Influence of dietary lipid supplements on methane production, digestion, milk yield and milk fatty acid composition in dairy cows

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INTRODUCTION

• Ruminant livestock production is important in meeting future increases in global demand for food

• Ruminants contribute to environmental N and P excretion and greenhouse gas (CH_4 and N_2O) emissions

• Need to lower GHG emissions and increase the sustainability of ruminant food production

• Fat supplements shown to be effective in lowering enteric CH_4 production in ruminants

Experimental objectives

Examine the influence of supplementing grass silage based diets with myristic acid, rapeseed, safflower or linseed oils on animal performance, ruminal CH_4 emissions, nutrient digestion and milk fatty acid composition.

Rapeseed

Safflower

Linseed

MATERIAL AND METHODS

Five Finnish Ayrshire lactating dairy cows in mid-lactation fitted with rumen cannula:

5×5 Latin square

Experimental periods: 28 days (15 d adaptation, 8 d sampling and 5 d washout)

Experimental treatments: control diet, or the same diet **with 50 g/kg diet DM of myristic acid (pure), rapeseed, safflower or linseed oils replacing concentrate ingredients.**

Diets offered as a **TMR based on grass silage** (60:40 F:C ratio on DM basis)

Formulation and chemical composition of experimental total mixed rations

	Treatment				
	Control	Myristic acid	Rapeseed oil	Safflower oil	Linseed oil
Inclusion rate (g/kg DM)					
Grass silage	**600**	**597.2**	**597.2**	**597.2**	**597.2**
Barley	**180**	**147**	**147**	**147**	**147**
Molassed sugar beet pulp	**90**	**73**	**73**	**73**	**73**
Rapeseed meal	**115**	**115**	**115**	**115**	**115**
Urea	**-**	**2.8**	**2.8**	**2.8**	**2.8**
Myristic acid	**-**	**50**	**-**	**-**	**-**
Rapeseed oil	**-**	**-**	**50**	**-**	**-**
Safflower oil	**-**	**-**	**-**	**50**	**-**
Linseed oil	**-**	**-**	**-**	**-**	**50**
Vitamins and minerals	**15**	**15**	**15**	**15**	**15**
Chemical composition (g/kg DM, unless otherwise stated)					
DM	493	498	498	498	498
OM	913	914	914	914	914
CP	**164**	**165**	**165**	**165**	**165**
EE	**36.5**	**85.0**	**85.0**	**85.3**	**85.1**
NDF	**394**	**379**	**379**	**379**	**379**
GE (MJ/kg DM)	**18.4**	**19.5**	**19.6**	**19.6**	**19.6**

Sample collection in each period:

Silage and concentrate/milk yield: d 19 - 23

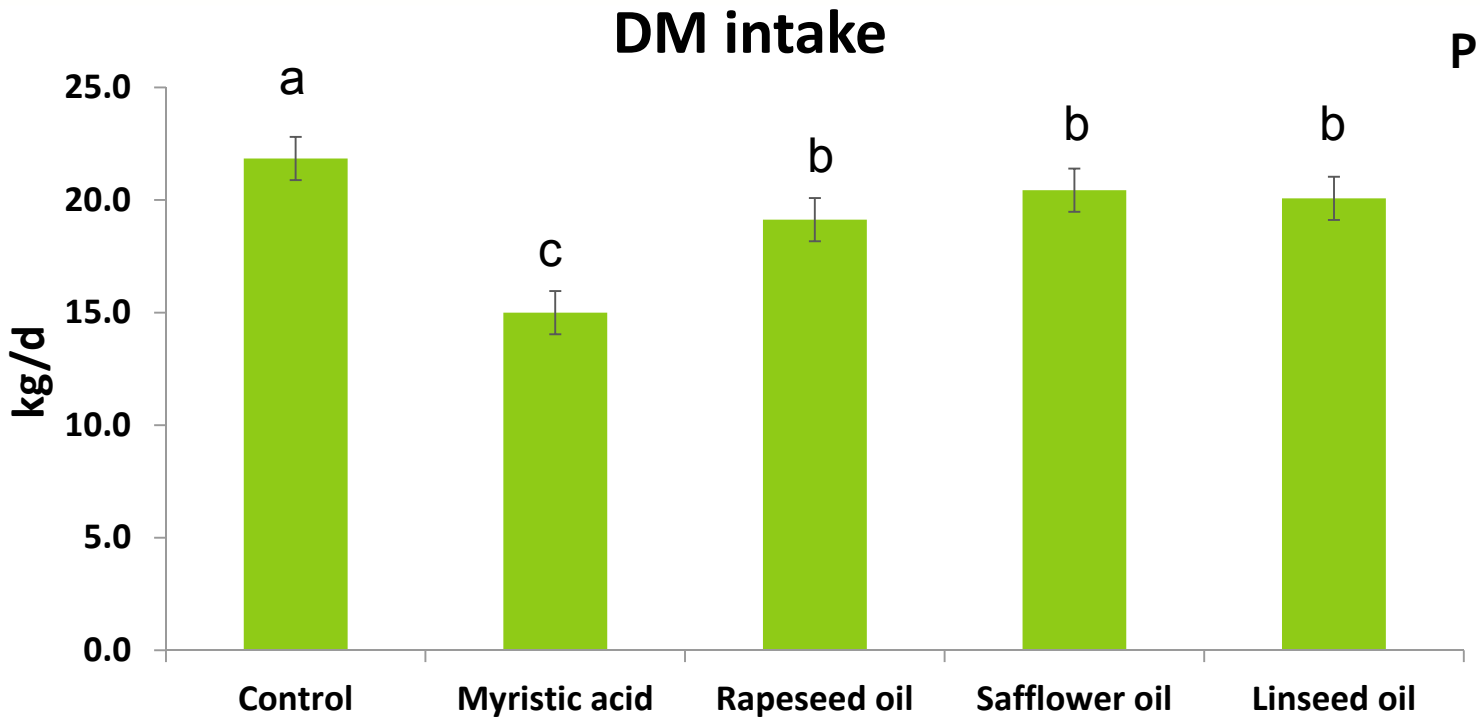
Milk composition: 6 milkings starting from the afternoon on d 20

Rumen fluid: 1.5 h intervals from 0600 to 1630 h on d 23.

Ruminal CH_4 production: SF_6 tracer technique and sampling of rumen gases d 16 - 22

Total faecal collection d 19 - 23

RESULTS



Compared to control (%)	-31.3	-12.4	-6.5	-8.1

Effect of dietary lipid supplements on **rumen fermentation characteristics**

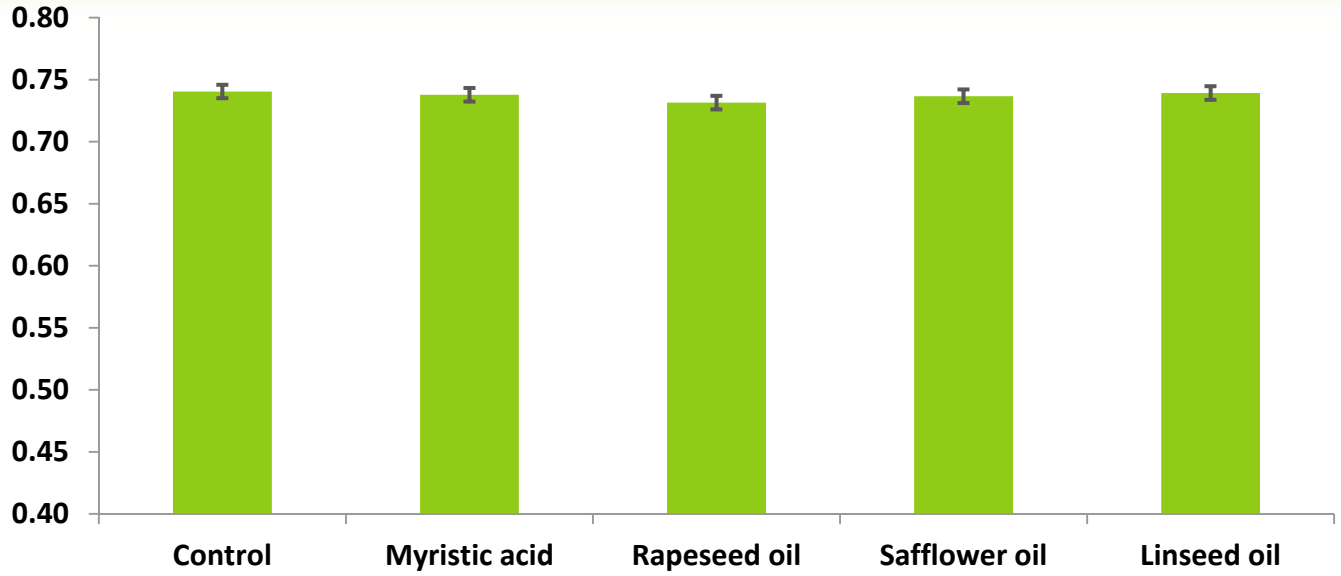
	Treatment					SEM	*P*-value
	Control	Myristic acid	Rapeseed oil	Safflower oil	Linseed oil		
pH	6.63	6.69	6.47	6.57	6.52	0.143	0.09
NH3-N (mmol/L)	5.77^{b}	**8.74^{a}**	7.35^{b}	7.70^{b}	6.87^{b}	0.651	**< 0.01**
Total VFA (mmol/L)	113	109	109	110	114	4.5	0.59
Molar proportion (mmol/mol)							
Acetate	661	650	662	663	666	5.5	0.32
Propionate	186	194	181	186	184	4.9	0.46
Butyrate	103	104	107	105	104	2.9	0.70
Isobutyrate	9.68^{a}	9.72^{a}	9.08^{ab}	**8.55^{b}**	**8.44^{b}**	0.421	**0.06**

$^{a\text{-}b}$ Within a row means without a common superscripts differ ($P < 0.05$).

Effect of dietary lipid supplements on **milk production**

	Treatment					SEM	*P*-value
	Control	Myristic acid	Rapeseed oil	Safflower oil	Linseed oil		
Yield							
Milk (kg/d)	28.7^{a}	**22.1^{b}**	29.0^{a}	29.6^{a}	28.6^{a}	2.97	**< 0.01**
Fat (g/d)	1131^{ab}	**1014^{b}**	1213^{a}	1162^{a}	1213^{a}	107.8	**< 0.05**
Protein (g/d)	977^{a}	**682^{b}**	949^{a}	976^{a}	950^{a}	87.3	**< 0.01**
Lactose (g/d)	1290^{a}	**929^{b}**	1291^{a}	1331^{a}	1291^{a}	137.1	**< 0.01**
Concentration (g/kg)							
Fat	39.2^{c}	**46.7^{a}**	41.8^{bc}	39.3^{c}	**42.8^{b}**	1.29	**< 0.01**
Protein	34.3^{a}	**31.1^{b}**	33.1^{a}	33.1^{a}	33.4^{a}	0.64	**< 0.01**
Lactose	45.1^{a}	**41.7^{b}**	44.2^{a}	44.8^{a}	45.0^{a}	0.68	**< 0.01**

Apparent digestibility of OM



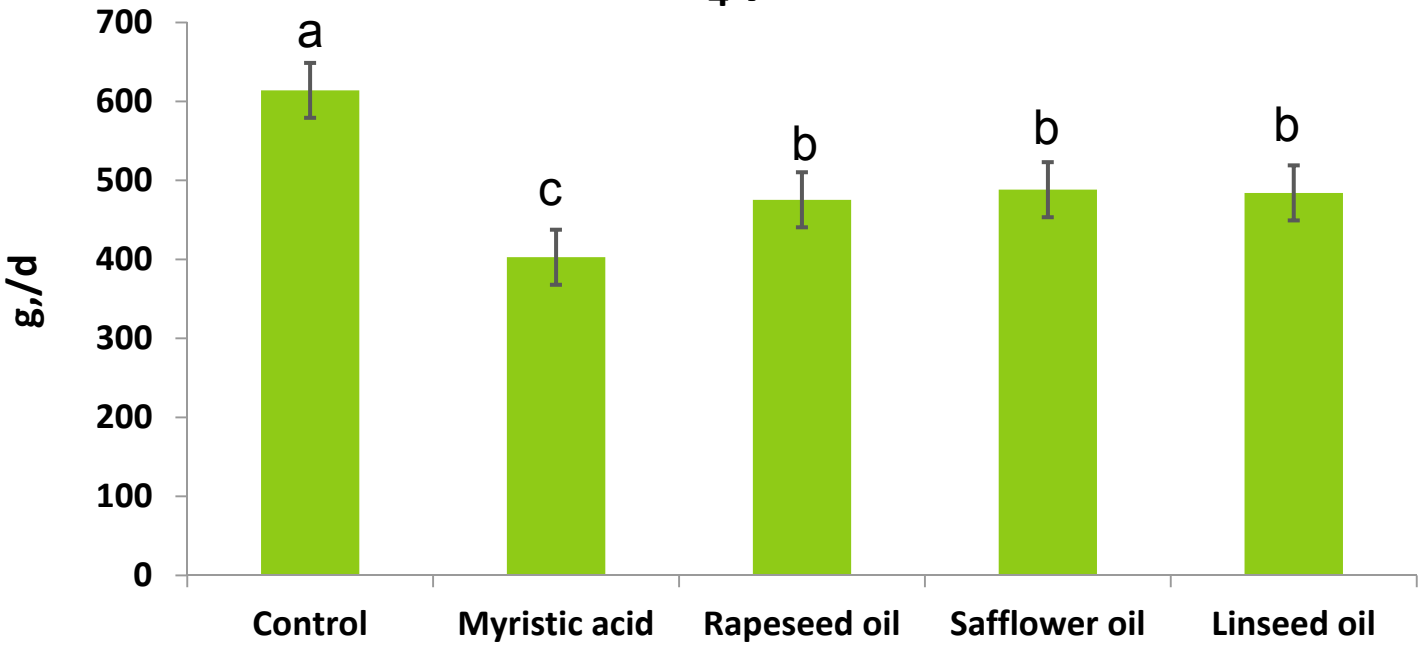
P value = 0.86

Similar trend for NDF, ADF and gross energy

Greater N digestibility for myristic acid compared with other treatments.

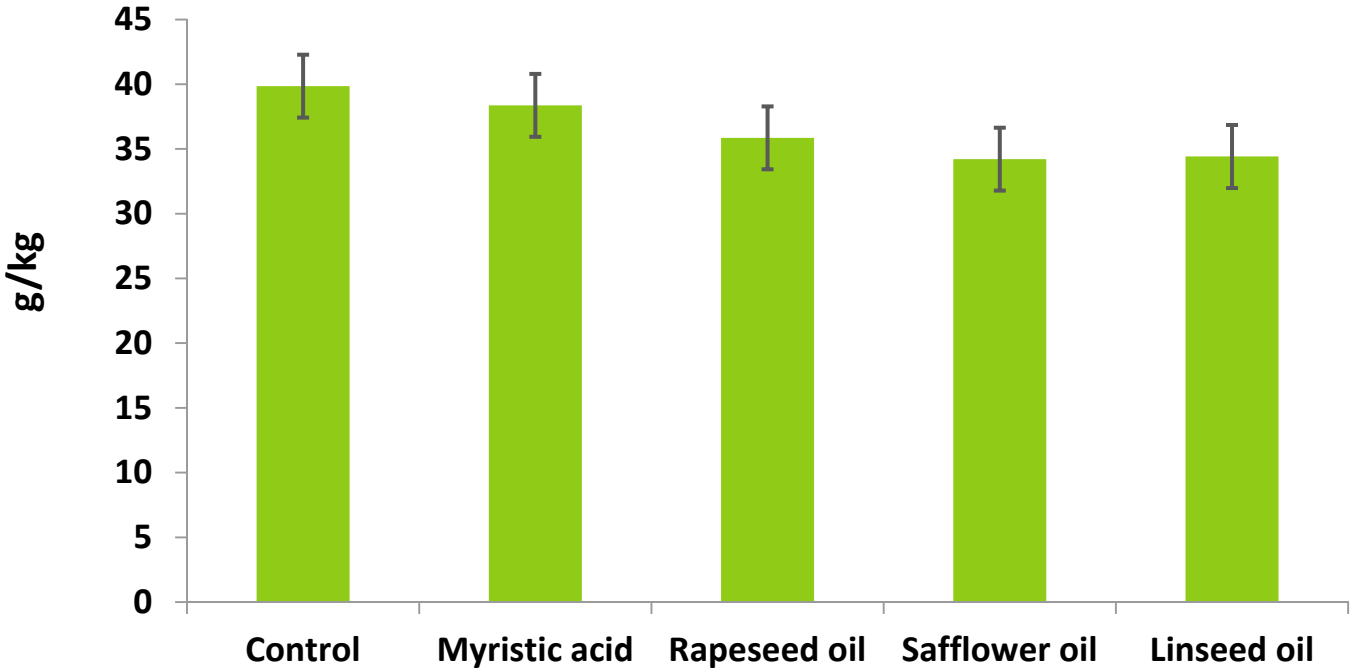
Ruminal CH_4 production

P value < 0.05



	Myristic acid	Rapeseed oil	Safflower oil	Linseed oil
Compared to control (%)	-34.4	-22.6	-20.5	-21.2

Ruminal CH_4 production / digested OM

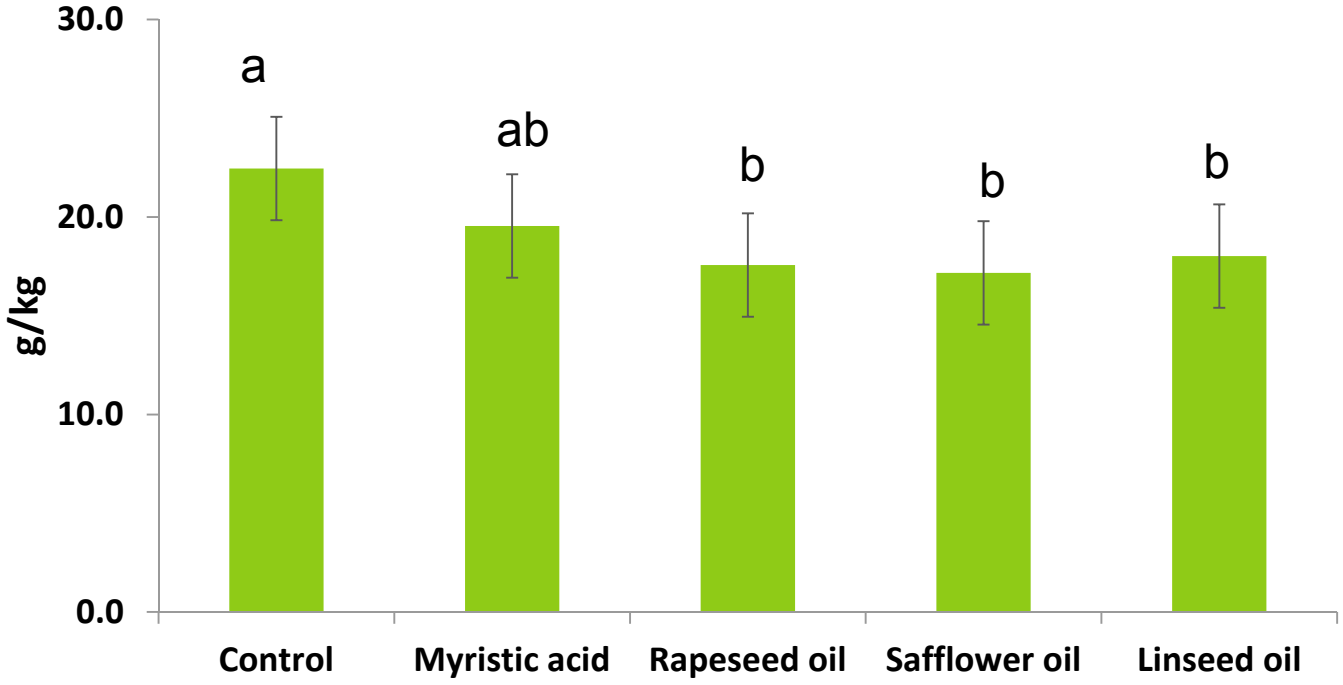


P value = 0.13

Compared to control (%)	-3.7	-10.0	-14.1	-13.6

Ruminal CH_4 production / milk yield

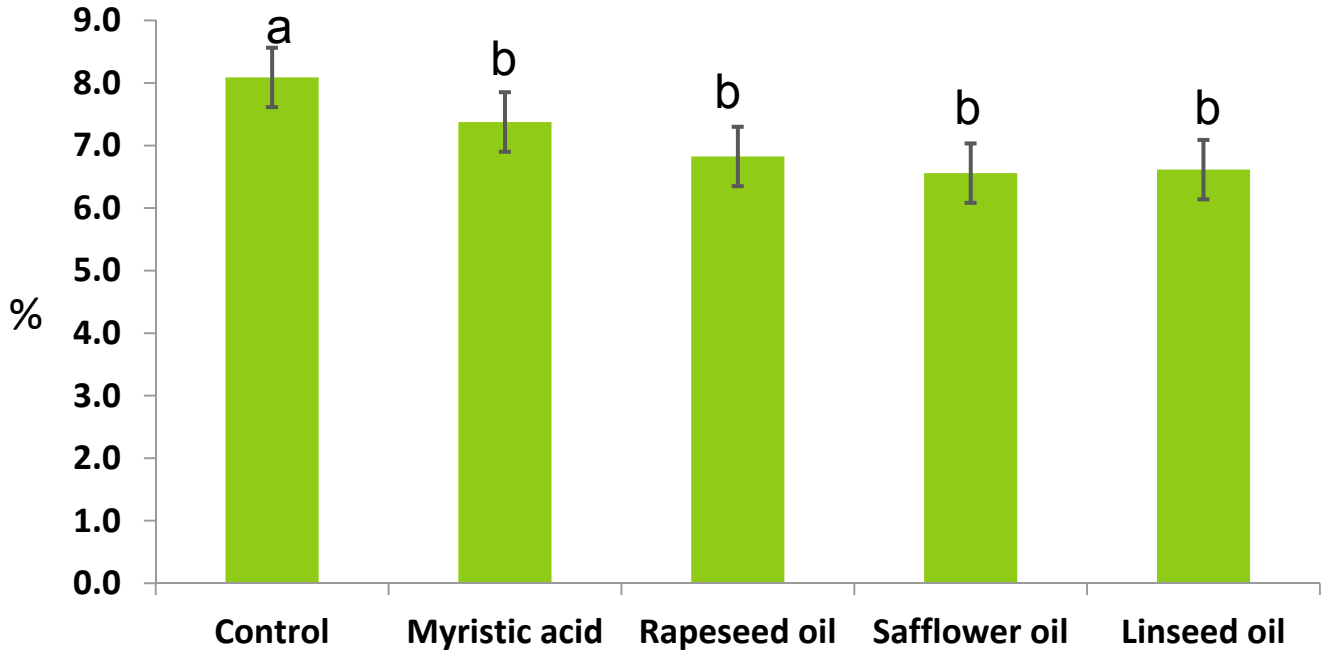
P value < 0.05



Compared to control (%)	-13.0	-21.8	-23.6	-19.8

CH_4 loss / gross energy intake

P value < 0.05



Compared to control (%)	-8.8	-15.6	-18.9	-18.2

Effect of dietary lipid supplements on **milk fatty acid composition** of lactating cows

Fatty acid (g/100 g FA)	Treatment					SEM	*P-value*
	Control	Myristic acid	Rapeseed oil	Safflower oil	Linseed oil		
C4-C14	27.7^{b}	**44.2^{a}**	18.3^{c}	18.1^{c}	18.8^{c}	1.01	< 0.01
14:0	12.9^{b}	**31.7^{a}**	8.51^{c}	8.17^{c}	8.28^{c}	0.837	< 0.01
cis-9 14:1	1.07^{b}	3.69^{a}	0.70^{c}	0.68^{c}	0.64^{c}	0.100	< 0.01
16:0	30.8^{a}	21.3^{b}	18.2^{c}	18.4^{c}	17.8^{c}	0.74	< 0.01
Σ 16:1	2.59^{a}	2.97^{b}	2.15^{c}	2.20^{c}	2.12^{c}	0.085	< 0.01
18:0	9.57^{b}	5.22^{c}	17.2^{a}	16.2^{a}	16.7^{a}	0.53	< 0.01
trans-11 18:1	1.39^{cd}	0.970^{d}	1.77^{c}	**3.66^{a}**	**2.43^{b}**	0.269	<.0001
Σ *trans* 18:1	3.47^{d}	3.38^{d}	6.67^{c}	9.44^{a}	8.57^{b}	0.366	< 0.01
Σ 18:1	20.5^{b}	20.0^{b}	**36.3^{a}**	**36.5^{a}**	**35.0^{a}**	1.02	< 0.01
Σ 18:2	1.99^{cd}	1.87^{d}	2.19^{c}	**2.62^{b}**	**3.65^{a}**	0.139	< 0.01
Σ CLA	0.738^{cd}	0.611^{d}	0.892^{c}	**1.66^{a}**	**1.23^{b}**	0.109	< 0.01
18:3n-3	0.449^{a}	0.212^{c}	0.317^{b}	0.275^{b}	0.475^{a}	0.027	< 0.01

Continue…

Fatty acid (g/100 g FA)	Treatment					SEM	*P-value*
	Control	Myristic acid	Rapeseed oil	Safflower oil	Linseed oil		
Summary KJ15							
Σ *trans* fatty acids	5.00[c]	5.04 [c]	8.48[b]	11.4 [a]	11.8 [a]	0.46	< 0.01
Σ SFA	70.4[a]	69.0 [a]	**55.7 [b]**	**54.5 [b]**	**55.1 [b]**	1.32	< 0.01
Σ MUFA	25.6 [b]	27.7 [b]	**40.3 [a]**	**40.4 [a]**	**38.7 [a]**	1.11	< 0.01
Σ PUFA	3.72 [c]	3.08 [d]	3.77[c]	**4.92 [b]**	**5.92[a]**	0.259	< 0.01

KJ15 Include these totals in the previous slide

Shingfield, 27/08/2014

CONCLUSIONS

- **Dietary plant oil supplements can be used to lower ruminal CH_4 production in dairy cows without compromising animal performance**
- **Myristic acid lowered substantially ruminal CH_4 production, a response accompanied by decreases in dry matter intake and milk production.**
- **All plant oils lowered total saturated fatty acids in milk fat. Both safflower and linseed oils increased milk fat polyunsaturates and total conjugated linoleic acid concentrations.**

Thank you for your time and attention!