Italian Journal of Animal Science

ISSN: (Print) 1828-051X (Online) Journal homepage: https://www.tandfonline.com/loi/tjas20

Effects of fat supplementations on milk production and composition, ruminal and plasma parameters of dairy cows

F. Tagliapietra, S. Schiavon, A. Simonetto, Dal Maso & L. Bailoni

To cite this article: F. Tagliapietra, S. Schiavon, A. Simonetto, Dal Maso & L. Bailoni (2007) Effects of fat supplementations on milk production and composition, ruminal and plasma parameters of dairy cows, Italian Journal of Animal Science, 6:sup1, 367-369, DOI: 10.4081/ijas.2007.1s.367

To link to this article: https://doi.org/10.4081/ijas.2007.1s.367

Effects of fat supplementations on milk production and composition, ruminal and plasma parameters of dairy cows

F. Tagliapietra, S. Schiavon, A. Simonetto, M. Dal Maso, L. Bailoni

Dipartimento di Scienze Animali. Università di Padova, Italy

Corresponding author: Franco Tagliapietra. Dipartimento di Scienze Animali. Facoltà di Agraria, Università di Padova. Viale dell'Università 16, 35020 Legnaro, (PD) Italy - Tel. +39 0039 49 8272622 - Fax: + 39 0039 49 8272633 - Email: franco.tagliapietra@unipd.it

ABSTRACT: The effects on milk yield and quality caused by the same amount (325 g/d/cow) of lipids provided by 3 different fat sources (hydrogenate palm fat, HF; calcium salt palm fat, CaSF; full-fat toasted soybean, TS), top dressed to a common total mixed ration, were investigated. Supplementations did not affect feed intake and milk yield, but markedly changed the acidic profile of milk fat. CaSF and TS significantly increased the proportions of unsaturated fatty acids of milk fat with respect to control and to HF. The 3 fat sources did not affect the concentrations of ammonia and VFA of rumen fluid. TS only slightly increased ($P<0.10$) plasma urea content because of a higher dietary protein supply, with respect to the other treatments. The use of a low amount of toasted and cracked full fat soybean seem to be interesting to increase the energy concentration of diets in replacement to commercial fat products and it can be use to modify the milk fat quality increasing the fraction with benefit effects on human health.

Key words: Dairy cow, Fat supplements, Whole soybean, Milk quality.

INTRODUCTION – Fat supplementation is commonly used in the feeding of dairy cows, in order to increase the energy density of the rations, particularly on high yielding cows. It is known that the kind of fat source can affect feed intake, rumen activity, milk yield and quality (Coppock, 1991). However, less information are available about the effects of different fat sources on the fatty acid profile of milk. Aim of this paper was to compare the effects of three different fat sources on milk yield and quality and on some rumen fluid and plasma indicators.

MATERIAL AND METHODS – Twenty four lactating cows were divided in 4 groups according to days in milk (129±87 d), parity (2.0±1.1), milk production (29.1±5.4 kg/d), and body condition score (2.9±0.3). Each group received a total mixed ration (TMR) as basal diet (Control) top dressed with 325 g/d/cow of lipids from hydrogenated palm fat (HF: 325 g/d), from calcium soap of palm fat (CaSF: 400 g/d) and from full-fat toasted cracked soybean seeds (TS: 1570 g/d). TMR contained corn silage (32.7% DM), permanent meadow hay (21.3% DM), dehydrated alfalfa (10.9% DM), soybean meal (10.0% DM), protein-mineral premix (8.8% DM), cracked corn (8.7% DM), and dry sugar beet pulp (7.6% DM). Each cow, according to a scheduled feeding scheme, received a further concentrate feed supply from automated feeding stations, according to their level of milk yield. The trial lasted 36 days (July-August 2006; 15 days adaptation and 21 days experimental). Samples of each ingredient, TMR and feed residues from each group, were weekly collected and analysed for their proximate composition (Martillotti *et al.*, 1987) and their fatty acids profile by chromatographic procedure (Folch *et al.*, 1957). Milk samples from each cow were collected weekly to evaluate their proximate composition, their FA profile and their clotting parameters (Formagraph apparatus: CRM 48, Polo Trade, PD, I). Samples of blood and rumen fluid were collected from each cow at the last experimental day, 1 hour and 3 hours after feeding. The effects of fat supplementations (Fs) were tested, by ANOVA, using animal within Fs as error term.

RESULTS AND CONCLUSIONS – In tables 1 and 2 the chemical composition of fat supplements and of the experimental diets are given. The lipid content of the control diet was about half of the supplemented diets. The mean crude protein (CP) content of the diets was around 16% DM, except for ST where mean CP was 17.7% DM.

Table 1. Chemical composition and acidic profile of the fat sources used.

Item		Hydrogenate fat	Calcium salt fat	Toasted soybean
Dry matter (DM)	%	99.9	96.2	92.5
Crude protein	% DM	-	-	39.7
Ether extract (EE)	"	100	84.5	22.4
Calcium	"	-	9.5	-
SFA	% EE	95.4	55.3	16.6
MUFA	"	5.3	36.3	25.8
PUFA	"	0.2	8.4	57.6
Milk UF	/kg DM	2.61	2.21	1.34

Table 2. Mean chemical composition of experimental diets.

Item		Control	HF	CaSF	TS
Dry matter	%	48.6	49.3	49.4	51.7
Crude protein	% DM	16.0	15.8	15.9	17.7
Ether extract	"	2.65	4.18	4.09	3.97
Starch	"	17.8	17.8	18.0	17.1
NDF	"	41.0	40.1	39.7	38.6
Milk UF	/kg DM	0.93	0.96	0.96	0.96

HF = Hydrogenate fat diet; CaSF= calcium salt fat diet; TS= full-fat toasted soybean diet.

Table 3. Feed intake, milk production, chemical composition, clotting parameters and acidic profile.

Item	Diet Control	SE HF	CaSF	TS		
DM intake	kg/d	20.1	20.6	21.7	21.9	0.2
Milk production	"	27.3	29.3	30.1	30.2	2.8
Fat corrected milk (FCM, 4%)	"	25.5	28.6	30.3	29.5	2.5
Milk fat	%	3.55	3.85	4.05	3.85	0.10
Milk protein	"	3.12	3.18	3.31	3.20	0.04
SFA	% fat	73.15^{B}	73.33^{B}	68.37^{A}	69.54^{A}	0.40
MUFA	"	23.27^{A}	23.57^{A}	27.75^{C}	25.35^{B}	0.35
PUFA	"	3.57^{B}	3.10^{A}	3.88^{C}	5.11^{D}	0.07
ω3	"	0.44^{B}	0.35^{A}	0.42^{B}	0.59^{C}	0.01
ω6	"	2.49^{B}	2.13^{A}	2.68^{B}	3.64^{C}	0.06
CLA	"	0.36^{a}	0.34^{a}	0.47^{b}	0.51^{b}	0.02
r	min	12.3	13.4	17.8	13.6	1.8
k_{20}	"	2.57^{a}	3.69^{ab}	5.13^{b}	3.72^{a}	0.70
A_{30}	mm	27.3	26.9	26.8	27.4	2.0

^{A,B,C} P<0.01; ^{a,b,c} P<0.05; r = renneting clotting time in samples that clotted within 45 min;
k_{20} = rate of curd firming in samples that clotted within 45 min; A_{30} = curd firmness after 30 min.

DM intake, milk yield, fat and protein milk contents were not significantly affected by the treatments (Table 3); FCM observed for HF, CaSF and ST groups were, respectively, 3.1, 4.8 and 4.0 kg/d higher with respect to that of the Control (P>0.10). Previous studies indicated that milk fat synthesis is inhibited by the fatty acids produced in the rumen during bio-hydrogenation of unsaturated FA. Milk fat depression has been associated to diets rich in PUFA (Bauman and Griinari, 2003). Hydrogenate fatty acids and calcium salts are commonly supplied in order to increase the energy intake and to minimizing the negative effects of fat on rumen fermentations. However, calcium salts of FA are not entirely protected in the rumen and, the dissociation of the calcium ions allows rumen biodegradation of unsaturated FA (Wu *et al.,* 1991). Therefore CaSF and TS diets were expected to induce milk fat depression. Such expectation was not confirmed in this study perhaps due to the low amount of fat (around 4% DM), and the physical form of cracked soybean seeds. Notwithstanding, the amount and the source of fat supplied markedly influenced the fatty acid profile of milk (P<0.01), leading to different ratios between SFA, MUFA and PUFA across treatments. With respect to Control, HF reduced the proportion of PUFA, ω3 and ω6 (P<0.01); CaSF increased the proportion of MUFA and PUFA (P<0.01), while TS increased all the unsaturated fatty acids components (MUFA, PUFA, ω3, ω6 and CLA; P<0.01). No relevant effects due to the fat supply were detected on the clotting parameters, although for the CaSF a slightly increase of k_{20} was observed (P<0.05). Treatments did not affect the rumen fluid parameters (Table 4), as well as the metabolic profile. The blood urea content observed for the TS treatment tended to be only slightly higher to that of control (P<0.01). In conclusion, the supply of toasted and cracked full fat soybean seeds can be a good farm solution to reduce the cost of fat supplementation and to improve milk fat quality for human nutrition when required and economically convenient.

Table 4. Rumen fluid composition and plasma metabolic profile.

Item		Diet				SE
		Control	HF	CaSF	TS	
Rumen fluid profile						
- pH		6.65	6.40	6.54	6.60	0.13
- Ammonia	mmol/l	8.54	10.49	8.67	8.82	1.11
- Acetate	% VFA	57.96	56.96	57.12	57.73	0.77
- Propionate	"	22.84	22.24	21.05	21.26	1.00
- Butyrate	"	13.66	14.13	15.14	14.54	0.55
Plasma profile						
- Total Protein	g/l	75.83	74.66	80.33	76.50	2.25
- Albumin	"	33.33	35.33	35.16	35.83	1.34
- Urea	mmol/l	5.20^{α}	4.98^{α}	$5.93^{\alpha\beta}$	6.77^{β}	0.48
- Glucose	"	2.18	2.21	2.05	2.30	0.17
- Total Cholesterol	"	3.45	4.04	4.21	4.64	0.38
- NEFA	meq/l	0.172	0.165	0.207	0.150	0.02
- AST	U/l	123.0	68.5	73.0	66.5	19.7
- GGT	"	36.7	29.8	29.2	28.0	6.46
- CK	"	143.0^{β}	79.8^{α}	$119.2^{\alpha\beta}$	$102.2^{\alpha\beta}$	17.1

$^{\alpha,\beta}$*P<0.10; AST: amino transferase; GGT: γ-glutamyl transferase; CK: creatine kinase.*

The Authors want to thank Consorzio Agrario di Padova e Venezia (Padova, Italy) for feed supply.

REFERENCES –**Bauman**, D.E., Griinari, J.M. 2003. Nutritional regulation of milk fat synthesis. Annu. Rev. Nutr. 23:203-227. **Coppock**, C.E., Wilks, D.L. 1991. Supplemental fat in high-energy rations for lactating cows: effects on intake, digestion milk yield, and composition. J. Anim. Sci. 69:3826-3837. **Folch**, J., Less, M., Stanley, G.H.S., 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226:497-509. **Martillotti**, F., Antongiovanni, M., Rizzi, L., Santi, E., Bittante, G., 1987. Metodi di analisi per la valutazione degli alimenti di interesse zootecnico. Quaderni Metodologici n.8 IPRA-CNR, Roma, I. **Wu**, Z., Ohajuruka, O.A., Palmquist, D.L. 1991. Ruminal synthesis, biohydrogenation, and digestibility of fatty acids by dairy cows. J. Dairy Sci. 74:3025-3034.