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Affecting milk composition of Jersey cows in grass silage of different cuts with or without rapeseed

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Agenda

- Background
  - Fatty acids, Antioxidants, Sources
- Aim - Hypotheses
- Experimental work
- Results
- Discussion
  - Comparison with literature
- Conclusions

Fatty acids in milk

- More than 400 FA in milk

- Milk fat contains:

✓ ~60-75% SFA
  - Palmitic acid (C16:0)

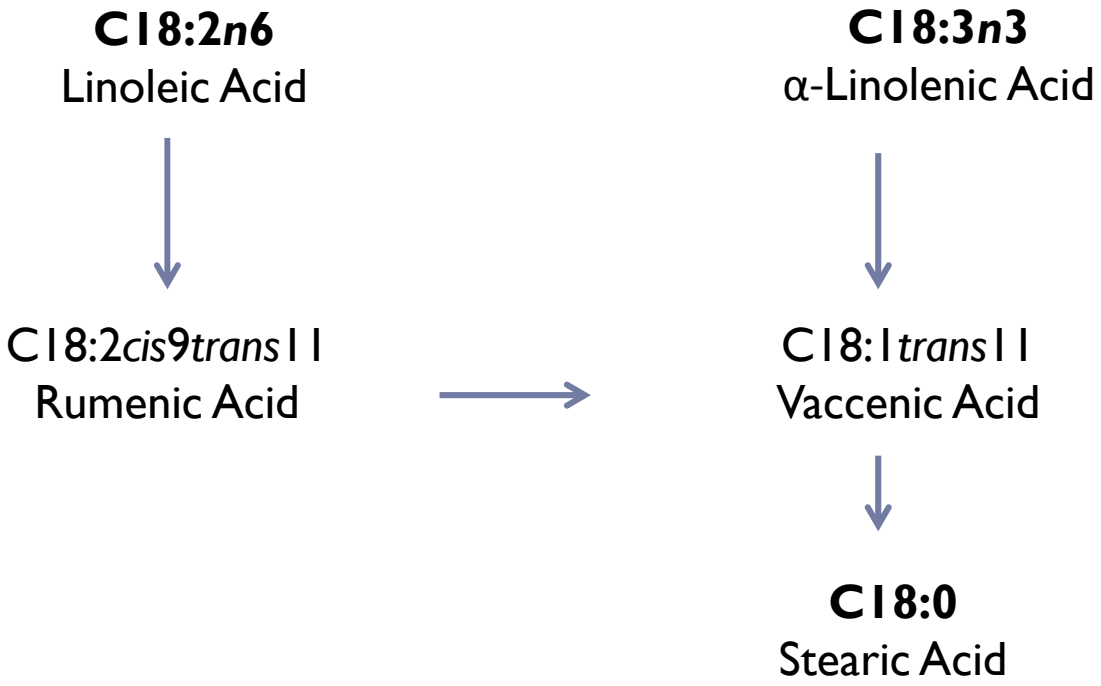
✓ 20-25% MUFA
  - Oleic acid (C18:1*cis*9)

✓ 0-5% PUFA
  - Linoleic (C18:2*n*6), α-linolenic acid (C18:3*n*3)

- Replace SFA with cis-MUFA & PUFA

Lipid metabolism

1. Hydrolysis
2. Biohydrogenation of unsaturated FA



Antioxidants

- Carotenoids:
  - xanthophylls (lutein and zeaxanthin) – *not* converted into vitamin A
  - carotenes - precursors of vitamin A

- Tocopherols:
  - α-, β-, γ- and δ-tocopherols: saturated vitamins
  - Alpha-tocopherol→ highest antioxidant activity

- Antioxidants: delay oxidation of milk

Sources of FA and antioxidants

1. Grass forages

- Source of UFA and *n*-3 PUFA, carotenoids and tocopherols
- Variations according to species, cultivars, conservation method, maturity or times of harvest

2. Oilseeds

- Increased caloric density of the ration
- ↓short-chain FA and SFA, ↑long-chain FA, MUFA and PUFA

Aim

- To evaluate the effect of grass silage of different harvest times with or without rapeseed supplementation on fatty acid, carotenoid and tocopherol content in milk of Jersey cattle

Hypotheses

- Autumn grass compared with spring grass:
- less fibre & more FA →lower biohydrogenation and higher UFA in milk
- ↑ leaves, ↑ carotenoids in silage and milk

- Supplementation with rapeseed:
- increased linolenic content in milk
- increased level of α-tocopherol in milk

Material and Methods

- 36 Jersey cows
- 4 treatments in a 4 X 4 Latin square design
- 4 periods of 3 weeks
- Grass silage: mixture of red and white clover & perennial ryegrass

- Diets:
- SGS-R0 = spring grass silage without rapeseed
- SGS-R1 = spring grass silage with rapeseed
- AGS-R0 = autumn grass silage (3rd and 4th regrowth) without rapeseed
- AGS-R1 = autumn grass silage (3rd and 4th regrowth) with rapeseed

Formulation of diets (% of DM)

	Treatments[†]			
Mixed ration	SGS-R0	SGS-R1	AGS-R0	AGS-R1
SGS [‡]	66.0	63.7		
AGS 3rd regrowth[‡]			33.0	32.0
AGS 4th regrowth[‡]			33.0	32.0
Barley	18.0	17.3	18.0	17.3
Rapeseed		7.0		7.0
Rapeseed meal	9.0	5.2	9.0	5.2
Beet pellets	6.0	6.0	6.0	6.0
Feeding salt	0.2	0.2	0.2	0.2
Mineral mix	0.9	0.9	0.9	0.9
Expected intake (kg DM/day)				
Mixed ration	19.2	20.0	19.2	20.0
Concentrate in AMS[§]	2.5	2.5	2.5	2.5

Results

Milk production & Chemical composition

	SGS-R0	SGS-R1	AGS-R0	AGS-R1
DMI (kg)	16.7	16.6	16.7	16.9
ECM	28.9	28.8	28.6	28.7
Crude fat (g/kg DM)	38	64	38	64
Crude protein	185	181	209	204
NDF	308	302	282	277

- ECM was affected by feeding treatments

DMI: dry matter intake
ECM: energy corrected milk
NDF: neutral detergent fibre

FA composition of feed (g/kg of DM)

	Rapeseed	SGS	AGS (3rd+4th regrowth)
C16:0	20.7	4.0	4.65
C18:0	7.3	0.4	0.5
C18:1*cis*9	253.4	0.4	0.5
C18:2*n*6	92.1	3.8	4.4
C18:3*n*3	52.7	18.7	24.4

✓Rapeseed: higher oleic content
✓AGS: highest FA composition than SGS

Effect of feeding on milk FA composition (g/kg of FA)

	Treatments					
	GS		R		P-value	
	S	A	0	I	GS	R
C12:0	42.8 ± 0.7	41.8 ± 0.7	45.3 ± 0.7	39.3 ± 0.7	0.162	<0.001
C14:0	107.4 ± 1.2	107.4 ± 1.2	111.0 ± 1.2	103.8 ± 1.2	0.988	<0.001
C16:0	311.2 ± 3.8	295.9 ± 3.6	327.4 ± 3.7	279.7 ± 3.7	<0.001	<0.001
C18:0	112.3 ± 1.8	115.7 ± 1.7	94.9 ± 1.7	133.0 ± 1.7	0.141	<0.001
C18:1*cis*9	168.7 ± 3.3	180.4 ± 3.2	160.9 ± 3.2	188.2 ± 3.2	0.001	<0.001
C18:2*n*6	13.9 ± 0.2	14.5 ± 0.2	14.5 ± 0.2	13.9 ± 0.2	0.033	0.029
C18:3*n*3	7.8 ± 0.1	9.3 ± 0.1	8.6 ± 0.1	8.6 ± 0.1	<0.001	0.972
CLA*cis*9*trans*11	5.7 ± 0.2	5.2 ± 0.2	5.5 ± 0.2	5.5 ± 0.2	0.128	0.983

Note: results are mean ± standard error of mean

FA recovery from feed to milk (g/g)

	Treatments					
	GS		R		P-value	
	S	A	0	I	GS	R
C16:0	4.38 ± 0.09	3.82 ± 0.09	4.39 ± 0.09	3.82 ± 0.09	<0.001	<0.001
C18:2*n*6	0.11 ± 0.03	0.11 ± 0.03	0.11 ± 0.03	0.11 ± 0.03	0.49	0.81
C18:3*n*3	0.04 ± 0.02	0.05 ± 0.01	0.04 ± 0.02	0.05 ± 0.02	0.001	0.57

- AGS and rapeseed in the diet:
- ✓Higher recovery of C18:3*n*3
- ✓ Lower *de novo* synthesis of C16:0

Antioxidant composition of feed

(mg/kg of DM)

	Rapeseed	SGS	AGS (3^{rd}+4^{th} regrowth)
α-tocopherol	56.2	91.2	54.7
γ-tocopherol	23.3	21.4	21.85
Lutein	6.4	334.4	386.8
Zeaxanthin		99.7	129.0
β-carotene	0.8	268.2	249.1

- AGS compared to SGS:
  - ✓Lower α-tocopherol
  - ✓Higher carotenoids

Effect of feeding on milk antioxidant content (mg/kg of milk fat)

	Treatments					
	GS		R		P-value	
	S	A	0	I	GS	R
α-tocopherol	31.74 ± 1.12	28.69 ± 1.08	28.80 ± 1.11	31.63 ± 1.10	0.007	0.012
β-carotene	22.02 ± 1.13	24.38 ± 1.15	24.57 ± 1.13	21.83 ± 1.12	0.003	<0.001

- AGS:
  - ✓Lower α-tocopherol
  - ✓Higher β-carotene
- Rapeseed:
  - ✓Higher α-tocopherol
  - ✓Lower β-carotene

Discussion

FA content of grass silage of different cuts

Earlier findings:

Study	Cutting dates	Autumn VS Summer grass
This study	May, September, October	↑ C16:0, C18:0, C18:1, C18:2, C18:3
Dewhurst *et al.* 2001	July, October	↑ C16:0, C18:1, C18:2, C18:3
Elgersma *et al.* 2003	June, September	↑C16:0, C18:2 ↓C18:1, C18:3

✓Similar results with Dewhurst *et al.* (2001)
✓In contrast with the results of Elgersma *et al.* (2003)

Antioxidant content of grass silage of different cuts

Earlier findings (in mg/kg DM):

Study	β-carotene	Lutein	α-tocopherol
This study	172 - 326	334 - 395	24 - 91
Larsen *et al.* 2012	150	509	28
Elgersma *et al.* 2013	48	195	39

✓Similar results with Larsen *et al.* (2012)
✓Differences with results of Elgersma *et al. (*2013)

✓Difference in studies:
–fresh grass with white clover
–method of determination (?)

Recovery of FA

- Larsen *et al.* (2012): ↓ recoveries of C18:2*n*6 and C18:3*n*3 when these fatty acids ↑
- Present study: ↑ recovery of C18:3*n*3 with rapeseed
  - Higher inclusion of oilseeds leads to lower biohydrogenation rate
- C18:3*n*3 from linseed and grass silage VS from rapeseed and grass silage

Conclusions

- AGS and rapeseed:
- ↓ C16:0 in milk
- ↑ C18:0, C18:1*cis*9, C18:2*n*6, C18:3*n*3 in milk
- ↓ biohydrogenation rate of C18:3*n*3
- ↑α-tocopherol & β-carotene in milk

Conclusions (2)

- manipulation of the forage harvest time and oilseed inclusion can alter milk composition

- enhance MUFA and PUFA concentrations in milk
- positively affect the oxidative stability of milk and improve nutritional quality of milk

Thank you!

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