Danish Research Centre for
Organic Food and Farming

Progress Report 2008 and Application for Continuation in 2009

for research funding under the research programme:

Research in Organic Food and Farming
International Research Co-operation and Organic Integrity
(DARCOF III 2005-2010)

Funded by the Ministry of Food, Agriculture and Fisheries
under the Finance and Appropriation Act, Sections 24.33.02.10

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1. Project title and acronym

Organic Milk of High Quality – Development of Production Concepts Based on grazing of the Dairy Cows and Gentle Treatment of the Milk during Handling and Processing

ORMILKQUAL

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2. Project journal number

3304-FOJO-05-38-01

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3. Project period (month, year)

Start of project: 0306
End of project: 0310

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[ændinger i forhold til ansøgningen skal tydeligt fremgå]

7. Midterm description of the project, its results and progress, and application for continuation in 2009

A. Project summary

Table A.1: Work package list (from application)

WP No.	WP title	Responsible scientist	Budget DKK	Start	End	Deliverable No.
1.	Grassland and feeding in a farm perspective	Troels Kristensen, JPM	4.725.375	0106	1209	D1.1-D1.5
2.	Milk quality in relation to feeding of the dairy cow with a high level of legumes	Jacob H. Nielsen, ARK	5.034.042	0106	1209	D2.1-D2.6
3.	Modern milking technologies suitability for organic milk production	Lars Wiking, ARK	1.157.417	0106	1208	D3.1-D3.4
4.	Novel and gentle milk treatment for high quality organic milk with improved functionality	Richard Ipsen, DT	3.082.925	0106	1208	D4.1- D4.8
Total			14.000.000			

Objectives and expected achievements

To establish a basic understanding of i) how feeding with high levels of grass and legumes influence the over all quality of organic milk and dairy products and document how a sustainable, intensive and economic sound dairy production can be obtained together with a high quality organic milk with a composition and flavour different from conventionally produced milk. ii) milking strategies for sustainable milk production based on feeding with high levels of grass and legumes iii) how novel and gentle pasteurisation processes can improve flavour of milk, retain the native enzymes and milk proteins and improve the functionality of the milk for processing, and hereby exploit the necessary knowledge to set up different production concepts covering the chain from production of pasture to consumer perception and willingness to pay for high quality products, which can ensure production of economical sustainable organic milk and dairy products of differentiated and high quality.

Midterm results and progress

C.1 Description (summary) of main results and conclusions for each year

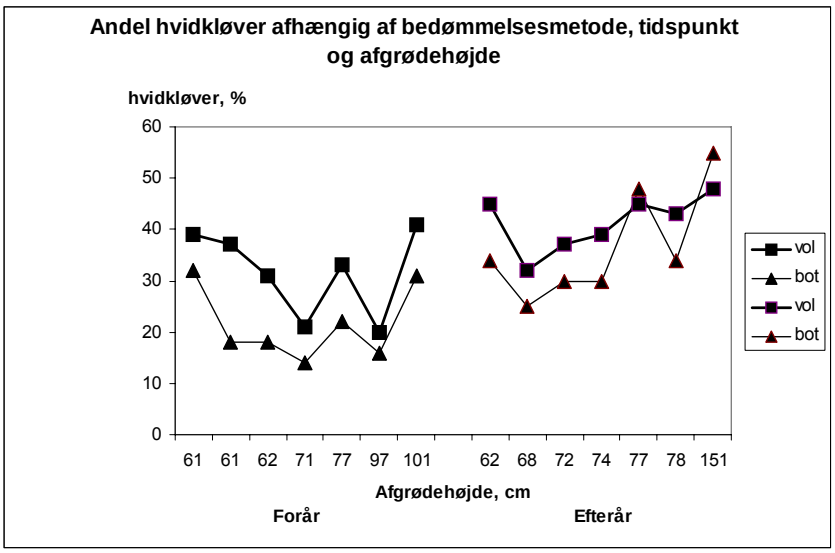
[Her skal der kun stå resultater og konklusioner for de enkelte år, men ikke noget om projektets forløb i forhold til planen]

WP1: Grassland and feeding in a farm perspective

2007

The effect of feeding on the milk quality was studied at 7 private farms, twice during the summer period (may and august) when cows were at pasture. The theme in year 2007 was different proportion of grass and white clover in the sward and in the feed ration.

Figure 1. Content of white clover in the pasture at seven farms in May and August related to



sward height and method of measuring (vol: by visual inspection or bot: by drymatter in grass and clover).

Table 1. Estimated intake of white clover drymatter, proportion of total intake and hours at pasture in seven farms in May and August.

Hvidkløver i rationen

	Heino	Esben	Kristen	Jan	Willem	Uffe	Ole
Maj måned:							
Kg tørstof	5,0	1,1	2,0	1,4	1,7	1,6	2,9
% af rationen	27	6	10	9	10	10	17
Timer på græs	20	7-18	8-18	7-16	6,5	8	8-18
August måned:							
Kg tørstof	4,1	1,0	2,7	2,2	1,5	2,4	4,8
% af rationen	21	5	14	14	8	15	28
Timer på græs	9	18	21	16	7,5	7,5	8,5

Proportion of legumes in the pasture and the diet was the major focus in the project; therefore there has been some additional registration and calculation within this area. Based on the intake and the botanical composition of the pasture (figure 1) it was calculated how large part of the ration – both in absolute kg and in proportion of DM – that came from legumes (Table 1). The hours at pasture is given as additional information to the proportion of pasture in the diet.

Milk production, both in kg milk and in content of fat, protein, urea and somatic cell count might have impact on milk composition. Indirectly as some components is synthesized in milk by amount more than content. Also the age of the cows – lactation no. - and the stage in lactation has and impact on milk composition, but as the variation between the farms was low it might not be visible in the bulk

milk. Table 2 gives the figures on milk yield, fat and urea content. The total intake of DM and energy was quit close related to production level, while there was some variation in protein and fat level due to the different feed items.

Table 2. Daily milk yield in average of the lactating cows and content of fat and urea in bulk milk at herd level seven farms in May and August.

Besætningen i forsøgsperioderne

	Heino	Esben	Kristen	Jan	Willem	Uffe	Ole
Maj måned:							
Mælk, kg pr. ko	27,1	21,1	25,1	16,5	16,1	17,6	17,6
Fedt, %	3,56	3,87	4,04	5,79	5,41	5,34	5,69
Urea, mmol	3,8	3,6		3,2	4,3	4,5	2,7
August måned:							
Mælk, kg pr. ko	20,6	21,4	22,1	13,4	15,8	14,8	16,9
Fedt, %	3,91	3,93	3,94	5,56	5,34	5,4	5,6
Urea, mmol	6,4	4,5	6,5		5,4	5,8	6,0

Winter feeding

In the application was the effect of different feeding regimes during winter planed to be conducted at the private farms by keeping the silage from fields with different proportion of white clover in separate silos. This concept was accepted by four of the farms, but unfortunately only two farmers ended by having two well-defined separate silage bunks. As farm was the experimental unit is were a too low number of observations. In an other project at the institute (Korn – optimal anvendelse I økologiske rationer til malkekøer / Fonden for økologisk Jordbrug) the purpose was to examine if toasting of field beans at 140^{o}C could improve the energy content and protein value of the ration and thereby improve milk production. A potential interaction with the composition of the remaining ration was tested with either a high or a low proportion of maize silage in the ration. By using milk from this project it became possible to look at the effect of the two factors on milk composition and flavour as well. The experiment was conducted as a 2*2 factor experiment with 48 Holstein Frisian cows. The first factor was field beans, either untreated (U) or heat treated (T). The second factor was maize silage proportion of forage, either low (L) or high level (H). In Table 5 is given the intake (kg drymatter) in each of the four treatments and in Table 6 is production figures including some of the parameters describing the milk composition looking at either type of beans or level of maize.

Table 3. Dry matter intake.

Treatment	UL	TL	UH	TH
Kg DM/cow/day				

Field beans, untreated	4,8	0	5,1	0
Field beans, toasted	0	5,0	0	4,9
Oats	2,1	2,2	2,3	2,4
Maize silage	2,1	2,1	5,0	4,9
Grass-clover silage	15,0	14,5	11,9	11,8

Table 4 Milk yield and content in milk from cows feed different type of field beans or rations with different proportions of maizesilage.

Treatment	Field beans		Maize silage	
	Untreated	Treated	Low	High
ECM, kg	32,1	32,1	31,5	32,7
Milk, kg	30,2	30,7	30,0	30,8
Fat, kg	1,365	1,337	1,312	1,389
Fat, g/kg	**45,9**	**44,5**	44,9	45,5
Protein, kg	1,015	1,009	0,997	1,027
Protein, g/kg	**34,1**	**33,6**	33,7	34,0
α--tocopherol	21,6	21,8	22,8	20,7
Luteine	11,9	13,4	**14,4**	**11,0**
Zeaxanthine	1,74	1,99	2,00	1,73
Cantaxanthin	5,6	6,9	6,9	5,7
β-cryptoxanthin	3,3	3,6	3,83	3,10
β-caroten-isomers	37,2	39,7	**42,4**	**34,5**
α-caroten	0,84	1,14	1,14	0,84
β-caroten	179	198	**201**	**175**

Figures with **bulk** is significant different ($p<0.05$)

Heat treatment had no significant effect on the content of carotenoids, though the level of all carotenoids was higher (7-36%) in milk from cows fed heat-treated field beans compared with milk from cows fed untreated field beans. The **proportion of maize silage** in the diet had significant effect on the level of the carotenoid,: luteine, B-caroten-isomer and B-caroten. The content of all carotenoids was higher (16-36%) for the treatment with a low proportion compared with a high proportion of maize silage. There was no significant effect on the level of α-tocopherol, though the level of α-tocopherol was 10% higher for low compared with high level of maize silage.

The proportion of maize silage in the diet had significant effect on the level of most of the fatty acids in milk, while heat treatment of field beans compared with untreated field beans increased the proportion of the fatty acid C18:1Cis9 and decreased the proportion of the fatty acids C15:1, C18 and C18:3n3 in milk.

2008

The theme in 2008 is different types of legumes (white clover, red clover or Lucerne). The knowledge about Lucerne as part of the grass sward in systems with intensive grazing is limited, therefore some additional registration has been made both in year 2007 when the sward was established and during the period of utilization in 2008 (Table 5). As seen, is the proportion of Lucerne in 6 of the farms both in May and August at a very low level.

Table 5. Botanical composition in the sward (% of dry matter). Mean samples of the grazed areas 2008.

	May				August				
Farm	Grass	White clover	Red clo-ver	Lucerne	Grass	White clover	Red clo-ver	Lucerne	Herbs
10-6	69	23	1	3	33	54	0	1	6
11-6	66	32	2	1	35	47	6	0	8
12-6	77	22	0	1	54	43	0	1	1
13-6	67	24	6	3	37	54	7	0	0
14-6	82	11	0	2	68	21	0	4	3
15-6	77	13	0	1	68	22	0	1	2
16-6	71	10	0	17	37	44	0	18	0

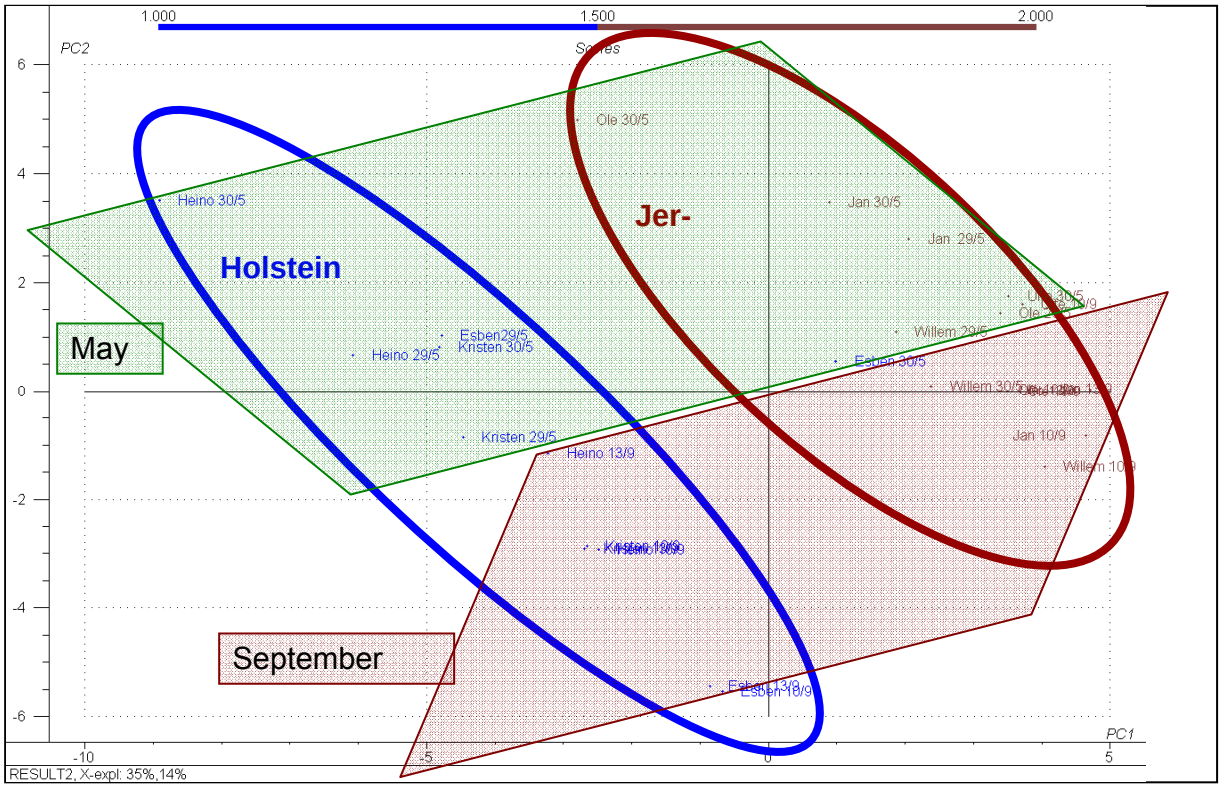
Lucerne does not fit so well with the continuous grazing system as practised on these farms. The rotation system used at farm 16-6 seems to fit better with the needs of Lucerne. This is due to the fact, that Lucerne needs a rest period for building up energy resources in stems and roots. Therefore the effect of a rest period in May was examined on five farms. An area was fenced of in May in grazing period one, and in August in grazing period 2 this area was compared with a grazed area in May. Surprisingly, we found no positive effect of the rest period on the proportion of Lucerne in the sward, the herbage production or the weight of the single plants. Thus a management composed of on cut in spring and thereafter grazing seems not to improve the competitiveness of Lucerne.

WP2: Milk quality in relation to feeding of the dairy cow with a high level of legumes

Summer 2007

Milk collected from the seven organic farms (as described in WP1) were analyzed for tocopherols, carotenoids and fatty acids. A Principal Component Analysis (PCA) of these results (Fig. 1) clearly shows that milk samples from Jersey cows have a different composition than milk samples from Holstein cows.

Fig. 1: Scores plot from a PCA of FA, carotenoids and tocopherol analyses in Holstein and Jersey milk samples collected in seven Danish organic farms in May and September 2007.



Our results (Table 1) comply with datas from former studies as Holstein cows produced a milk containing on average 3.57 % fat vs. 4.33% for Jersey cows (data not shown) with a higher ratio UFA/SFA (0.47 vs. 0.39, averaged values for May and September).

Table 1: Milk FA composition of Holstein and Jersey cows from seven Danish organic farms in May and September 2007.

(% of total FA)	Holstein		Jersey	
	May	Sept.	May	Sept.
SCSFA	15.18	15.27	15.62	16.57
MCSFA	12.69	12.87	12.70	13.17
LCSFA	38.74	40.98	42.59	43.33
MUFA	29.04	27.05	25.37	23.35
PUFA	4.35	3.83	3.72	3.58
Ratio UFA/SFA	0.50	0.45	0.41	0.37

SCSFA: Short Chain Saturated Fatty Acid (C4-C12), MCSFA: Middle Chain SFA (C13-C17), LCSFA: Long Chain SFA (>C18), MUFA: Mono Unsaturated FA, PUFA: Poly Unsaturated FA

Palmquist and Beaulieu (1992) found that C6 to C14 and C18:0 FA (as percentage of total FA) were 8 to 42 % and 13% higher respectively in Jersey than Holstein and that C18:1 was 15% lower. We find here that the differences are less marked but follow the same trends (2.5 to 14%, 8% and 14% respectively) the difference is expected to be related to differences in feeding used in the two studies.

Table 2: Milk FA average composition of Holstein and Jersey cows from seven Danish organic farms in May and September 2007.

(% of total FA)	Holstein	Jersey
C4	4.52	4.29
C6	2.40	2.48
C8	1.38	1.48
C10	3.07	3.48
C11	0.35	0.36
C12	3.51	4.00
C13	0.19	0.20
C14	11.36	11.57
C14:1	0.98	0.89
C15	1.23	1.17
C15:1	0.31	0.31
C16	27.38	29.61
C16:1	1.97	1.81
C17	0.81	0.78
C17:1	0.27	0.22
C18	11.22	12.09
C18:1Trans 9	0.29	0.27
C18:1 Trans 11	2.88	2.59
C18:1CIS 9	21.30	18.21
C18:2N6Trans	0.04	0.04
C18:2N6CIS	1.65	1.58
C18:3N6	0.00	0.00
C18:3N3	0.99	0.90
CLA 9-11	1.09	0.84
CLA 10-12	0.01	0.01
Other FAs	0.81	0.82

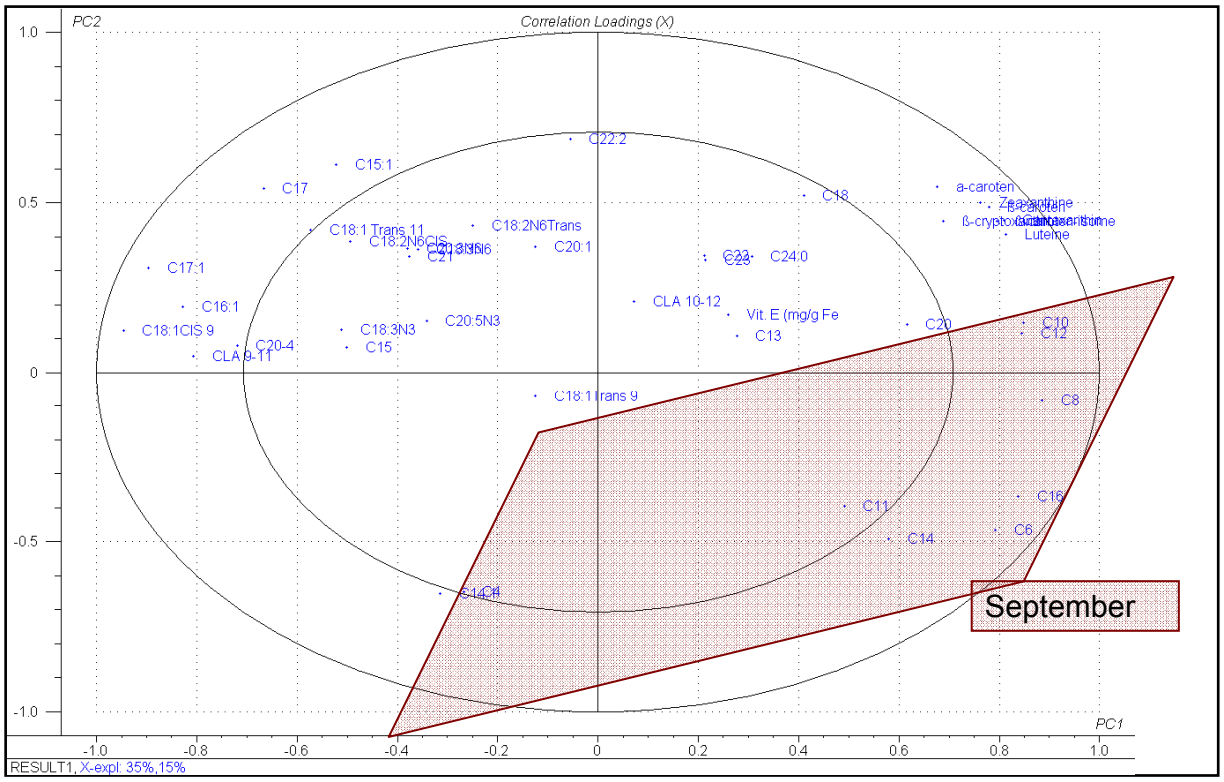
Our results clearly show that jersey milk contains 4 times more carotenoids (average of all carotenoids) than milk produced by Holstein cows (Table 3). Jersey cows do not possess the enzymes needed to convert β-carotene into vitamin A, which explains the higher levels of carotenoids in Jersey milk.

Table 3: Milk carotenoid average composition of Holstein and Jersey cows from seven Danish organic farms in May and September 2007.

(μg/L)	Holstein	Jersey
Luteine	17.90	119.92
Zeaxanthine	2.24	13.57
Cantaxanthin	3.82	10.43
β-cryptoxanthin	3.96	12.35
13-cis-β-caroten	36.55	125.04
α-caroten	1.18	3.33
β-caroten	214.66	698.49

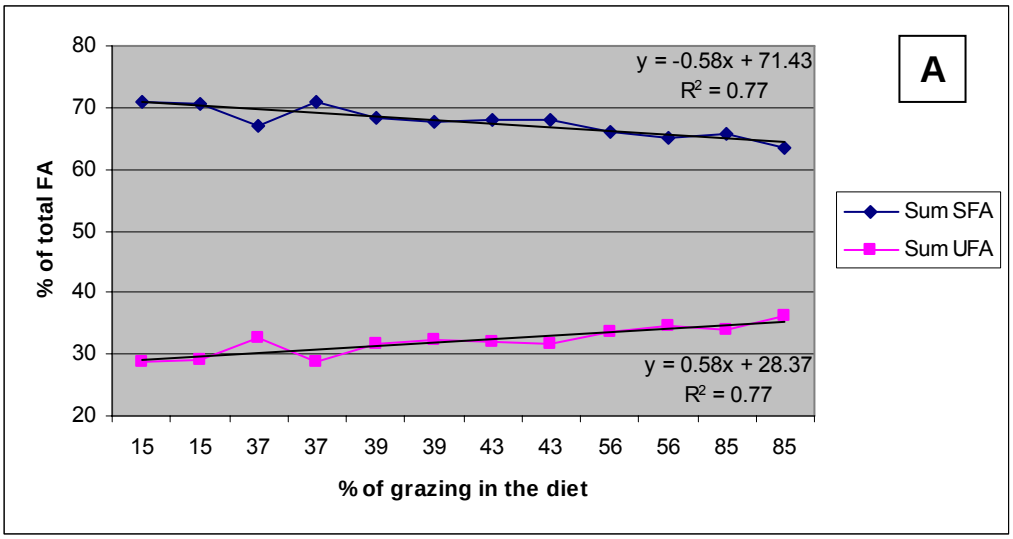
The same PCA (Fig. 1) also shows a season effect on milk composition for both types of milks: there is a tendency towards higher contents in SFA (C6, C8, C11, C14 and C16) in September compared to May (Fig. 2).

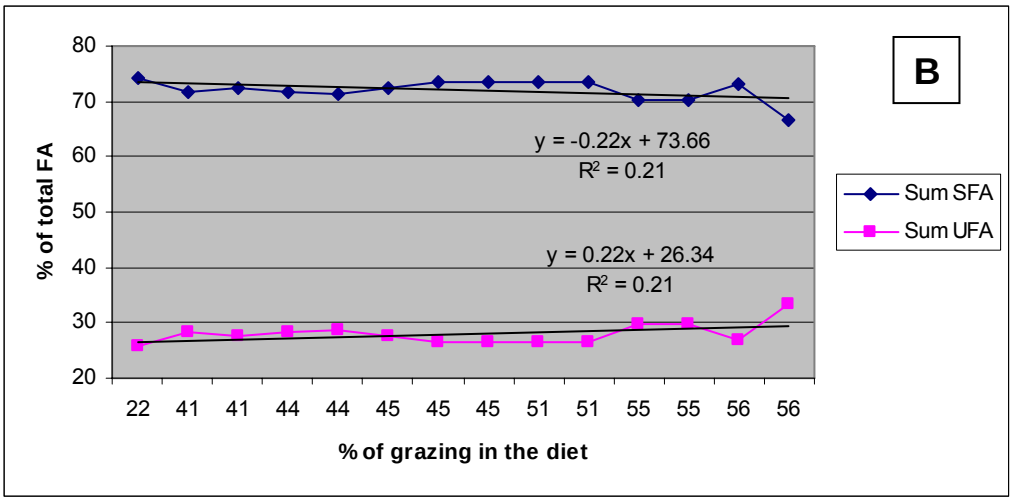
Fig. 2: Loadings plot from the PCA (presented in Fig.1) of FA, carotenoids and tocopherol analyses in Holstein and Jersey milk samples collected in seven Danish organic farms in May and September 2007.



The present results confirm a positive linear relationship between grazing and UFA for milk produced by Holstein cows (Fig. 3A), however interestingly they do not show the same positive effect on milk produced by Jersey cows (Fig. 3B).

Fig. 3: Effect of the percentage of grazing on the FA composition of milks produced by Holstein (A) and Jersey (B) in seven Danish organic farms in May and September 2007.



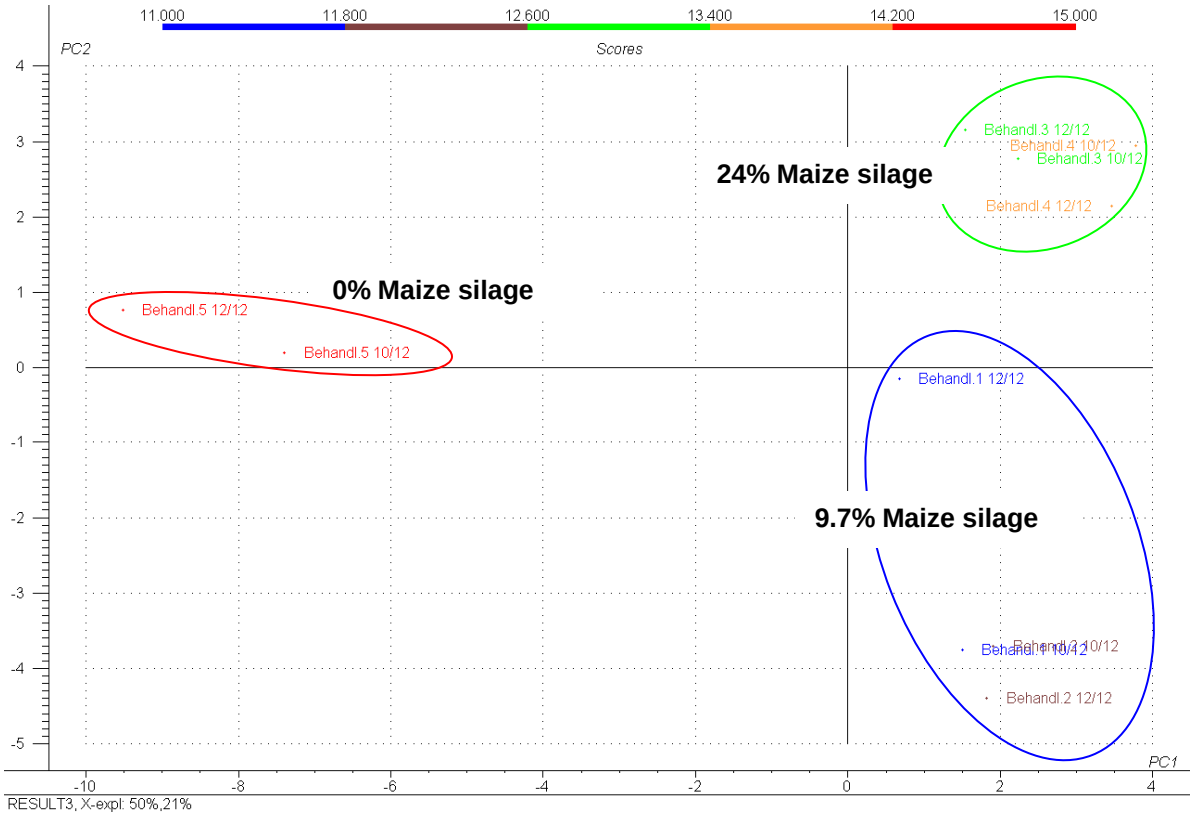


The FA composition of milk is the result of both *de novo* synthesis in the mammary gland and metabolic processes in the rumen. From our results it appears that Holstein cows have a FA synthesis which is directly correlated by a linear relationship to the percentage of grazing in the diet (R^2 correlation factors > 0,75). Metabolic processes from the rumen do not seem to be affected by the grazing activity as the FA resulting from these processes do not vary considerably with increasing grazing proportion in the diet. Jersey cows also show slight linear relationships between the FA in milk and the percentage of grazing in the diet, however the correlation factors are far lower, thus suggesting that other factors affect the content of these FA in Jersey milk (most probably rumen biohydrogenation).

December 2007

Milk produced under the experimental conditions presented in WP1 was collected and analyzed for tocopherols, carotenoids and fatty acids. Figure 4 presents a PCA of these results.

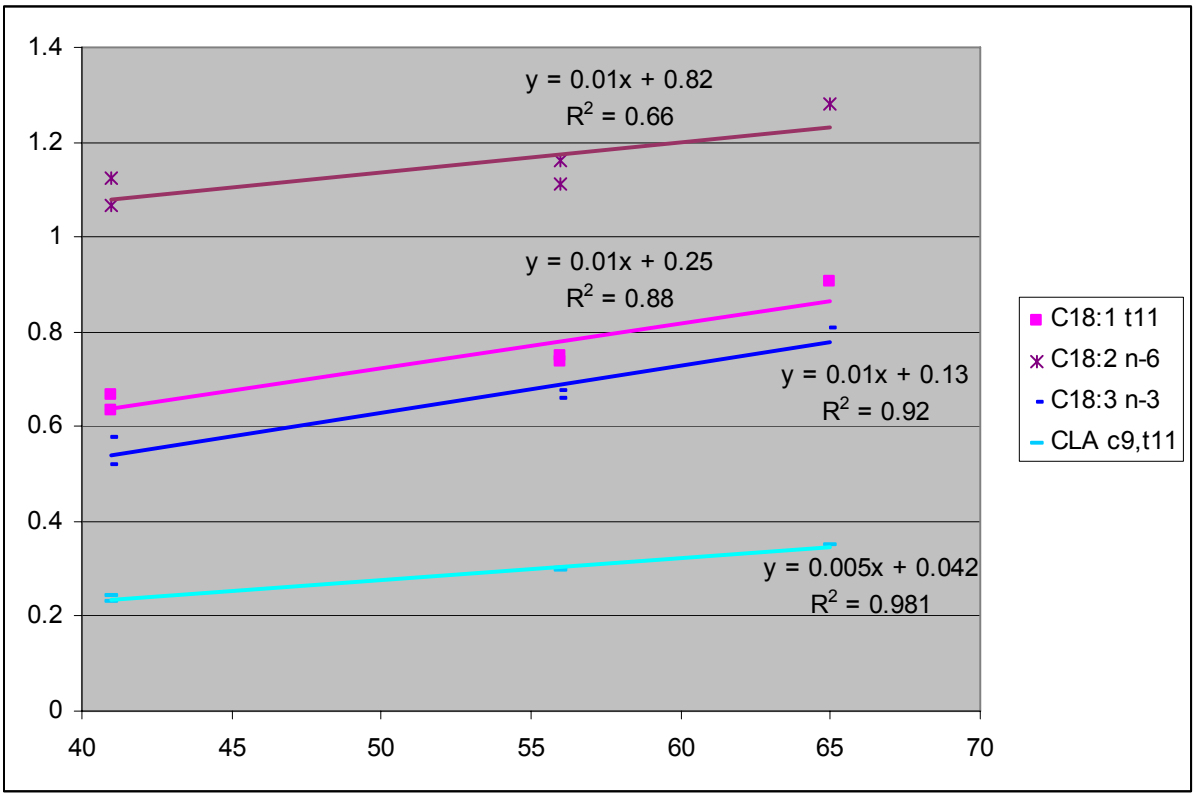
Fig. 4: Scores plot from a PCA of FA, carotenoids and tocopherol analyses of milk samples collected in December 2007.



This PCA clearly shows that the percentage of maize silage/grass-clover silage in the diet strongly influences the composition of milk, while the heat treatment of beans does not have any effect. This is also described in WP1."

This winter study shows very strong positive linear relationships between content of grass-clover silage and several MUFA and PUFA in milk, especially linolenic acid and CLA c9, t11 (Fig. 5).

Fig. 5: Effect of the percentage of grass-clover silage in the diet on the FA composition of milks produced by 48 Holstein cows in December 2007.



Furthermore is a publication describing the relation between grazing different legumes and the concentration of phytoestrogens in the milk in manuscript Concentration of phytooestrogens in grass and milk from cows fed white clover, red clover, lucerne or chicory pasture" C. Andersen, T.S. Nielsen, S. Purup,T. Kristensen, J. Eriksen, J. Sørensen and X.C. Fretté.

In conclusion it is found that feeding Jersey cows with grass silage or grazing will not affect the concentration of α-linolenic acid to the same extent as feeding Holstein cows with the same share of silage. As Jersey cows are very common in production of organic milk this could influence the opportunities to improve the amount of α-linolenic acid in the milk through feeding in herds with Jersey cows.

Sensory Analysis

Two different experiments have been conducted during 2008 (May and August 2008) to evaluate how different levels of lucerne (and red clover) influence the sensory quality. Milk from seven farms (the same farms as in 2007) different in breed (Holstein-Fries and Jersey), amounts of lucerne (red clover on 2 farms) in the grass field and amounts of grass in the feed. The results of the sensory descriptive analysis showed differences between breed; milk from Jersey cows were described as yellow, with creamy flavour and fatty aftertaste and milk from H-F cows being described by more flavour descriptors as bitter, metallic, boiled milk flavour and grey appearance. Results also showed variations between seasons. As the results showed differences between the farms (not only with regard to breed) there are strong indications of the sensory quality of the milk to be affected by the quality of the feed

ration, i.e. amount of maize (maize-like odour and flavour) and amount/quality of silage (stable-like odour, flavour and aftertaste). Thus the results for 2008 reveal the same basic patterns as for 2007.However, no production or botanical data are available yet and thus the relations to these data are yet to be investigated.

WP 3: Effect of grass feeding on enzymes involved in the synthesis of milk fat

All activities are postponed until the end of 2008 as principal researcher Lars Wiking has been on exchange to the University of Ghent. The project running in collaboration with University of Ghent is concerning crystallization of milk fat with different content of CLA and highly relevant for the present WP. Furthermore have the project leader found that Lars Wiking's expertise and pre-knowledge in relation to pumping and disrupture of the milk fat globule are important for the results of the WP. A new person without the same expertise will not be able to fulfil the deliverables to the same extent. We have therefore decided to focus and concentrate the effort in 2009.

WP 4: Novel and gentle milk treatment for high quality organic milk with improved functionality

In continuation of earlier experiments, two trials were performed using APV's pilotscale unit for infusion pasteurization with skimmed milk and whole milk. One trial elucidated the previously observed differences between skim and whole milk, and the other test included microfiltration. The milk was tested for Total Aerobic Count of microorganisms, particle sizes, viscosity, spectroscopy, (FT-IR and Front face fluorescence) rennet Coagulation properties, acidification properties and aroma compounds (this last yet to be analyzed). In addition sensory analysIs has been performed, i.e. a preference test on non-standardized milk from a previous experiment and sensory profiling on skim milk from the two trial performed in the pasty year (exp. 3 and 4). Additionally, chemical analyses were performed on activity of indigenous enzymes, protein denaturation, dry matter, pH and fat globule size.

The following are the main conclusions from the performed experiments:

Microbiology and physical chemical changes:
- Inactivation level for microorganisms at least the same as for HTST pasteurization
- Changes in viscosity, z-average and fat globule size have been observed and are probably correlated
- Flash cooling (an integrated part of infusion pasteurization) may cause partial disruption of the fat globules. The small fat globules created may affect skimming efficiency, volume fraction and particle interactions and can explain the observed changes in physical-chemical properties
- Front face fluorescence spectroscopy seems a promising technique to differentiate between intensity and method of heat treatment. The data processing not finished, but a the preliminary results show that the method could be useful.
- Coagulation time tends to increase with increasing treatment temperature and the gel strength also to increase with increasing temperature for non-standardized milk and decrease with increasing temperature for skim milk. There is a tendency towards decreased acidification times with increase in heat treatment intensity.

A paper reporting on this for Int. J. Food Technology will be submitted ult september.

Sensory experiments:
Two sensory experiments have been carried out since the last reporting. The first experiment (Autumn 2007) included both microfiltration (MF) and infusion pasteurisation (IP) at 80 oC and 120 oC. Sensory descriptive analysis showed clear differences regarding IP temperatures. Samples with higher pasteurisation temperature showed more distinct characteristics regarding so called negative flavour and aftertaste descriptors as metallic and astringent. At the lower IP temperature there was also a clear distinction regarding MF, where the IP-sample was found to be characterised by the so called "refrig-

erator family"; cardboard odour, cardboard sour flavour and plastid flavour. Opposed to the IP-80 sample was the MFIP-80 sample described by boiled milk odour, which might give an indication of "freshness". However, this relation is still to be elucidated. An importing finding was the reference pasteurisation sample being clearly different from all IP-samples and characterised by a sugar sweet and maize-like flavour; another indication of a more fresh sample. The results also showed very good correlation between watery flavour and the amount of dry matter in the samples.

The second experiment (Spring 2008) included industrially micro filtrated samples at two IP temperatures (80 oC and 120 oC), a low pasteurisation sample and a high pasteurisation sample. Basically, the sensory descriptive analysis confirmed the results of the first experiment. Infusion pasteurisation samples have different sensory characteristics (all related to so called negative attributes) than both high and low pasteurisation samples. Also differences between IP temperatures were found. The low pasteurisation sample was characterised by yellow colour and maize-like flavour (regarded as positive descriptors). The high pasteurisation sample was characterised by boiled milk odour and flavour, toffee-like flavour (all indications of Maillard reactions) and sugar sweet flavour. The IP samples were characterised by descriptors belonging to the "refrigerator family" as described above as well as by watery flavour. The IP-120 sample had a distinct astringent aftertaste and the IP-80 sample was further more characterised by bitter taste, metallic flavour and grey colour.

For both experiments samples have been evaluated after 7 days of storage (+4oC), which would be the minimum storage period for IP treated milk. This giving an indication of how "fresh" IP samples are being evaluated in comparison with traditional pasteurisation methods. However, detailed statistical analysis and the relationship to the physical and chemical data are still on-going (1 scientific paper planned).

Chemical:
For the first experiment the milk DM content decreased as function of infusion temperature in skim milk compared with the untreated milk and HTST treated milk. The microfiltration process did not significantly affect the DM content. For non-standardised milk the DM content was not uniformly affected. The pH of both skim milk and non-standardised milk increased slightly by infusion pasteurisation compared with untreated and HTST treated milk.

The analysis of selected indigenous enzymes and their activity showed that instant infusion and HTST inactivates alkaline phosphatase (AP), as required by regulations. The microfiltration alone did not affect the activity of AP compared with the level in untreated milk. Previous trials indicated that AP in non-standardised milk that was IP treated might be reactivated during cold storage of the milk. This will be examined further in the WP4 in future trials.

The activity of lactoperoxidase (LPO) was reduced approximately 1/3 by HTST, microfiltration alone and low temperature IP (72°C) alone, whereas at IP temperatures above 80°C the LPO activity was at the lowest detectable level of the analysis. Furthermore, xanthine oxidase is completely inactivated at temperatures above 85°C regardless of pasteurisation method and milk type.

The degree of denaturation of the whey proteins α-lactalbumin and β-lactoglobulin was analysed after acid precipitation of the milk samples of the first experiment but remains to be analysed in the second. The denaturation of both proteins increases with IP temperatures, and for α-lacalbumin in skim milk the maximum denaturation ~5% was obtained at temperatures >100°C. The degree of denaturation by HTST and microfiltration was not significantly different from the untreated milk. For β-lactoglobulin in skimmilk the response in denaturation was higher than for α-lactalbumin. The IP samples showed a linear increase in β-lactoglobulin denaturation with increasing temperatures from 72-120°C reaching a maximum denaturation of ~20%. In comparison, the microfiltration resulted in a slight degree of denaturation of β-lactoglobulin of ~3-5%, whereas HTST treated milk was not significantly different compared with non-treated milk.

C.2 Fulfilment of deliverables and milestones

(To be completed for each work package)

[Tabeller over deliverables og milestones fra ansøgningen opstilles for hver workpackage. Delive-

rables er forskellige former for offentligt tilgængelige produkter (artikler, rapporter, informationsmøder etc.) og det skal angives, hvilken form for produkt der er tale om. Milestones er væsentlige trin i forskningsprocessen. Der skal angives et tidspunkt for både deliverables og milestones (milestones ligger typisk tidligere end deliverables). Ændringer i deliverables og milestones forsynes med en notits om, at de er ændret i forhold til ansøgningen, og hvorfor de er ændret. Alle deliverables og milestones skal stå i rapporten, og de, der er passeret, mærkes af som udførte, eller der angives en ny dato. Større afvigelser kommenteres i D.]

Deliverables list (from application)

Workpackage 1						
Deliverable No	**Deliverable title**	**Lead scientist**	**Delivery date**	**Allocated scientific person moths**	**Type of deliverable**	**Fulfilled (ok) or deviations (d)***
D1.1	Yield and composition of milk from cows fed high levels of different legumes in relation to the composition of the legumes	JHN	March 2007	9	S	ok
D1.2	The effect of the sward composition on the milk quality – report from workshop	KAS	May 2008	2	R	ok
D1.3	The effect of winter feeding on the milk quality– report from workshop	TKR	May 2009	2	R	
D1.4	Popular papers on the effect of grassland species on milk quality –together with WP2	KAS	July 2009	1	P	
D1.5	Strategies for feed supply in relation to milk quality, productivity and economy at farm level	TKR	Dec 2009	6	S	

(The nature of the deliverables must be indicated by S = publication in scientific journal with peer review; P = publication in journals without peer review; R = reports; C = presentation at meetings and congresses or O = other types of deliverables, e.g., prototypes, models, websites, etc.).

Milestones list (from application)

Workpackage 1			
Milestone No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or deviations (d)***
M1.1	Contract made with 8 farmers and start of registration	April 2006	OK
M1.2	First annual meeting at the farms	Oct. 2006	OK
M1.3	Grazing experiment at Rugballegaard finished	Sept. 2006	OK
M1.4	First round of experiment during winter period	Dec. 2007	OK
M1.5	Workshop with focus on pasture-milk quality	Feb. 2008	OK
M1.6	Workshop with focus on winterfeeding – milk quality	Feb. 2009	

** Deviations are to be further discussed in D*

Deliverables list (from application)

Workpackage 2						
Delive-rable No	**Deliverable title**	**Lead scien-tist**	**Delivery date**	**Allocated scientific person moths**	**Type of de-liver-able**	**Fulfilled (ok) or devia-tions (d)***
D2.1	Shelf life of milk as affected by feeding of the dairy cow	JHN	Oct. 2008	9	S	
D2.2	Sensory attributes of milk from cows at winter feed	WB	June09	11	S	
D2.3	Sensory attributes of milk from cows at summer grazing	WB	Dec 09	11	S	
D2.4	Composition and flavour of milk from cows at summer grazing	JHN	Dec 09	10	S	
D2.5	Evaluation of the relationship between objective chemical and sensory quality attributes of different organic milk types	JHN	Dec 09	8	S	
D2.6	Conjoint analysis of product information, consumer attitudes and purchase be-haviour of organic milk	WB	Dec 09	12	S	

** Deviations are to be further discussed in D*

Milestones list (from application)

Workpackage 2			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or devia-tions (d)***
M2.1	Sensory studies of milk from intensive experiments with legumes has been performed	Sept. 2006	OK
M2.2	Analysis of milk from intensive experiments with legumes has been per-formed	Dec. 2006	OK
M2.3	Storage experiments of milk from different farms has been conducted	July 2008	OK
M2.4	Analysis of milk from farms using winter feed has been conducted	March 2009	
M2.5	Analysis of milk from farms using summer feed has been conducted	Oct. 2009	

** Deviations are to be further discussed in D*

Deliverables list (from application)

Workpackage 3						
Delive-rable No	**Deliverable title**	**Lead scien-tist**	**Delivery date**	**Allocated scientific person moths**	**Type of de-liver-able**	**Fulfilled (ok) or devia-tions (d)***
D3.1	Influence of feeding and cow breed on creaming in organic milk and effect of heat treatment	LW	Dec 07	6	S	D (ex-pected May09)
D3.2	Effect of grass feeding on enzymes in-volved in the synthesis of milk fat	LW	June 08	4	S	D (ex-pected Nov08
D3.3	Evaluation of sustainable grass feeding combined with new milking systems in	LW	July 08	5	S	D (ex-pected

	relation to lipolysis in milk					Oct09
D3.4	Strategy for cooling and milking frequency for farmers using automatic milking	LW	Oct 08	4	R	

Milestones list (from application)

Workpackage 3			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or deviations (d)***
M3.1	Methods to measure the expression of enzymes responsible for fat synthesis are developed	Oct 2006	OK
M3.2	Methods to analysis for agglutinins are developed	Oct. 2006	D
M3.3	Studies of how feeding influences creaming are conducted	Sept. 2007	D
M3.4	Experiment with heat treatment are conducted	Sept. 2007	D
M3.5	Case studies of AMS using pasture have ended	Dec. 2007	D

** Deviations are to be further discussed in D*

Deliverables list (from application)

Workpackage 4						
Deliverable No	**Deliverable title**	**Lead scientist**	**Delivery date**	**Allocated scientific person moths**	**Type of deliverable**	**Fulfilled (ok) or deviations (d)***
D4.1	Effect of infusion pasteurization alone or in combination with micro-filtration on the shelf-life of milk	JHN	June 07	5	S	d (expected Jan 09)
D4.2	Effect of infusion pasteurization alone or in combination with micro-filtrationon microflora	RI	June 08	8	S	D (expected jan 09)
D4.3	Paper in a Danish trade journal summarizing how organic milk can best be trated for drinking milk or cheese making	RI	March 08	1	P	ok
D4.4	Effect of infusion pasteurization alone or in combination with micro-filtration on the composition of flavour components	JHN	Oct 08	9	S	
D4.5	Effect of infusion pasteurization alone or in combination with micro-filtration on whey protein denaturation and enzyme activity	JHN	Dec 08	9	S	
D4.6	Effect of infusion pasteurization alone or in combination with micro-filtration in relation to changes in the milk fat globule membrane	JHN	Dec 08	7	S	
D4.7	Effect of infusion pasteurization alone or in combination with micro-filtration on suitability of milk for production of high quality cheese	RI	Dec 08	15	S	
D4.8	Effect of infusion pasteurization alone or in combination with micro-filtration on	WB	Dec 08	6	S	

	milk on sensory quality with special emphasis on “freshness”					

Milestones list (from application)

Workpackage 4			
Mileston No	**Milestone title**	**Delivery date**	**Fulfilled (ok) or deviations (d)***
M4.1	Establishment of the limits for the applied treatments (infusion pasteurization and micro-filtration) ensuring microbial safety of the resulting milk	March 2007	OK
M4.2	Mapping of the influence of the applied treatments (infusion pasteurization and micro-filtration) on the chemical attributes of the milk	June 2008	OK
M4.3	Mapping of the influence of the applied treatments (infusion pasteurization and micro-filtration) on denaturation of the major whey proteins and their aggregation and reaction with other proteins in milk	June 2008	OK
M4.4	Elucidation of how the applied treatments (infusion pasteurization and micro-filtration) affect the flavour of milk and set up of a definition of the descriptors ‘freshness’. Including correlation to chemical attributes	June 2009	
M4.5	Determination of the best treatment for fresh drinking milk and for further processing (cheese making)	June 2009	

D. Description of deviations and subsequent adjustments of plans

[Her skal der kun stå en kort forklaring på de afvigelser, der er anført i C.2, og en beskrivelse af de ændringer i planerne, det har givet anledning til. Der skal ikke gives resultater eller konklusioner]

D3.1 –D3.3 Postponed until 2009 because Lars Wiking have other projects for the moment

D4.1 and D4.2: Experiments have been performed and publication will be submitted January 2009

E: Project publications and other products

[Produkter under 1 skal kopieres fra Organic Eprints. Dette gælder også for produkter, som kun delvist er finansieret af FØJO. Listen fra Organic Eprints kan findes på hjemmesiden http://www.okoforsk.dk/projekt/index.html under "Project publications" på de enkelte projekter.]

[Produkter under 2 er mundtlige præsentationer og andet, som ikke skal kunne findes i Organic Eprints]

1. **Products from Organic Eprints archive**
   http://orgprints.org/view/projects/DA3_ORMILKQUAL.html

Eriksen, J; Søegaard, K and Kristensen, T (2007) Afgræsning af blandinger med bælgplanter og cikorie. *Nyhedsbrev fra Forskningscenter for Økologisk Jordbrug og Fødevaresystemer*. Online at <http://www.foejo.dk/nyhedsmail/august_2007/ko.html>

Eriksen, J; Søegaard, K; Kristensen, T; Fretté, XC; Wiking, L and Holm Nielsen, J (2007) Herbage and milk productivity and quality when grazing different legumes and herbs. Poster presented at 14th symposium of the European Grassland Federation, Ghent, 3-5 September; Published in *Grassland Science in Europe* 12, page pp. 212-214.

Eriksen, J; Søegaard, K; Kristensen, T; Fretté, XC; Wiking, L and Holm Nielsen, J (2006) Herbage and milk productivity and quality when grazing different legumes and herbs. Paper presented at COST 852 Quality Legume-based Forage Systems for Contrasting Environments. Final Meeting, Gumpenstein, Austria, Aug 30 - Sep 2; Published in *Book of abstracts*, page 42.

Fretté, Xavier C (2008) Effect of grazing white clover pasture on milk composition of Holstein and Jersey cows. Poster presented at Food Research Day, Aarhus University - Århus, 9 september 2008.

Fretté, Xavier C (2008) Effect of grazing white clover pasture on milk composition of Holstein and Jersey cows. [oral] Presentation at *Dansk/svensk netværk for mælkekvalitets-forskning*, Faculty of Agricultural Sciences - Tjele - Denmark, 10 september 2008.

Fretté, Xavier C; Sørensen, John and Nielsen, Jacob H (2008) Græsmarksafgrødernes sammensætning – en kompleks sag. In *Ny KvægForskning*, April, No 1, page 2. Kvægbrugets Forsøgscenter og Aarhus Universitet, Det Jorbrugsvidenskabelige Fakultet i samarbejde med Dansk Kvæg.

Fretté, Xavier C.; Kristensen, Troels; Eriksen, Jørgen; Søegaard, Karen; Sørensen, John and Nielsen, Jacob H. (2008) Effect of Herbage on Milk Composition. Working Paper.

Hougaard, A.B.; Hammershøj, M. and Ipsen, R. (2007) Infusion pasteurization of skim milk: Effects of different time-temperature combinations. Poster presented at European Congress of Chemical Engineering 6, Special Symposium - Innovations in Food Technology (LMC Congress), Copenhagen, 16-20 september 2007.

Hougaard, A.B. and Ipsen, R. (2008) Infusion pasteurization of milk: Influence on the viscosity and casein micelle size. Poster presented at Food Colloids 2008, Le Mans, France, 6-9 April.

Hougaard, A.B. and Ipsen, R. (2008) Infusion pasteurization of whole milk and skim milk: Influence on viscosity and particle size . Poster presented at The Nordic Rheology Conferencen 2008, Copenhagen, Denmark, 27-29 August.

Kristensen, Troels; Eriksen, Jørgen and Søegaard, Karen (2007) Afgræsning af græsblandinger med bælgplanter og cikorie. *Ny Kvægforskning* 5(2):2.

Romano, Rosaria ; Næs, Tormod and Brockhoff, Per Bruun (2007) The use of analysis of variance and three-way factor analysis methods for studying the quality of a sensory panel. Paper presented at Sixth Scientific Meeting of the CLAssification and Data Analysis Group of the Italian Statistical Society, Macerata, Italy, 12th-14th september, 2007; Published in *Cladag07 Abstracts*.

Romano, Rosaria; Vestergaard, Jannie S.; Kompany-Zareh, Mohsen and Bredie, Wender L. P. (2008) Monitoring panel performance within and between sensory experiments by multi-way analysis. Paper presented at First joint meeting of the société francophone de classification and the classification and data analysis group of Italian statistical society, Caserta, Italy, 11-13 June, 2008; Published in *Book of short papers*.

Vestergaard, J. S. (2007) Hvordan smager mælken? [What does the milk taste like?]. In *Ny Kvægforskning*, April, Volume 5, No 2, page pp. 3-3.

Vestergaard, J. S.; Kristensen, T. ; Eriksen, J. ; Søegaard, K. ; Fretté, X. C. and Bredie, W. L.P. (2007) Sensory quality of organic milk based on grazing and high ratio of legumes in the feeding ration. Poster presented at 7th Pangborn Sensory Science Symposium, Minneapolis, MN, USA, 12-16 August 2007; Published in *7th Sensory Science Symposium Abstract Book*.

2. Other products (oral presentations, public meetings, field days, etc.)

Oral presentation:
The use of analysis of variance and three-way factor analysis methods for studying the quality of a sensory panel authors: Rosaria Romano, Tormod Næs, Per Bruun Brockhoff
conference: Sixth Scientific Meeting of the CLAssification and Data Analysis Group of the Italian Statistical Society, University of Macerata (Italy), September 12th - 14th, 2007.

* 25-75% financed by DARCOF
** 5-25% financed by DARCOF

F. Scientific education

The knowledge achieved in the present project is used in relation to teaching of dairy engineers at KU-life and students enrolled at Molecular nutrition and food technology.

G. National and international cooperation

International collaboration with QLIF project. New collaboration about organic milk with the State University of California.
Several new national projects has been started with basis in results from the present project

Critical reflection on the project

[Her gives der en kritisk refleksion over projektets planer, forløb og resultater. Det kan rumme refleksioner over det videnskabelige håndværk med hensyn til fx metodevalg, prøvbarhed og udførelse; over eventuelle ændringer i relevans som følge af ændringer i omverdenen eller som følge af den læring der er sket i projektet; samt over aspekter af forskningsudvikling, især i relation til FØJOs mål om at udvikle tværgående og relevant forskning (og hvad der evt. kunne gøres bedre). Her diskuteres endvidere væsentlige justeringer af projektet som følge af afvigelser fra planen (fra C.2 og D) og andre væsentlige ændringer.]

The project is on-going and we expect that the project will contribute with new knowledge about the relation between feeding of the dairy cow and milk composition/flavour and new knowledge about gentle pasteurisation techniques. However it seems to be a problem to use direct grazing as feeding as it is very difficult to control consumption for the individual cow. Furthermore is it difficult to find herds where feeding is well described and where there is a span in eg share of grass. This makes the results weaker in relation to extract conclusions from the achieved datas.

Modern milking technologies suitability for organic milk production
Due to a funding from the Danish Research Agency to Lars Wiking has most of the research concerning milking technologies been postponed to 2009 where a concentrated research effort will be performed. Further will the projct be expanded with a national survey about accumulation of free fatty acids in milk for robotic milking systems giving an indication of the extend of the problem og lipolyse in organic milk

8. Budget

A. Account for any change in budgets

Due to postponed activities has 472.000 kr been moved to 2009 for activities at Department of Food Science, AU

B. Budget for the whole project (1.000 DKK)

Total consumption of funds from DARCOF and expected consumption this year and coming years

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	191	26	73,5	44	42,25		186
Technical personnel	81,9	20,3	24,85	20,75	11		76,9

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	6957	988	2677	1509	1501		6935
Technical personnel	2283	531	717	718	367		2339
Other operational costs	2025	221	1018	398	572		1995
Equipment	72	12	22	0			69
Others (please specify)	329	186	57	98	45		329
Direct costs	11666	1938	4492	2753	2485		11667
Indirect costs (20% of direct costs)	2334	387	880	551	514		2333
Total	14000	2324	5372	3304	3000		14000

Appendix I. Detailed budget

A. Budget for each participating institute (1.000 DKr)

Name of Institute: University of Aarhus, Faculty of Agricultural Sciences

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	119	21	43,75	27	27,25,255		119
Technical personnel	71,9	17,8	23,85	18,75	11		71,4

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	4591	822	1641	993	1042		4498
Technical personnel	1983	445	689	578	367		2079
Other operational costs	1660	139	679	343	497		1658
Equipment	57	0	0	0	0		0
Others (please specify)	329	186	57	98	45		386
Direct costs	8620	1592	3066	2012	1951		8621
Indirect costs (20% of direct costs)	1725	318	595	403	407		1723
Total	10345	1910	3661	2415	2359		10345

Name of Institute: University of Copenhagen, Faculty of Life Sciences

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	72	5	307	175	155		
Technical personnel	10	2.5	12	22jh	3		

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	2366	166	10366	5166	4596		21776
Technical personnel	300	86	286	1406	06		2546
Other operational costs	365	82	3396	556	756		5516
Equipment	15	12	226	06	06		346
Others (please specify)	0	0					
Direct costs	3046	345	14266	7416	5346		30466
Indirect costs (20% of direct costs)	609	69	2856	1486	1076		6096
Total	3655	414	17116	8896	6416		36556

Comments:

B. Budget for each participating department (1.000 DKK)

Name of Institute and department: Faculty of Agricultural Sciences, Department of Food Science

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	81	11	335	206	175		814
Technical personnel	39,5	11	154	9.53	44		31,9

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	2814	381	11282	6600	5377		27066
Technical personnel	979	253	4133	2900	1322		10888
Other operational costs	781	112	5788	544	367		7811
Equipment							
Others (please specify)							
Direct costs	4574	746	21199	10044	7056		45744
Indirect costs (20% of direct costs)	915	149	4066	2011	1588		9144
Total	5489	895	25255	12055	8644		54899

Comments:

Name of Institute and department: Faculty of Agricultural Sciences, Department of Agricultural and Environment

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							

Scientific personnel	33	9	6,75	7	10,25		33
Technical personnel	31,9	6,8	8,85	9,25	7		31,9

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	1553	395	320	333	505	0	1553
Technical personnel	991	192	276	288	235	0	991
Other operational costs	868	27	91	289	461	0	868
Equipment	57	0	0	0	0	0	0
Others (please specify)	329	186	57	98	45	0	386
Direct costs	3798	800	744	1008	1246	0	3798
Indirect costs (20% of direct costs)	760	160	149	202	249	0	760
Total	4558	960	893	1210	1495	0	4558

Comments:

Name of Institute and department: Faculty of Agricultural Sciences , Department of animal welfare and nutrition

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consumption 2008	2009	2010	Total
Man-months							
Scientific personnel	5	1	4	0			5
Technical personnel	0,5	0	0	0			0

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consumption 2008	2009	2010	Total
Salaries							

Scientific personnel	224	46	193	0			239
Technical personnel	13	0	0	0			0
Other operational costs	11	0	10	0			10
Equipment							
Others (please specify)							
Direct costs	248	46	203	0			249
Indirect costs (20% of direct costs)	50	9	40	0			49
Total	298	55	243	0			298

Name of Institute and department: University of Copenhagen, Faculty of Life Sciences, Department of Food Science

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	72	5	307	175	155		
Technical personnel	10	2.5	12	22jh	3		

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	2366	166	10366	5166	4596		21776
Technical personnel	300	86	286	1406	06		2546
Other operational costs	365	82	3396	556	756		5516
Equipment	15	12	226	06	06		346
Others (please specify)	0	0					
Direct costs	3046	345	14266	7416	5346		30466
Indirect costs (20% of direct costs)	609	69	2856	1486	1076		6096
Total	3655	414	17116	8896	6416		36556

Comments:

C. Budget for co-financing from each participating institute (1.000 DKK)

Name of Institute and department: Faculty of Agricultural Sciences, Department of Food Sciences

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							

Scientific personnel	4	0,5	0.80	0.55	0.50,50,50,5		2.33
Technical personnel	0	3					33

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	234	25	533	388	388		2344
Technical personnel		80	6				
Other operational costs	258	90	966	505	222		2588
Equipment							
Others (please specify)							
Direct costs	492	195	1499	888	606		4924
Indirect costs (20% of direct costs)	98	39	330	181	111		988
Total	590	234	1179	1066	711		5900

Comments:

Name of Institute and department: Faculty of Agricultural Sciences, Department of Agricultural Systems and Environment

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Man-months							
Scientific personnel	0	0	0	0	0	0	0
Technical personnel	0	0	0	0	0	0	0

Year:	Original budget	Consump-tion 2005/2006	Consump-tion 2007	Expected consump-tion 2008	2009	2010	Total
Salaries							
Scientific personnel	0	3	0	0	0	0	3
Technical personnel	0	21	0	0	0	0	21
Other operational costs	30	0	0	0	0	0	0
Equipment	0	0	0	0	0	0	0
Others (please specify)	59	782	0	0	0	0	782
Direct costs	89	806	0	0	0	0	806
Indirect costs (20% of direct costs)	1090	177	223	274	296	0	970
Total	1179	983	223	274	296	0	1776

Comments: