The amount of maize in the feed ration influences milk composition in Northern Spain

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Abstract

The oceanic climate conditions of Asturias (Spain) are favourable for grass and pasture production. However, the use of concentrates in dairy-cow diets has increased in the last decades. The aim was to study the differences in milk composition in the four feeding systems identified in the North of Spain through the monitoring of 16 dairy farms. The criteria to describe feeding systems were: grazing (G) and non-grazing. Moreover, three subgroups were identified within 'non-grazing' in terms of the percentage of the usable agricultural area (UAA) designated to maize culture: less than 20% (20M), about 50% (50M) and more than 75% (75M) of UAA. Four dairy farms were selected by their feeding system. Feed and milk were sampled and analysed in summer, autumn and winter of 2014. The results show that the protein, lactose and solids-non-fat in milk were higher (P<0.05) in 75M than in the other feeding systems. The highest fat content (P<0.05) and the lowest content of linolenic acid (P<0.01) and conjugated linoleic acid (CLA) (P<0.05) were in winter, when there was less use of grass. The concentration of saturated acids increased in the 75M system (P<0.05), reducing the ratio unsaturated:saturated (P<0.05). The fatty acid profile was influenced by feed management, with the grazing system producing an increase in vaccenic acid (P<0.001) and CLA (P<0.01).

Keywords: dairy cow, fatty acids, milk quality, pasture, maize

Introduction

Northern Spain has an oceanic climate, generally warm with wet summers and mild winters. These climate conditions are favourable for grass and pasture production. Taking this situation into account, grazing is proposed as a strategy to reduce the cost of feeding inputs in dairy cow farms. However, the dairy sector has been intensified in the last decades (Álvarez *et al.*, 2008). The economic evaluation of dairy cow farms in the studied area (Asturias, Spain) shows that there is a large dependence of the usable agricultural area (UAA) designated to maize culture (Servicios Técnicos de Central Lechera Asturiana, 2012). The purchase of feedstuffs from off-farm sources is lower in dairy cow systems with the highest UAA designated to maize culture. However, there are areas where there is less UAA designated to maize crop, due to the high altitude and slope. Pasture-based systems allow farmers to produce at lower cost (Soder and Rotz, 2001). In addition, cows grazing fresh grass produce milk with improved fatty acid profiles for human health, especially CLA and linolenic acid (Morales-Almaráz *et al.*, 2011). Increasing the concentration of desirable FA in ruminant products has received greater attention recently (Elgersma *et al.*, 2006). The aim was to study the differences in the milk composition and FA profiles in four feeding systems identified in Asturias (Spain).

Materials and methods

According to official data there are currently 2,446 dairy farmers in Asturias. Results from a previous survey in this region showed that the best criteria to describe the feeding systems used were: grazing farms (G) and non-grazing farms. In addition, three subgroups were identified in the non-grazing system according to the percentage of UAA designated to maize culture: less than 20% (20M), between 20% and 75% (50M) and more than 75% (75M) of UAA. Four dairy farms were selected by feeding system identified (n=16), and feed and milk were sampled and analysed three times (summer, autumn and

winter of 2014). Milk samples were analysed for fat, protein, urea, lactose and solids-non-fat-content. Milk FA profile was determined by gas-liquid chromatography. The results were analysed by ANOVA (R Core Team, 2014) using feeding system (F) and season (S) as main factors.

Results and discussion

The results show that the protein, lactose and solids-non-fat in milk were higher ($P<0.05$) in 75M than in the other feeding systems (Table 1). This feeding system, which used a high level of maize in the ration, has more energy available for the animal, producing an increased in protein and lactose content in milk. It was also noted that the fat content in milk was not influenced by the feeding system, but was affected by the season. The fat content in milk was higher in winter than in summer ($P<0.05$).

Table 2 shows the proportion of unsaturated and saturated fatty acids and the main C18 FA. Considering the total FA, the season had no effect on the degree of fat saturation. However, the concentration of saturated acids was highest ($P<0.05$) in the 75M management, reducing the ratio unsaturated:saturated fatty acids. The season had no effect on FA profile except on CLA and linolenic acid (C18:3 *n-3*) proportion. The lowest content of CLA and linolenic acids appeared in winter *(*$P<0.05$). This could be

Table 1. Chemical analysis of milk from four dairy cow feeding systems identified in Asturias (Spain) during summer, autumn and winter 2014.

	Season			Feeding systems[1]				Factors[2]			
	Summer	Autumn	Winter	G	20M	50M	75M	rsd	S	F	S×F
Fat (g 100 g^{-1})	3.71[b]	3.84	3.91[a]	3.84	3.89	3.74	3.82	0.206	*	ns	ns
Protein (g 100 g^{-1})	3.15	3.15	3.19	3.14	3.12[b]	3.13	3.29[a]	0.137	ns	*	ns
Lactose (g 100 g^{-1})	4.73	4.75	4.78	4.72[b]	4.73	4.76	4.82[a]	0.086	ns	*	ns
Solids-non-fat (g 100 g^{-1})	8.64	8.64	8.72	8.61[b]	8.63	8.61[b]	8.86[a]	0.198	ns	*	ns
Urea (mg kg^{-1})	280	302	274	255	303	279	310	49.9	ns	ns	ns

[1] G = grazing system; 20M = less than 20% usable agricultural area (UAA) destined for maize culture; 50M = 20-75% UAA destined for maize culture; 75M = more than 75% UAA destined for maize culture. rsd = relative standard deviation.

[2] S = season, F = feeding system. Statistical significance * = $P<0.05$.

[a,b] Values in the same row with different letters differ significantly.

Table 2. Proportion of unsaturated and saturated fatty acids and the proportion of the major C18 fatty acids (in g 100 g^{-1}).

	Season			Feeding systems[2]				Factors[3]			
	Summer	Autumn	Winter	G	20M	50M	75M	rsd	S	F	S×F
SFA	69.68	68.73	69.62	69.27	68.42	66.81[b]	74.04[a]	5.550	ns	*	ns
UFA	30.33	31.35	30.4	30.86	31.58	33.19[a]	25.96[b]	5.551	ns	*	ns
UFA/SFA	0.44	0.47	0.44	0.45	0.47	0.51[a]	0.37[b]	0.121	ns	*	ns
C18:0	12.17	10.52	11.32	11.35	10.73[b]	13.26[a]	9.58[b]	2.192	ns	**	ns
C18:1 trans11	1.02	0.88	0.76	1.26[a]	0.90[a]	0.89[a]	0.39[b]	0.422	ns	***	ns
C18:1 cis9	23.31	23.82	24.34	23.83	24.94	25.90	19.55	5.395	ns	ns	ns
C18:2 n-6	1.87	1.39	1.45	1.26	1.47	2.04	1.48	0.695	ns	ns	ns
CLA	0.36[a]	0.25	0.22[b]	0.40[a]	0.28	0.26	0.14[b]	0.152	*	**	ns
C18:3 n-3	0.24[b]	0.39[a]	0.19[b]	0.33	0.26	0.30	0.18	0.140	**	ns	ns

[1] SFA: saturated fatty acids; UFA: unsaturated fatty acids.

[2] Feeding systems: G = grazing system; 20M = less than 20% usable agricultural area (UAA) destined to maize culture; 50M = 20-75% UAA destined to maize culture; 75M = more than 75% UAA destined to maize culture.

[3] Factors: S = season; F = feeding system. Statistical significance: * = $P<0.05$, ** = $P<0.01$, *** = $P<0.001$.

[a,b] Values in the same row with different letters differ significantly.

explained by less use of forage during winter. The increase of CLA was very important in summer (0.359 g 100 g^{-1} FA, $P<0.05$) and, moreover, in the grazing system (0.397 g 100 g^{-1} FA, $P<0.01$). CLA and vaccenic acids (C18:1 trans11) were higher ($P<0.01$) in the grazing system (0.397 and 1.255 g 100 g^{-1} FA, respectively) than the 75M system (0.136 and 0.385 g 100 g^{-1} FA, respectively).

Conclusions

Increased proportions of maize in the feed ration improve the milk chemical composition in terms of protein, lactose and solids-non-fat, while the concentration of fat content was affected by the season. In addition, by using pastures results showed it is possible to improve the FA profile of cow milk, especially in the proportions of vaccenic acid and CLA. Information from this study supports previous findings that there is a potential for increased value-added attributes of milk, and that these differences could be identified in terms of differences between feeding systems during different seasons in the studied area.

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