TRUEFOOD

Traditional United Europe Food

Contract no. FOOD-CT-2006-016264

Instrument: Integrated Project

Thematic Priority: Food Quality and Safety (# 5)

D4.1.1b-1
Interim Report on the effect of different oilseed supplementation of cow diets on the nutritional quality of milk and animal health after the first lactation

Due date of deliverable: October 2008
Actual submission date: October 2008

Start date of project: 1 May 2006 Duration: 48 months

Organisation name of lead contractor for this deliverable: IRTA – P10

Revision: final

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Services)	X
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

D4.1.1b-1 Interim Report on the effect of different oilseed supplementation of cow diets on the nutritional quality of milk and animal health after the first lactation

FERLAY Anne, MARTIN Bruno, POMIES Dominique, CHILLIARD Yves.
INRA, UR Herbivores 1213, Theix, F-63122 Saint Genès Champanelle

ABSTRACT

An efficient alternative to improve the nutritional quality of dairy fat is the supplementation of the cows' diet with vegetable seeds rich in polyunsaturated fatty acids (PUFA). Many studies reported that oilseed supplementation of cow diets increases the milk PUFA (including CLA and Omega 3 FA) content in parallel with a decrease in saturated FA level. Nevertheless, as the duration of these experiments was short (some weeks), it has not been possible to reveal if there are long-term effects of feeding oilseeds on metabolism and health of animals. The main aim of Subtask 4.1.1.b is therefore to quantify during two successive lactations, the effects of long-term supplementation of different oilseeds rich in cis9-C18:1 or C18:3n-3 on nutritional quality of milk and on animal production, health and reproductive performances. This trial began on October 2007 and involved 60 Holstein cows from an INRA experimental herd. From calving until the 6th week of lactation, the cows were fed a same diet; the data obtained during this period will be used as covariate term. Then, after a 3 weeks transition period, each cow received one of the 5 diets for the entire lactating and dry periods. During the winter, cows were fed a grass based diet (75% grass silage and 25% hay) supplemented or not, with different sources or rapeseeds - whole seed, extruded seeds and a oil rich cake - or extruded linseeds. Most of the analyses that were intended to be performed on the milk and plasmas are in progress. It is therefore too soon to draw the first conclusions concerning the main aims of the work. Therefore, this text only reports the first results obtained during the first 19 weeks of lactation.

The lipid supplement provided an oil level from 2.5 to 3% of dietary dry matter intake. The dry matter intake is not affected by the lipid supplements chosen in this trial but the animal weight seems to be depressed as well as the milk protein content. On the contrary, the milk yield and fat content are not modified. The first results concerning the animal health and reproductive performance are too preliminary to state any conclusion.

INTRODUCTION

One alternative to improve the nutritional value of dairy products is the supplementation of the cow's diet with oilseeds rich in polyunsaturated fatty acids (PUFA). This approach is particularly feasible in areas with oilseed processing industries. Many studies reported the effects of oilseed supplementation of cow diets on milk fatty acid (FA) composition, increasing the milk PUFA (including CLA and Omega 3 FA) content in parallel with a decrease in saturated FA level (Chilliard *et al.,* 2007). For dairy cows, this supplementation leads generally to higher milk yield and lower fat content (Chilliard and Ferlay, 2004 ; Glasser *et al*., 2008). Nevertheless, as the duration of these experiments was short (some weeks), it has not been possible to reveal if there are long-term effects of feeding oilseeds on metabolism and health of animals. In particular, when diets rich in PUFA are used in the long term, the response of the milk FA composition is unknown and the dietary PUFA may impair animal health. Moreover, milks rich in PUFA appear to be more sensitive to oxidation (Palmquist *et al.,* 1993). Diets rich in grass forage could supply natural antioxidants as carotenoids, vitamin E or polyphenols (Nozière *et al*., 2006). The high amount of natural antioxidants into the diets may limit the putative risks of oxidation of PUFA.

The main aim of Subtask 4.1.1.b is therefore to quantify during two successive lactations the effects of long-term supplementation of different oilseeds (either rich in cis9-C18:1 or C18:3n-3) on nutritional quality of milk and on animal production, health and reproductive performance. We will also evaluate the putative remnant effects of lipid supplementation on the dairy performances during the beginning of the following third lactation.

The specific objectives of this Subtask are to quantify the effect of long-term oilseed supplementation on milk yield and composition, on milk FA composition and on animal health. The lipids chosen for the experiment are extruded linseeds, rich in C18:3n-3 and different forms of rapeseeds, rich in both C18:1cis9 and C18:3n-3 (crude seed, extruded seed and oil-rich cake). We chose to focus in this trial on rapeseeds because it is produced in large amounts in many European countries. In addition, oil-rich rapeseed cakes are by-products of the farm extraction of rapeseed oil that could be used by some farmers as agro-diesel.

In this deliverable we report the first results obtained during the first part of the first lactation.

EXPERIMENTAL

The experiment was carried out in the INRA experimental farm of Orcival, located in a mountain grassland area (1000 m elevation) of the Auvergne region (France). The dairy herd is composed of 110 Holstein dairy cows.

The animals were studied 4 weeks before predicted calving date and will remain in the same treatment group for two consecutive lactations. From calving and until the 6^{th} week post-calving, the cows were fed the same diet without lipid supplementation, and measurements for covariate adjustments of data were taken during these weeks. Grass forage (75% silage + 25% hay) was fed ad lib and concentrates were distributed according to the individual energy and protein requirements. At the end of this period, the 60 lactating cows were divided into five groups of 12 cows based on similarity in calving date, milk yield, fat content, protein content, lactation stage, and parity to receive, after a 3 weeks transition period, one of the 5 diets for the entire lactating and dry period. The first group received daily a control diet (diet C) based on 70% of grass forage (75% grass silage + 25 % hay) and 30 % concentrate. The second group received the same diet in which a part of concentrate was substituted for extruded rapeseeds (diet ER). The third group received diet C in which a part of concentrate was substituted for whole rapeseeds (diet R). The fourth group received the diet C in which a part of concentrate was substituted for rapeseed cake (diet RC). Finally, the fifth group received the diet C in which a part of concentrate was substituted for extruded linseeds (diet EL). Except for C diet, the lipid supplement provided an oil level of 3% of dietary dry matter (DM) intake. The diets were calculated so that individual energy and protein intake covered at least 95 and 100% of the INRA energy and protein requirements, respectively (INRA, 2007). Refusals, if any, were collected and weighed daily (4 days each week) to calculate each week the individual amount of concentrate and the net intake of each animal in each diet. During grazing and dry period, the cows received the same lipid supplement than during winter period at constant amount (5 kg/day).

Cows were housed in a tie-stall barn and were milked at 06:00 h and 16:00 h in a milking parlour. Milk yield was recorded individually each day of the lactation. Milk fat, protein, lactose content and somatic cell count were determined for all the individual cows at 4 consecutive milking each week. Cows were weighed and body condition was recorded during

the 2nd and 4th week after calving and then every 2 weeks. Milks samples for FA profile and antioxidant (vitamin A and E and carotenoids) analyses were taken 6 times during the lactation, according to winter or grazing feeding period. Blood samples were also taken 5 times for β-hydroxybutyrate, glucose, NEFA, carotenoids, vitamins A and E, and health indicators (peroxidation, liver health and inflammation).

Registrations were made of mastitis, or any other health disturbance occurring according to observations made by the herdsmen and veterinary practitioners. Reproductive traits were evaluated by interval from calving to first ovulation (by measuring the progesterone in milk once a week), first heat (by observation) and conception, number of AI per conception, and calving interval.

RESULTS

At this stage (October 2008), the first lactation is over for all the cows. The individual measurements concerning the milk yield and composition and the animal intake, health and reproductive performance have been recorded but are not yet fully synthesized. The analyses of milk and plasma are in progress. This report presents only with the first results obtained during the 19th first weeks of the first lactation when the cows were indoors.

INDIVIDUAL INTAKE

The individual intake, milk yield and composition are reported in table 1.
First, we have to notice that for 3 of the 4 experimental diets, we did not reach the expected 3% of oil in the dietary DM intake providing from the lipid supplements. This discrepancy is due to the fat content of the seeds was lower than that expected. For the rest of the experiment, the oil intake will be increased.
The forage and total dry matter intake as well as the energy and nitrogen intakes were similar in all the treatments but the energy balance was lower in the RC diet and higher in the R diet. Intermediate values are observed for the C, ER and EL diets. Surprisingly, the animal weight was numerically lower with the supplemented diets, whatever the source of the supplement. The higher weight losses observed with the supplemented diets could be due to a misevaluation of the energy of the oilseeds or to a decrease of the efficiency of the digestion in the case of the supplemented diets and/or to a decrease in the weight of digestive content of the cows, due to the non-significant decreases in DM intake. These tendencies have to be confirmed during the rest of the lactation because these weight differences were not confirmed by the evaluation of the body condition score that was not significantly affected by the diets.

The nitrogen balance was lower in the C diet in comparison to the R and EL diets. Intermediates values were observed for ER and RC diets. These differences could explain the lower milk urea content observed in the C diet.

MILK YIELD AND COMPOSITION

The milk yield was similar between the different diets. It ranged from 26.9 to 28.8 kg/d/cow for the different diets. The milk fat content was not significantly depressed by the lipid supplements tested in this trial. In contrast, the milk protein content of the milks was significantly reduced by the lipid supplementation. The lowest value was observed for the RC diet where the energy balance was the lowest. The milk lactose content, somatic cell counts and the post-milking lipolysis were not affected by the diets.

REPRODUCTION AND HEALTH

Actually it is difficult to evaluate the effect of the supplements on the cow's reproductive performances because the first ovulation and artificial insemination occurred when the cows were fed their experimental diet only for a few weeks. It can just be stated that the success of the first artificial insemination was particularly low in the ER and EL diets. On the opposite, it was higher in the R diet.

We did not observe any significant increase of the number of cows that declared at least one mastitis, but the total number of mastitis was numerically higher in the RC and EL diets.

These results have to be confirmed on a longer period.

CONCLUSIONS

Most of the analyses that were intended to be performed on the milk and plasmas are in progress. It is therefore too soon to draw the first conclusions concerning the main aims of the study. Nevertheless, the first data obtained permit to show that during the first 19 weeks of lactation, although the animal intake is not affected by the oil rich supplements chosen in this trial, the animal weight seems to be depressed as well as the milk protein content. On the contrary, the milk yield and fat content are not modified. The first results concerning the animal health and reproductive performances are too preliminary to state any conclusion.

Table 1. Ingredient, energy and protein intakes, milk yield, fat, protein and lactose content, energy and protein balances, body weight and condition score and reproduction and health parameters from cows fed a grass based diet (75% grass silage and 25% hay) supplemented or not (C), with different sources of rapeseeds - whole seeds (R), extruded seeds (ER) and a oil-rich cake (RC)- or extruded linseeds (EL).
Values reported are adjusted means of the data collected from weeks 9 to 19.

		Rapeseeds			Linseeds	Diet
Item[1]	Control	Whole (R)	Extruded (ER)	Cake (RC)	Extruded (EL)	
Fat from the seeds (% DMI)	0	2.5	2.4	3.2	2.8	
Forage intake (kgDM/d)	14.2	14.2	13.6	13.2	13.3	ns
Total dry matter intake (kgDM/d)	20.2	20.1	19.4	18.9	19.0	ns
Energy intake (UFL²/d)	18.3	18.6	18.1	17.5	17.9	ns
Energy balance[3] (UFL²/d)	1.2 ab	1.9 b	1.1 ab	0.5 a	1.1 ab	*
Nitrogen intake (gPDI²/d)	1755	1655	1641	1602	1665	ns
Nitrogen balance[3] (gPDI²/d)	- 56 a	50 b	-1 ab	- 1 ab	48 b	*
Body weight (kg)	626 a	616 ab	615 ab	593 b	609 ab	***
Body Condition Score (0-5)	1.72	1.63	1.47	1.69	1.66	ns
Milk yield (kg/d)	27.9	26.9	28.4	28.8	27.4	ns
Fat content (g/kg)	35.5	36.4	34.9	35.6	36.5	ns
Protein content (g/kg)	29.7 c	28.6 bc	28.0 ab	26.7 a	28.6 bc	***
Lactose content (g/kg)	48.6	48.4	48.7	49.5	48.9	ns
Somatic cell counts (log 10/ml)	5.32	5.15	5.17	5.03	5.31	ns
Urea (g/L)	0.17 a	0.31 c	0.27 bc	0.18 a	0.24 b	***
FFA[4] (log10mEq/100g TFA)	- 0.44	- 0.46	- 0.43	- 0.42	- 0.36	ns
Interval calving - 1st ovulation (d)	49	56	49	46	45	ns
Interval 1st ovulation/ 1ère heat (d)	21	29	24	50	35	ns
Interval calving – 1st heat (d)	*78*	*93*	*77*	*100*	*84*	ns
Pregnant cows after the 1st AI[5]	50%	75%	25%	50%	10%	*
Number of cows with at least 1 mastitis	4 (33%)	5 (42%)	5 (42%)	4 (33%)	7 (58%)	ns
Number of mastitis	9	10	8	17	19	ns

[1]a, b, c, d, Means on the same row with different superscripts differ (P<0.05), [2]UFL: Forage Unit, PDI, Protein digestible in the intestine (INRA, 1989); [3]Balance = intake-maintenance and production requirements; [4] FFA: Milk Free Fatty Acids after 24 hours storage at 4°C; [5] AI: Artificial Insemination.

FUTURE APPROACH

At this stage (October 2008), the first lactation is over for all the cows. The individual measurements achieved during the first lactation that concern the milk yield and composition and the animal intake, health and reproductive performance will be fully synthesized in the next months. The analyses of milk and plasma collected during the 1st lactation will be finished in April 2009. The treatments that were applied to the cows in 1st lactation and also during the dry period will continue during the 2nd lactation for the 40 cows remaining in the experiment. These cows will calve from the 1st of November and until the 15th of February.

REFERENCE LIST

Chilliard Y., Ferlay A., 2004. Dietary lipids and forages interactions on cow and goat milk fatty acid composition and sensory properties. Reproduction Nutrition Development. 45. 467-492.

Chilliard Y., Glasser F., Ferlay A., Bernard L., Rouel J., Doreau M., 2007. Diet, rumen biohydrogenation and nutritional quality of cow and goat milk fat. Eur. J. Lipid Sci. Technol., 109, 828-855.

Glasser F., Ferlay A., Chilliard Y. 2008. Oilseed Lipid Supplements and Fatty Acid Composition of Cow Milk: A Meta-Analysis. Journal of Dairy Science. 91: in press.

INRA, 2007. Alimentation des bovins, ovins et caprins. Besoins des animaux – Valeur des aliments. Editions Quae, c/o Inra, RD 10, 78026 Versailles, France.

Nozière P., Graulet B., Lucas A., Martin B., Grolier P., Doreau M. 2006. Carotenoids for ruminants: From forages to dairy products. Animal Feed Science and Technology. 131: 418-450.

Palmquist DL, Beaulieu AD, and Barbano DM 1993. Feed and animal factors influencing milk fat composition. Journal of Dairy Science, 76, 1753-1771.