J. Dairy Sci. 98:1–15
http://dx.doi.org/10.3168/jds.2014-8322

Fatty acid profile differs between organic and conventionally produced cow milk independent of season or milking time

B. H. Schwendel,*[1] P. C. H. Morel,† T. J. Wester,† M. H. Tavendale,* C. Deadman,‡ B. Fong,‡ N. M. Shadbolt,† A. Thatcher,† and D. E. Otter*
*AgResearch Grasslands Research Centre, Tennent Drive, Palmerston North 4442, New Zealand
†Massey University, Tennent Drive, Palmerston North 4474, New Zealand
‡Fonterra Research Centre Palmerston North, Dairy Farm Road, Palmerston North 4474, New Zealand

ABSTRACT

Differing amounts of fresh forage and concentrates fed, and level of input contributes to the differences reported in fatty acid (FA) composition of organic and conventionally produced cow milk. In many previous studies designed to investigate this phenomenon, comparisons were made between grazed organic cows and housed conventional cows. In the present study, we have investigated differences between organic and conventional milk produced using year-round pasture grazing, as practiced in New Zealand. The FA composition was determined in milk sampled at morning and evening milking in both spring and autumn. Samples were taken from 45 cows from the Massey University organic herd and compared with 50 cows from the corresponding conventional herd grazed and managed similarly at the same location. Forty-three out of 51 analyzed FA were influenced by season, whereas 28 were different between production systems. In addition, one-half were also different due to time of milking. Levels of linoleic acid and α-linolenic acid were higher in organic milk, whereas conjugated linoleic acid (CLA) and vaccenic acid were higher in conventional milk. The first 3 FA (linoleic acid, α-linolenic acid, and CLA) were more abundant in milk harvested during autumn, and the CLA concentration was also significantly influenced by time of milking. Our results confirm reports that the FA profile is affected by season and time of milking, and we also showed an effect due to the production system, when both sets of cows were kept continuously on pasture, even after taking milking time and seasonal effect into account.
Key words: milk, fatty acid, organic, milking time

INTRODUCTION

Milk contains approximately 400 different FA, which makes it the most complex natural fat system (Lindmark Månsson, 2008). The FA profile in cow milk is influenced by diet, with variations predominantly caused by differing amounts of fresh forage and concentrates eaten (Croissant et al., 2007; Coppa et al., 2013). Other factors reported to influence the FA profile of milk include differences within and between breed (Soyeurt et al., 2008; Maurice-Van Eijndhoven et al., 2011), season (Heck et al., 2009), climate (Kamleh et al., 2010), stage of lactation (Craninx et al., 2008), and management (Fall et al., 2008). Any of those factors, as well as the interactions between them, might contribute to the concentration of individual FA in milk, with many of the mechanisms behind those effects not fully understood. Consequently, when attempting to study the effect of one specific factor (e.g., diet) on milk FA profile, it is necessary to eliminate, or to account for and control, other potential influences. Estimations of the differences between the FA composition of milk from organic and conventional farming systems are compromised in that many studies investigating the compositional disparities between organic and conventionally produced milk have not considered or been able to control factors that could have resulted in, or contributed to, such differences (e.g., diet, breed, and so on). Consequently, differences were attributed solely to the effect of the farming system. Many studies to date reporting differences between organic and conventionally produced milk have not used similar diets. It has to be acknowledged that this factor is most likely to differ between these systems. This demonstrates the difficulty when comparing data from organic and conventional farm data, because the factors that constitute the differences between the systems are, in most countries, irrevocable components of the systems. On the other hand, studies investigating the effect of diet did not consider the possible effect of the farming system (organic vs. conventional). Additionally, comparisons among stud-

Received May 4, 2014.
Accepted November 27, 2014.
[1]Corresponding author: Heike.Schwendel@AgResearch.co.nz

ies are problematic because it is difficult to account for any number of variables, including sampling conditions, inherent differences in farming systems among regions, levels of inputs, and even regulatory differences in conventional and organic production among countries. This may explain the differences in quantity for individual FA in and between systems as reported in different studies comparing organic and conventionally produced milk (Ellis et al., 2006; Collomb et al., 2008; Slots et al., 2009). A study with multiple side-by-side organic versus conventionally managed pasture-based herds observed over several years would be desirable to account variation within each system at different locations and climatic conditions. In practice, however, it has not been possible to identify several farms that would be able to exclude the variety of influence factors we were able to exclude in our study.

The aim of the present study was to determine whether differences are present in FA composition between organic and conventional cow milk produced in an all-year-round pasture grazing system as commonly used in New Zealand.

MATERIALS AND METHODS

Farm and Herd Data

During the 2010 to 2011 milking season, milk samples were collected from individual cows of one organic (45 cows) and one conventional herd (50 cows) at Massey University, Palmerston North, New Zealand (Kelly et al., 2005). Both herds were derived from a single herd, which was divided in 2001 after taking breeding value, production value, somatic cell count, age, and parity of each individual animal into account to create 2 matching herds. Characteristics of both farms and herds during the 2010 to 2011 milking season are averaged over the milking season and listed in Table 1, with animal data originating from monthly herd testing. Milking was conducted at 0600 h in the morning and 1400 h in the afternoon, with cows given access to new pasture after each milking event. Daylight hours were from 0544 to 2033 h, and from 0714 to 1947 h in spring and autumn, respectively. The amount of pasture available for each cow before milk sample collection in spring was 9.0 and 9.3 kg of DM for conventional and 11.8 and 11.8 kg of DM for organic cows, in the morning and afternoon, respectively. In autumn, the amount of pasture available was 8.1 and 8.1 kg of DM for conventional and 11.4 and 8.7 kg of DM for organic cows in the morning and afternoon, respectively.

A cider vinegar-garlic mixture (Dairy-Mate Direct Health Products Ltd., Nelson, New Zealand) was added daily to the water trough of organic cows, as a food supplement and natural antibiotic (Ozturk et al., 2009). This resulted in an estimated consumption of 10 mg of garlic oil per cow per day. Additionally, during late spring and early summer (October–December), organic cows were drenched daily with approximately 18 g (20 mL) of fish oil (BioSea Ltd., Nelson, New Zealand), to

Table 1. Farm and animal characteristics averaged over lactation period for organic and conventional herds

Item	Organic	Conventional
Farm factor		
Number of cows	45	50
Stocking rate cow/ha	2.2	2.4
N fertilizer application, kg/ha	14.7 organic fertilizer[1]	123.0 urea, ammonium sulfate
Herbage yield, t of DM/ha	10.4	11.4
Animal factor		
Breed,[2] %		
Friesian	56.1	77.7
Jersey	40.2	21.0
Ayrshire	1.1	
Mean days in lactation at sampling in spring/autumn	90/202	100/212
Mean breeding worth[3]	79	94
Mean production value	95	112
Mean age, yr	3.7	4.0
Mean milk volume, L/cow per day	17.2	17.8
Mean milk protein, %	3.67	3.60
Mean milk fat, %	5.53	5.00
Mean SCC, × 1,000 cells/mL	163.1	151.6

[1]Osflo Fertilizer Ltd., New Plymouth, New Zealand.

[2]Average blood blend of the herd.

[3]New Zealand ranks dairy cows by their expected ability to breed high merit replacements, described as breeding worth.