Effect of Ca-soap linseed oil on the rumen fermentation pattern and on the characteristics of goat milk

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Introduction

1. Compensation the negative energy balance in the first 90 to 100 days of lactation.

2. Solutions to avoid the negative effects of native fats/oils at a high level in the diet.

3. Milk fat composition of goat milk:

a. cheese production (kg/kg milk), colour, taste;

b. fatty acid composition, human dietetics and health.

4. Supplementation of diet with fats/oils:

changes of milk fat content and fatty acid composition.

Structure of the study

1. ***In vitro*** trial: to observe effects of the bypass fat on rumen fermentation.

2. Field trial: to examine the influences of bypass fat on goat milk composition.

Objectives

To investigate

the effect of saponified linseeed oil on the activity of rumen microbes, focusing on fibre digestion and

fermentation pattern in the rumen and

stability of the bypass fat product in the rumen.

Materials and methods - *In vitro* trial

Animals: 6 rumen-cannulated rams (avg BW: 60 kg);

Housing: in separated stands;

Daily rations

1. Control period:

    1.2 kg lucerne hay + 0.3 kg concentrate;

2. Test period: control diet + 75 g Ca-soap of linseed oil.

Method: *Tilley and Terry* (1963)

Sampling of the rumen fluid: 3 hours after feeding;

Examined parameters: pH, NH_3, volatile fatty acids, ADF

Composition of Ca-soap (%)

Solid content: **96.9**

Crude ash: **15.4**

Ether extract: **81.5**

Ca: **9.0**

Lauric acid (C12:0): **0.01**

Myristic acid (C14:0): **0.24**

Palmitic acid (C16:0): **5.80**

Palmitolenic acid (C16:1): **0.01**

Stearic acid (C18:0): **3.41**

Oleic acid: C18:1): **20.36**

Linolic acid (C18:2): **16.41**

Linolenic acid (C18:3): **51.64**

Others: **2.12**

Table 1

Molar proportion of the volatile fatty acids in the rumen fluid (mol/100 mol)

	Control period	Test period
Acetate, %	68,9±1,50	67,05[b] ±1,12
Propionate, %	16,85±1,03	17,37±1,05
Isobutyrate, %	0,52±0,07	0,65[c] ±0,07
Butyrate acid, %	12,37±1,12	13,43[a] ±0,67
Isovalerate, %	0,55±0,12	0,62±0,08
Valerate, %	0,81±0,14	0,91±0,11

Note:

Control period: feeding of daily ration with no supplementation

Test period: feeding of daily ration supplemented with bypass fat

[a]: significant difference (P<5%)

[b]: significant difference (P<1%)

[c] significant difference (P<0.1%)

Results 1

Effect of Ca-soap of linseed oil on the rumen fermentation pattern

1. **pH stayed stabile in control and test groups (6.07 vs. 6.06);**

2. **Acetate (C2) production decreased (88.33 vs. 84.82 mmol/l) and the propionate (C3) level increased (21.06 vs. 22.32 mmol/l) after feeding the bypass fat;**

3. **The ratio of molar concentrations of C2 and C3 decreased (4.17 vs. 3.84) by ca. 8 percent;**

4. **Total VFA production of C2 and C3 was not influenced (126.18 vs. 126.63 mmol/l).**

Table 2

Changes of ruminal degradation of ADF influenced by the Ca-soap of linseed oil

	Control period		Test period	
Daily ration	Control	Test	Control	Test
Residue of ADF, g	0,213	0,148[b]	0,204	0,149[ab]
Degraded ADF, g	0,249	0,314	0,258	0,313
Residue of ADF, %	46,10	32,03	44,16	32,25
Degraded ADF,%	53,90	67,97	55,84	67,75

Note:

Control period: daily ration with no supplementation for the whethers

Test ration: daily ration supplemented with bypass fat for the whethers

Control daily ration: basal diet with no supplementation for the *in vitro* trial

Test ration: basal diet supplemented with bypass fat for the *in vitro* trial

[a]: significant difference (P<1%)

[b] significant difference (P<0.1%)

Results 2
Effects of Ca-soap of linseed oil on fibre degradation in the rumen

1. **ADF residue was higher in the samples including by-pass fat (2.10 and 2.05 g ADF, when control diet was fed vs. 0.149 and 0.156 g ADF, when test diet (supplemented with Ca-soap) was fed, respectively);**

2. **Only the bypass fat content of the samples, but not the type of daily ration had effects on the microbial activity and on the cell wall degradation;**

3. **Degradation rate of ADF was approx. 56 percent in control diet and 67 percent in diet supplemented bypass fat, respectively.**

Secretion of milk fat and milk fat composition

1. Fatty acid composition of goat milk;
2. Influences of lactation period and energy balance;
3. Effects of fat supplementation on the milk fat secretion and on the fatty acid composition:
   a. Ca-soaps and capsulated oils,
   b. non-protected oils or seeds,
   c. interactions of roughages and supplemented oils.

Objectives of the field trial

To study the effects of Ca-soap of linseed oil on the

- solid content
- milk fat,
- milk protein
- lactose
- fatty acid composition

of goat milk in the first 100 days of lactation .

Materials and methods 1 - Field trial

14 Saanen does, ca. 20 days *post partum*
divided into control and test groups equally.

Control diet:
ad libitum lucerne hay, millet straw,
0.6 kg concentrate (60% maize, 40% wheat).

Test diet: control diet+75 g Ca-soap of linseed oil.

Materials and methods 2 - Field trial

2 control periods : no fat supplementation;

5 test periods: diet supplemented with Ca-soap.

Milk sampling: 1× per week for 7 weeks

Analysis of milk composition:

- solid content, milk fat, milk protein, lactose,
- fatty acids (after distraction by HCl, extraction with dietyl-ether and petrol-ether;

  Chrompack CP 9000, 100×25 mm quartz capillary)

Table 4 Changes of milk fat content in field trial

	Milk fat,	g/100 g
	Control group	**Test group**
Periods		
Control 1	4.71±0.29	4.66±0.74
Test 1	4.72±0.30	3.93[a]±0.58
Test 2	4.72±0.42	3.77[a]±0.77
Test 3	3.70±0.76	3.87±0.55
Test 4	3.53±0.09	3.87±0.44
Test 5	3.63±0.39	3.18±0.91
Control 2	3.76±0.23	3.38±0.60

Notes:

Control 1: before supplementation with Ca-soap

Test 1-5: supplementation with Ca-soap

Control 2: 7 days after supplementation with Ca-soap

[a] significant difference: $P<0.05$

Table 5 Changes of milk protein content in field trial

	Milk protein, g/100 g	
	Control group	**Test group**
Periods		
Control 1	3.47±0.19	3.37±0.33
Test 1	3.51±0.07	3.34±0.28
Test 2	4.72±0.42	3.77[a]±0.77
Test 3	3.31±0.29	3.02±0.25
Test 4	3.55±0.09	3.87±0.44
Test 5	3.63±0.09	3.18±0.91
Control 2	3.76±0.23	2.94[b]±0.26

Notes:

Control 1: before supplementation with Ca-soap

Test 1-5: supplementation with Ca-soap

Control 2: 7 days after supplementation with Ca-soap

[a] significant difference: $P<0.05$

[b] significant difference: $P<0.01$

Table 6 Average fatty acid composition of the goat milk

Fatty acids, %		Control group	Test group
Capric acid	C10:0	9,43±1,87	8,23±0,49
Lauric acid	C12:0	5,11±1.73	3,75±0,06
Miristic acid	C14:0	10,96±2,34	10,06±0,56
Palmitic acid	C16:0	28,07±5,95	26,29±2,52
Palmitolenic acid	C16:1	0,89±0,11	0,70±0,13
Stearic acid	C18:0	9,96±1,18	14,31±1,07
Oleic acid	C18:1	24,70±1,42	23,14±0,59
Linoleic acid	C18:2	2,41±0,32	2,60±0,05
Linolenic acid	C18:3	1,01±0,08	1,07±0,06
Others	C20-24	0,64±0,03	0,68±0,01

Results of the field trial 1

Changes of milk composition influenced by Ca-soap of linseed oil:

1.Milk solid content: in control group ↑

2. Milk fat content: in the control group ↑(in average by 7.9%; significant differences (P<0.05) on the 2nd and 3rd weeks)

3. Milk protein content: opposite tendencies in the groups (control group ↑ - test group ↓, significant differences (P<0.05 and P<0.0 on the3rd and 7th weeks, respectively)

4. Lactose content: no significant changes, small fluctuations in the test group.

Results of the field trial 2

Changes of milk fatty acid composition influenced by Ca-soap of linseed oil:

1. All saturated fatty acids ↓ (from 53.6% to 48.3% in average); with the exception of stearic acid (↑ by 43.7%),

2. Proportions of unsaturated fatty acids changed by different tendencies:

- palmitic acid and oleic acid ↓ (by 6.8 and 6.7%, respectively);
- linoleic acid and linolenic acid ↑ (by 7.9 and 5.9%, respectively).

Conclusions

1. Effects of Ca-soap of linseed oil (5.4% of dry matter) in wethers:

- no negative influence on the volatile fatty acid composition of rumen fluid,

- no detrimental effect on the digestion of crude fibre (ADF) in the rumen.

2. Effects of Ca-soap of linseed oil (4.6% of dry matter) in does:

- composition (especially. milk fat and fatty acids) of goat milk can be influenced,

- when milk fat content decreased, proportions of linoleic and linolenic acid increased.

Suggestions

More investigations would be necessary concerned:

- the dose responses of soaps of vegetable oils of high unsaturated fatty acid contents on rumen microbial activity,

- the effects of saponified vegetable oils on fatty acid contents of goat milk focusing on the changes of unsaturated *trans* fatty acids.