition of raw milk determines, to a large extent, the nutritional value and the technological properties of milk and dairy products. Therefore, the composition of milk is of great importance for the dairy industry and there is great interest in changing the composition of milk. The composition of milk varies with stage of lactation, feeding, health status of the cow. and genetic factors (Fox and McSweeney 1998). Because different countries use different breeds and feeding regimens and have different calving patterns and breeding practices, milk composition will also differ among countries. To gain insight into the milk composition in the Netherlands, it is therefore essential to examine the composition of the milk produced by Dutch cows.

The Dutch raw milk composition has changed during the past decades because of changes in the feeding regimen and breeding practices or other changes in dairy husbandry. For example, fat percentage increased from 3.8% in 1960 to 4.4% in 2005 (Eurostat, 2008). It is unclear, however, whether the composition of milk fat also changed during this period. A detailed overview of the milk composition is also needed to set a standard to detect favorable or unfavorable changes in the future. An investigation of Swedish dairy milk composition in the 1970s and in 1996 showed a substantial decrease in the CN content of Swedish raw milk during this period (Lindmark-Månsson et al., 2003). Such a decrease in CN content would also be unfavorable for the Dutch dairy industry, because in the Netherlands approximately 50% of the milk is used for cheese production.

When determining the composition of raw milk, it is important to realize that within one country the composition is not constant. Milk composition varies considerably throughout the seasons, as shown in multiple studies (Jahreis et al., 1996; Auldist et al., 1998; Lindmark-Månsson et al., 2003; Lock and Garnsworthy, 2003). These seasonal changes offer problems and opportunities for dairy manufacturers. Spreadability of butter, for example, is better when it is produced from summer fat compared with winter fat. Studies concerning seasonal variation have tended to be small scale and have studied milk samples from a limited number of cows from one herd (Jahreis et al., 1996; Auldist et al., 1998; Lock and Garnsworthy, 2003). However, milk composition between herds differs markedly, even within herds from the same breed (Stoop et al., 2008). Therefore, these studies may not give a reliable overview of the seasonal variation of the milk supplied to the dairy factories. To our knowledge, only a very limited number of studies have analyzed the raw milk composition that represents the total milk supply of a whole country

Received February 19, 2009.
Accepted June 18, 2009.
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Table 1. Analysis methods used to determine raw milk composition

Component	Method	Reference
Protein, NPN	ISO 8968-1	ISO (2001)
True protein	Calculated; protein, NPN	
CN	ISO 17997-1	ISO (2004a)
CN number	Calculated; CN/true protein	
Fat	ISO 1211	ISO (1999)
Lactose	ISO 22662	ISO (2005)
DM	NEN 6844	NEN (1991)
Cell count	ISO 13366-1	ISO (1977)
Urea	ISO 14637	ISO (2004b)
Freezing point	ISO 5764	ISO (2002)
Protein composition	Capillary zone electrophoresis	Heck et al. (2008)
Fatty acid composition	Gas chromatography	Schennink et al. (2007)

(Lindmark-Månsson et al., 2003). Furthermore, most studies concerning seasonal variation have analyzed samples only once a month or once a season (Muuse et al., 1986; Palmquist et al., 1993; Wolff et al., 1995; Jahreis et al., 1996). Kelly et al. (1998) and Elgersma et al. (2004) showed that milk composition changes when cows switch from a silage-based diet to a fresh grass-based diet and back. Because such changes in the diet of cows occur very rapidly (e.g., with changing weather conditions), milk composition can change markedly, even on a week-to-week basis. Therefore, to gain better insight into the factors that cause seasonal changes in milk composition in the Netherlands, a higher sampling interval is preferred.

The aim of this study was to provide an up-to-date standard for Dutch raw bovine milk composition and to investigate seasonal variation in the main components and in the composition of the protein and fat fractions. To achieve this, every week for 1 yr, we analyzed in detail the milk composition of 1 milk sample that was representative of the total Dutch milk supply.

MATERIALS AND METHODS

Samples and Methods of Analysis

The samples used were the same dairy milk samples that are collected routinely by the Dutch milk control station (MCS) as a representative Dutch milk sample. Every week from February 2005 until February 2006, bulk milk samples from 17 dairy plants situated in the Netherlands were collected, pooled, and conserved with 0.03% sodium azide. In total, 52 milk samples that were representative of the Dutch dairy milk composition in every week in 1 yr were analyzed. All 52 samples were analyzed for all the components using analytical methods, as summarized in Table 1.

Total saturated fat was calculated as the sum of C4:0, C5:0, C6:0, C7:0, C8:0, C9:0, C10:0, C11:0, C12:0, C13:0, C14:0 *iso*, C14:0, C15:0, C15:0 *iso*, C15:0 *anteiso*, C16:0, C16:0 *iso*, C17:0, C17:0 *iso*, C17:0 *anteiso*, C18:0, C19:0, and C20:0. Fatty acid unsaturation indices, namely, the C10 index, C12 index, C14 index, C16 index, C18 index, and conjugated linoleic acid (**CLA**) index, as proxies for Δ^9-desaturase activity in the mammary gland, were calculated from the ratio between the product and the sum of the product and precursor fatty acid as described by Schennink et al. (2008).

Statistical Analysis

The mean value for a component was calculated as the weighted mean of all 52 samples. For components that showed seasonal variation, the coefficient of variation (**CV**), and the minimum and maximum values were calculated. The minimum and maximum values were the monthly averages based on the 4 or 5 samples that represented these months. To determine the presence of seasonal variation in a milk component, the month of sampling was tested as a fixed effect in a general linear model using Genstat, 10th edition (VSN International Ltd., Hemel Hempstead, UK).

RESULTS AND DISCUSSION

Main Components

Holstein-Friesian is the predominant dairy breed in the Netherlands (NRS, 2008); therefore, the analyzed milk samples largely reflect the milk composition of Holstein-Friesian cows. Table 2 shows the mean values of several basic milk parameters of Dutch raw milk in 2005. In 2005, fat and protein percentages were higher in raw milk from the Netherlands than in milk from all other European countries in the same year (Eurostat, 2008). When comparing milk composition with the literature values of other countries, it is important to take into account the year in which the samples were taken. Large changes in milk composition in the past decades have occurred in many countries (Eurostat, 2008) be-