

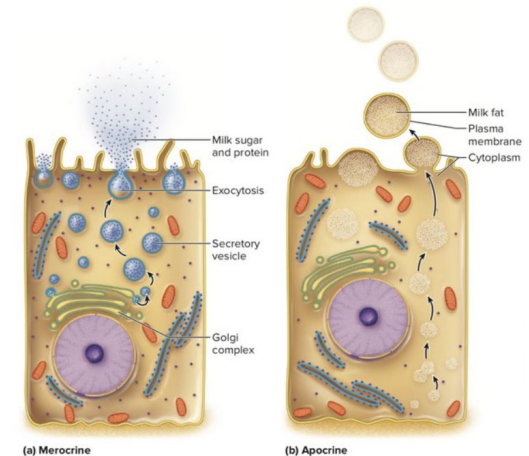
Differences in goat milk yield and composition between evening and morning samples

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Introduction

- Difference between morning & evening milkings
 - Efficient milk recording strategies, e.g. alternated one-milking recording
 - Physiological insights
- Several studies in dairy cattle. Limited info goats
- Differences goats and cows, e.g.
 - Milk yield
 - Milk secretion: merocrine vs apocrine
 - Extended lactations



Aim

Differences morning and evening milkings in goats

- Magnitude
- Identify factors, e.g.
 - Milking interval
 - Temperature Humidity Index
 - Animal, including genetics



Material and Methods

Data from 5 dairy goat farms

Goat farms in the Netherlands

- Average NL: 752 goats.
- No access to pasture.
- Extended lactations.



Material and Methods

Milk recording data

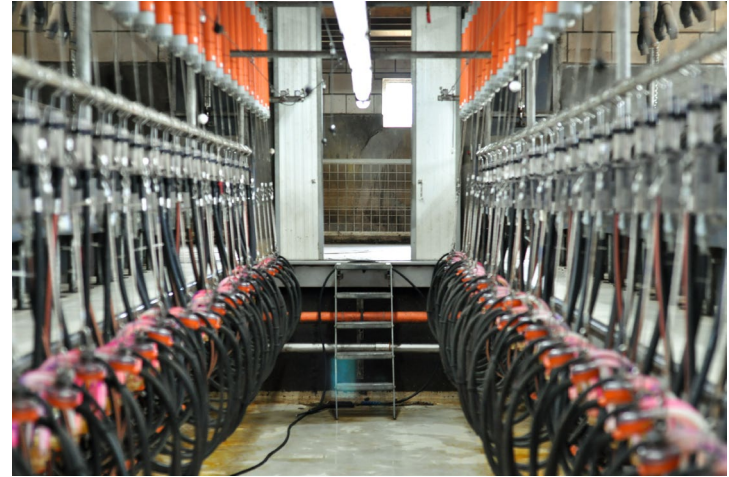
- Milk yield and composition (n=53,366)
 - ✓ Test-day
 - ✓ Evening
 - ✓ Morning
- 2018 – early 2023
- ~6 test-days/year
- Milking time morning & evening
 - milking interval
(n=44,609, 4 Farms)



Material and Methods

➤ Herdbook

- Lambing date
- Age
- Parity
- Pedigree



➤ Weather conditions on test day → Temperature Humidity Index (THI)

$$\text{THI} = 0.8 * \text{T-max} + \text{RH} * (\text{T-max} - 14.4) + 46.4$$

T-max = Highest temperature (°C)

RH = Average Relative Humidity

Statistical analysis

Response variables

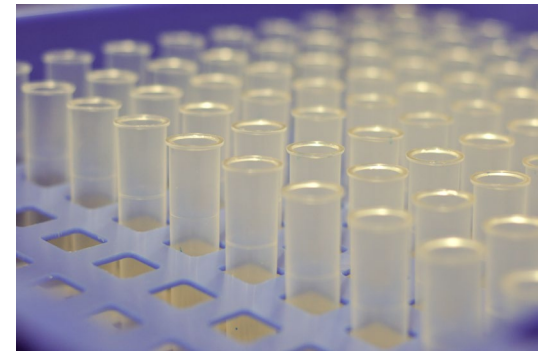
Difference (Evening-Morning) (Δ)

Fixed effects

- Season (Winter, Spring, Summer, Fall)
- Parity (1, 2, 3, ≥ 4)
- Days in Milk (β)
- Temperature Humidity Index (β)
- Interval between milking's (β)

Random effects

- Herd-Test-Day
- Permanent environment
- Genetic



Results - descriptive

n=53,366

	Test-day
Milk kg	3.85
Fat%	4.18
Protein%	3.54
Lactose%	4.27

Results - descriptive

	Test-day	Evening	Morning
Milk kg	3.85	1.88	1.97
Fat%	4.18	4.44	3.95
Protein%	3.54	3.54	3.53
Lactose%	4.27	4.28	4.26

Results - descriptive

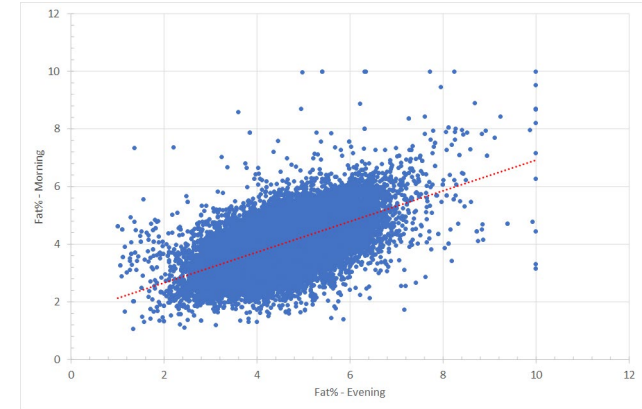
	Test-day	Evening	Morning	Evening – Morning (Δ)
Milk kg	3.85	1.88	1.97	-0.08
Fat%	4.18	4.44	3.95	0.49
Protein%	3.54	3.54	3.53	0.01
Lactose%	4.27	4.28	4.26	0.01

Fat% differs between morning and evening milk samples

Results - descriptive

n=53,366

	Evening vs Morning	
	Δ	r
Milk kg	-0.08	0.83
Fat%	0.49	0.60
Protein%	0.01	0.88
Lactose%	0.01	0.84



Results – Random effects

n=44,609, 4 Farms

	h^2	Repeat.	HTD
Δ Milk kg			
Δ Fat%			
Δ Protein%			
Δ Lactose%			

$$h^2 = \frac{\sigma_{Genetic}^2}{\sigma_{Total}^2}$$

$$Repeat. = \frac{\sigma_{Genetic}^2 + \sigma_{Ep}^2}{\sigma_{Total}^2}$$

$$HTD = \frac{\sigma_{HTD}^2}{\sigma_{Total}^2}$$

Results – Random effects

	h^2	Repeat.	HTD
Δ Milk kg	0.02	0.07	0.03
Δ Fat%	0.03	0.07	0.09
Δ Protein%	0.01	0.03	0.06
Δ Lactose%	0.02	0.03	0.15

SE~0.005

SE~ 0.004

SE: 0.005-0.018

- Genetic component is (very) small
- Low repeatability - some differences between goats
- Herd-Test-Date: Δ Lactose%

Results – Significance Fixed effects ($-\log_{10}(p)$)

	Season	Parity	DIM	THI	Milk interval
Δ Milk kg					
Δ Fat%					
Δ Protein%					
Δ Lactose%					

$$-\log_{10}(p=0.001) = 3$$

Results – Significance Fixed effects ($-\log_{10}(p)$)

	Season	Parity	DIM	THI	Milk interval
Δ Milk kg	1.8				
Δ Fat%	3.4				
Δ Protein%	0.5				
Δ Lactose%	0.1				

	Evening – Morning
Δ Milk kg	-0.08
Δ Fat%	0.49
Δ Protein%	0.01
Δ Lactose%	0.01

Δ Fat%
 Winter: 0.43
 Summer: 0.51

Results – Significance Fixed effects ($-\log_{10}(p)$)

	Season	Parity	DIM	THI	Milk interval
Δ Milk kg	1.8	2.5			
Δ Fat%	3.4	0.6			
Δ Protein%	0.5	1.0			
Δ Lactose%	0.1	9.5			

	Evening – Morning
Δ Milk kg	-0.08
Δ Fat%	0.49
Δ Protein%	0.01
Δ Lactose%	0.01

Δ Lactose%
 Parity 1 : 0.012
 parity ≥ 4 : 0.032

Results – Significance Fixed effects ($-\log_{10}(p)$)

	Season	Parity	DIM	THI	Milk interval
Δ Milk kg	1.8	2.5	2.1	0.6	
Δ Fat%	3.4	0.6	0.5	0.1	
Δ Protein%	0.5	1.0	0.0	0.3	
Δ Lactose%	0.1	9.5	0.2	1.4	

Small effects of DIM and THI on differences evening vs morning milk

Results – Significance Fixed effects ($-\log_{10}(p)$)

	Season	Parity	DIM	THI	Milk interval
Δ Milk kg	1.8	2.5	2.1	0.6	>300.0
Δ Fat%	3.4	0.6	0.5	0.1	113.8
Δ Protein%	0.5	1.0	0.0	0.3	87.0
Δ Lactose%	0.1	9.5	0.2	1.4	122.0

Strong effects of milking interval on differences evening vs morning milk

Results – Predicted effects milking interval

Results – predicted effects milking interval

Δ Milk kg
Δ Fat%
Δ Protein%
Δ Lactose%

Evening - Morning
-0.08
0.49
0.01
0.01

Evening - Morning
0.02
0.41
0.03
0.03

Evening - Morning
-0.32
0.68
-0.04
-0.05

Evening-Morning

Morning-Evening

~12.5 hours



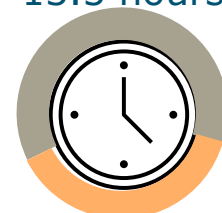
~11.5 hours

12 hours



12 hours

13.5 hours



10.5 hours

12:12 interval – still difference in Fat%!!

Discussion

- Results are in line with those found in dairy cattle
 - Hargrove (1994): “ Fat percentages in the morning were lower, even when milking intervals were nearly equal.”
 - Cassandro et al (1995): “milking interval is the most important source of variation for yield ratios”
- Jing et al. (2021): “The milk fat content in dairy cows follows a rhythmic pattern and is thought to be regulated by circadian rhythms.”
 - circadian rhythm in expression of lipogenic genes PER2, SREBF1, and PPARG

- Strong effects of milking interval on differences evening vs morning milk
- At the same milking interval, Fat% is lower in morning than in evening milk

