Milk-fat composition of dairy cows

can be improved by use of genetic variation

Anke Schennink, Marianne Stoop, Marleen Visker, Jeroen Heck,
Henk Bovenhuis, Jan van der Poel, Hein van Valenberg, Johan van Arendonk

Animal Breeding & Genomics Centre
Dairy Science & Technology Group

Aim of the Dutch Milk Genomics Initiative

Aim: to identify the possibilities to use breeding for improving milk quality

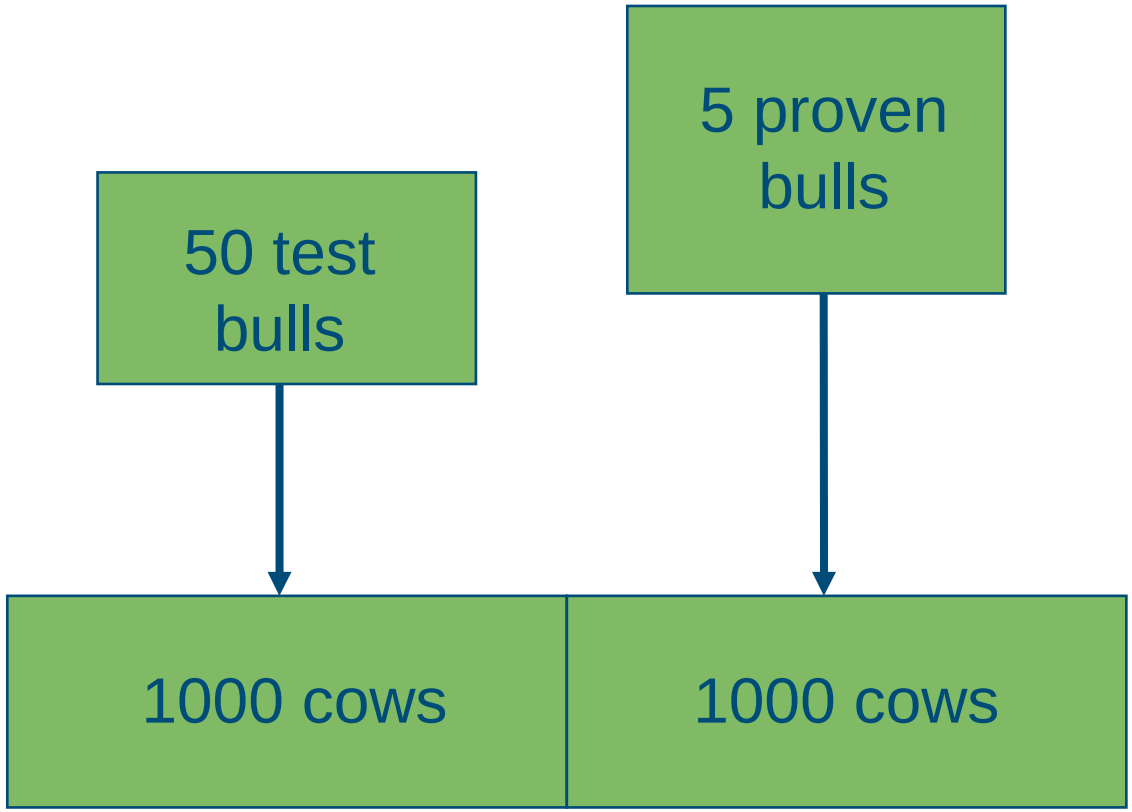
Genetic variation	Milk composition	Product quality

- ✓ Human health
- ✓ Technological properties

New

- Detailed milk composition
- Cooperation: from genes, to composition, to products

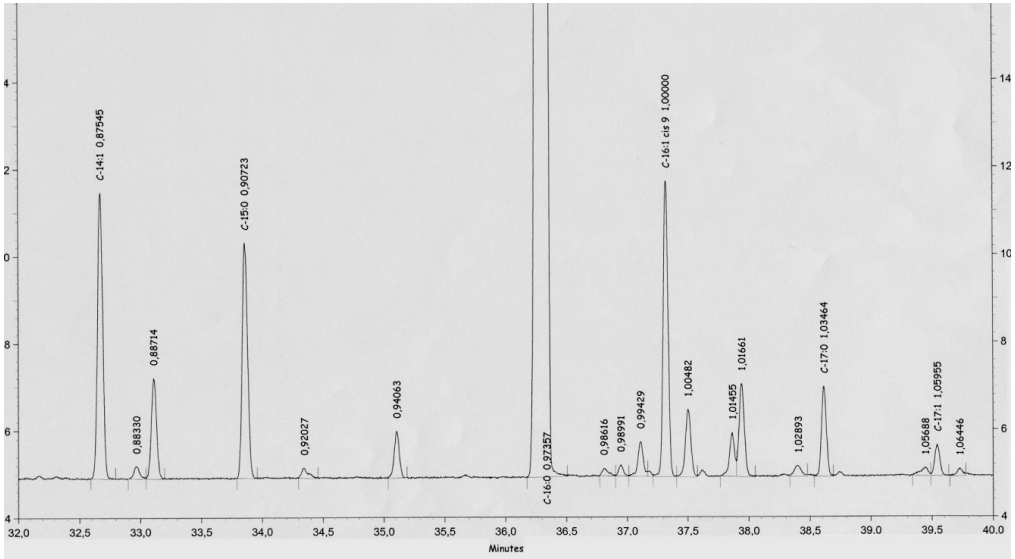
Resource population



Samples

- Milk sample (February-March 2005)
  - Milk production traits
  - Detailed milk-fat composition
- Blood sample
  - DGAT1 polymorphism genotyped

Milk-fat composition by gas chromatography

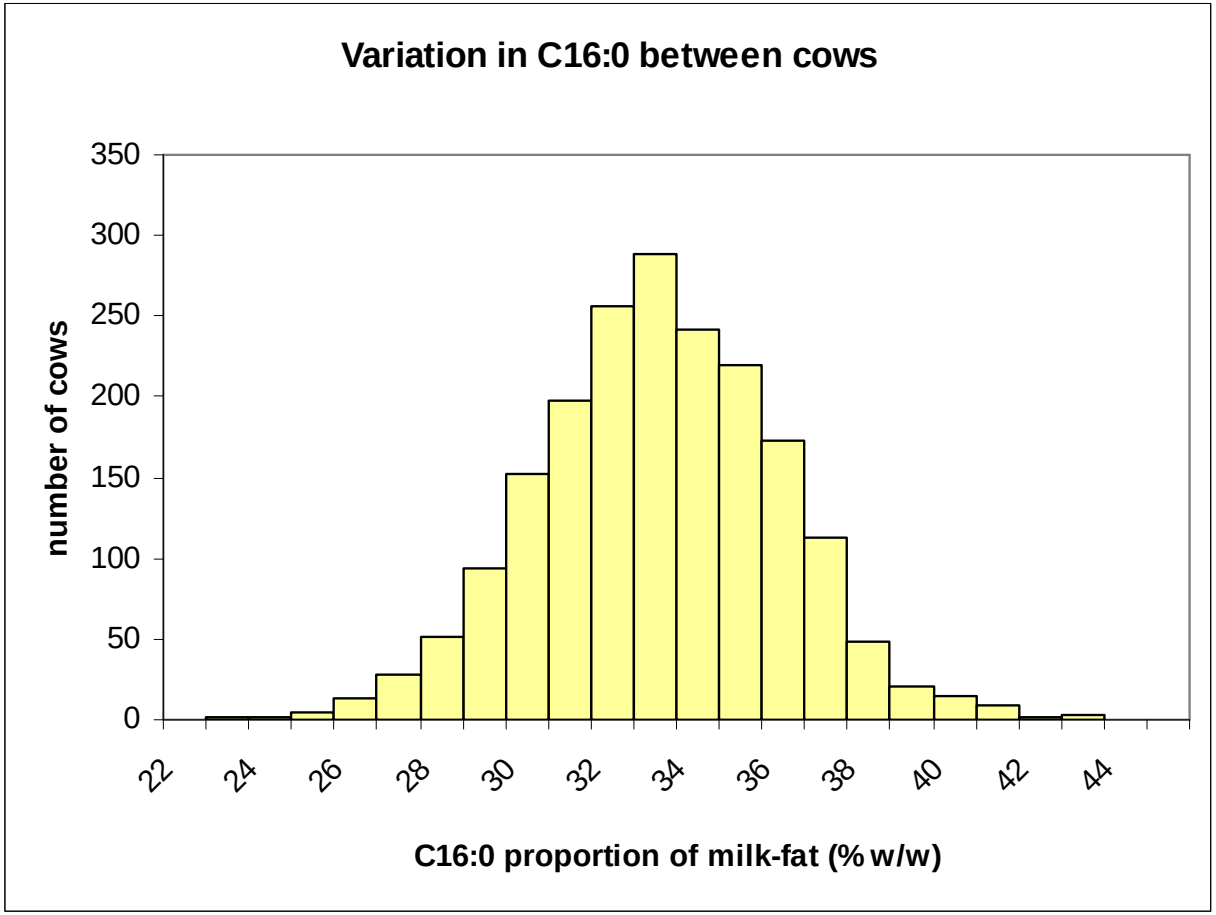


- > 100 fatty acids measured
- 45 fatty acids identified
- 13 fatty acids >1% w/w

Milk-fat composition

Fatty acid	Name	Proportion (%)
C4:0-C12:0		14.2
C14:0	Myristic acid	11.6
C16:0	Palmitic acid	32.6
C18:0	Stearic acid	8.7
C18 unsaturated		22.2
C18:2*cis*-9,*trans*-11	Rumenic acid or CLA *cis*-9,*trans*-11	0.4
C18:3*cis*-9,12,15	α-linolenic acid	0.4

Phenotypic variation in milk-fat composition



Genetic and herd effects

Fatty acid	Mean	Heritability	Ratio genetic/herd
C4:0-C12:0	14.2	0.59	1.7
C14:0	11.6	0.59	2.8
C16:0	32.6	0.43	1.1
C18:0	8.7	0.23	1.0
C18 unsaturated	22.2	0.28	0.6
C18:2*cis*-9,*trans*-11	0.4	0.42	0.4
C18:3*cis*-9,12,15	0.4	0.26	0.1

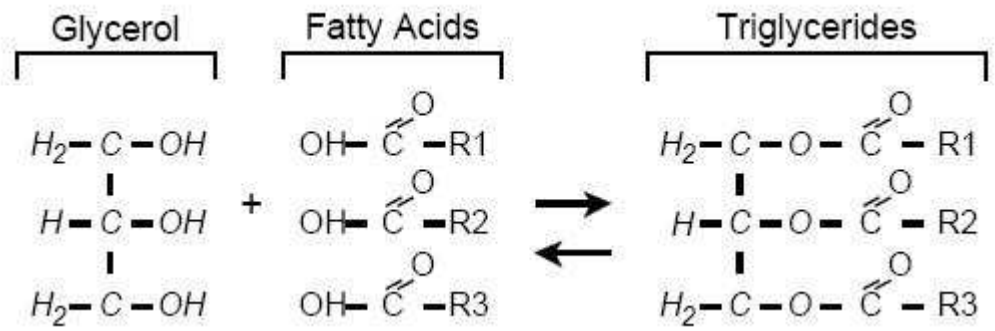
Standard errors of heritabilities were between 0.07 and 0.11

Summary

- Large genetic variation in milk-fat composition
- Short and medium chain fatty acids are under stronger genetic control than long chain fatty acids

DGAT1 polymorphism

- DGAT1 K232A mutation has effect on milk-fat percentage
  - DGAT1 catalyses the esterification of a fatty acyl-CoA to the *sn*-3 position of a diacylglycerol



Grisart *et al* 2002, Winter *et al* 2002

DGAT1 effects on milk-fat composition

Trait	***KK*** (n=289)	***KA*** (n=829)	***AA*** (n=644)	**P value**
Fat%	0	-0.45	-0.98	<0.001
C4:0-C12:0	0	0.16	0.03	ns
C14:0	0	0.43	0.79	<0.001
C16:0	0	-1.02	-2.52	<0.001
C18:0	0	-0.18	-0.10	ns
C18 unsaturated	0	0.80	2.12	<0.001
C18:2*cis*-9,*trans*-11	0	0.02	0.05	<0.001
C18:3*cis*-9,12,15	0	0.02	0.04	<0.001

DGAT1 effects on milk-fat composition

Trait	*KK* (n=289)	*KA* (n=829)	*AA* (n=644)	P value	$r^2_{genetic}$%
Fat%	0	-0.45	-0.98	<0.001	50
C4:0-C12:0	0	0.16	0.03	ns	
C14:0	0	0.43	0.79	<0.001	23
C16:0	0	-1.02	-2.52	<0.001	40
C18:0	0	-0.18	-0.10	ns	
C18 unsaturated	0	0.80	2.12	<0.001	53
C18:2*cis*-9,*trans*-11	0	0.02	0.05	<0.001	16
C18:3*cis*-9,12,15	0	0.02	0.04	<0.001	28

Conclusions

- Large genetic variation in milk-fat composition
- Short and medium chain fatty acids are under stronger genetic control than long chain fatty acids
- DGAT1 explains large part of the genetic variation in milk-fat composition

Impact

- Natural variation gives opportunities to use selective breeding to improve milk-fat composition

Acknowledgements

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stw

Thank you!

Natural variation gives opportunities to use selective breeding to improve milk-fat composition

Schennink *et al* (2007) Animal Genetics

Anke.Schennink@wur.nl

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Animal Breeding & Genomics Centre