Comparison of Lipid Composition of Milk from Half-Danish Jersey Cows and United States Jersey Cows

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ABSTRACT

We studied differences in lipid composition of milk from Jersey cows with US sires and from Jersey cows with Danish sires. Milk samples were obtained on DHIA test day from 32 cows with Danish sires and 32 herdmates with US sires in two herds. The Jerseys with US sires were paired with those with Danish sires by parity and stage of lactation. Mean percentage of milk fat was 5.7% for Jerseys with Danish sires and 4.8% for Jerseys with US sires. Total fat per day was the same (.91 kg) for both groups. Detailed analysis of milk lipids indicated that lipid composition of milk was similar for cows with US sires and those with Danish sires. However, milk from Jerseys with Danish sires contained more free cholesterol than milk from Jerseys with US sires, 17.5 versus 14.3 ± .6 mg/dl. The proportion of polyunsaturated fatty acids was greater for milk from Jerseys with US sires than for milk from Jerseys with Danish sires (2.3 vs. 2.1%). Although lipid composition of milk from both groups was generally similar, the milk of Jersey cows with Danish sires had higher concentrations of free cholesterol and lower proportions of polyunsaturated fatty acids, both of which are possible negative factors for health of consumers.

(**Key words**: lipids in milk, half-Danish sires, Jersey cows, United States sires)

Abbreviation key: **DES** = Dairy Experiment Station, Lewisburg, Tennessee; **DJ** = half-Danish Jersey; **FA** = fatty acids; **UJ** = United States Jersey.

INTRODUCTION

Breeding schemes for the Jersey herd at the Dairy Experiment Station (Lewisburg, TN; **DES**) have been designed to improve milk production. Use of sires with high PTA for milk production has substantially improved production, but 38.6% of the DES females are related to three sires. In 1988, this herd averaged 6551 kg of milk, 320 kg of milk fat at 4.9% milk fat, and 246 kg of protein at 3.6% protein (1). These values exceeded the average for Jersey herds on DHI test and registered with the American Jersey Cattle Club by 393 kg of milk and 32 kg of milk fat.

Interest in comparison and quantification of the genetic composition of the US and Danish Jersey herds and concern over narrowing of the genetic base of the US Jersey breed have prompted importation of semen from Danish sires. Jerseys in Denmark produce less milk (5030 kg in 1992) than do US Jerseys, but their milk has a higher content of milk fat (10). Thus, the average production of 4% FCM of Danish Jerseys actually exceeds the average FCM production of US Jerseys (**UJ**). Within the last few years, semen from Danish sires

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has been used to produce half-Danish cows (Danish Jersey × UJ; **DJ**) in the DES herd and in the Randleigh herd at North Carolina State University, Raleigh. Current research has shown that crossing UJ and Danish strains of Jersey cattle resulted in some hybrid vigor for production traits. Thus, crosses of UJ and Danish Jerseys averaged about 2% more milk and fat (10, 11). The objective of this study was to determine how the introduction of genes from Danish Jersey sires affected lipid composition in milk of cows sired by Danish bulls in two herds. The lipid composition of milk fat from this newly formed genetic group (DJ) was characterized and compared with that of UJ.

MATERIALS AND METHODS

Breeding Program

This experiment was conducted with Jersey cows of the Randleigh herd at North Carolina State University and with Jersey cows of the DES as a joint project of the ARS, USDA and the University of Tennessee. The 32 DJ cows consisted of the offspring from 15 Danish sires (21 cows from North Carolina State University and 11 cows from DES). These cows were compared with 32 UJ (21 cows from North Carolina State University and 11 cows from DES). All records were from first lactations.

Lipid Analysis

Milk samples were collected at the time of DHIA monthly test and shipped on ice (0°C) by overnight carrier to Beltsville for lipid analysis. Samples were extracted into 2:1 (vol:vol) chloroform:methanol by the Folch procedure (8) immediately upon arrival.

Lipid classes in the total lipid extract were determined by quantitative densitometry in situ (3, 4), following separation by two-stage TLC (6) on 20- × 20-cm Si250-PA(19C) Baker laned preadsorbent silica gel plates (J. T. Baker Inc., Phillipsburg, NJ). After TLC development, the separated lipids were visualized by charring and quantitatively measured by in situ spectrophotodensitometry (Shimadzu CS-930 Dual Wavelength TLC Scanner; Shimadzu Scientific Instruments Inc., Columbia, MD). Optical densities of sample zones were compared with least squares regression lines of standards for individual lipid classes to determine the amount of each class present in the sample.

Total fatty acids (**FA**) were transmethylated with acetyl chloride (9) and determined by wide bore capillary GLC (5). The FA methyl esters were analyzed by a gas chromatograph (Hewlett-Packard 5890; Hewlett-Packard Co., Palo Alto, CA) equipped with a flame ionization detector on a 15-m × .32-mm i.d. fused silica open tubular capillary column cross-linked with a 1.0-μm film of DB 225 (J & W Scientific Inc., Folsom, CA). Peak amounts were determined using the method of an internal standard (methyl nonanoate), and report data were stored and analyzed by computer. Identities of FA methyl esters and their relative responses were determined by GLC of known quantitative standards.

Statistical Analysis

Comparisons were by analysis of variance with the general linear models procedure of SAS (12). Main effects of breed, herd, and interactions of breed and herd were examined for significance (7).

RESULTS AND DISCUSSION

Milk Production and Composition

Least squares means for milk production and composition are in Table 1. The DJ cows produced less milk than the UJ cows. The milk from DJ cows had higher percentage of fat (5.67 vs. 4.77%) and protein (4.09 vs. 3.74%) than milk from UJ cows (Table 1; $P < .0001$). These changes in milk composition were consistent with the higher fat and protein contents of milk from Jerseys in Denmark. The higher milk yield and lower fat yield of UJ cows in the present study agree well with records from

TABLE 1. Milk production and composition of US Jersey (UJ) and half-Danish (DJ) Jersey cows.

Item	UJ	DJ	SE	$P <$
n	32	32		
Milk, kg	5177	4729	87	.002
Fat,				
kg	544	591	9.1	.0001
%	4.77	5.67	.07	.0001
Protein,				
kg	425	425	7.7	NS[1]
%	3.74	4.09	.04	.0001

[1]$P > .05$.

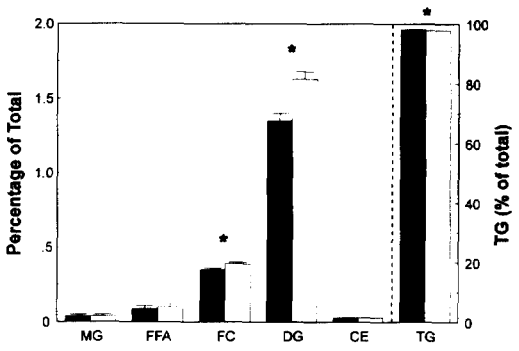

Figure 1. Lipid classes of milk of US (solid) and half-Danish (open) Jersey cows. Asterisks above columns denote a significant difference between the groups ($P < .05$). CE = Cholesteryl esters, DG = diglycerides, FC = free cholesterol, MG = monoglycerides, and TG = triglycerides.

a large population of UJ and Danish Jersey crosses recently reported (11). The higher fat composition of milk from DJ cows might be a possible positive factor for milk processing requirements (e.g., for cheese production).

Figure 1 compares neutral lipids of the milk from UJ and DJ cows, expressed as a percentage of total neutral lipids. The milk from DJ cows contained more free cholesterol than milk from UJ cows, based on concentration (17.5 vs. 14.3 mg/dl; $P < .0004$) and as a percentage of total lipid (.39 vs. .35%, $P < .002$). The milk from DJ cows also contained more diglycerides than milk from UJ cows (73.6 vs. 55.3 mg/dl, $P < .0001$; 1.63 vs. 1.35%, $P < .0005$). Total triglycerides were higher in milk from UJ cows than from milk of DJ cows (98.14 vs. 97.80%, $P < .0001$).

The very significant increase in fat percentage, which reflects an increase of milk fat synthesis for the DJ cows, was accompanied by changes in the concentrations and proportions of some FA (Figure 2). The FA of milk fat from $C_{4:0}$ to $C_{14:0}$, in addition to about 50% of $C_{16:0}$, arise from de novo synthesis within the mammary gland (2). In contrast, the

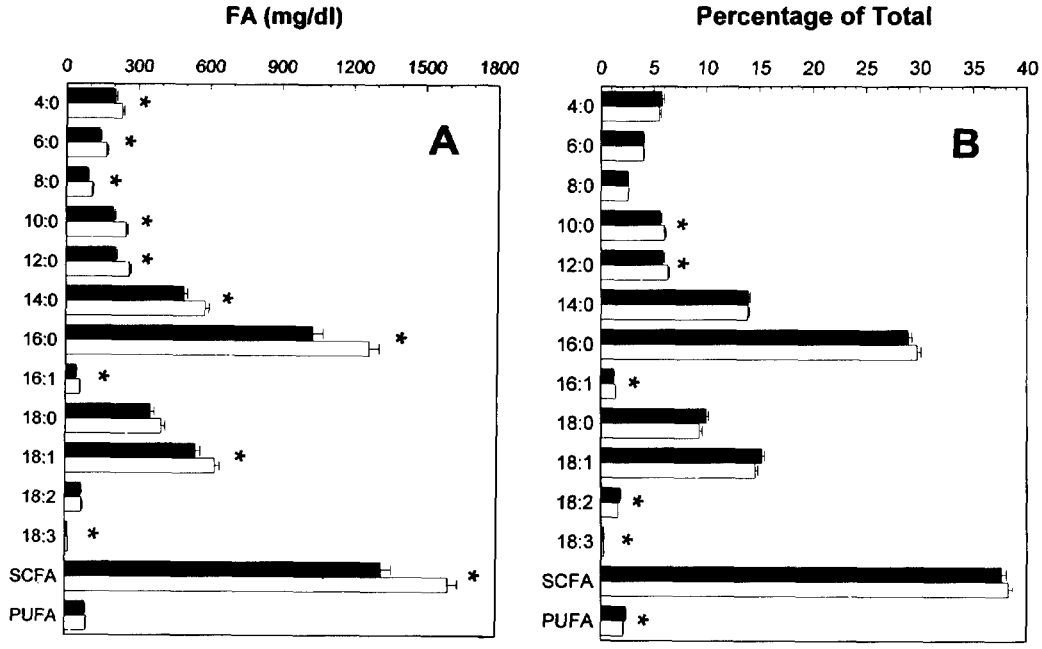

Figure 2. Changes in fatty acid (FA) composition (carbon chain length:number of double bonds) of milk of US (solid) and half-Danish (open) Jersey cows. The FA concentrations are expressed as milligrams per deciliter (A) and FA composition (B) as percentage of total FA. Asterisk columns denote a significant difference between the groups ($P < .05$). SCFA = Short- and medium-chain FA; PUFA = polyunsaturated FA.

longer chain FA are supplied from circulating lipids and arise from dietary sources or from depot lipids. The increase of milk fat synthesis for the DJ cows increased the concentrations of the short- and medium-chain FA of the milk (Figure 2A). The total concentration of polyunsaturated FA ($C_{18:2}$, $C_{18:3}$, $C_{20:3}$, $C_{20:4}$; however, $C_{20:3}$ and $C_{20:4}$, present in extremely low concentrations; not shown in Figure 2A) did not increase for the DJ cows. Figure 2B shows the FA in milk as percentages of total FA. In general, comparison of the lipid composition of milk of DJ cows with UJ cows (Figure 2B) reveals that the relative proportions of the FA present for both groups were similar, although some individual FA showed small changes. The medium-chain FA ($C_{10:0}$ and $C_{12:0}$) and $C_{16:1}$ increased slightly, but $C_{18:2}$ and $C_{18:3}$ decreased slightly. The proportions of total polyunsaturated FA were lower for DJ cows than for UJ cows (2.1 vs. 2.3%, $P < .04$) (Figure 2B).

Overall, the introduction of Danish semen into the UJ population has positive and negative implications. Increased genetic variation and higher fat yield of milk from DJ cows are provided, and FA composition is only slightly changed. The higher concentrations of free cholesterol and lower proportions of polyunsaturated FA in milk from DJ cows were statistically significant, but the very slight differences do not appear to be biologically significant as negative factors for consumer health. However, the lower milk production of the DJ cows, 448 kg less milk (Table 1), is a negative feature.

CONCLUSIONS

Comparison of the composition of milk from UJ cows and from the DJ cows demonstrates that only minor effects were encountered. All of the possible positive and negative economic, nutritional, and efficiency parameters should be considered. There appears to be little to be gained from the introduction of Danish Jersey germplasm into the UJ population. Milk production of DJ cows was lower than that of UJ cows, but fat percentage was much higher for milk of DJ cows. Other possible effects of introducing Danish germplasm, such as the impact on mastitis frequency and longevity, were not investigated.

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