Milk fatty acid profile of dairy cows is affected by forage species, parity, and milking time

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Introduction I

- Consumption of milk has been challenged due to association between saturated fatty acid and cardiovascular diseases

However

Beneficial effect of some bioactive fatty acid (CLA isomers) on human health

- **Feeding strategies** has been accepted as one of the most important factor affecting milk fatty acid profile with emphasis on the health-promoting poly unsaturated fatty acids and CLA isomers

Introduction II

- Milk from cows fed a **high proportion of green forages** is known to contain higher proportion of unsaturated fatty acids and bioactive component
- Effects of forage type on milk fatty acid profile

Objective of the present study

to investigate the effect of **high proportion** of different **forage species,** and in addition effect of **parity**, and **milking time** on milk fatty acid profile

Materials and methods

- 12 primiparous and 24 multiparous Danish Holstein cows
- Cows milked 2 times (evening and morning)
- Ad libitum feeding with total mixed rations containing 70 (%DM) forage silage
  - ✓ Early perennial ryegrass (EPR)
  - ✓ Late perennial ryegrass (LPR, 2 weeks after first cut)
  - ✓ Festulolium (FEST)
  - ✓ Tall fescue (TF)
  - ✓ Red clover (RC)
  - ✓ White clover (WC)
  - ✓ 50% red clover:50% late perennial ryegrass (RC-LPR)
  - ✓ 50% white clover:50% late perennial ryegrass (WC-LPR)

- Fatty acids identified by GC

Materials and methods

- Latin square design
- Statistical analysis

$$Y_{ifjklm} = \mu + F_i + M_f + Par_j + P_k + D_l + C_m + \varepsilon_{ifjklm}$$

F was the fixed effect of forage source

M was the fixed effect of milking time (f = morning, evening),

Per was the fixed effect of parity (j = primiparous, multiparous),

P was the fixed effect of period (k = 1 to 4),

D was the regression coefficient for DIM_l,

C was the random effect of cow (m = 1 to 36)

Results and discussion

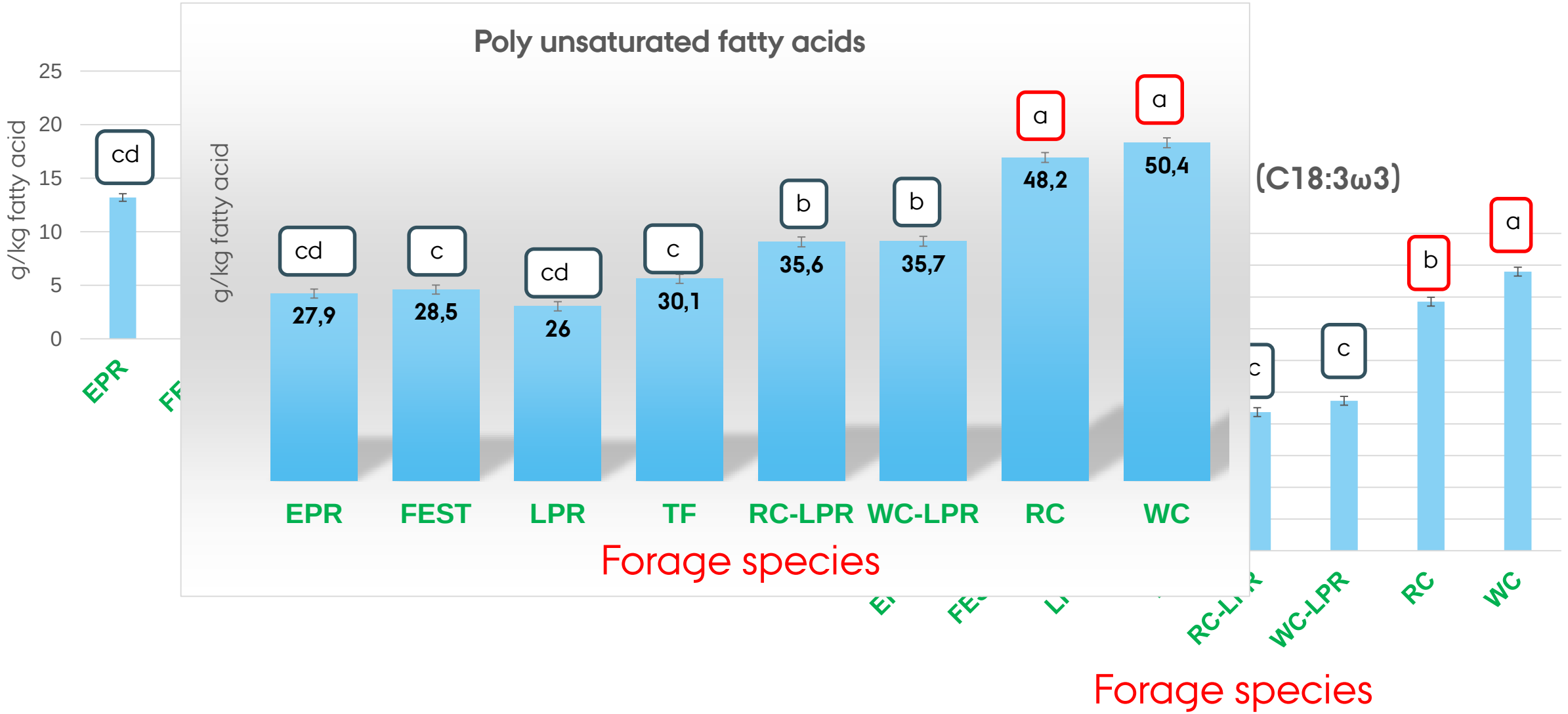
Effect of different forage species on fatty acid intake (g/d)

	Forage species								P-values	
	EPR	FEST	LPR	TF	RC-LPR	WC-LPR	RC	WC	Forage	Parity
Total fatty acids	339^{c}	330^{cd}	260^{e}	313^{d}	316^{d}	362^{b}	**367^{b}**	**438^{a}**	<.001	<.001
Linoleic acid (C18:2ω6)	91.7^{c}	91.1^{c}	82.1^{d}	82.7^{d}	98.9^{b}	104^{b}	**113^{a}**	**116^{a}**	<.001	<.001
Linolenic acid (C18:3ω3)	142^{b}	135^{bc}	88.8^{e}	133^{c}	112^{d}	140^{b}	**136^{b}**	**183^{a}**	<.001	<.001

Highest DMI and fatty acid content in RC and WC

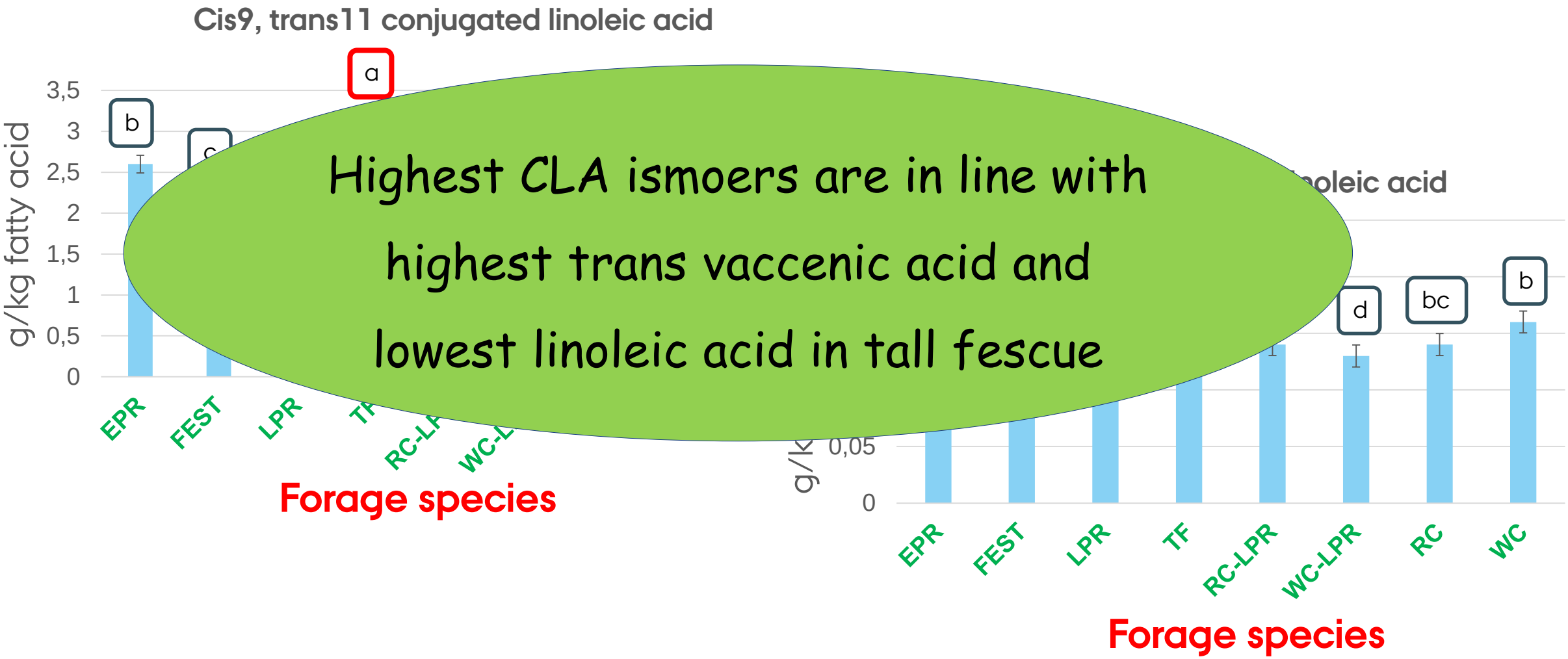
Results and discussion

Effect of different forage species on milk fatty acid profile



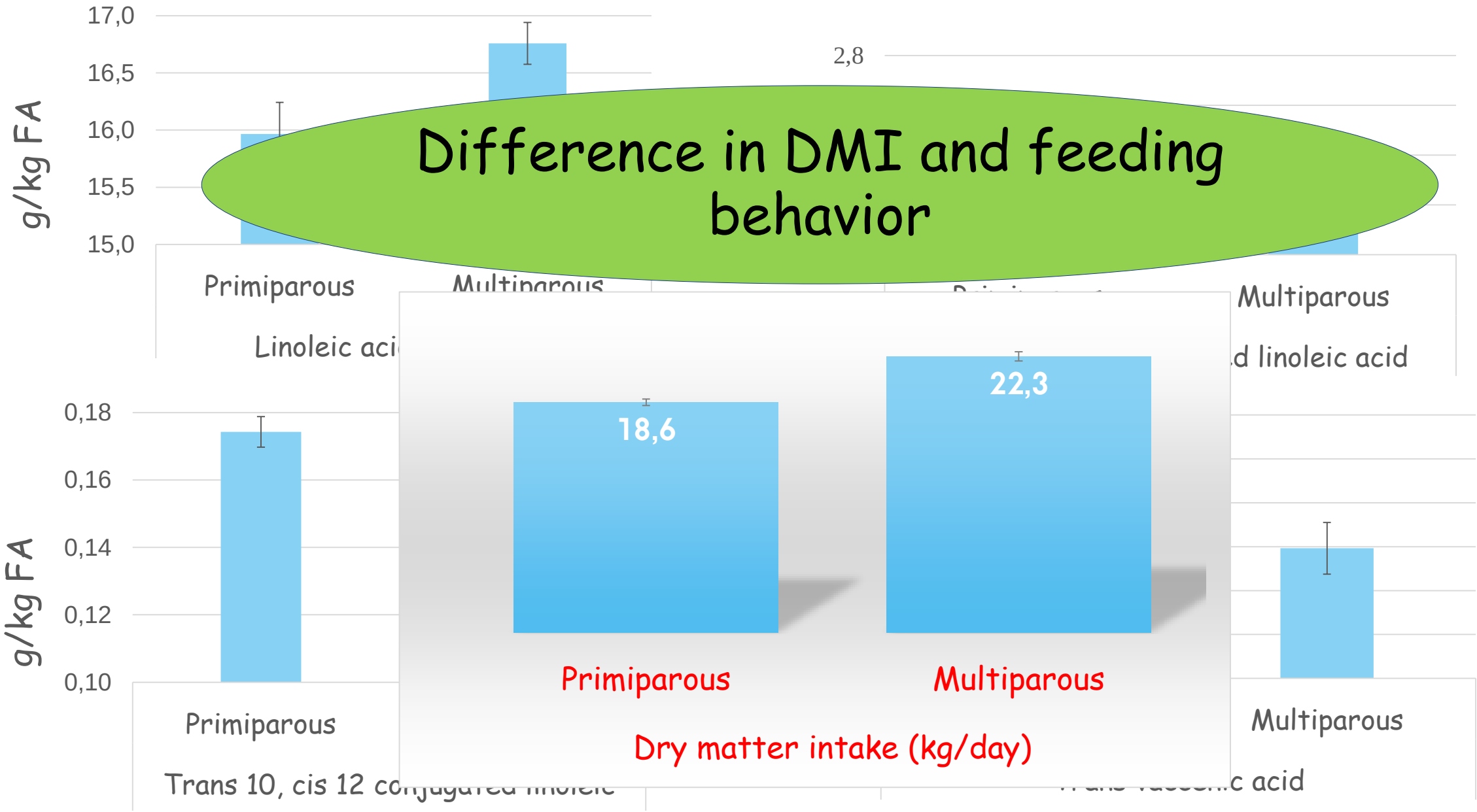
Results and discussion

Effect of different forage species on conjugated linoleic acid isomers



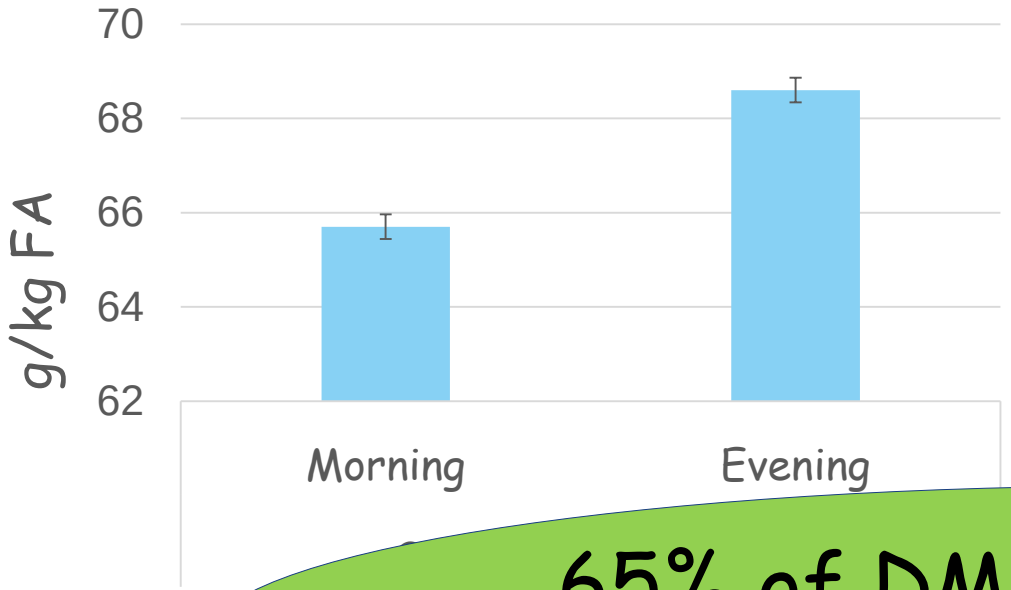
Highest CLA ismoers are in line with highest trans vaccenic acid and lowest linoleic acid in tall fescue

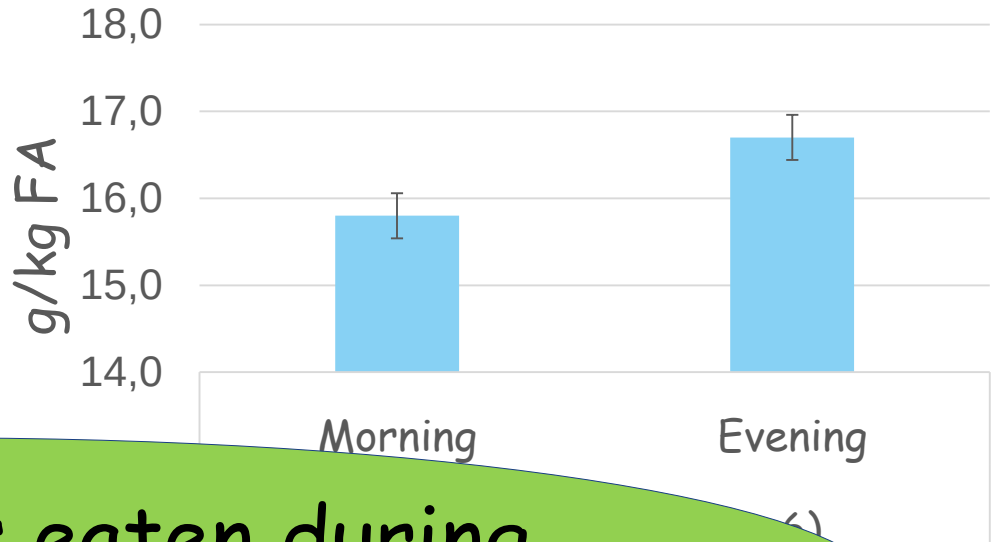
Effect of parity on milk fatty acid profile



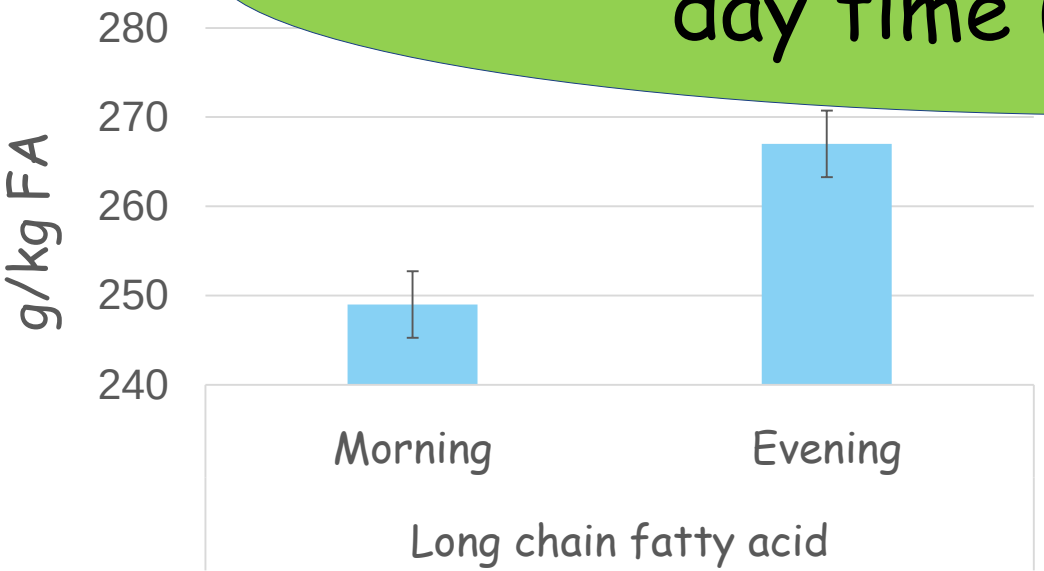
Difference in DMI and feeding behavior

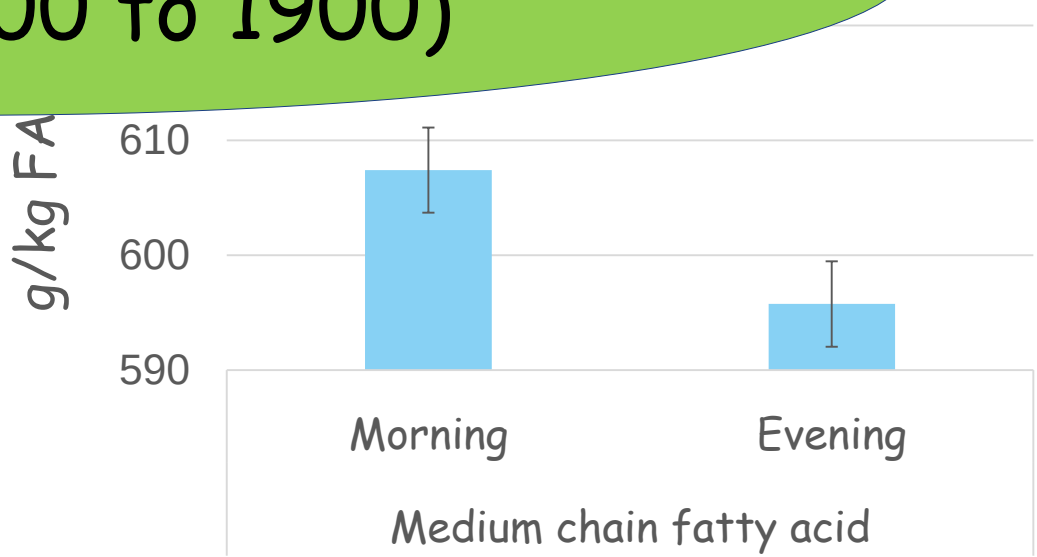
Effect of milkings on milk fatty acids





65% of DMI was eaten during day time (0600 to 1900)





Conclusion

- ✓ Different response in milk fatty acid to the different forage species
  - ➢ Inclusion of white and red clover in the dairy cow rations can be practical approach to increase linoleic and linolenic in milk fatty acids
- ✓ **Higher** concentration of **conjugated linoleic acid isomers** in milk from primiparous than multiparous cows
- ✓ **Higher** concentration of **FA originated from diets** in evening milking compared to morning milking

Thanks for your attentions

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Results and discussion

Table1.Total fatty acid content (g/kg DM), fatty acid proportion (g/kg FA) of forage species

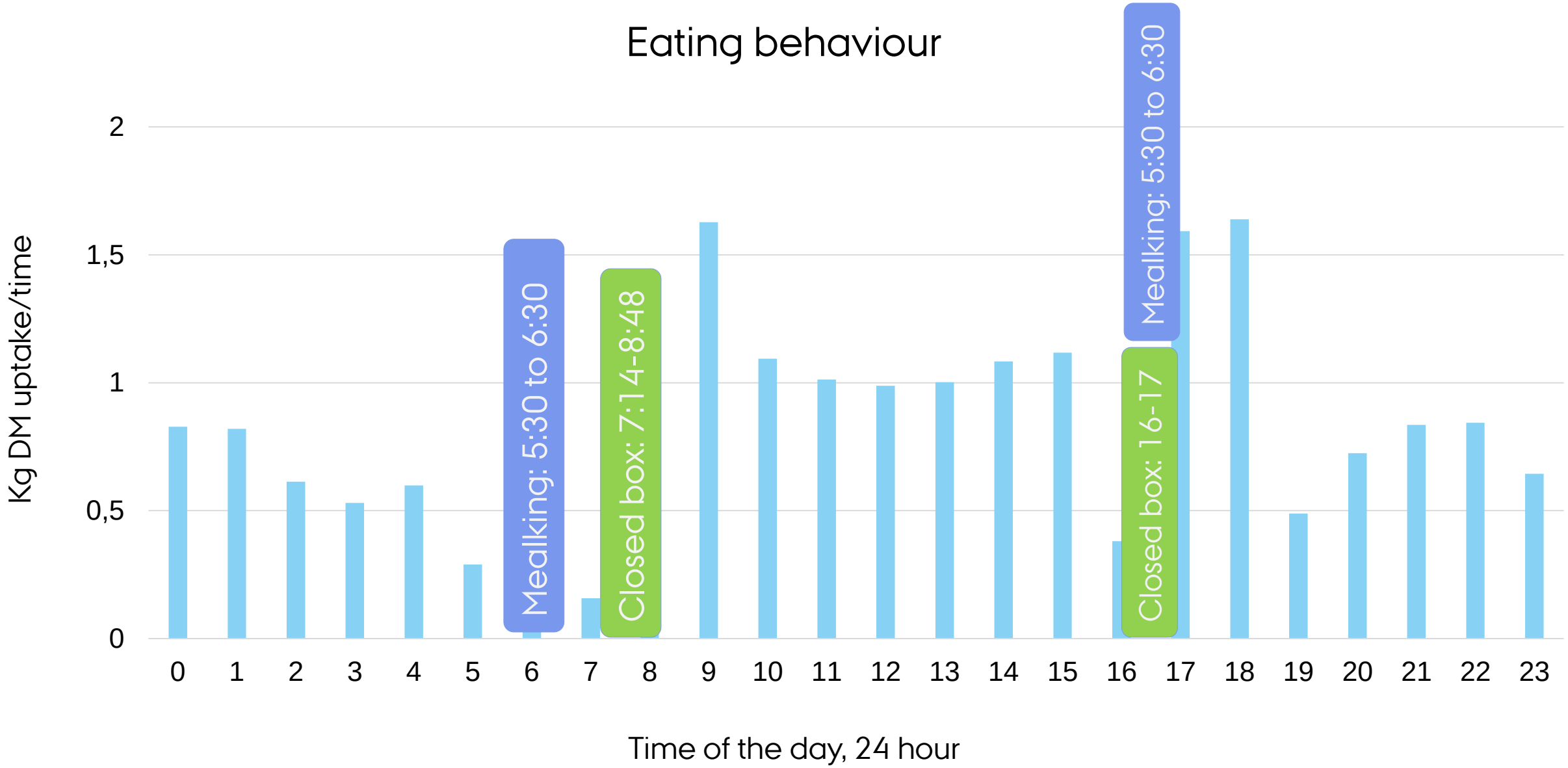
	Early perennial ryegrass	Festulolium	Late perennial ryegrass	Tall fescue	Red clover	White clover
Total fatty acids	16.5±0.6	15.6±0.3	11.8±0.3	16.1±0.6	16.5±0.3	20.9±2.0
C16:0	171±16.4	179±27.3	190±12.0	182±29.9	180±38.6	183.3±32.2
C18:0	20.6±9.9	17.6±1.7	22.2±5.5	16.7±2.0	26.3±4.9	23.1±5.4
C18:1ω9	23.3±5.4	18.1±8.3	30.6±5.6	18.5±10.2	17.6±2.5	18.7±6.9
C18:2ω6	140±6.9	141±11.9	162±10.5	128±25.0	193±10.6	160±14.7
C18:3ω3	586±32.4	583±37.0	524±33.5	601.5±29.5	517±46.8	549±74.0

Table 3. Intake of dry matter (kg/d), fatty acid (g/d) of cows fed different forage species.

	Forage species									P-values*			
	EPR	FEST	LPR	TF	RC-LPR	WC-LPR	RC	WC	SEM[1]	F	P	DIM	M
C18:0	65.0^{b}	68.6^{b}	61.4^{c}	79.4^{a}	65.3^{b}	68.6^{b}	62.3^{bc}	66.9^{b}	1.94	<.001	0.24	<.001	<.001
C18:1ω9	138^{b}	135^{b}	132^{b}	174^{a}	134^{b}	133^{b}	136^{b}	133^{b}	4.58	<.001	0.17	<.001	<.001
18:1 trans[2]	10.8^{b}	8.9^{c}	8.6^{c}	14.1^{a}	9.4^{bc}	9.0^{c}	9.6^{b}	9.5^{b}	0.48	<.001	<.001	<.001	0.08
C18:2ω6	13.2^{cd}	13.5^{c}	12.9^{d}	14.2^{c}	16.9^{b}	16.2^{b}	21.7^{a}	21.8^{a}	0.38	<.001	0.007	0.02	<.001
C18:3ω3	4.48^{ef}	5.46^{d}	4.14^{f}	5.31^{de}	8.73^{c}	9.45^{c}	15.7^{b}	17.6^{a}	0.27	<.001	0.99	0.59	<.001
c9, t11 CLA	2.60^{b}	2.18^{c}	1.95^{c}	3.19^{a}	2.19^{c}	2.23^{b}	2.47^{b}	2.57^{b}	0.11	<.001	0.008	0.16	0.87
t10, c12, CLA	0.18^{ab}	0.14^{cd}	0.14^{d}	0.20^{a}	0.14^{d}	0.13^{d}	0.14^{bc}	0.16^{b}	0.009	<.001	<.001	0.003	<.001
PUFA[6]	27.9^{cd}	28.5^{c}	26.0^{d}	30.1^{c}	35.6^{b}	35.7^{b}	48.2^{a}	50.4^{a}	0.73	<.001	0.87	0.98	<.001

*F, forage type, P; parity, DIM; days in milk

EPR = early perennial ryegrass; FEST = festulolium; TF = tall fescue; LPR = late perennial ryegrass; RC-LPR = 50% red clover:50% late perennial ryegrass; WC-LPR = 50% white clover:50% late perennial ryegrass; RC = red clover; WC = white clover. $^{a\text{-}e}$ Means within a row with different subscript differ according to Tukey's test ($P < 0.05$).


Eating behaviour
Kg DM uptake/time
2
1,5
1
0,5
0
Mealking: 5:30 to 6:30
Closed box: 7:14-8:48
Closed box: 16-17
Mealking: 5:30 to 6:30
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time of the day, 24 hour

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Digestibility and clover proportion determine milk production when silages of different grass and clover species are fed to dairy cows

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	Treatment[1]							
Item	EPR	FEST	TF	LPR	RC-LPR	WC-LPR	RC	WC
Ingredient								
Early perennial ryegrass silage	700							
Festulolium silage		700						
Tall fescue silage			700					
Late perennial ryegrass silage				696	350	350		
Red clover silage					350		700	
White clover silage						350		700
Soybean meal	120	120	120	119	120	120	120	120
Wheat, rolled	158	158	158	157	158	158	158	158
Mineral and vitamin mix[2]	18.5	18.5	18.5	18.4	18.5	18.5	18.5	18.5
NaCl	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2
Urea, 46% N				6.2				
Titanium oxide	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Chemical composition[3]								
DM, g/kg of fresh matter	432 ± 2.8	372 ± 1.1	499 ± 2.5	425 ± 2.3	401 ± 1.7	404 ± 1.1	381 ± 1.4	386 ± 1.9
Ash	81.0 ± 0.6	87.1 ± 0.4	85.9 ± 0.6	74.5 ± 0.2	90.6 ± 1.2	93.0 ± 1.3	107 ± 0.7	109 ± 1.7
CP	171 ± 1.6	167 ± 2.3	178 ± 3.1	159 ± 1.3	181 ± 2.7	206 ± 1.7	213 ± 2.1	268 ± 2.3
NDF	316 ± 1.7	340 ± 3.1	372 ± 4.6	369 ± 1.9	315 ± 3.1	283 ± 5.8	248 ± 3.5	202 ± 3.9
ADF	164 ± 1.2	183 ± 1.6	187 ± 2.3	199 ± 1.2	182 ± 0.9	163 ± 3.1	160 ± 1.5	131 ± 1.1

[1]EPR = early perennial ryegrass; FEST = festulolium; TF = tall fescue; LPR = late perennial ryegrass; RC-LPR = 50% red clover:50% late perennial ryegrass; WC-LPR = 50% white clover:50% late perennial ryegrass; RC = red clover; WC = white clover.
[2]Composition: Ca, 142 g/kg; P, 44 g/kg; Mg, 58 g/kg; Na, 80 g/kg; Mn, 3,546 mg/kg; Zn, 3,989 mg/kg; Cu, 1,330 mg/kg; Co, 22 mg/kg; I, 199 mg/kg; Se, 47 mg/kg; vitamin K_3, 99 mg/kg; vitamin A, 883 IU/g; vitamin D_3, 182 IU/g; vitamin E, 6.4 IU/g.
[3]n = 16 for DM and n = 4 for the remaining components. Mean ± SEM is given.