Lactation Stage-Dependent Genome-wide Effects on Breeding Values in Holstein Friesians

***E.M. Strucken*[*], R.H. Bortfeldt[*], J. Tetens[†], G. Thaller[†] and G.A. Brockmann[*]**

[*] Breeding Biology and Molecular Genetics, Humboldt-Universität zu Berlin, Invalidenstraβe 42, 10115 Berlin, Germany

[†] Animal Breeding and Husbandry, Christian-Albrechts Universität zu Kiel, Olshausenstr. 40, 24098 Kiel, Germany

Introduction

- Many quantitative traits differ phenotypically over time
- Milk production traits have been characterised over the last century
- Dairy cows have energy deficiency in early lactation

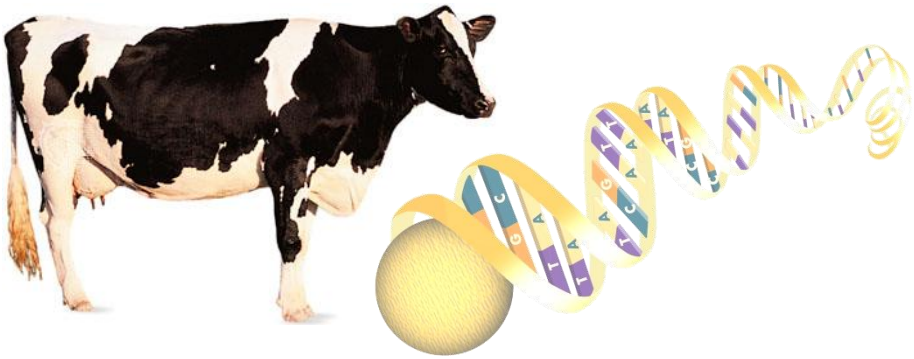
- Recent studies demonstrated time dependency for variances and genetic effects
- *DGAT1* effects are less pronounced and reversed for milk yield and protein content in early lactation

Hadjipavlou *et al.* 2008; Strucken *et al.* 2011, J. Dairy Sci **94:442–449**

Introduction

Aim of this study

- Characterise genetic effects in early lactation
- Compare results for early lactation with 305d records



Material & Methods

- Estimated Breeding Values (**EBVs**) **provided by VIT** (Vereinigte Informationssysteme Tier, Verden, Germany)
- EBVs of **2,405 bulls** averaged over lactation 1-3
  - **First 60** lactation days in 5 **10-day intervals** (Interval 1 = 11-20 DIM)
  - **305d**
- EBVs for **milk yield** and **content traits** ↘
- EBVs for **fat and protein yield** ↗

EBV – estimated breeding value DIM – days in milk

Material & Methods

- Bovine **50k BeadChip** (Illumina)
- Array cleaned of **duplicates**, **not yet allocated** markers and **remapped** (Schmitt *et al.* 2010)
- **2,339 animals** and **43,627 markers** passed quality control
- Genome wide association study with **GenABEL** (Aulchenko *et al.* 2007)
  - Population stratification (GRAMMAS)
  - Genomic control (Lambda deflation factor)
  - Multiple testing (Bonferroni)

Results & Discussion

- **43** genome wide significant markers for **intervals as well as 305d records**
- Most markers on **BTA 14** with 70-75 % around ***DGAT1***
- Almost all markers were **significant in all intervals** (except protein yield)
- Markers not significant in all intervals were mainly for **intervals 3-5**

Number of significant markers

	Interval					
	1	2	3	4	5	305d
MKG	7	11	18	20	20	23
FKG	22	22	23	24	25	24
PKG	-	-	1	1	3	8
FP	32	32	32	33	33	39
PP	18	22	24	23	22	27

Results & Discussion

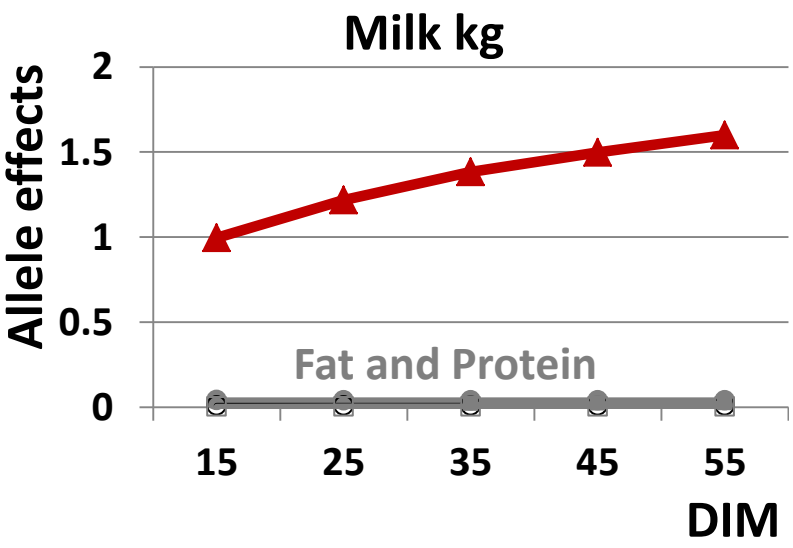
- **7 unique markers** for intervals as well as 305d records
- Markers on **BTA 6** (casein cluster) only significant in first 60 DIM
- 2 marker on **BTA 14** only significant in 305d records
  - 2.5 Mb

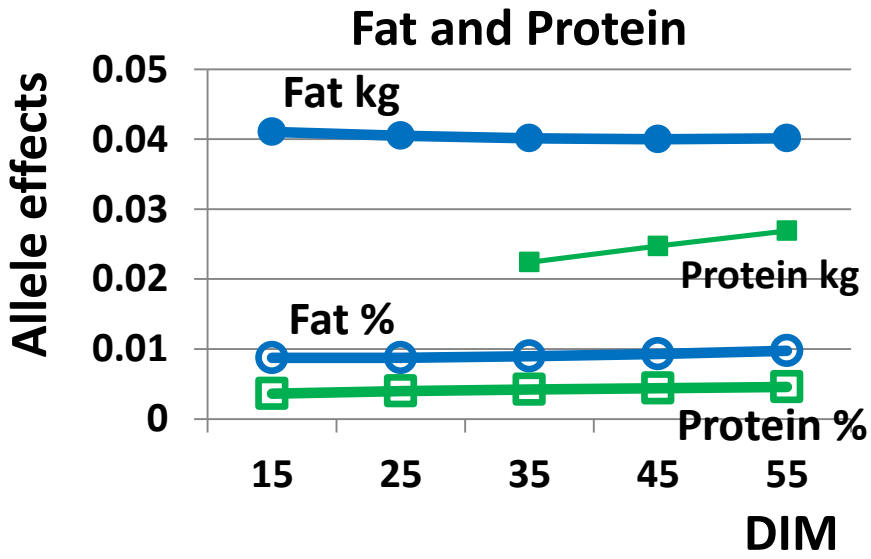
BTA	POSITION (BP)	TRAIT	DIM	P-VALUE
6	84,194,537 - 91,692,660	PP	11-60	~4^{-7}
14	2,239,116 - 2,736,947	FKG, FP	305d	~4^{-7}

DIM – days in milk

Results & Discussion

- 2 groups of effect changes
- EBVs for **milk yield ↘** and for **fat yield ↗**
- *DGAT1* has strong effects on **fat yield**





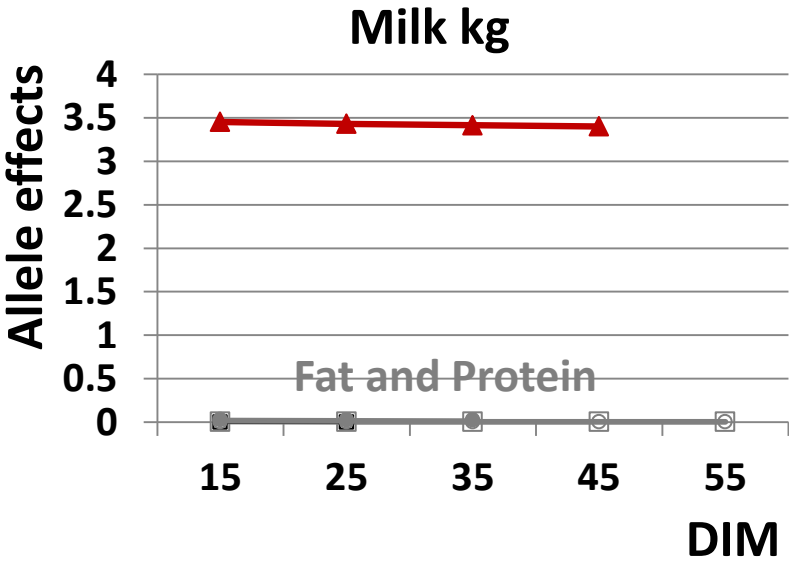
Change of effect sizes in **first 60** days in milk (**DIM**) for **BTA 14**

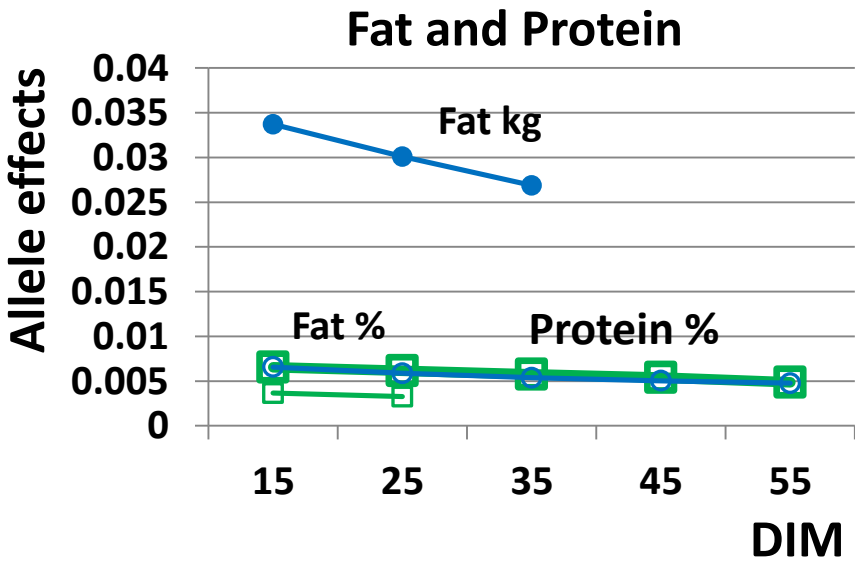
EBV – estimated breeding value

Winter *et al.* 2001; Kühn *et al.* 2007

Results & Discussion

- LSM only for protein content on BTA 6 possible
- Marker on **BTA 6** close to **casein cluster**
- **Casein** genes synthesise main part of **milk proteins**





Change of effect sizes in **first 60** days in milk (**DIM**) for **BTA 6**

LSM – least square means

Caroli et al. 2009

Results & Discussion

- Differences between Intervals and 305d records highly significant for **yield traits**

LSM differences (± Std. Error) between intervals and 305d records for **content traits** separated after BTAs

		LSM Differences			
		BTA 14		BTA 6	
Records		Fat %	Protein %	Fat %	Protein %
305	1	- 0.0053 ±0.0002 *	- 0.0024 ±0.0001 *	-	0.00061 ±0.0004
	2	- 0.0052 ±0.0002 *	- 0.0020 ±0.0001 *	-	0.00021 ±0.0004
	3	- 0.0050 ±0.0002 *	- 0.0017 ±0.0001 *	-	- 0.00019 ±0.0004
	4	- 0.0047 ±0.0002 *	- 0.0016 ±0.0001 *	-	- 0.00057 ±0.0004
	5	- 0.0042 ±0.0002 *	- 0.0014 ±0.0001 *	-	- 0.00109 ±0.0004

*** P<0.0001**

LSM – least square means

Conclusion

- The change in EBVs is neither an indicator for the change in effect size over time nor the number of detectable loci

- Effect size of loci changes over time
  - Biological function of genes only at certain times?
  - Change of active genes over time?

EBV – estimated breeding value

Conclusion

- Effects of known genes show change in effect size against their known influence
  - Linked genes?
  - Biological function of genes only at certain times?
- Course of a lactation is affected by performance at the beginning of lactation
  - Marker with bigger effects at the beginning and increasing effect sizes over time are promising targets for further investigations and can be useful in genomic breeding value estimation

Thank you very much for your attention

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Thank you very much for your attention

EBV – estimated breeding value