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The Duration of Outdoor Stay affects the Urinary and Faecal Nitrogen Excretion in Dairy Cows

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INTRODUCTION

> indoor confinement

Health issues
↓ natural behaviours
↓ fitness



> outdoor access

↑ leg and muscle fitness
↑ natural behaviours
↓ udder injuries
↓ hock lesions

Faeces
Urine



Nitrogen
Excretion



Soil / Water
Pollution

OBJECTIVE

To assess the **urination and defecation behaviours** along with the **nitrogen excretion** produced by lactating cows during different timings of the day in an **outdoor exercise area**, to then **estimate the load of cows** allowed considering the nitrogen limitation in manure established by the EU directive.

MATERIALS & METHODS

LOCATION

Dairy farm (ISIS Paolino d'Aquileia, Udine, Italy)

Free stall + automatic milking system

November – December 2022

TREATMENTS (timings)

- Morning > 9:00 – 11:00 ➤ Out 4h
- Afternoon > 14:00 – 16:00 ➤ Out 4h

- Noon > 11:30 – 13:30 ➤ Out 2h

EXTERNAL Paddock (670m²)



Experimental design

Latin Square Design : 3 periods of 2 weeks each

	<i>Group 1</i>	<i>Group 2</i>	<i>Group 3</i>
<i>Period 1</i>	Out 2	Out 4	In
<i>Period 2</i>	In	Out 2	Out 4
<i>Period 3</i>	Out 4	In	Out 2

MATERIALS & METHODS

Animals

Animals' characteristics

Groups	3 groups (G1, G2, G3)
Animals	6 Italian Simmental lactating cows
Milk Px (kg/d)	26.8 ± 3.4
DIM (d)	103 ± 35
Parity	2.0 ± 1.4

Diet

TMR (grass silage + alfalfa hay)

Forage:Concentrate 62:38

Diet

Ingredients, % DM

Grass silage	26.4
Alfalfa hay	32.8
Barley straw	2.7
Corn meal	17.3
Barley meal	12.4
Compound feed	8.4

Chemical composition of the diet, % DM

DM, % as fed	51.2
Crude Protein	14.7
NDF	38.7
Starch	21.1
NE _L , MJ/kg of DM	5.8

MATERIALS & METHODS

Method

1. BEHAVIOURAL OBSERVATIONS

Urination and Defecation

- Frequency
- Duration

2. SAMPLES COLLECTION

- Faeces (150 g, manual)
- Urine (15 ml, manual using a stick)

3. LAB ANALYSES

- DM of faeces
- Total Nitrogen of faeces and urine

Statistical analysis

$$Y_{ijkl} = \mu + T_i + C_j + (T \times C)_{ij} + DAY_k + e_{ijkl}$$

T : timing (3 levels: morning, noon, afternoon)

C : cow (6 levels)

T x C : Interaction T x C

DAY : covariate of day of observation

e: error

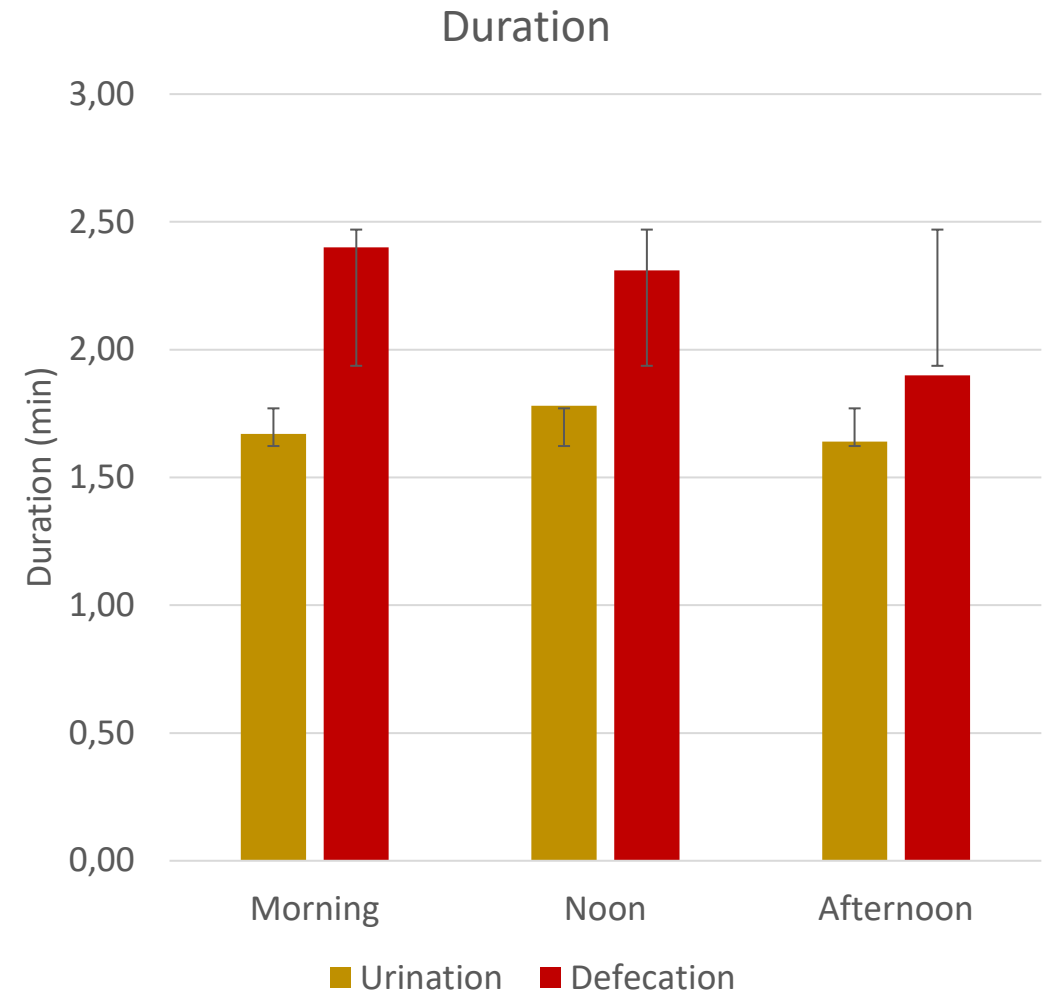
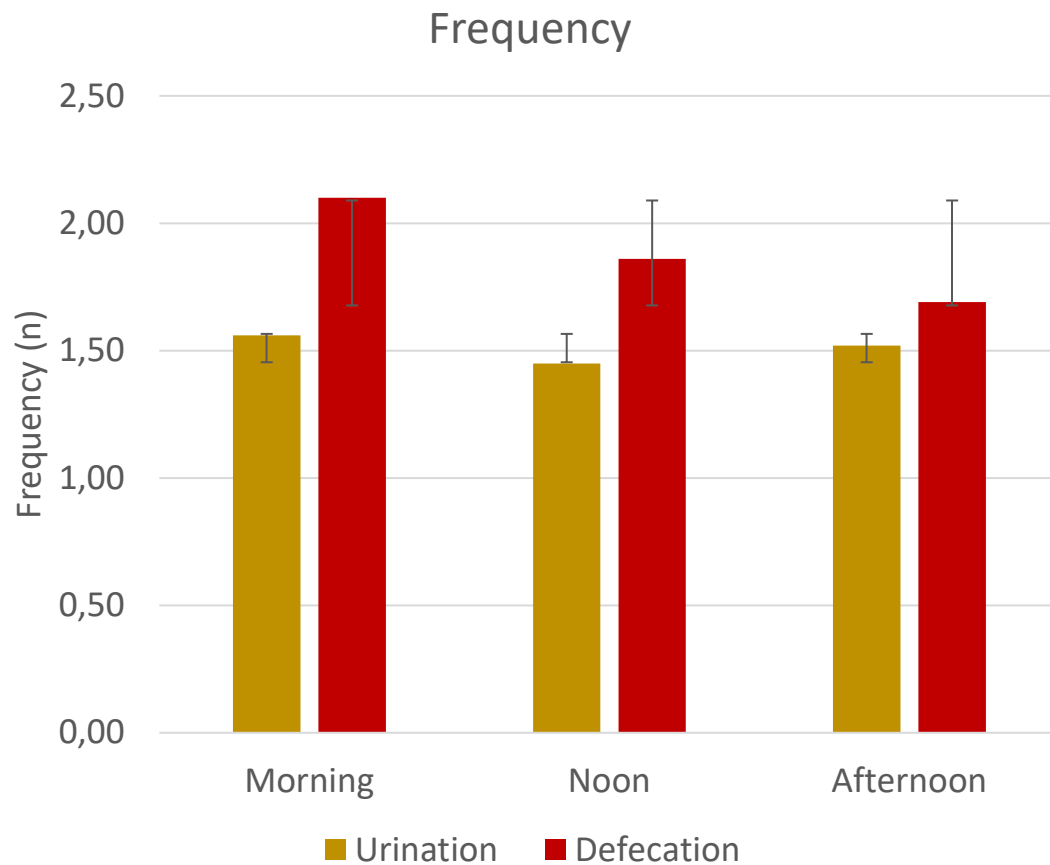
> Pearson Correlations among all variables

RESULTS - ANOVA

F-value of the urination and defecation behaviours and the N excretion during the 2-hours of outdoor access

		TIMING	COW	TxC	DAYS
Behaviour					
Urination	duration (min)	0.153	5.100***	1.333	2.735
	frequency (n)	0.118	6.034***	1.271	4.346*
Defecation	duration (min)	1.089	0.780	0.691	0.663
	frequency (n)	1.040	1.194	1.051	0.062
Excretion					
Urine weight (kg)		0.055	0.929	0.677	0.507
N content in urine (%)		1.587	0.389	0.462	1.032
N output of urine (g)		1.612	0.292	0.412	0.187
Faecal weight (kg)		8.720***	0.897	3.625**	0.326
Dry matter of faeces (%)		0.620	1.015	0.945	1.376
N content in faeces (%DM)		4.318*	0.460	1.179	0.054
N output in faeces (g)		8.912***	1.175	3.342**	0.644
Total N output (g)		7.594**	0.785	1.464	0.702

RESULTS - Urination and defecation behaviours



RESULTS - Nitrogen excretion



LSM of the Nitrogen excretion during the 2 hours of outdoor access

	Timing			SEM
	Morning	Noon	Afternoon	
Urine weight (kg)	2.81	2.78	2.60	0.460
N urine (%)	0.49	0.42	0.33	0.063
N output urine (g)	14.80	12.51	9.08	2.268
Faecal weight (kg)	3.82^a	2.74^b	2.17^b	0.284
N faeces (%)	2.16^a	2.03^{ab}	1.69^b	0.117
N output faeces (g)	13.16^a	10.20^b	7.08^c	1.020
Total N output	27.97^a	22.71^a	16.16^b	2.147

RESULTS – Pearson Correlations

Pearson correlations among the residuals of the variables considered in the study (n=60)

Variable	2	3	4	5	6	7	8	9	10	11	12
1. Urination (min)	0.91***	0.11	0.07	0.39**	-0.04	0.22°	-0.03	0.00	0.03	-0.08	0.19
2. Urination (freq)		0.06	0.08	0.44**	0.01	0.29*	-0.07	-0.10	-0.09	-0.15	0.23°
3. Defecation (min)			0.89***	-0.05	-0.06	-0.14	0.45**	0.38**	0.32*	0.43**	0.06
4. Defecation (freq)				0.00	-0.01	-0.07	0.50***	0.38**	0.33*	0.49***	0.15
5. Urine weight (kg)					0.40**	0.77***	0.03	-0.04	-0.14	-0.13	0.76***
6. N content of urine (%)						0.75***	-0.31*	-0.19	-0.16	-0.36**	0.62***
7. N output of urine (g)							-0.26*	-0.05	-0.17	-0.34**	0.89***
8. Faecal weight (kg)								0.24°	0.31*	0.94***	0.17
9. Dry matter of faeces (%)									0.65***	0.35**	0.12
10. N content of faeces (%DM)										0.40**	0.01
11. N output of faeces (g)											0.11
12. Total N output (g)											

Values within a row with different superscripts differ significantly at *** $P < 0.001$, ** $P < 0.01$, * $P < 0.05$. A tendency of significance is reported for ° $P < 0.1$.

CONCLUSIONS

- 1 The **timing of exit** of the cows affected the **amount of faeces** and **faecal nitrogen excretion**
- 2 The **lowest nitrogen excretion** for dairy cows to access outdoor areas was produced in the **afternoon**, from **2:00** to **4:00 p.m**
- 3 The correlation between the N output and the frequency of each behaviour is higher for defecation than for urination.
- 4 The **N total output** depends on the N output of **urine**.

IMPLICATIONS & PERSPECTIVES

Considering a 2-hour daily exit along the whole year and the **limit of nitrogen** given by the EU Nitrates Directive (91/676), the **maximum load of cows per hectare** would be equal to **17, 21, and 29** for **morning, midday, and afternoon** outings, respectively.

Other studies must be done considering breed, milking system, season, timing, logistic aspects and cost.



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THANK YOU

Questions are welcome