Bovine Milk Fats and Organic Dairying


Abstract: Organic milk is seen as more healthy in terms of its fatty acid (FA) profile. In three on-farm crossover trials with 10–12 cows in each group, different forages were compared for their potential to improve the FA composition. Different hay qualities (hay of pasture vs. hay of leys), additional energy sources (fodder beets vs. wheat) and roughage qualities (hay of pasture vs. grass silage) were compared for their effect on the FA composition of the milk. Rumenic acid (CLA cis-9, trans-11) and alpha-linolenic acid (ALA) were selected as principal markers to evaluate effects. The overall CLA cis-9, trans-11 was low (3.6–6.3 g kg−1 fat), whereas ALA levels were intermediate (6.8–9.4 g kg−1 fat). Differences between the forages were explained by the fat metabolism of the ruminants. Organic winter milk is low in several desirable FAs. Diets rich in mature fodder and sugar were a poor choice for an improved FA composition.

The authors include in this article, a note that it is known that feeding of oil seeds is a secure way to modulate FA composition but they are expensive and others have suggested that direct uptake of these seeds in the human diet would be more effective than feeding them to cows.

Their study looked at different forages fed in the winter to maintain beneficial fatty acid profile: these included comparing traditional hay from permanent pasture vs “ley” (species mix with more legumes), fodder beets vs wheat concentrate, and hay vs silage. They conclude that “fodder will not be improved by additional feeding of sugar-based fodders like fodder beets or grains. Within the choice of roughages, an improvement of the FA composition can be achieved by artificial drying of hay and/or hay based on leys of grass and clover.”


Abstract: Organic production methods have in the past been shown to have benefits for the environment, biodiversity, soil quality, animal welfare and reduced pesticide residues. In addition to these qualities they may also contribute directly to human health. In an exploratory study, raw (bulk) cow’s milk from five organic and five neighbouring conventional farms were compared at the end of the winter housing period. Farm management clearly differed; e.g. organic cows ate less concentrates and forage maize, and more silage of grass clover and hay. The levels of CLA (conjugated linoleic acid) and omega 3 fatty acids were significantly higher in the organic milk. No clear difference in taste was observed: the organic milk was generally considered creamier and tended to taste more of hay and grass than conventional milk. An indication of the health status of the cows was obtained by immunological research. In the organic milk the lymphocyte rest value tended to be lower and after stimulation the cells from organic milk had a higher stimulation index than those in conventional milk. In addition to the more conventional milk analysis two experimental holistic methods were used as an indicator of milk quality: biophoton emission and biocrystallization. These methods showed that organic milk was systematically more ‘balanced’: it had a more ‘ordered structure’ and showed better ‘integration and coordination’. From this pilot study it can be concluded that overall the organic milk scored better than the conventional milk for both the conventional and holistic measures. Whether these results have an impact on human health needs to be explored in other studies.


Abstract: The effect of supplementing the diet of grazing dairy cows with fish oil (FO) and linseed oil (LSO) on milk conjugated linoleic acid (CLA) was investigated. Sixteen Holstein cows (170±19 DIM) were assigned into two groups and fed a grain supplement (8.0 kg/d; DM basis) containing 800 g of saturated animal fat (CONT) or 200 g FO and 600 g LSO (FOLSO). All cows grazed together on Sudan grass pasture ad libitum and were fed the treatment diets for 3 wks. Cows were milked twice a day.
and milk samples were collected during the last three days of the trial. Milk production (24.89 and 22.45 kg/d), milk protein percentage (2.76 and 2.82) and milk protein yield (0.68 and 0.64 kg/d) for the CONT and FOLSO diets, respectively, were not affected (p>0.05) by treatment diets. Milk fat percentage (3.90 and 2.86) and milk fat yield (0.97 and 0.64 kg/d) were lower (p<0.05) with the FOLSO diet compared with the CONT diet. The concentration and yield of milk cis-9 trans-11 CLA were higher (p<0.05) with the FOLSO diet (2.56% of total FA and 16.44 g/d). respectively) and lower concentrations of cis-9 trans-11 CLA content compared with the CONT diet (0.66% of total FA and 6.44 g/d, respectively). The concentrations of milk trans C18:1 and vaccenic acid (VA) were higher (p<0.05) with the FOLSO diet (13.53 and 7.48% of total FA) respectively) compared with the CONT diet (3.69 and 2.27% of total FA). In conclusion, supplementing the diet of grazing cows with FO and LSO increased milk cis-9 trans-11 CLA content but reduced milk fat content and yield.


Abstract: Previous studies showed differences in fatty acid (FA) and antioxidant profiles between organic and conventional milk. However, they did not (a) investigate seasonal differences, (b) include non-organic, low input systems or (c) compare individual carotenoids, stereoisomers of α-tocopherol or isomers of conjugated linoleic acid. This survey-based study compares milk from three production systems: (i) high-input, conventional (10 farms); (ii) low-input, organic (10 farms); and (iii) low-input non-organic (5 farms). Samples were taken during the outdoor grazing (78 samples) and indoor periods (31 samples). During the outdoor grazing period, on average, milk from the low-input systems had lower saturated FAs, but higher mono- and polyunsaturated FA concentrations compared with milk from the high-input system. Milk from both the low-input organic and non-organic systems had significantly higher concentrations of nutritionally desirable FAs and antioxidants – conjugated linoleic (60% and 99%, respectively) and α-linolenic (39% and 31%, respectively). acids, α-tocopherol (33% and 50%, respectively) and carotenoids (33% and 80%, respectively) – compared with milk from the high-input system. Milk composition differed significantly between the two low-input systems during the second half of the grazing period only; with milk from non-organic cows being higher in antioxidants, and conjugated linoleic acid, and that from organic cows in α-linolenic acid. In contrast, few significant differences in composition were detected between high-input and low-input organic systems when cows were housed. They concluded that milk composition is affected by production systems by mechanisms likely to be linked to the stage and length of the grazing period, and diet composition, which will influence subsequent processing, and sensory and potential nutritional qualities of the milk.

Of their results, they found that, on average, the total fat content was higher in milk from what they called “low input” systems (LI) compared with the “high input” system (HI), and was significantly higher for the non-organic LI system compared with the HI system. Note that all cattle in this study were grazed; the HI group received grass silage and concentrates during indoor feeding—outdoor: 37% fresh forage, 29% stored, 34% concentrate; indoor: 56% stored; 44% concentrate—while the organic LI group has fed “conserved forage-based diets during the winter indoor period”—outdoor: 84% fresh, 8% stored, 8% concentrate; indoor: 24% fresh, 54% stored, 23% concentrate—and the non-organic LI group had only fresh forage—outdoor: 95% fresh, 5% concentrate; indoor: same.

They conclude that “The finding of lower percentages of SFA and contrasting higher percentages of MUFAs in milk from the NO-LI system and higher PUFA (specifically α-LA and CLA9) and antioxidant content (α-tocopherol and β-carotene) of milk from both LI systems, compared with that from HI farms during the outdoor grazing period, is not surprising in view of the contrasting diets, i.e. LI with more than 80% of DMI from fresh forage vs less than 40% with HI.


Abstract: This study of UK retail milk identified highly significant variations in fat composition. The survey, conducted over 2 yr replicating summer and winter, sampled 22 brands, 10 of which indicated organic production systems. Results corroborate earlier farm-based findings considering fat composition of milk produced under conventional and organic management. Organic milk had higher concentrations of beneficial fatty acids (FA) than conventional milk, including total polyunsaturated fatty acids (PUFA; 39.4 vs. 31.8 g/kg of total FA), conjugated linoleic acid cis-9,trans-11 (CL9; 7.4 vs 5.6 g/kg of FA), and linoleic acid (α-LN; 6.9 vs. 4.4 g/kg of FA). As expected, purchase season had a strong effect on fat composition: compared with milk purchased in winter, summer milk had a lower concentration of saturated fatty acids (682 vs. 725 g/kg of FA) and higher concentrations of PUFA (37.6 vs. 32.8 g/kg of FA), CL9 (8.1 vs. 4.7 g/kg of FA), and α-LN (6.5 vs. 4.6 g/kg of FA). Differences identified between sampling years were more surprising; compared with that in yr 2, milk purchased in year 1 had higher concentrations of PUFA (37.5 vs. 32.9 g/kg of FA), α-LN (6.0 vs. 5.1 g/kg of FA), and linoleic acid (19.9 vs. 17.5 g/kg of FA) and lower concentrations of CL16:0 and CL14:0 (332 vs. 357 and 110 vs. 118 g/kg of FA, respectively). Strong interactions were identified between management and season as well as between season and year of the study. As in the earlier farm studies, differences in fat composition between systems were greater for summer compared with winter milk. Large between-year differences may be due to changes in weather influencing milk composition through forage availability, quality, and intake. If climate change predictions materialize, both forage and dairy management may have to adapt to maintain current milk quality. Considerable variation existed in milk fat composition between brands.
Increasing fresh forage intake or the use of vegetable oil and oilseeds supplements have been shown to increase PUFA supply in ruminant diets and alpha-LN, CLA, and total PUFA concentration in milk fat. Total SFA concentration did not differ between management systems, however, concentration of myristic acid (C14:0) a FA thought to carry the highest CHD risk was significantly higher in organic.


Abstract: During a 12-month study, bulk-tank milk was collected monthly from 3 dairies each of which collected both organic and conventional milks (from integrated farming) in the mountain regions of Switzerland. All milk samples were analyzed for fatty acid (FA) composition. Organic and conventional milks did not significantly differ with respect to saturated FA (SFA) nor **trans** FA contents, but organic milk had significantly higher contents of polyunsaturated FA (PUFA) (p<0.01), conjugated linolenic acid (CLA) (p<0.001), n-3 FA (p≤0.001) and branched FA (p<0.001). Conventional milk had higher contents of mono-unsaturated FA (MUFA) (p<0.05) and n-6 FA (p<0.01). Significantly higher levels of grasses and lower levels of cereal concentrates in the fodder of organic farming could well explain these results. The differences in the fatty acid composition of milk between the two farming systems were nevertheless small because of low differences in the fodder composition.


Abstract: There is considerable interest in altering the fatty acid composition of milk with the overall aim of improving the long-term health of consumers. Important targets include reducing the amounts of medium-chain saturated fatty acids, enhancing cis-9 18:1 to reduce cardiovascular risk, as well as increasing concentrations of trans-11 18:1 and cis-9, trans-11 18:2 which have been shown to exert anti-carcinogenic properties in a range of human cell lines and animal models. Most studies have examined use of plant or marine oils, vegetable oilseeds or rumen protected or inert lipids in the diet to modify milk fatty acid composition, with much less attention paid to the fatty acid composition of the basal forage. We review recent progress in this area and identify potential for increasing the levels of mono- and poly-unsaturated fatty acids (MUFA and PUFA) in milk produced by dairy cows in high-forage systems. We also review the range of levels of important MUFA and PUFA in milk achieved by feeding the major classes of forage, as well as considering effects of less common forages to reveal potential new approaches to manipulate rumen fatty acid metabolism. Even though forages contain relatively low levels of lipid, they are often the major source of fatty acids in ruminant diets. We describe ways in which herbage species, cultivar, conservation method and level of forage in the diet of dairy cows affect rates and extents of ruminal biohydrogenation of dietary fatty acids and milk fatty acid composition. Discussion of the potential to increase recovery of forage PUFA in milk first considers genetic approaches to increase PUFA in forage, including in a range of animal management systems. Losses of fatty acids during forage conservation and storage are described along with strategies to reduce such losses. We describe plant traits, such as polyphenol oxidase, tannins and outflow rates from the rumen, which are associated with reduced rumen biohydrogenation. Similarly, we describe plant factors associated with increased levels of biohydrogenation intermediates in the rumen. The second aspect of this review focuses on effects of forage composition on metabolism of supplementary PUFA showing that both the level and type of forage in the diet are important determinants of ruminal lipid metabolism and milk fatty acid responses to plant and marine oils. Whilst increased use of forage in the diet does not produce the large 18:3 n-3, conjugated linoleic acid or cis-9 18:1 enrichment, or saturated fatty acids depletion in milk, that can be achieved with dietary oil supplementation, beneficial changes can be made without substantial increases in milk trans fatty acids. Trans fatty acids are an important issue for future research, both because of their generally negative effect on human health, as well as because the trans-11 18:1 appears to be an exception to this generalization.

As a review article, the authors describe many findings to date, including: a) the number and timing of cuts within a year appears to have a major effect on the fatty acid concentrations in forages; b) grazed herbage generally leads to increased levels of PUFA in milk; c) there is increasing evidence that not all forages behave in the same way when exposed to biohydrogenating bacteria in the rumen (one of the simplest approaches to reduce rumen biohydrogenation is to alter the rumen microflora by reducing rumen pH); and d) there is increasing evidence that in addition to forage species and conservation method, the relative proportion of forage in the diet is an important factor regulating the extent of ruminal biohydrogenation and the formation of fatty acid intermediates.


Abstract: During a 12-mo longitudinal study, bulk-tank milk was collected each month from organic (n = 17) and conventional (n = 19) dairy farms in the United Kingdom. All milk samples were analyzed for fatty acid (FA) content, with the farming system type, herd production level, and nutritional factors affecting the FA composition investigated by use of mixed model analyses.
Models were constructed for saturated fatty acids, the ratio of polyunsaturated fatty acids (PUFA) to monounsaturated fatty acids, total n-3 FA, total n-6 FA, conjugated linoleic acid, and vaccenic acid. The ratio of n-6:n-3 FA in both organic and conventional milk was also compared. Organic milk had a higher proportion of PUFA to monounsaturated fatty acids and of n-3 FA than conventional milk, and contained a consistently lower n-6:n-3 FA ratio (which is considered beneficial) compared with conventional milk. There was no difference between organic and conventional milk with respect to the proportion of conjugated linoleic acid or vaccenic acid. A number of factors other than farming system were identified which affected milk FA content including month of year, herd average milk yield, breed type, use of a total mixed ration, and access to fresh grazing. Thus, organic dairy farms in the United Kingdom produce milk with a higher PUFA content, particularly n-3 FA, throughout the year. However, knowledge of the effects of season, access to fresh grazing, or use of specific silage types could be used by producers to enhance the content of beneficial FA in milk.


Abstract: Six Holstein Friesian dairy cows were utilized for 14 weeks in an indoor feeding trial with fresh grass to evaluate the effects on milk composition of different perennial ryegrass varieties. Thereafter, the cows were stocked day and night on a pasture during one month. The milk fatty acid (FA) profile was determined in milk samples collected from individual cows at the 2 and 141 week of the indoor trial and at the end of the grazing period. The proportion of saturated FA declined after grazing and the proportions of mono- and polyunsaturated FA increased.

They conclude, “Fatty acid composition of milk is different and may be more healthy, when cows are grazed than when they are stall-fed.”


Abstract: Changing societal drivers and consumer demands require systems that provide desired products through improved, sustainable production processes. In this paper dairy product supply chains were analysed, with emphasis on milk quality in relation to feed. Milk fatty acids were analysed in milk produced in different regions, various seasons, and with different feeding systems and also in forages and concentrates. A rapid screening method for conjugated linoleic acid (CLA) in milk fat was developed. Milk from cows on fresh green forage, especially grazed grass, had a much higher unsaturated:saturated FA proportion with more poly-unsaturated FA (beneficial for heart diseases) and more conjugated linoleic acid (CLA isomer rumenic acid, C18:2 c9,t11, possible anti-cancer effects) than milk from silage-fed cows. The FA composition of milk has recently become less favorable than before, e.g., in the 1960s, due to different feeding practices and nobody is aware because it was never monitored, but essential FA and CLA levels have dropped substantially. With lowfat dairy products, human intake of these is declining even further, as ruminant products are the main source of CLA intake. Farmers from some dairy cooperatives in The Netherlands that produce milk from grazed grass now receive a premium on top of their milk price, so compared with farmers that keep their cows indoors year-round, these primary producers benefit from the higher market value at the end of the production chain.

The FA content of maize is much lower than of grass and the FA profile of lipids in oils seeds used in concentrates is highly variable.

Cows on pasture grazing lush green grass at a high herbage allowance produce milk with the highest concentrations of PUFA. Sources of variation in lipid concentration in plants are species, growth stage, temperature and light intensity. Fresh grass contains a high proportion (0.50-0.75) of its total fatty acid content in the form of α-linolenic acid, C18:3.


Abstract: Fatty acids, vitamins and minerals in milk are important for the human consumer, the calf and the cow. Studies indicate that milk from organic and conventional dairy herds may differ in these aspects. The aim of this study was therefore to investigate whether there are differences in the fatty acid composition and concentration of vitamins and selenium in milk between organic and conventional herds in Sweden. Bulk tank milk was sampled in 18 organic and 19 conventional dairy herds on three occasions during the indoor season 2005–2006. Herd characteristics were collected by questionnaires and from the official milk recording scheme. Multivariable linear mixed models were used to evaluate the associations between milk composition and type of herd, while adjusting for potential confounders and the repeated observations within herd. In addition to management type, variables included in the initial models were housing type, milk fat content, herd size, average milk yield and time on pasture during summer. The median concentration of conjugated linoleic fatty acids (CLA) was 0.63% in organic compared with 0.48% in conventional herds, the content of total n-3 fatty acids was 1.44% and 1.04% in organic and
conventional milk, respectively, and the content of total n-6 fatty acids was 2.72% and 2.20% in organic and conventional milk, respectively. The multivariable regression models indicated significantly higher concentrations of CLA, total n-3 and n-6 fatty acids in organic milk and a more desirable ratio of n-6 to n-3 fatty acids, for the human consumer, in organic milk. The multivariable models did not demonstrate any differences in retinol, α-tocopherol, β-carotene or selenium concentrations between systems. Median concentrations of α-tocopherol were 0.80 μg/ml in organic and 0.88 μg/ml in conventional milk, while for β-carotene the median concentrations were 0.19 and 0.18 μg/ml, respectively; for retinol, the median concentration was 0.32 μg/ml in both groups; the median concentrations of selenium were 13.0 and 13.5 μg/kg, respectively, for organic and conventional systems.


Abstract: The objective of the study was to evaluate the effects of the nature of forages on cow milk fatty acid (FA) composition. Compared with concentrate diet, pasture (with a greater effect of young grass compared to mature grass) favours enrichment of milk fat in cis9C18:1 and conjugated linoleic acid (CLA). Percentages of cis9C18:1 and CLA in milk fat were intermediate for groups that received maize silage, mountain natural grassland or ryegrass hay, and ryegrass silage. Pasture decreased the atherogenicity index of milk fat, when compared with other diets.


Abstract: The fatty acid (FA) composition of bulk milk fat was examined on three mountain dairy farms in the Czech Republic. Milk samples were collected in the period of indoor grass silage feeding (November–April) and in the grazing period (May–October). In total fifty FAs were identified in the milk fat. The two-way ANOVA with factors of the farm and of the period of milk sample collection was used for the evaluation of variation in FA concentrations. Significant differences between the farms (P < 0.01) were found in the concentration of five FAs, which accounted for 30.40 g/100 g total FAs. Significant differences between the indoor and the grazing period (P < 0.01) were found in the concentration of sixteen FAs, which accounted for 63.86 g/100 g total FAs. The content of long-chain (> C16), mono- and polyunsaturated FAs in the milk fat was higher in the grazing period (49.22, 31.69 and 4.69 g/100 g total FAs) than in the indoor period (42.25, 27.55 and 4.15 g/100 g total FAs, respectively; P < 0.01). The proportion of conjugated linoleic acid (CLA) was also higher in the grazing period (1.09 g/100 g total FAs) than in the indoor period (0.74 g/100 g total FAs; P < 0.01). The medium-chain (C12–C16) and the saturated FAs were more abundant in the milk fat in the indoor period (48.91 and 67.16 g/100 g total FAs) than in the grazing period (41.31 and 62.16 g/100 g total FAs; P = 0.001 and P < 0.01, respectively). These results indicated a positive influence of seasonal grazing on the FA profile of cow milk fat as regards its potential health effects in consumers.


Abstract: During one year's period bulk milk samples were collected monthly from three different types of farms: 1. conventional farming - indoor feeding with silages the whole year, 2. conventional farming - grazing during summer season, 3. ecological farming - grazing during summer season. Conjugated linoleic acids (CLA), trans vaccenic and other trans isomers of milk fatty acids were analyzed. Variation of CLA in milk fat was substantial (0.26 to 1.14 % of total methyl esters) and was season-dependent. The lowest percentage of CLA (0.34 %) was found in the group, fed only fermented roughage and concentrates (most intensive production farm) the highest (0.80 %) in the ecologically produced milk fat. The concentration of CLA and trans vaccenic acid was positively correlated. There is a growing interest in CLA, considered to be beneficial in prevention of carcinogenesis. Its percentage in milk products can be increased through a suitable dietary regimen.


Abstract: The nutritional image of bovine milk fat has suffered for years because of the association of saturated fatty acids and coronary heart disease. Thus the alteration of fatty acid composition has been a long-term strategy. Forages, even though containing a relatively low level of lipids, are the cheapest and often the major source of beneficial unsaturated fatty acids in ruminant diets. Recent progress in the research of factors affecting fatty acid content and composition in fresh and preserved forages and the associations between feeding such forages and milk fat profile are reviewed. Milk from cows grazed or fed fresh forage, especially from species-rich grasslands or forage legumes, has a considerably higher ratio of unsaturated to saturated fatty acids and a higher content of nutritionally beneficial trans-fatty acids (e.g. CLA, vaccenic acid) than milk from cows fed silage or hay. Grass and legume silages seem to affect the fatty acid profile more propitiously than maize silage.
There are detrimental effects of prolonged wilting and field drying on the content of both total FAs and PUFAs. Milk fat from cows fed grass or legume silages seems to have the nutritionally more favorable composition than fat from cows fed maize silage. However, the former fats are more prone to oxidation.


Abstract: Dairy products are the main source of conjugated linoleic acid (CLA), a functional food component with health benefits. The major source of cis-9, trans-11 CLA in milk fat is endogenous synthesis via delta9-desaturase from trans-11 18:1, with the remainder from incomplete rumen biohydrogenation of linoleic acid. Diet has a major influence on milk fat CLA; however, effects of physiological factors have received little attention. Our objectives were to examine milk fat content of CLA and the CLA-desaturase index with regard to: 1) effect of breed, parity, and stage of lactation, and 2) variation among individuals and the relationship to milk and milk fat. Holstein (n = 113) and Brown Swiss (n = 106) cows were fed a single diet and milk sampled on the same day to avoid confounding effects of diet and season. Frequency distributions demonstrated that milk fat content of CLA and CLA-desaturase index varied over threefold among individuals, and this needs to be considered in the design of experiments. Holsteins had a higher milk fat content of CLA and CLA-desaturase index, but breed differences were minor. Parity and days in milk also had little or no relationship to the individual variation for these two CLA variables. Breed, parity, and days in milk accounted for < 0.1, < 0.3, and < 2.0% of total variation in CLA concentration in milk fat, respectively. Milk fat content of CLA and CLA-desaturase index were essentially independent of milk yield, milk fat percent, and milk fat yield. We speculate that the basis for the genetic variation among individuals is related to rumen output of trans-11 18:1 and to a lesser extent cis-9, trans-11 CLA, and to the tissue amount and activity of delta9-desaturase.

They concluded that, "Breed (Holstein vs. Brown Swiss), parity, and [days in milk] DIM had little relationship to the individual variation for these two CLA variables. Likewise, these CLA variables were essentially independent of milk yield, milk fat percent, and milk fat yield. Overall, the physiological and genetic basis for the individual variation in milk fat content of CLA and the CLA-desaturase index remains to be identified, but it must be related to two broad aspects—rumen output of trans-11 18:1 and to a lesser extent cis-9, trans-11 CLA, and to the amount and activity of Δ9-desaturase in tissues."


Three experiments were conducted to investigate the hypothesis that cows grazing on pasture produce the highest proportion of c-9 t-11 CLA in milk fat and no further increase can be achieved through supplementation of diets rich in linoleic acid, such as full-fat extruded soybeans or soybean oil. In experiment 1, 18 lactating Holstein cows were used in a randomized complete block design with measurements made from wk 4 to 6 of the experiment. In experiment 2, three cannulated lactating Holstein cows were used in a 3×3 Latin square design. Each period was 4 wk with measurements made in the final wk of each period. Cows in both experiments were assigned at random to treatments: a, conventional total mixed ration (TMR); b, pasture (PS); or c, PS supplemented with 2.5 kg/cow per day of full-fat extruded soybeans (PES). In both experiments, feed intake, milk yield, milk composition, and fatty acid profile of milk and blood serum were measured, along with fatty acid composition of bacteria harvested from rumen digesta in experiment 2. In experiment 3, 10 cows which had continuously grazed a pasture for six weeks were assigned to two groups, with one group (n = 5) on pasture diet alone (PS) and the other group (n = 5) supplemented with 452 g of soy oil/cow per day for 7 d (OIL). In experiment 1, cows in PS treatment produced 350% more c-9, t-11 CLA compared with cows in TMR treatment (1.70 vs. 0.5% of fat), with no further increase for cows in PES treatment (1.50% of fat). Serum c-9, t-11 CLA increased by 233% in PS treatment compared with TMR treatment (0.21 vs. 0.09% of fat) with no further increase for cows in PES treatment (0.18% of fat). In experiment 2, cows in PS treatment produced 300% more c-9 t-11 CLA in their milk fat compared with cows in TMR treatment (1.77 vs. 0.59% of fat), but no further increase for cows in PES treatment (1.84% of fat) was observed.

They concluded, “Cows grazing perennial ryegrass pasture produced 300-350% more c-9, t-11 CLA compared with cows on a TMR diet, with no further increase resulting from supplementation of linoleic acid through full-fat extruded soybeans or soy oil. Concentrations of bacterial and serum c-9, t-11 CLA were increased by 200 to 300% for cows grazed on pasture compared with cows on a TMR diet, but no further increase was achieved with supplementation of full-fat extruded soybeans... Based on the findings of these experiments and the conditions in which they were carried out, it was concluded that c-9, t-11 CLA in milk from cows grazing perennial ryegrass pasture is not likely to be further enhanced by supplementing linoleic acid through full-fat extruded soybeans or soy oil. It is, however, possible to increase total c-9, t-11 CLA and TVA through supplementation of full fat extruded soybeans without compromising the milk yield, particularly from cows in late lactation.”

Abstract: We reported previously that feeding incremental levels of ground flaxseed (GFLAX) linearly reduced DMI, milk production, and contents and yields of milk components. Flaxseed is a high-energy oilseed rich in α-linolenic acid. It is well established the impact of flaxseed on changing milk fatty acids (FA) profile but there is limited research about the effects of GFLAX on milk FA composition, particularly in cows fed high-forage diets. In a recent needs assessment of research and educational needs of the organic dairy industry in the Northeast, 84% of respondents indicated the development of value-added dairy products as one of the most pressing areas for dairy research (Pereira et al., 2013 JDS 96:7340-7348), thus justifying additional studies with flaxseed. Twenty organically-managed Jersey cows (425 ± 37 kg of BW and 111± 62 DIM) in the beginning of the study were blocked by milk yield and parity and randomly assigned to treatment sequences in 5 replicated 4 × 4 Latin squares to investigate the effects of incremental levels of GFLAX (0, 5, 10, or 15% diet DM) on milk FA composition. All cows were fed TMR containing (% of diet DM): 55% alfalfa-grass baleage, 8% grass hay, and 37% concentrate; soybean meal (from 6 to 2% of diet DM) and corn meal (from 27 to 16% of diet DM) were replaced with GFLAX (from 0 to 15% of diet DM) while roasted soybean (2% of diet DM) was maintained constant across treatments. Diets were isonitrogenous (mean = 18.3% CP) but crude fat increased from 3.8 to 7.4% when replacing soybean meal and corn meal with GFLAX. Milk concentration (% of total milk FA) of total n-3 FA (0.74 to 1.42%), tC18:1 (1.35 to 2.63%), c9, t11 CLA (0.47 to 0.87%), total CLA (0.55 to 1.08%), total monounsaturated FA (21.9 to 34.3%), and total polyunsaturated FA (2.87 to 4.72%) increased linearly in response to increasing levels of GFLAX. Conversely, milk concentrations of n-6 FA (1.78 to 1.49%) and total saturated FA (72.7 to 58.1%), and the n-6 to n-3 ratio (2.42 to 1.06) declined linearly with increasing levels of GFLAX. Quadratic effects were observed for total n-3 FA, tC18:1, c9, t11 CLA, total CLA, and the n-6 to n-3 ratio. It can be concluded that GFLAX is an effective supplement to enrich milk with bioactive FA of potential health benefits for humans.


Abstract: The uniqueness of ruminant milk lipids is based on their high concentration of CLA. Maximal CLA concentrations in milk lipids require optimal conditions of ruminal fermentation and substrate availability, conditions like those present in pasture-fed cows. Our previous work showed that farm management (indoor feeding vs. pasture feeding) markedly influenced the CLA concentration. In this study, the objective was to evaluate the influence of the farm management system as dependent on different locations. Milk samples from different locations (Thuringia and the Alps, representing diverse altitudes) were collected during the summer months and analyzed for FA profile and CLA isomer distribution. The proportion of PUFA and total CLA in milk fat was significantly lower in milk from indoor cows compared with the pasture cows in the Alps. The trans-11 18:1 in milk fat of Alpine cows was elevated, in contrast to lower values for trans-10 18:1. Milk from cows grazing pasture in the Alps was higher in EPA and lower in arachidonic acid than milk from indoor-fed cows. The proportion of cis, trans/trans, cis isomers of CLA was 10% higher from the pasture cows than from the Alpine cows. In addition to the major isomer cis-9, trans-11, this difference also occurred for the trans-11, cis-13 isomer, which represented more than a fourth of the total CLA present in milk fat. This is the first report showing a special isomer distribution in the milk fat of cows living under very natural conditions. We hypothesize that the CLA isomer trans-11,cis-13 is formed in large quantity as a result of grazing mountain pasture, which is rich in α-linolenic acid.

This relatively early study explains that rumenic acid is the major CLA component in ruminant milk fat and meat fat. The authors contend that the content of CLA in milk fat can vary widely. The underlying factors resulting in this variation are related predominantly to diet and to the farming methods for ruminants. Furthermore, the milk fat content of CLA is also related to animal variation.

They conclude that the CLA content of milk fat correlates with the FA concentration of the pasture. They say that low ruminal pH often found in high-performance cows fed concentrate-rich rations alters the microbial ecosystem to favor synthesis of trans-10 monoene or conjugated diene, or both. On the other hand, optimal ruminal fermentation in cows grazing herb-rich pasture (optimal pH, PUFA as substrate for tVA) minimizes the formation of trans-10 FA. The absence of this depressing agent maximizes the desaturation of tVA (40). Milk fat synthesized under these conditions is rich in CLA and relatively poor in tVA.

They hypothesize that linolenic acid is an indirect precursor of trans-11,cis-13 CLA.


Abstract: The influence of grass-only diets either from rye-grass-dominated lowland pastures (400 m above sea level) or botanically diverse alpine pastures (2000 m) on the FA profile of milk was investigated using three groups of six Brown Swiss cows each. Two groups were fed grass-only on pasture (P) or freshly harvested in barn (B), both for two experimental periods in the lowlands and, consecutively, two periods on the alp. Group C served as the control, receiving a silage-concentrate diet and permanently staying in the lowlands. Effects of vegetation stage or pasture vs. barn feeding on milk fat composition were negligible. Compared with the control, α-linoleic acid (18:3n−3) consumption was elevated in groups P and B (79%, P<0.001) during the lowland periods but decreased on the alp to the level of C owing to feed intake depression and lower 18:3n−3 concentration in the alpine forage. Average 18:3n−3 contents of milk fat were higher in groups, P and B than in C by 33%

Abstract: There is increased consumer awareness that foods contain microcomponents that may have beneficial effects on health maintenance and disease prevention. In milk fat these functional food components include EPA, DHA, and CLA. The opportunity to enhance the content of these FA in milk has improved as a result of recent advances that have better defined the interrelationships between rumen fermentation, lipid metabolism, and milk fat synthesis. Dietary lipids undergo extensive hydrolysis and biohydrogenation in the rumen. Milk fat is predominantly TG, and de novo FA synthesis and the uptake of circulating FA contribute nearly equal amounts (molar basis) to the FA in milk fat. Transfer of dietary EPA and DHA to milk fat is very low (<4%); this is, to a large extent, related to their extensive biohydrogenation in the rumen, and also partly due to the fact that they are not transported in the plasma lipid fractions that serve as major mammary sources of FA uptake (TG and nonesterified FA). Milk contains over 20 isomers of CLA but the predominant one is cis-9,trans-11 (75–90% of total CLA). Biomedical studies with animal models have shown that this isomer has anticarcinogenic and anti-atherogenic activities. cis-9,trans-11-CLA is produced as an intermediate in the rumen biohydrogenation of linoleic acid but not of linolenic acid. However, it is only a transient intermediate, and the major source of milk fat CLA is from endogenous synthesis. Vaccenic acid, produced as a rumen biohydrogenation intermediate from both linoleic acid and linolenic acid, is the substrate, and \( \Delta^9 \)-desaturase in the mammary gland and other tissues catalyzes the reaction. Diet can markedly affect milk fat CLA content, and there are also substantial differences among individual cows. Thus, strategies to enhance milk fat CLA involve increasing rumen outflow of vaccenic acid and increasing \( \Delta^9 \)-desaturase activity, and through these, several-fold increases in the content of CLA in milk fat can be routinely achieved. Overall, concentrations of CLA, and to a lesser extent EPA and DHA, can be significantly enhanced through the use of diet formulation and nutritional management of dairy cows.


Abstract: This paper presents recent results from studies to verify whether it is possible to modify, in bovine and caprine dairy products, the content of components which are of nutritional interest to consumers, by changing the composition of the animal diet. The main components described were the minor and major fatty acids (including C18:1 and C18:2 isomers), lipophilic micronutrients (carotenoids, vitamins A and E) and the global antioxidant status. For bovine milk and cheese, diets rich in concentrate or maize silage, when compared to grass-based diets, especially pasture, led to a lower content in carotenoids and vitamin E and an impaired antioxidant status. Milk from pasture was also richer in oleic and conjugated linoleic acids (CLA) than milk from concentrate or maize silage diets. However, the influence of the pasture seems to be variable depending on the developmental stage or the botanical composition of the grass. These experimental results were confirmed by analyses of bulk milk or cheeses originating from different geographic areas where diets vary. For caprine milk or cheese, the response of milk fatty acids composition to diet is similar to that of cows at least for major fatty acids including CLA, and several interactions between effects of forage (corn silage, alfalfa or ryegrass hay, fresh grass) and of lipid supplements (linseed oil or high-oleic sunflower oil) on major and minor fatty acids, including trans 18:1 and 18:2 isomers were observed. Furthermore, grazing goats, when compared to goats kept indoors and fed hay, showed a higher content of unsaturated fatty acids, CLA, vitamin A and a better antioxidant status. In conclusion, varying diet composition allows the content of micronutrients and fatty acids in dairy products to change rapidly and efficiently.


Abstract: Increasing sales of organic milk mean intensified tests for authenticity are required. In addition to comprehensive documentation, analytical methods to identify organic milk, and thus to differentiate it from conventional milk, are needed for consumer protection. Because the composition of milk is fundamentally dependent on the feeding of the cows, thirty-five samples from both production systems in Germany, including farm and retail milk, were collected within 12 months, to reflect seasonal variation, and appropriate properties were analysed. Fatty acid analysis enabled organic and conventional milk to be completely distinguished, because of the higher \( \alpha \)-linolenic acid (C18:3\( \omega \)3) and eicosapentaenoic acid (C20:5\( \omega \)3) content of the
former. Organic milk fat contained at least 0.56% C18:3ω3 whereas the maximum in conventional milk was 0.53%. Because of the parallel seasonal course of the C18:3ω3 content of organic and conventional retail samples, however, time-resolved comparison at the five sampling dates resulted in a clearer difference of 0.34 ± 0.06% on average. Analysis of stable carbon isotopes (δ¹³C) also enabled complete distinction of both types of milk; this can be explained by the different amounts of maize in the feed. For conventional milk fat δ¹³C values were −26.6% or higher whereas for organic milk fat values were always lower, with a maximum of −28.0%. The time-resolved average difference was 4.5 ± 1.0%. A strong negative correlation (r = −0.92) was found between C18:3ω3 and δ¹³C. Analysis of a larger number of samples is required to check the preliminary variation ranges obtained in this pilot study and, probably, to adjust the limits. Stable isotopes of nitrogen (δ¹⁵N) or sulfur (δ³⁴S) did not enable assignment of the origin of the milk; in cases of ambiguity, however, some trends observed might be useful in combination with other properties.

In this study, both retail and bulk milk was evaluated. Fatty acid profiles were indicative of seasonal changes, for example CLAs were higher in the spring and summer than winter. The researchers found that organic milk contained more CLAs than conventional in spring and summer; but were almost identical levels in winter. They concluded that α-linolenic acid content of organic milk fat was always higher than for conventional milk fat and the stable carbon isotopes (δ¹³C) value was always lower (presumably but less corn in diet of organic cattle).


Abstract: Consumers are becoming increasingly health conscious, and food product choices have expanded. Choices in the dairy case include fluid milk labeled according to production management practices. Such labeling practices may be misunderstood and perceived by consumers to reflect differences in the quality or nutritional content of milk. Our objective was to investigate nutritional differences in specialty labeled milk, specifically to compare the fatty acid (FA) composition of conventional milk with milk labeled as recombinant bST (rbST)-free or organic. The retail milk samples (n=292) obtained from the 48 contiguous states of the United States represented the consumer supply of pasteurized, homogenized milk of 3 milk types: conventionally produced milk with no specialty labeling, milk labeled rbST-free, and milk labeled organic. We found no statistical differences in the FA composition of conventional and rbST-free milk; however, these 2 groups were statistically different from organic milk for several FA. When measuring FA as a percentage of total FA, organic milk was higher in saturated FA (65.9 vs. 62.8%) and lower in monounsaturated FA (26.8 vs. 29.7%) and polyunsaturated FA (4.3 vs. 4.8%) compared with the average of conventional and rbST-free retail milk samples. Likewise, among bioactive FA compared as a percentage of total FA, organic milk was slightly lower in trans 18:1 FA (2.8 vs. 3.1%) and higher in n-3 FA (0.82 vs. 0.50%) and conjugated linoleic acid (0.70 vs. 0.57%). From a public health perspective, the direction for some of these differences would be considered desirable and for others would be considered undesirable; however, without exception, the magnitudes of the differences in milk FA composition among milk label types were minor and of no physiological importance when considering public health or dietary recommendations. Overall, when data from our analysis of FA composition of conventional milk and milk labeled rbST-free or organic were combined with previous analytical comparisons of the quality and composition of these retail milk samples, results established that there were no meaningful differences that would affect public health and that all milks were similar in nutritional quality and wholesomeness.


Abstract: The objective of this study was to investigate the effect of level of 1) pregrazing herbage mass (HM) and 2) level of daily herbage allowance (DHA) on the performance and fatty acid (FA) composition of milk from grazing dairy cows. Sixty-eight Holstein-Friesian dairy cows were allocated to either a high or low pregrazing HM (1,700 vs. 2,400 kg of DM/ha; >40 mm), and within HM treatment, cows were further allocated to either a high or low DHA (16 vs. 20 kg of DM/d per cow; >40 mm) in a 2 × 2 factorial design. Pregrazing HM did not affect dry matter intake (17.5 +/- 0.75 kg/d), milk production (22.1 +/- 0.99 kg/d), milk composition (milk fat, 3.88 +/- 0.114%; milk protein, 3.28 +/- 0.051%), body weight (525 +/- 16 kg), or body condition score (2.65 +/- 0.06%). Increasing DHA increased dry matter intake (+1.5 kg/d) but did not affect any other variable measured. Cows grazing the low HM or high DHA had a higher daily intake of total FA (+0.12 and +0.09 kg/d, respectively, for the low HM and high DHA), α-linolenic acid (LNA; +0.08 and +0.05 kg/d, respectively, for the low HM and high DHA), and linoleic acid (+0.01 for both the low HM and high DHA) compared with either the high HM or low DHA. Milk conjugated linoleic acid (cis-9, trans-11 isomer) was not affected by treatment (13.0 +/- 0.77 g/kg of total FA); however, large variation was recorded between individual animals (range from 5.9 to 20.6 g/kg of total FA). Milk concentrations of LNA were higher for animals offered the low HM (5.3 g/kg of total FA), but across treatments, milk concentrations of LNA were low (4.9 +/- 0.33 g/kg of total FA). The present study indicates that changes in HM and DHA do not have a great effect on the milk FA composition of grazing dairy cows. Further enhancement of the beneficial FA content in milk purely from changes in grazing strategy may be difficult when pasture quality is already high.
They say, “Many studies have shown that increased pasture intake leads to elevations in the CLA and n-3 FA concentrations of milk, potentially because of higher concentrations of LNA in particular in fresh herbage compared with either conserved forages or cereal-based concentrate feeds. Conjugated linoleic acid is synthesized by ruminal microorganisms during the ruminal biohydrogenation of LNA and LA. The majority of tissue and milk CLA is formed through de novo mammary tissue synthesis from the desaturation of another product of this ruminal biohydrogenation process, vaccenic acid, to cis-9, trans-11 CLA. This latter reaction is catalyzed by the actions of the enzyme stearyl coenzyme A, otherwise known as Δ9-desaturase, and is responsible for up to 90% of the cis-9, trans-11 CLA found in milk fat.”

“Because it is now well established that the CLA and n-3 PUFA content in milk is increased under grazing-based production systems when compared with TMR-based systems, understanding how to further increase these beneficial FA in milk from grazing dairy cows is an important objective of grassland research. Therefore, the objective of this study was to investigate the effect of different grazing strategies, based on both the quality and quantity of herbage offered, on the milk FA composition of grazing dairy cows.”

“The most effective strategy to increase the CLA and n-3 PUFA content of milk appreciably is therefore strategic supplementation of grazing cow diets. This is an expensive approach, and supplementation in general, particularly from mid-lactation onward, is not in harmony with low-cost pasture-based production systems. To this end, there is a requirement to examine regimens to improve the nutraceutical composition of milk through improved pasture management.”

Cows grazing a low pregrazing herbage mass (HM) had a higher intake of total FA (n3-fatty acid), LNA (n-3 PUFA LA), and LA (dietary PUFA LA), which was related to the high herbage content of both LNA and total FA in the low herbage mass (LH and LL) treatments. This is not surprising, given that longer regrowth periods are necessary to generate pastures with greater pasture cover, and several authors have demonstrated that FA content in grasses declines as the duration of the regrowth period increases. In addition, cows grazing a high daily herbage allowance (DHA) had a higher intake of FA, but this seemed to be more closely related to the higher DMI than to differences in pasture quality. With regard to differences in FA intake across the season, the variation seemed to be more a function of differences in FA composition of the pasture than differences in DMI. There was no effect of diet on milk concentrations of either CLA or vaccenic acid (VA) during any of the periods measured.

The results of the present study indicate that changes in HM and DHA (at least of the magnitude studied) did not greatly affect the composition of milk FA in grazing dairy cows, despite variation between treatments in dietary FA intake. Milk concentrations of CLA were unaffected by treatment, and only stage of lactation seemed to affect the CLA content as the grazing season progressed, which was mirrored by an associated increase in the Δ9-desaturase enzyme activity index. We also recorded large variation in milk FA between individual animals, which may have contributed to the absence of significant differences between treatments. Milk LNA was higher at a low HM, but these differences seem to have no practical importance because the content of LNA in milk was low across the whole experiment, independent of treatment. Enhancing the concentration of health-promoting FA in milk through manipulation of grazing management alone (under the high-quality pasture conditions used here) will be difficult; thus, future research should focus more on identifying the biological basis for the significant interanimal variation in milk FA concentration recorded here and in other studies.


Abstract: As a contribution to the debate on the comparison of nutritional quality between conventional versus organic products, the present study would like to provide new results on this issue specifically on dairy products by integrating the last 3 years’ studies using a meta-analysis approach with Hedges’ d effect size method. The current meta-analysis shows that organic dairy products contain significantly higher protein, ALA, total omega-3 fatty acid, cis-9,trans-11 conjugated linoleic acid, trans-11 vaccenic acid, eicosapentanoic acid, and docosapentanoic acid than those of conventional types, with cumulative effect size (± 95% confidence interval) of 0.56 ± 0.24, 1.74 ± 0.16, 0.84 ± 0.14, 0.68 ± 0.13, 0.51 ± 0.16, 0.42 ± 0.23, and 0.71 ± 0.3, respectively. It is also observed that organic dairy products have significantly (P < 0.001) higher omega-3 to -6 ratio (0.42 vs. 0.23) and Δ9-desaturase index (0.28 vs. 0.27) than the conventional types. The current regulation on organic farming indeed drives organic farms to production of organic dairy products with different nutritional qualities from conventional ones. The differences in feeding regime between conventional and organic dairy production is suspected as the reason behind this evidence. Further identical meta-analysis may be best applicable for summarizing a comparison between conventional and organic foodstuffs for other aspects and food categories.

The authors contend that, “Significantly higher amounts of protein, ALA, n-3, CLA9, VA, EPA and DPA in organic dairy products than in conventional products, as well as a higher ratio of n-3 to n-6 (approximately twofold) and 9-desaturase index, indicate that the organic dairy product may have a premium nutritional quality,” – mostly attributed to high fresh forage diet among organic cattle no matter the country or certification standards.

They say, “The availability and variability of feed vary with the season, which then indirectly influences the nutrient composition of milk.” However, despite seasonally available feeds, organic dairy products “seem able to maintain ‘premium’ nutritional quality during the whole season.”
Botanically diverse pastures are commonly used in New Zealand to reduce the ruminant environmental impact by replacing conventional pastures with a mixture of various species. These include white clover (RGD), chicory, plantain and big trefoil (HSD), or chicory, plantain, prairie grass and lucerne (TFD). Milk samples from these pastures were collected and analyzed for their fatty acid profiles.

Abstract: Consumer perception of organic cow milk is associated with the assumption that organic milk differs from conventionally produced milk. The value associated with this difference justifies the premium retail price for organic milk. It includes the perceptions that organic dairy farming is kinder to the environment, animals, and people; that organic milk products are produced without the use of antibiotics, added hormones, synthetic chemicals, and genetic modification; and that they may have potential benefits for human health. Controlled studies investigating whether differences exist between organic and conventionally produced milk have so far been largely equivocal due principally to the complexity of the research question and the number of factors that can influence milk composition. A main complication is that farming practices and their effects differ depending on country, region, year, and season between and within organic and conventional systems. Factors influencing milk composition (e.g., diet, breed, and stage of lactation) have been studied individually, whereas interactions between multiple factors have been largely ignored. Studies that fail to consider that factors other than the farming system (organic vs. conventional) could have caused or contributed to the reported differences in milk composition make it impossible to determine whether a system-related difference exists between organic and conventional milk. Milk fatty acid composition has been a central research area when comparing organic and conventional milk largely because the milk fatty acid profile responds rapidly and is very sensitive to changes in diet. Consequently, the effect of farming practices (high input vs. low input) rather than farming system (organic vs. conventional) determines milk fatty acid profile, and similar results are seen between low-input organic and low-input conventional milks. This confounds our ability to develop an analytical method to distinguish organic from conventionally produced milk and provide product verification. Lack of research on interactions between several influential factors and differences in trial complexity and consistency between studies (e.g., sampling period, sample size, reporting of experimental conditions) complicate data interpretation and prevent us from making unequivocal conclusions. The first part of this review provides a detailed summary of individual factors known to influence milk composition. The second part presents an overview of studies that have compared organic and conventional milk and discusses their findings within the framework of the various factors presented in part one.

The authors suggest that diet, breed, individual animal genetics, stage of lactation, management, season, and interaction amongst these factors affect milk composition and need to be taken into account when evaluating diets.

The article suggests that a low ratio of n-6 to n-3 fatty acids, for example, is beneficial for human health. The western diet is typically too high in n-6 fatty acids, with possible negative consequences such as cardiovascular disease, cancer, and inflammatory and autoimmune diseases. Current recommendations for a n-6:n-3 ratio target 1:1 or 2:1 or even a 4:1, for particular patients. The n-6:n-3 ratio essentially describes the concentrations of linoleic acid (LA) vs alpha-linolenic acid (ALA). Forage is rich in ALA whereas cereals contain higher amounts of LA. A lower n-6:n-3 ratio is therefore indicative of a forage-based diet. Protein varied between organic and conventional. Protein concentration may be affected by supplements and forage/grain type.

The authors suggest that retail samples represent a mixture of milk from a wide variety of individual cows and farms – this consequently “dilutes” the effect of individual cows and specific farm practices. They say that results were inconsistent for most even-chain saturated fatty acids. Results for MUFA s and PUFAs were more consistent and higher concentrations of vaccenic acid (VA), CLA, ALA, and EPA in organic milk has been reported independently of the country of origin, sampling season, and year. This may suggest that organic cows consume a different diet (higher amounts of pasture and other forages) than conventional cows. This can be seen as a direct result of the regulations mandating that organic dairy cows in the US and European countries have access to pasture and outdoor areas.

Clearly the authors of this review disregard any nutritive properties of organic milk. In a companion article, “Organic and Conventional Milk – Comparing Apples to Apples?” available at: http://www.adsa.org/Portals/0/SiteContent/docs/press/JDS_Feb15_PR_Schwendel_FINAL.pdf, they say, “Therefore in terms of nutrients in milk, there is nothing distinct about organic milk that makes it unique from conventionally produced milk once the different factors that influence milk production are compared or adjusted for. If animal genetics, health, breed, diet, management, or environment differs, then so will the composition of the milk produced.”


Abstract: Botanically diverse pastures are commonly used in New Zealand to reduce the ruminant environmental impact by reducing the methane production from the rumen digestion. In order to evaluate the effects diverse pasture species have on the milk fatty acid profile seventy-two lactating Friesian-Jersey crossbred dairy cows were used in a randomised block design with two replicates of six treatments. Six different pasture mixtures were fed at a daily allowance of approximately 15 kg DM/cow/day. The mixtures were categorised as either a simple or a diverse pasture. The simple mixtures all contained white clover with the addition of either a standard diploid perennial ryegrass (RG), a diploid high sugar ryegrass (HS) or tall fescue (TF). The three diverse mixtures included each of the simple mixtures with the addition of either chicory, plantain, prairie grass and red clover (RGD), chicory, plantain and big trefoil (HSD), or chicory, plantain, prairie grass and lucerne (TFD). Milk samples...
were collected and the fatty acid profile was analysed using Fatty Acids Methyl Esters (FAME) analysis. The proportion (g/100g of milk fat fatty acids) of linoleic and linolenic acid increased while the proportion of cis-9, trans-11 C18:2 (CLA) decreased in milk from cows grazing the diverse pastures compared to cows fed the simple pastures. These changes were probably associated with a shift in the rumen microbial population or rumen metabolic routes caused by several secondary metabolites present in some plants, e.g. herbs and legumes. As a consequence the lipolysis and biohydrogenation decreased, resulting in an increased rumen outflow of linoleic and linolenic acid. These assumptions are based on the reported effects of secondary metabolites on rumen methanogenesis. The results of this study suggest that it is possible to change the milk fatty acid profile through inclusion of diverse plant species in the pastures which provides opportunities to change the fatty acid composition to become more beneficial from a human health perspective.

He concludes, “Feeding botanically diverse pastures to dairy cows affect the milk fat fatty acid proportions, increasing the proportions of PUFA, especially of linoleic and linolenic acid. The higher transfer efficiency of these fatty acids from feed to milk is probably caused by changes in the rumen environment due to various plant metabolites present in herbs and legumes that have antimicrobial activity and may interfere with the biohydrogenation in the rumen and the microbial population. Including more diverse plant species in the ruminant diet provides an opportunity to produce healthier products from a human perspective with higher concentrations of unsaturated fatty acids. This, along with the reported decreases in rumen methanogenesis from cows fed diverse forages, indicates that the effect of secondary plant metabolites on ruminant production merit further investigation.”


Abstract: Information collected at the Dairying Research Corporation milk composition laboratories [New Zealand] on the fatty acid composition of milk fat spanning the 1994/95 to 1998/99 dairying seasons is summarized. The data comprised 1350 determinations in 18 different experiments from 965 individual Friesian cows that calved in July/August and grazed solely on pasture. A seasonal effect on fatty acid composition was observed. In general, concentrations of fatty acid groups and individual fatty acids were similar in spring and autumn but differed in summer. The ratio of an estimate of preformed (total fatty acids>C17:0) and an estimate of de novo- (total fatty acids<c16:1) synthesised fatty acids altered during the season. In early lactation (August), the ratio of preformed:de novo fatty acids (P:S) was 0.76 declining to 0.51 by December and increasing to 0.80 by late autumn. The concentration of total unsaturated fatty acids followed a similar trend: 30.4% in August, 24.5% in December and 32.8% in April. In early lactation, milk fat from primiparous compared with multiparous cows had higher oleic acid (C18:1), total unsaturated fatty acids and P:S ratio, indicating greater mobilization of body fat. Conjugated linoleic acid (CLA) varied from 1-1.4% through spring, declined to 1.0% in summer and increased to 1.6% by April. The seasonal changes in milk fat composition reflected the seasonal trends in the characteristics of milk fat for processing. For example the softness of milk fat as calculated from a relationship previously established between fatty acid composition and solid fat content at 10°C (SFC10), varied seasonally. Milk fat was softer in late spring (SFC10, 53%) becoming harder (SFC10, 61-63%) during December to February and softer (SFC10, 54%) in autumn. The healthiness of milk fat, as described by the concentration of unsaturated fatty acids and CLA, varied throughout the season. The lowest concentrations were in summer or in mid-lactation and the highest in autumn or late lactation. This information will be useful to manufacturers of milk products to target specific milk fat products to particular times of the year.

These authors contend that annual variations in the fatty acid profile of milk fat is influenced more by the time of the year than stage of lactation – they attribute levels of feeding and changes in the lipid composition of pasture for the variation. They suggest that any time underfeeding occurs, there will be a change in fatty acid composition of milkfat. This study showed that single fatty acids and fatty acid groups present in milkfat vary seasonally in a predictable manner; for example, CLA concentrations increased through spring, declined in summer then increased again in autumn—the highest concentrations for the season were in October and April.


Summary: A 3-year dairy grazing experiment at 3.2 vs. 2.2 cows/ha was conducted by NC State University with related projects on immunocompetence measures (Va Tech); a cooperating farm study of fatty acids in milk related to pasture intake (Clemson); and rolled barley/molasses or citrus pulp/molasses partially replacing corn supplement (Clemson). Higher stocking rate with more supplement yielded more milk, similar health and reproduction, lower measures of immunocompetence, but more stored forage fed off pasture. Higher pasture intakes associated with higher CLA in milk. Supplement source did not affect milk yield although protein percentages were lower on the citrus pulp diet.

“Cows fed only pasture had 500% more milk CLA than controls fed a total mixed ration and hay and a linear relationship was seen between pasture consumption and CLA... It was our initial intent to characterize the milk CLA response according to forage type. We were unable to do this, however, because of the wide array of forages grazed and because the
farmers used a wide variety of forage combinations in their grazing scheme. However, we concluded that milk CLA content was highly correlated with estimated pasture intake over a wide variety of forages, breeds, herds, and management conditions.


Abstract: Variations in conjugated linoleic acid (CLA) concentrations in Holstein dairy cows milk, depending on feeding systems in different seasons was investigated. Milk samples were collected from Holstein dairy cows, which either grazed for whole days (WG), only daylight hours (TG), or were offered a total mixed ration (TMR) and experienced no grazing (NG), from April to December of 2005. In April, November and December, the cows in TG and WG treatments received grass silage and some concentrate, while from May to October, the cows grazed on temperate pasture. The cows in NG treatment received the TMR throughout the season. The major fatty acid obtained in the pastures was linolenic acid. There was no significant difference in the pasture’s linolenic acid concentrations from May to September, but there was a significant decrease in October. However, the linolenic acid concentrations obtained in the pasture were always much higher than those obtained from the TMR. Linoleic acid was also the major fatty acid in the TMR, but these concentrations were higher in the TMR than in the pasture. There was no significant difference in milk cis9trans11CLA (c9t11CLA) concentrations between the three feeding systems while the cows were fed on conserved pasture in April, November and December. Although c9t11CLA concentrations were lower in the TMR, it was found that the cows which grazed in fresh pasture experienced significantly higher concentrations of c9t11CLA in their milk than those which received only TMR. It was also found that cows in the WG treatment experienced higher c9t11CLA concentrations than those in the TG treatment. In the WG and TG treatments, c9t11CLA concentrations were highest in June, after which, they gradually decreased (p<0.05) with season. Overall, trans11C18:1 and c9t11CLA were greatly influenced by season, with higher variation in the WG treatment than in the TG treatment and no variation in the NG treatment.