Genetic correlation between composition of bovine milk fat in winter and summer, and DGAT1 and SCD1 by season interactions

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Bovine milk fat:

→ fat-soluble vitamins and bio-active lipids
→ important sources of **energy** in human diets (German & Dillard, 2006)

**Genetic factors** influence milk fat composition, which shows **genetic variation** (e.g., Schennink et al., 2007)

**Polymorphisms in** DGAT1 and SCD1 **have been recognized as having large effects** on milk fat composition (e.g., Schennink et al., 2008)

**Nutrition** can alter milk fat composition (e.g., Chilliard et al., 2007)

→ indications that it affects **mammary lipogenic gene expression** (e.g., Mach et al., 2011)
**Seasonal variation** in European countries (e.g., Heck et al., 2009)

<table>
<thead>
<tr>
<th>FA composition</th>
<th>Winter</th>
<th>Summer</th>
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<tbody>
<tr>
<td>SFA</td>
<td>69.0%*</td>
<td>65.7%*</td>
</tr>
<tr>
<td>UFA</td>
<td>25.0%*</td>
<td>28.0%*</td>
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Significant levels via t-test: * = significant difference

Cows in **winter** → indoors + silage
Cows in **summer** → pasture + fresh cut grass

**Genotype by season interaction?**
Aims

Is milk fat composition in winter genetically the same trait as in summer?

1) Estimate genetic correlations between winter and summer milk samples

2) Test for DGAT1 and SCD1 by season interactions
Phenotypes and Genotypes

~ 2,000 first lactation Holstein-Friesian cows from 400 herds in the Netherlands

**Morning milk samples** - Winter and Summer

**Individual FA measured by Gas Chromatography**

- C4:0-C18:0, C10:1-C18:1cis-9
- C18:1trans-6-11,
- C18:2cis-9,trans-11(CLA)
- C18:2cis-9,12, C18:3cis-9,12,15

**DGAT1 K232A polymorphism** → 1,692 animals

**SCD1 A293V polymorphism** → 1,637 animals
Heritability estimates between winter and summer milk samples
Heritability estimates are similar between winter and summer milk samples.
Herd variances in winter and summer milk samples
Herd variances in winter and summer milk samples

Increased herd variances in summer compared to winter milk samples
Genetic correlations between winter and summer milk fat composition
Genetic correlations between winter and summer milk fat composition

Significance levels via likelihood ratio test:

ns = non-significantly different than 1

= significantly different than 1
Genetic correlations between winter and summer milk fat composition

Summer and winter milk fat composition can be largely considered as genetically the same trait.
Aims

Is milk fat composition in winter genetically the same trait as in summer?

1) Estimate genetic correlations between winter and summer milk samples

2) Test for DGAT1 and SCD1 by season interactions
Effects of DGAT1 and SCD1 between winter and summer milk samples

**DGAT1 232A allele:**

- **Negatively associated** with fat%, most FA with less than 18 carbons, SFA, and C10 to C16 unsaturation indices
- **Positively associated** with C14:0, unsaturated C18, UFA, and C18 to CLA unsaturation indices

**SCD1 293V allele:**

- **Negatively associated** with C18:0, C10:1 to C14:1cis-9, C18:1trans-11, C10 to C14 unsaturation indices
- **Positively associated** with C8:0 to C14:0, C16:1cis-9, C16 to CLA unsaturation indices
Effects of DGAT1 and SCD1 between winter and summer milk samples

**DGAT1 232A allele:**

- **Negatively associated** with fat%, most FA with less than 18 carbons, SFA, and C10 to C16 unsaturation indices

**SCD1 293V allele:**

- **Negatively associated** with C18:0, C10:1 to C14:1 cis-9, C18:1 trans-11, C10 to C14 unsaturation indices
- **Positively associated** with C8:0 to C14:0, C16:1 cis-9, C16 to CLA unsaturation indices

Effects of DGAT1 and SCD1 are similar between winter and summer milk samples.
Genotype by season interactions

No interactions

Re-ranking

Scaling
DGAT1 by season interaction was found for:

- C4:0, C6:0, C8:0, C10:0, C12:0, and C14:0,
- C16:1\textit{cis}-9, C18:1\textit{cis}-9, CLA, and C18:3\textit{cis}-9,12,15,
- SFA and UFA,
- C14 and C16 unsaturation indices.
Effects of DGAT1 K232A polymorphism on C14:0 and C18:1cis-9.
DGAT1 by season interaction suggest scaling rather than re-ranking.
C18:1trans-11 was the only one to show SCD1 by season interaction
Effects of SCD1 A293V polymorphism on C18:1\textsuperscript{trans}-11 Winter and Summer.
SCD1 by season interaction suggest scaling rather than re-ranking.
Conclusions

- **Heritability** estimates between winter and summer milk samples were *similar*.

- **Increased herd variances** were found in *summer* compared to winter milk samples.

- Summer and winter milk fat composition can be **largely considered** as genetically the **same trait**.

- **Effects of DGAT1 and SCD1** are similar between winter and summer milk samples.

- **DGAT1 and SCD1 by season interactions** are present and suggest **scaling** rather than re-ranking.

Thank you!