Associations between DGAT1 and SCD1 polymorphisms and production, conformation and functional traits in dairy cattle

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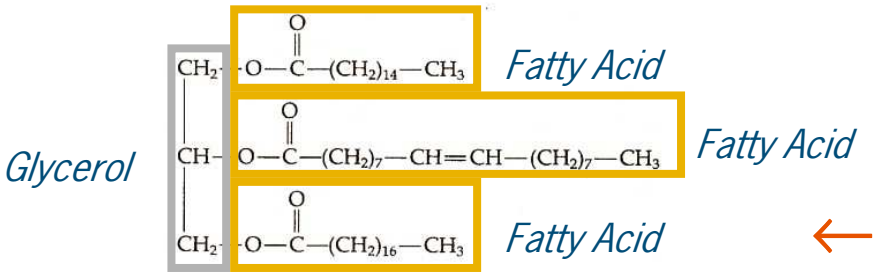
Introduction

- DGAT1 and SCD1 play an important role in fat metabolism
- DGAT1 is involved in triglyceride synthesis



← **DGAT1**

- DGAT1 polymorphism (A/K) in cattle (Grisart et al. 2002; Winter et al. 2002) is associated with
  - Major effects on milk production traits, especially fat%
  - Milk fat composition (e.g. Schennink et al. 2007)

Introduction

- DGAT1 and SCD1 play an important role in fat metabolism
- SCD1 is involved in desaturation of fatty acids:

SCD1

saturated FA → unsaturated FA

- SCD1 polymorphism (A/V) in cattle (Taniguchi et al. 2004) is associated with
  - Carcass fat composition (e.g. Taniguchi et al. 2004)
  - Milk fat composition (e.g. Mele et al. 2008; Schennink et al. 2008)

Introduction

SCD1 and DGAT1 are key targets in human drug development:

Flowers and Ntambi (2008)

"..modulation of SCD1 activity ... strongly influences several facets of energy metabolism to affect susceptibility to obesity, insulin resistance, diabetes and hyperlipidemia."

Hughes (2009)

"Two targets in particular (SCD1 and DGAT1)....are advancing toward proof of concept in human trials"

Are there effects in dairy cattle of DGAT1 and SCD1 polymorphisms on other traits than fat content/composition?

Introduction

Aims of this study

- Estimate change of allele frequencies in time for SCD1 and DGAT1 in Dutch Holstein Friesians
- Estimate effects of SCD1 and DGAT1 polymorphisms on production, conformation and functional traits in Dutch Holstein Friesians

Material and Methods

- ~4000 progeny tested bulls
- Birth year: 1985-2005
- >80% HF
- Genotypes from customised CRV 50k SNP array (Illumina)

Material and Methods

- Statistical model:

$$y_{ijkl} = \mu + (\text{breed}*\text{birth year})_i + \text{genotype}_j + \text{animal}_k + e_{ijkl}$$

  - Breed: red HF or black HF
  - Genotype: SCD1 or DGTAT1
  - Animal – account for pedigree relationships

- Report associations $p<0.003$ ($-\log(p)>2.5$)

Material and Methods

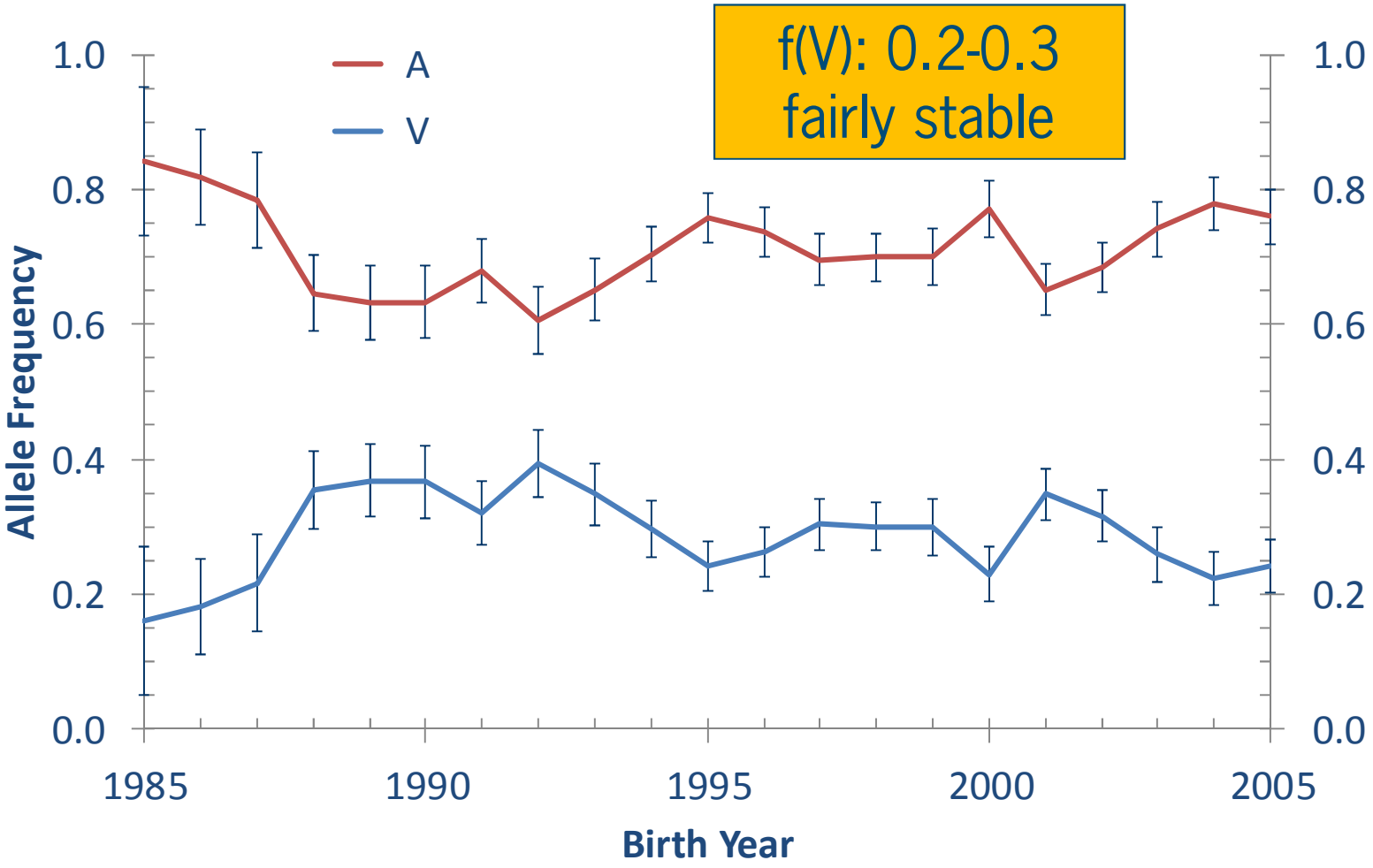
Traits: estimated breeding values for 48 traits

- Milk production traits
- Udder health
- Fertility
- Milking speed
- Calving ease
- Longevity
- Conformation traits

Several traits are standardised:
mean = 100, σ = 4, larger values = positive

SCD1

SCD1 A293V – Allele frequencies



SCD1 - Associations

Trait	-log(p)	VV	AV	AA
KG Fat	7.7			
KG Protein	3.0			
NR56	3.8			
Gestation Length	3.1			
Rump width	3.5			

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SCD1 - Associations

Trait	-log(p)	VV	AV	AA
KG Fat	7.7	7.0	3.6	0
KG Protein	3.0	2.8	1.8	0
NR56	3.8	-0.78	-0.35	0
Gestation Length	3.1	-0.73	-0.39	0
Rump width	3.5	0.33	0.49	0

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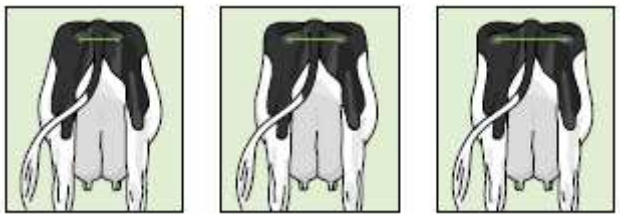

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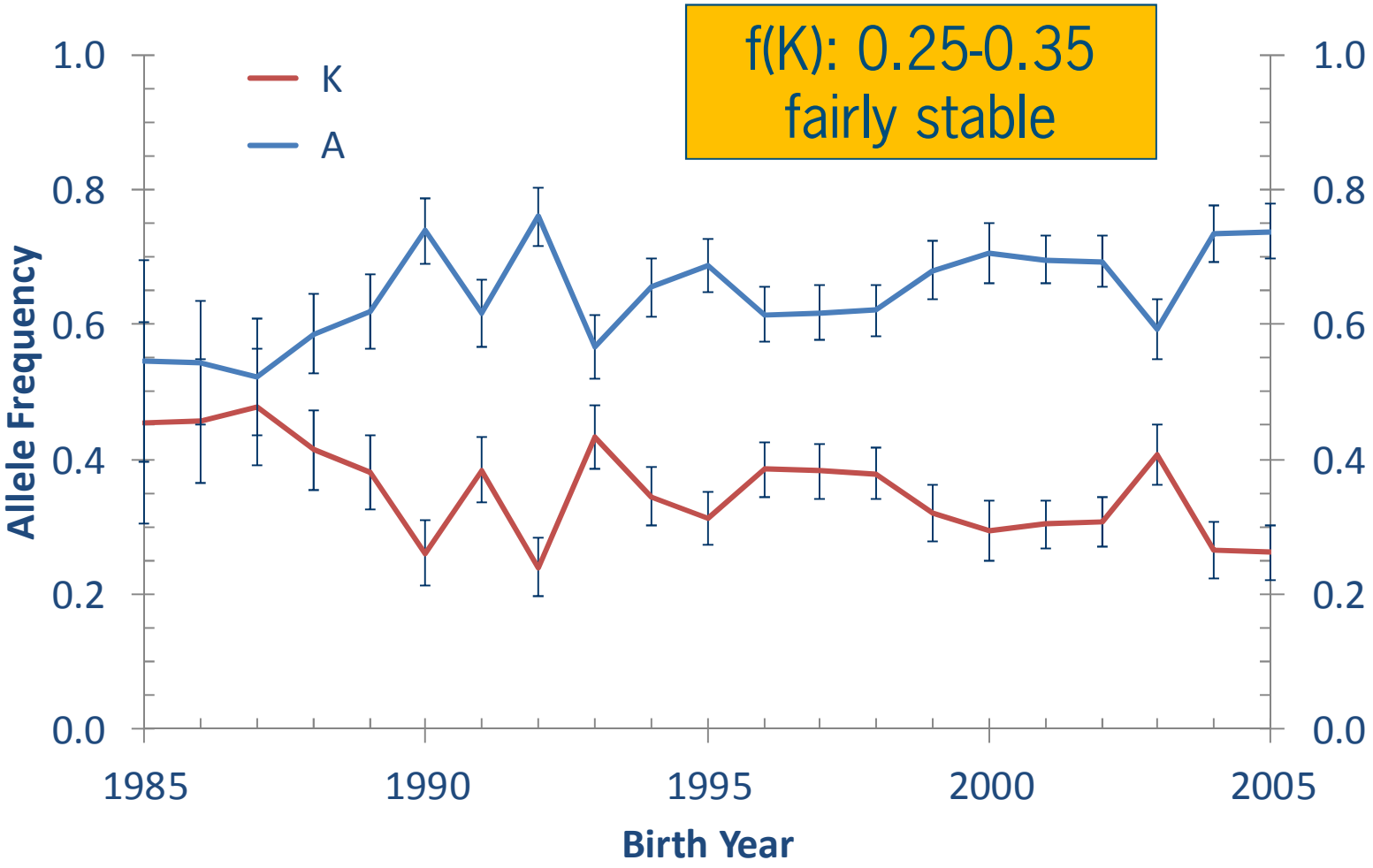
SCD1 - Conclusions

- Frequency of the SCD1 V allele in the Dutch HF is 0.2-0.3 and is fairly stable
- V allele of SCD1 associated with higher fat and protein yield.
- V allele of SCD1 associated with reduced fertility and shorter gestation length
- Suggestive evidence that V allele of SCD1 is associated with lower body condition score: -log(p)=2.0

DGAT1

DGAT1 K232A – Allele frequencies



DGAT1 - Associations

Trait	-log(p)	AA	AK	KK
KG milk	127.6			
KG Fat	153.9			
KG Protein	38.6			
Fat %	Hugh			
Protein %	136.6			
Maturity	12.8			
Gestation Length	3.0			

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DGAT1 - Associations

Trait	-log(p)	AA	AK	KK
KG milk	127.6	356	0	-351
KG Fat	153.9	-14.4	0	14.5
KG Protein	38.6	5.3	0	-5.3
Fat %	Hugh	-0.36	0	0.39
Protein %	136.6	-0.08	0	0.09
Maturity	12.8	-0.73	0	0.83
Gestation Length	3.0	-0.42	0	0.11

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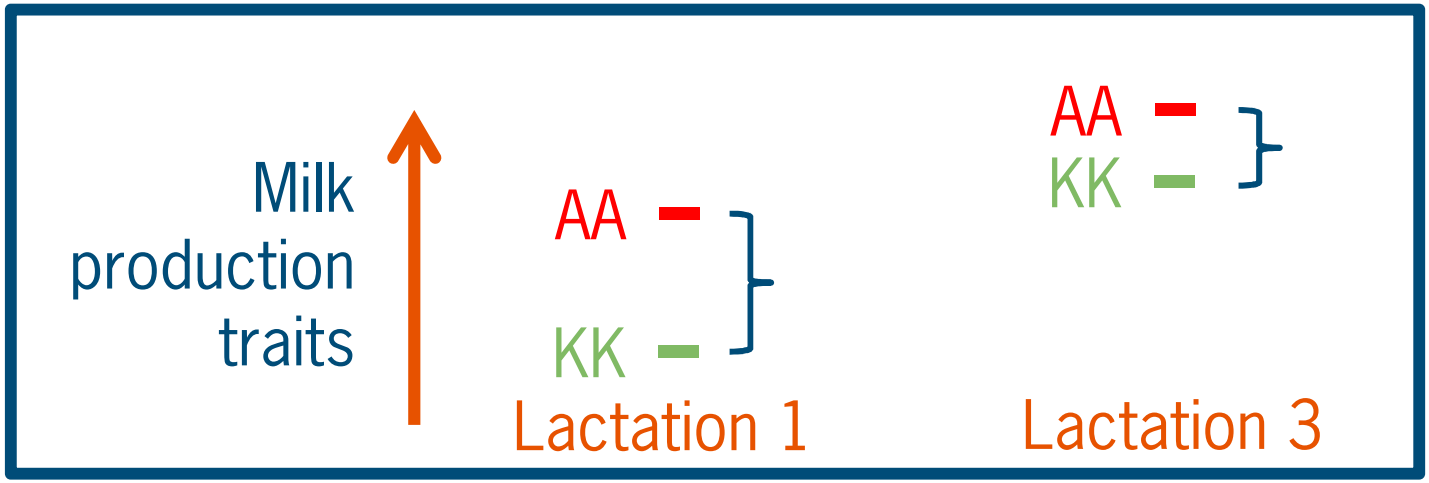
DGAT1 - Associations

Trait	-log(p)	AA	AK	KK	KK-AA
KG milk	127.6	356	0	-351	-707
KG Fat	153.9	-14.4	0	14.5	28.9
KG Protein	38.6	5.3	0	-5.3	-10.6
Fat %	Hugh	-0.36	0	0.39	0.75
Protein %	136.6	-0.08	0	0.09	0.17
Maturity	12.8	-0.73	0	0.83	1.56
Gestation Length	3.0	-0.42	0	0.11	0.53

Maturity: relative milk production in the second or third lactation as compared to the first lactation.

DGAT1 - Conclusions

- Frequency of the DGAT1 K allele is fairly stable
- Results confirm major effects of DGAT1 on milk production traits: K allele higher fat %, higher fat yield, lower milk and protein yield.
- K allele of DGAT1 associated with higher maturity:



- K allele of DGAT1 associated with shorter gestation length

DGAT1 and SCD1 polymorphisms not only associated with milk production traits but also with

- SCD1 – fertility
- DGAT1 - maturity

Thanks for your attention