Influence of *DGAT1* polymorphism on response of dairy cows to ruminal supplementation of linseed oil

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Introduction

The *DGAT1* gene encodes for the diacylglycerol acyltransferase enzyme which catalyzes the final step in triacylglycerol synthesis. Various polymorphisms have been reported for DGAT1. One of them, the K232A *DGAT1* polymorphism in which lysine as the 232nd amino acid is replaces by alanine, is associated with increased milk yield, lower fat and protein concentrations (Grisart *et al.*, 2001) and altered milk fatty acid (FA) composition (Schennink *et al.*,2007). Milk FA composition is, on the other hand, also affected by nutritional factors including dietary FA composition (Sterk *et al.*, 2011). Until now, no literature data could be retrieved to establish whether the response in milk FA composition of dairy cows to changes in dietary FA composition is influenced by *DGAT1* polymorphism. Therefore, a study was performed with 8 rumen-cannulated dairy cows in mid-lactation with different *DGAT1* polymorphism, receiving either palm fat or linseed oil.

Material and Methods

Eight rumen-cannulated cows were selected and blocked depending on *DGAT1* polymorphism: 4 cows were genotyped as AA and 4 as KK mutant. Cows were allocated to treatments in a change-over designed experiment with 2 periods. Cows were fed a partial mixed ration (49% grass silage, 33% corn silage, 11% soy bean meal, 5% and rapeseed meal and 2% premix on dry matter basis) ad libitum and 1 kg of concentrates during milking. Dietary treatments were palm fat and linseed oil supplementation at 500 g/d, dosed intra-ruminal in 2 equal portions after milking. Each treatment was given for two weeks. During the last 4 milkings of each period, milk yield was recorded and milk samples were taken to determine fat, protein and lactose content and milk FA composition. Data were statistically analyzed by ANOVA with cow and period as random, and genotype and treatment as fixed effects.

Results and discussion

Cows consumed on average 18.4 kg dry matter/day, including 2.8 kg of crude protein/d, 6.0 kg of NDF/d, and 1.6 kg crude fat/d. Compared to KK genotype, cows with AA genotype produced numerically less milk and had a lower milk fat and protein content (Table 1). The lower milk yield for cows with the AA genotype is in contrast with other observations (Grisart *et al.*, 2001; Schennink *et al.*, 2007), but was attributed to the difference in stage of lactation between cows. Compared to KK genotype, milk fat of cows with AA genotype had higher proportions of oleic and linoleic acids, which was compensated by lower proportions of caproic, caprylic and capric acid (Table 2), the latter in agreement with observations by Schennink *et al.* (2007).

As expected, compared to palm fat, feeding linseed oil resulted in a lower milk fat content. Compared to palm fat, feeding linseed oil resulted in higher proportions of C:18 FA in milk fat, which was compensated by lower proportions of C:14 and C:16 FA. Generally, no genotype × fat source interactions could be observed, except for stearic acid and cetoleic acid (C20:1, n11).

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Table 1. Effect of lipid supplementation and DGAT1 *polymorphism on milk yield and milk composition of dairy cows.*

Parameter	Treatment (lipid source)				SED	*P*-value		
	Linseed		Palm					
	DGAT1 genotype					G	L	L×G
	AA	KK	AA	KK				
Milk production								
Milk, kg /d	18.0	21.4	18.8	22.0	0.7	0.50	0.26	0.94
Fat, kg/d	0.59	0.81	0.66	1.14	0.07	0.04	0.01	0.05
Protein, kg/d	0.65	0.89	0.68	0.90	0.03	0.18	0.32	0.85
Milk composition								
Fat, g/kg	33.0	40.7	37.3	51.9	2.4	0.02	0.01	0.10
Protein, g/kg	36.5	42.3	36.6	41.5	0.97	0.03	0.61	0.54

[1] L: lipid source; G: *DGAT1* mutation; L×G: interaction.

Table 2. Effect of lipid supplementation and DGAT1 *polymorphism on milk fatty acid profile (g/100 g FA).*

Fatty acid	Treatment (lipid source)				SED	*P*-value		
	Palm		Linseed					
	DGAT1 genotype					G	L	L×G
	AA	KK	AA	KK				
C4:0	3.9	4.2	4.0	4.2	0.07	0.43	0.18	0.35
C6:0	1.9	2.3	1.9	2.3	0.05	0.03	1.00	0.51
C8:0	0.8	1.1	0.9	1.1	0.04	0.04	0.36	0.36
C10:0	1.7	2.2	1.8	2.2	0.12	0.05	0.43	0.79
C12:0	2.3	2.6	2.4	2.8	0.13	0.16	0.12	0.46
C14:0	8.9	9.2	9.5	9.7	0.26	0.67	0.03	0.95
C16:0	32.3	34.1	22.9	25.5	0.92	0.16	<0.001	0.57
C16:1, n7	2.2	2.2	1.4	1.6	0.08	0.90	<0.001	0.15
C18:0	8.6	9.4	10.0	10.0	0.25	0.59	0.01	0.06
C18:1, n9	24.3	20.7	25.8	21.8	0.45	0.03	0.01	0.56
C18:1, *trans*	2.6	2.6	4.2	4.3	0.49	0.91	0.01	0.84
C 18:1 other	1.3	1.2	2.3	2.1	0.14	0.27	<0.001	0.81
C18:2, n6	1.3	1.2	1.5	1.4	0.04	0.01	0.001	1.00
C18:2, c9,t11	0.8	0.7	1.7	1.6	0.20	0.49	0.01	0.93
C18:2, *trans*	1.2	1.0	3.3	3.0	0.26	0.40	<0.001	0.70
C18:3, n3	0.4	0.4	0.5	0.4	0.03	0.28	0.03	0.56
C 20:1, n11	0.1	0.1	0.2	0.2	0.02	0.67	<0.001	0.03

[1] L: lipid source; G: *DGAT1* mutation; L×G: interaction.

Conclusion

Although K232A *DGAT1* polymorphism altered milk composition and milk FA profile, the response in milk composition and milk FA profile to supplementing linseed oil was similar for AA and KK genotype cows.

References

Grisart, B., Coppieters, W., Farnir, F., Karim, L., Ford, C., Berzi, P., Cambisano, N., Mni, M., Reid, S., Simon, P., Spelman, R., Georges, M., Snel, R., 2001. Positional candidate cloning of a QTL in dairy cattle: Identification of a missense mutation in the bovine DGAT1 gene with major effect on milk yield and composition. Genome Res. 12, 222-231.

Schennink, A., Stoop, W.M., Visker, M.H.P.W., Heck, J.M.L., Bovenhuis, H., van der Poel, J.J., van Valenberg, H.J.F. and van Arendonk J.A.M., 2007. DGAT1 underlies large genetic variation in milk-fat composition. Anim. Genet. 38, 467-473.