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THE MILK FATTY ACID COMPOSITION AND CONJUGATED LINOLEIC ACID CONTENT OF JERSEY AND FLECKVIEH X JERSEY COW MILK IN A PASTURE BASED FEEDING SYSTEM

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SUMMARY

A number of fatty acids like omega-3, omega-6 and conjugated linoleic acid (CLA) present in the milk from dairy cows are considered beneficial nutrients for humans. The aim of the study was to compare the milk fatty acid (FA) content, particularly the CLA, omega-3, omega-6 FA content of the milk fat of Jersey (J) and Fleckvieh x Jersey (FxJ) cows in a pasture-based feeding system. All cows were fed the same diet consisting of kikuyu-ryegrass pasture supplemented with a standard concentrate mixture at 7kg per cow per day. Four to five milk samples were collected every five weeks from 10 days after calving (DIM) up to 175 DIM. In addition, two further samples were collected every five weeks from 240 DIM to the end of the lactation. All milk samples were collected at the evening and the next morning's milking and pooled for each cow. Samples were kept frozen at -20°C until laboratory analysis by gas liquid chromatography. Thirty six FAs were detected and concentration levels determined. All milk samples (128 for J and 239 for FxJ) were used to compare breeds for FA content. Total omega-6 and total CLA differed ($P<0.01$) between breeds being 1.571±0.040 and 1.754±0.029 and 0.630±0.023 and 0.740±0.018 g per 100 g milk fat for J and FxJ cows, respectively. For both breeds the CLA content of the milk fat showed a curvilinear increase with lactation stage possibly indicating a standard sampling time to determine cow differences for genetic merit analysis. Further studies are required to determine the milk FA composition in different milk products.

INTRODUCTION

The fat component of milk has for many years been regarded as unhealthy because of its affect on heart diseases in humans (Salter 2005). Health practitioners recommend that the fat content of the human diet be reduced for protection against cardiovascular diseases and some forms of cancer. This has resulted in the popularity of fat free and low fat milk (0 and 2% fat respectively) as well as low fat cheese and yoghurt products. However, the fat in milk is made up by a large number of saturated and unsaturated FAs each contributing differently to the health of people. Bovine milk is increasingly being recognized as an important source of energy, high-quality protein, and essential minerals and vitamins (Heaney 2000 and Neuman *et al*. 2003). The fat in milk has recently acquired an improved status as new research has shown that some FAs have a beneficial effect on the health status of people. It is especially omega-3 FA and conjugated linoleic acid (CLA) that have anticarcinogenic, antidiabetic and antidipogenic effects. The amount of CLA in cows' milk is affected mostly by their diet and healthy FAs increase when cows are on pasture (Mitchell and McLeod 2008) or when feeds such as extracted soy beans and cottonseed are fed (Collomb *et al*. 2006). While diet has a major influence on milk fat CLA (Chilliard *et al*. 2001), the effects of factors such as breed, stage of lactation and parity on the CLA content in milk fat have received little attention (Kelsey *et al*. 2003). Some studies indicated breed differences in CLA content (Lawless *et al*. 1999) with Montbéliarde having 13% greater CLA content in milk fat in comparison to Irish Holstein/Friesian, Dutch Holstein/Friesian and Normande. Large differences are observed among individual cows receiving the same diet (Kelsey *et al*. 2003). Crossbreeding is a means to overcome some breeding problems like fertility and longevity in some dairy breeds (Funk 2006). Recently, attention has been given towards using dual-purpose breeds in crossbreeding programmes to increase the beef production of crossbred animals while maintaining the milk yield of cows. The Fleckvieh, a Simmental-derived breed from Germany is one such breed. A study in Canada has shown that the milk from Fleckvieh x Holstein cows produced more CLA than purebred Holsteins under similar feeding conditions (Patrick *et al*. 2000, Lock & Bauman 2004). The aim of the paper was to compare the milk FA content of the milk of J and FxJ cows in a pasture-based feeding system.

MATERIAL AND METHODS

Location and Animals. This paper was based on an on-going breed comparison at the Elsenburg Research Farm of the Western Cape Department of Agriculture (Muller *et al*. 2009). Elsenburg is situated approximately 50 km east of Cape Town in the winter rainfall region of South Africa. The area has a typical Mediterranean climate with short, cold, wet winters and long, dry hot summers. To create two comparative pure- and crossbred dairy herds, all available J cows (n=46) were divided into two groups according to estimated breeding value for milk yield. Groups were randomly allocated to be inseminated by J or F bulls. During the following lactation period cows were inseminated with the alternative sire breed. The progeny born from the J and F sires were further inseminated with the same breed. Subsequently, the production performance of J (n=56) and FxJ (n=64) cows and their progeny was compared in a partly pasture-based feeding system. This consisted of mostly kikuyu pasture supplemented with a commercial concentrate mixture at 7 kg per cow per day regardless of milk yield and lactation stage. During winter the pasture was supplemented with a mixture of oats and lucerne hay. Fresh drinking water was freely available at all times.

Milk sample collection and analysis. Milk samples for FA analysis were collected and recorded every five weeks according to milk recording procedures. At each milk recording event, milk samples were collected from cows of both breeds. Milk was sampled from 10 days after calving (DIM) to about 175 DIM (milk tests 1 to 5) and thereafter from 240 DIM (milk tests 7 to 8). Milk samples were collected at the evening and next morning's milking session and combined. Milk samples were kept frozen at -20°C until laboratory analysis. Fatty acid composition of milk samples was obtained by gas liquid chromatography at the PROMEC Unit of the Medical Research Council. Thirty six FA were detected and concentration levels determined.

Statistical analyses. All milk samples (128 for J and 239 for FxJ) were analysed for 36 FAs. In the current study only the major FAs were presented. FAs were compared between breeds by analysis of variance using samples of all cows within breed as replicates using the GLM procedure (SAS Institute Inc.).

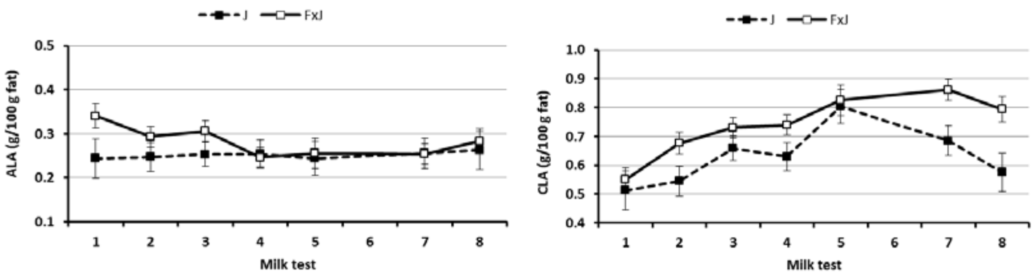
RESULTS AND DISCUSSION

Some FAs differed ($P<0.05$) between breeds being 1.533±0.032 and 1.664±0.025 for omega-6, and 0.621±0.021 and 0.725±0.015 g/100 g fat for total CLA content for J and FxJ cows, respectively (Table 1). The specific FAs trans 18:1, 18:2n-6 (LA, linoleic acid) and the main CLA isomer, C9 T11 18:2, also differed ($P<0.05$) between breeds. No significant difference in the omega-3 FA, α-linolenic acid (ALA, 18:3n-3) was observed. Maurice-Van Eijndhoven *et al*. (2011) compared 4 cattle breeds in the Netherlands, showing breed differences although results were confounded with breed-herd effects as only one breed per farm was sampled. Grazing- or non-grazing-based feeding systems largely influences milk FA composition (Palmquist *et al*. 1993). Kelsey *et al*. (2003) compared Holstein and Brown Swiss cows being fed a single diet and milk sampled on the same day to avoid confounding effects of diets and season. However, only minor differences between these two breeds were found. The CLA content of milk fat varied over threefold among individual cows. In the present study cows from both breeds were under similar feeding and management conditions.

Table 1. The mean±se fatty acid content (g/100 g fat) of the milk Jersey (J) and Fleckvieh x Jersey (FxJ) cows in a partly pasture-based feeding system (LA = linoleic acid; CLA = conjugated linoleic acid; ALA = α-linolenic acid)

	Breeds		P-values		
Fatty acids	J	FxJ	Breeds	Test	Breed x Test
Trans 18:1	0.918±0.026	1.018±0.020	0.003	0.019	0.723
LA n-6, 18:2	1.356±0.036	1.509±0.027	0.001	0.003	0.277
CLA (C9, T11, 18:2)	0.589±0.022	0.690±0.017	0.001	0.001	0.376
ALA n-3, 18:3	0.252±0.014	0.283±0.011	0.083	0.807	0.697
Total n-6	1.571±0.040	1.754±0.029	0.001	0.007	0.302
Total n-3	0.314±0.016	0.350±0.012	0.070	0.859	0.554
Ratio n-6/n-3	5.517±0.172	5.590±0.130	0.738	0.085	0.879
Total CLA	0.630±0.023	0.740±0.018	0.001	0.001	0.456

The results of milk recording test as affected by lactation stage or DIM on the content of ALA and total CLA is presented in Figure 1. While the level of ALA was not affected (P>0.05) by milk test event based on increasing DIM, for both breeds the CLA content in the milk fat increased potentially following a curvilinear trend ($R^2 = 0.74$ and $R^2 = 0.88$ for J and FxJ, respectively). This would suggest that for CLA, a standard sampling time should be considered to determine cow differences for genetic merit analysis or that results should be adjusted for lactation stage or DIM. The CLA content of both J and FxJ milk increased (P<0.05) by more than 40% from early in the lactation (<40 DIM) to later in lactation (>140 DIM). Similar trends were not observed for other FAs. However, Kelsey *et al*. (2003) found that lactation stage (DIM) had little effect (<2.0% of the total variation) on the CLA content of the milk fat of Holstein cows consuming a total mixed ration. Auldist *et al*. (1998) also found a small increase from 7.9 mg/g in early lactation (~30 DIM) to 9.7 mg/g FA in late lactation (~210 DIM). According to Stanton *et al*. (1997) lactation stage had no effect on CLA levels in milk fat, however, these studies were limited in scope, i.e. 36 cows ranging from 12 to 93 DIM. Frelich *et al*. (2009) found significant differences (P<0.05) between farms in the concentration of five FAs while 16 FAs of milk fat differed (P<0.01) between the indoor and the grazing period indicating the effect of pasture on FA content. The content of long-chain (>C16), mono- and poly-unsaturated FAs and CLA in the milk fat was higher in the grazing period. These results indicated a positive influence of seasonal grazing on the FA profile of cow milk fat as regards to its potential health effects for consumers (Frelich *et al*. 2009).



(a) (b)

Figure 1. The (a) ALA and (b) total CLA (b) content of the milk of Jersey (■) and Fleckvieh x Jersey (□) cows as affected by milk test

CONCLUSION

Some FAs differed between breeds although not all differences were significant. To demonstrate breed differences requires a significant number of animals from each breed. Milk test combined within DIM as per standard milk recording affected the CLA content of both J and FxJ milk which increased by more than 40% from early- to mid-lactation. Further studies are required to determine the FA composition in different milk products.

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