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The effect of feeding level on goats milk fatty acids and on insulin and leptin concentrations

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It has been reported that for a number of reasons, such as:

- ✓ Climatic conditions
- ✓ Seasonality of vegetation growth
- ✓ By –products availability
- ✓ Physiological stage of the animal and
- ✓ Group feeding which is a common practice

- Small ruminants particularly in the Mediterranean basin, face periods of feed shortage (under-feeding) or surplus (over-feeding)
- Ruminants have adapted to face such under- and over-feeding periods with the involvement of some hormones such as insulin and leptin

- Overfed ruminants store fatty acids (FA) in their white adipose tissue which are released as free fatty acids during under-feeding to cover energy deficits
- These FA are also used as a source of triglycerides precursors during lactation

- Adipose tissue mobilization accounts for less than 10% performed FA in milk fat, except during periods of negative energy balance when their proportion increases substantially
- Many studies with dairy cows, have examined the effect of physiological underfeeding of high producing animals in early lactation, but to our knowledge, data for small ruminants on the effect of long term under- and over-feeding on milk FA profile are very scarce

The objective of this study was:

to determine the effects of long term under- and over- feeding on milk chemical composition and fatty acids profile, as well as on plasma fatty acids, insulin and leptin concentrations in goats

Experimental Design

- ✓ Twenty four dairy goats of native breed were used for the experiment
- ✓ Three months post partum the goats were divided into three homogenous sub-groups (n=8) balanced by body weight and milk yield
- ✓ Each group was fed the same ration, but in quantities which covered 70% (under-feeding), 100% (control) and 130% (over-feeding) of their respective energy and crude protein requirements
- ✓ The quantities of food offered to the three groups were adjusted at the 0, 12, 24, 31, 39 and 52 experimental day according to their requirements based on their body weight and milk yield

Table 1 Average daily feed intake (kg/goat) by goats under the three dietary treatments throughout the experimental period

	<i>Feedstuff</i>	<i>Experimental day</i>					
		0	12	24	31	39	52
70%	Alfalfa hay	0.63	0.55	0.52	0.50	0.49	0.48
	Concentrate	0.63	0.55	0.52	0.50	0.49	0.48
100%	Alfalfa hay	0.90	0.87	0.84	0.78	0.75	0.73
	Concentrate	0.90	0.87	0.84	0.78	0.75	0.73
130%	Alfalfa hay	1.16	1.22	1.14	1.05	1.00	0.98
	Concentrate	1.16	1.22	1.14	1.05	1.00	0.98

- Individual milk and blood samples were collected from goats for fatty acids analysis at the 39th and 60th day from the beginning of the experiment
- The experimental data were analysed using the SPSS statistical package with a general linear model (GLM) for repeated measures analysis of variance with dietary treatments (T) and sampling time (S) as fixed effects according to the model: $Y_{ijk} = \mu + T_i + S_j + (T \times S)_{ij} + e_{ijk}$

RESULTS

Table 2. Evolution of the body weight (mean±SEM) of goats at the three dietary treatments throughout the experimental period

	Dietary treatments		
Experimental Day	Underfeeding (70%)	Control (100%)	Overfeeding (130%)
0	52.90±2.123	53.10±2.156	53.33±320
12	49.06±2.422	52.63±2.422	53.63±2.422
24	48.31±2.196	52.75±2.196	54.00±2.196
31	47.88^a ±2.328	52.63^{ab} ±2.328	55.63^b ±2.328
39	46.81^a ±2.162	51.06^{ab} ±2.162	54.56^b ±2.162
52	47.69^a ±2.263	51.94^{ab} ±2.263	55.00^b ±2.263
61	47.25^a ±2.131	52.63^{ab} ±2.131	55.63^b ±2.131

Table 3 Mean fat corrected milk yield (\pm SEM) (kg/day) and milk chemical composition (%) of goats at the three dietary treatments throughout the experimental period

	Experimental day	Dietary treatments		
		70%	100%	130%
Fat corrected milk yield (4 %)	0	0.70 \pm 0.083	0.70 \pm 0.083	0.70 \pm 0.083
	12	0.67 \pm 0.090	0.64 \pm 0.090	0.78 \pm 0.090
	24	0.42 \pm 0.078	0.49 \pm 0.078	0.64 \pm 0.078
	31	0.34^a \pm0.077	0.44^{ab} \pm0.077	0.65^b \pm0.077
	39	0.36 \pm 0.081	0.43 \pm 0.081	0.55 \pm 0.081
	52	0.34 \pm 0.061	0.45 \pm 0.061	0.51 \pm 0.061

Table 3 (cont.)

		Dietary treatments		
	Experimental day	70%	100%	130%
Fat (%)	0	5.41±0.269	5.00±0.269	5.35±0.269
	12	5.83±0.406	5.09±0.406	4.88±0.406
	24	6.02^a ±0.396	4.95^{ab} ±0.396	4.12^b ±0.396
	31	5.85^a±0.400	4.64^b±0.400	4.01^b±0.400
	39	6.04^a ±0.316	5.47^{ab} ±0.316	4.64^b±0.316
	52	6.11^a ±0.307	4.65^b ±0.307	4.68^b±0.307

Table 3 (cont.)

		Dietary treatments		
	Experimental day	70%	100%	130%
Lactose (%)	0	4.60±0.070	4.73±0.070	4.59±0.070
	12	4.52^a±0.065	4.75^b±0.065	4.82^b±0.065
	24	4.24^a±0.082	4.61^b±0.082	4.62^b±0.082
	31	4.34^a±0.068	4.59^b±0.068	4.70^b±0.068
	39	4.38^a±0.085	4.79^b±0.085	4.75^b±0.085
	52	4.27^a±0.083	4.49^{ab}±0.083	4.60^b±0.083

Table 3 (cont.)

		Dietary treatments		
	Experimental day	70%	100%	130%
Protein (%)	0	4.48±0.165	4.39±0.165	4.24±0.165
	12	4.75^{ab}±0.144	4.85^a±0.144	4.33^b±0.144
	24	4.99±0.211	4.81±0.211	4.41±0.211
	31	4.42±0.167	4.57±0.167	4.29±0.167
	39	4.25±0.169	4.31±0.169	4.20±0.169
	52	4.32±0.209	4.61±0.209	4.42±0.209

Table 4. The main fatty acids concentrations (% of total fatty acids) of total lipids of goats plasma between the dietary treatments and the two sampling times

Fatty acids	Dietary treatments (T)				Sampling time (S)			Effects		
	70 %	100 %	130%	SEM	39 days	60 days	SEM	T	S	TxS
C _{16:0}	18.14	18.11	17.81	0.393	18.08	17.96	0.321	NS	NS	NS
C _{18:0}	24.98	24.42	24.24	0.592	24.88	24.22	0.483	NS	NS	NS
<i>Cis-9</i> C _{18:1}	16.38^a	15.28^{ab}	14.66^b	0.672	15.13	15.75	0.548	*	NS	NS
C _{18:2n6c}	25.56^a	28.31^b	28.60^b	1.015	27.36	27.63	0.828	0.01	NS	NS
NEFA	0.20^a	0.07^b	0.10^b	0.029	0.17	0.09	0.022	***	NS	**

Table 5. The mean (\pm SEM) concentrations (ng/ml) of leptin and insulin of goats blood plasma at the three dietary treatments

	Dietary treatments (T)		
	70 %	100 %	130%
Leptin	1.59 \pm 0.113	1.44 \pm 0.113	1.57 \pm 0.113
Insulin	0.58^a\pm0.117	0.79^{ab}\pm0.117	1.01^{bc}\pm0.117

Table 6. The main individual fatty acids concentrations (% of total fatty acids) and fatty acids groups of goats milk at the three dietary treatments and the two sampling times

Fatty acids	Dietary treatments (T)				Sampling time (S)			Effects		
	70 %	100 %	130%	SEM	39 days	60 days	SEM	T	S	TxS
C _{4:0}	3.33^a	3.12^{ab}	2.91^b	0.158	3.13	3.11	0.189	*	NS	NS
C _{6:0}	2.93	2.79	2.73	0.118	2.80	2.84	0.096	NS	NS	NS
C _{8:0}	3.31	3.11	3.26	0.152	3.18	3.27	0.124	NS	NS	NS
C _{12:0}	4.42^a	4.76^a	5.69^b	0.404	4.77	5.15	0.330	**	NS	NS
C _{14:0}	8.37^a	9.25^{ab}	10.29^b	0.557	8.80^a	9.81^b	0.455	**	*	NS

Table 6 (cont.)

Fatty acids	Dietary treatments (T)				Sampling time (S)			Effects		
	70 %	100 %	130%	SEM	39 days	60 days	SEM	T	S	TxS
C _{16:0}	25.65^a	27.92^b	25.31^a	1.056	25.25^a	27.34^b	0.862	*	*	NS
C _{18:0}	9.07^a	7.45^{bc}	8.37^{ac}	0.684	8.65	7.94	0.558	NS	NS	NS
<i>Cis-9</i> C _{18:1}	20.45	18.1	17.7	1.533	19.14	18.36	1.268	NS	NS	NS
VA	1.35^a	1.19^a	1.65^b	0.112	1.46	1.33	0.091	***	NS	NS
CLA	0.52^{ab}	0.45^a	0.63^b	0.052	0.56	0.50	0.043	**	NS	NS

Table 6(cont.)

	Διατροφικές Επιδράσεις (T)				Δειγματοληψία (S)			Επιδράσεις		
	70 %	100 %	130%	SEM	39η ημέρα	60η ημέρα	SEM	T	S	TxS
Λιπαρά οξέα										
SCFA	20.23	19.65	20.21	0.970	19.61	20.45	0.792	NS	NS	NS
MCFA	13.87^a	14.98^a	17.08^b	0.945	14.59	16.04	0.771	**	NS	NS
LCFA	38.74^a	41.19^b	37.95^a	0.856	39.95	38.64	0.699	**	NS	NS

Table 6(cont.)

Fatty acids	Dietary treatments (T)				Sampling time (S)			Effects		
	70 %	100 %	130%	SEM	39 days	60 days	SEM	T	S	TxS
PUFA	4.15^a	3.59^b	4.17^a	0.273	4.10	3.84	0.223	NS	NS	NS
MUFA	23.02	20.58	20.59	1.593	21.75	21.04	1.300	NS	NS	NS

Conclusions

- ✓ Under- and over- feeding of goats leads to considerable alterations in milk chemical composition and fatty acids profile
- ✓ Both feeding levels resulted in significant increase in PUFA and decrease in LCFA concentrations in goat milk which has beneficial effects for human health

- ✓ The significant increase of $C_{18:0}$ in the milk fat of the underfed animals could possibly be a good indicator of the feeding level and underlines the species differences compared to cows where $C_{16:0}$ is the main FA which mobilized during under feeding conditions and
- ✓ Overfed goats had significantly higher insulin blood plasma concentration compared to underfed

Thank you
for
your attention