Session L4.7

Concentration of conjugated linoleic acid in grazing sheep and goat milk

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Introduction

Conjugated linoleic acids (CLA) represent a mixture of positional and geometric isomers of an 18 carbon fatty acid with two double bonds. Parodi (1977) was the first to demonstrate the presence of *cis*-9, *trans*-11 CLA in milk fat. This is the major isomer and it represents about 75-90% of the total CLA in milk fat. Animal sources, like milk fat and meat, especially from ruminants, are richer sources than plant sources. CLA have been demonstrated to have a range of positive health effects. These include suppression of carcinogenesis (Ip et al., 1994; Belury, 1995), antiobecity effect (Park et al., 1997), modulation of the immune system (Coook et al., 1993) and reductions in atherogenesis (Nicolosi et al., 1997) and diabetes (Houseknecht et al., 1998). It is formed in the rumen by anaerobic bacteria as an intermediate in the biohydrogenation of linoleic acid (LA) and from desaturation of vaccenic acid (*trans*-11 $C_{18:1}$) in the mammary gland via Δ^9-desaturase (Bauman et al., 2001). Plant oils are high in both linoleic and linolenic acids, which results in increased CLA production in the rumen and in the mammary gland. The CLA content of milk increases when ruminants are offered grazed grass. The objective of this study was to determine the CLA content and the fatty acid profile of sheep and goat milk fat throughout their lactation period, from January to June.

Materials and Methods

The present study was carried out in a typical mountainous highland of Greece, Arkadia prefecture, where six sheep and six goat representative farms which were selected at random. Milk and feed samples were taken at monthly intervals for fatty acids profile determination, by the method of Jiang et al. (1996) and Kelly et al. (1998), and compositional analysis. Sheep and goat nutrition was based mainly on supplementary feeding during the winter months, up to the end of March, while from April onwards grazing native pastures was the only source of feed. The University sheep farm was also used for milk sampling at the

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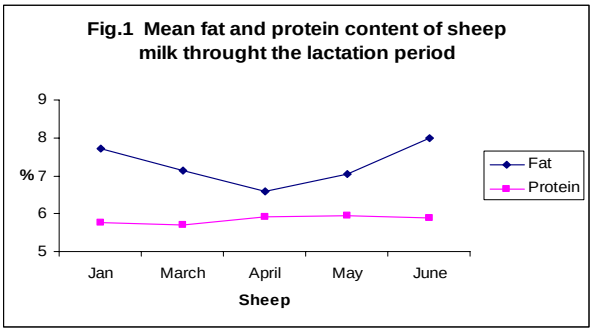
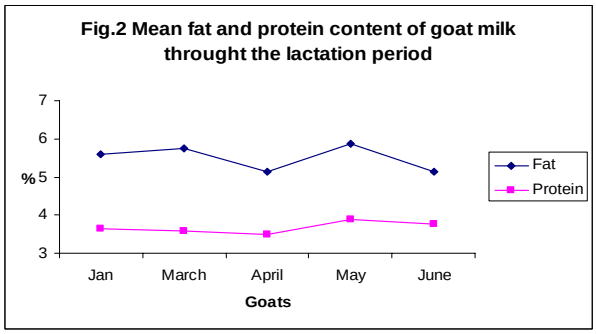
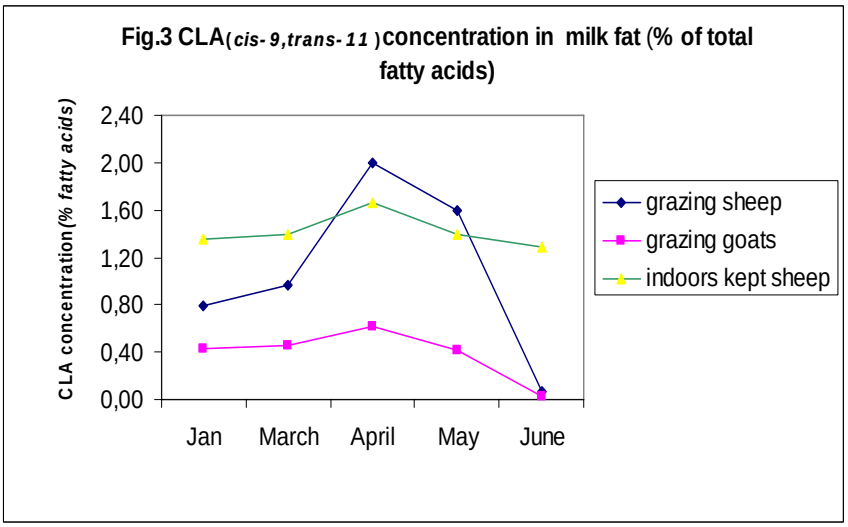
same period, as reference, because those sheep are kept indoors all year round without any grazing. Fifteen individual milk samples were also taken in April from a sheep and goat farm respectively, at the same day, for CLA determination, in order to see the variability inside the farm. The data were subjected to an ANOVA statistical analysis using the STATS GRAPHICS PLUS FOR WINDOWS V. 2.1 package at a level of 0.05.

Results







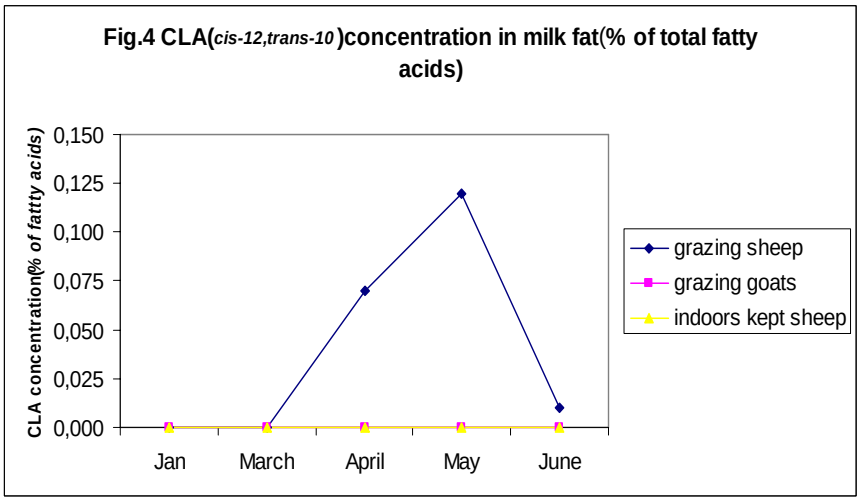


Table 1. The fatty acid profile of sheep milk fat

Month	MCFA	SFA	MUFA	PUFA	SFA:UFA	CLA_1	CLA_2
January	13.2^{a}	57.0^{a}	23.1^{a}	5.5^{a}	2.5^{a}	0.79^{a}	0^{a}
March	11.1^{a}	55.3^{ab}	23.3^{a}	6.5^{a}	2.3^{a}	0.97^{a}	0^{a}
April	15.2^{a}	53.5^{b}	22.0^{a}	8.1^{b}	2.3^{a}	2.00^{b}	0.07^{b}
May	20.5^{b}	57.2^{a}	16.9^{b}	3.9^{c}	3.9^{b}	1.60^{b}	0.12^{b}
June	5.7^{c}	53.0^{b}	33.4^{c}	6.9^{ab}	1.5^{c}	0.07^{c}	0.01^{a}
SEM	1.61	1.07	1.25	0.47	0.20	0.149	0.020
P	0.0000	0.0235	0.0000	0.0000	0.0000	0.0000	0.0004

MCFA: Medium Chain Fatty Acids= $C_{8:0}$+ $C_{10:0}$+ $C_{11:0}$+ $C_{12:0}$+ $C_{13:0}$
SFA: Saturated Fatty Acids= $C_{14:0}$+ $C_{15:0}$+ $C_{16:0}$+ $C_{18:0}$+ $C_{20:0}$+ $C_{22:0}$+ $C_{23:0}$+ $C_{24:0}$
MUFA: Mono-unsaturated Fatty Acids=$C_{14:1}$+ $C_{15:1}$+ $C_{16:1}$+ $C_{17:1}$+ $C_{18:1}$
PUFA: Poly-unsaturated Fatty Acids=$C_{18:2n6c}$ +$C_{18:2n6t}$ +$C_{18:3n6}$ +$C_{18:3n3}$ +CLA_1 +CLA_2 +$C_{20:2}$ +$C_{20:3n6}$ +$C_{20:4}$ +$C_{20:5}$
UFA: Unsaturated Fatty Acids= PUFA +MUFA
CLA_1 : *cis-9 , trans-11*
CLA_2 *: cis-12 , trans-10*

Table 2. The fatty acid profile of goat milk fat

Month	MCFA	SFA	MUFA	PUFA	SFA:UFA	CLA_1
January	13.6^{a}	59.3^{a}	20.7^{a}	5.5^{a}	3.0^{a}	0.43^{a}
March	11.9^{a}	59.5^{a}	21.7^{a}	6.5^{a}	2.8^{a}	0.45^{a}
April	13.7^{a}	56.1^{ab}	23.7^{ac}	8.1^{b}	2.4^{a}	0.62^{a}
May	20.5^{b}	57.2^{ab}	16.9^{b}	3.9^{c}	3.9^{b}	0.41^{a}
June	14.2^{a}	54.8^{b}	25.0^{c}	6.9^{ab}	2.4^{a}	0.03^{b}
SEM	1.23	1.37	1.08	0.47	0.19	0.071
P	0.0006	0.0973	0.0002	0.0000	0.0001	0.0001

Table 3. Variation of CLA content in sheep and goat milk between individual animals of the same flock/herd.

	n	Mean	SE	min	Max
Sheep	15	1.53	0.30	0.13	3.16
Goats	15	0.30	0.02	0.20	0.50

Table 4. Fatty acid profile of grass.

Month	MCFA	SFA	MUFA	PUFA	LOA	LNA	SFA/UFA
January	0.35	13.07	1.63	84.86	9.28	69.09	0.16
March	0.23	19.15	9.50	71.10	57.51	11.24	0.25
April	0.46	14.50	1.19	83.84	22.98	56.80	0.17
May	0.42	18.73	1.30	79.54	34.14	42.14	0.23
June	0.85	21.88	5.61	71.65	40.83	21.57	0.29

LOA :linoleic acid $C_{18::2}$
LNA :linolenic acid $C_{18:3}$

Table 5. Fatty acid profile of maize grain and concentrate

	MCFA	SFA	MUFA	PUFA	LOA	LNA	CLA_1	CLA_2
Maize grain	0	13.71	1.06	85.22	83.27	1.82	0	0
Concentrate	0	18.57	1.57	79.85	76.84	2.74	0	0.14

Conclusions

The results of this study showed that:

a. the CLA content of grazing sheep and goat milk fat increased significantly in April-May (early growth stage of grass) and then declined, while that of indoors kept sheep was more or less constant during the same period.

b. the isomers *cis*-9, *trans*-11 and *cis*-12, *trans*-10 of CLA were found in grazing sheep milk fat, while in indoors kept sheep and goats milk fat was found only the *cis*-9, *trans*-11 isomer.

c. the CLA content of sheep milk fat was much higher than that of goats.

d. there was considerable variation in milk fat CLA content between farms and inside the farm (individual variation).

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