



PhD course:

From milk to cheese - focused on Northern European types of cheese

Objective

The students should obtain an in depth knowledge of all aspects related to cheesemaking, with a special focus on the most recent research within the topic.

Scientific content of the course

The course “Cheese science - from milk to cheese” is an advanced course for PhD students and young scientists in Dairy Science focusing on the Northern European approach of cheesemaking. The students participating in this course will mainly have a Master degree **in Food Science or a comparable background** and the scientific content of the course will be based on this assumption. The content of the course will therefore be based on the most recent research. The course focus on the aspects related to cheesemaking:

- as milk quality and milk treatment;
- coagulation kinetics during renneting;
- structure development of the cheese curd;
- antimicrobial interactions; starter cultures;
- influence on cheese making and the foundation for flavour development and cheese making technology.

Cheesemaking is a complicated biochemical process, and in spite of extensive research, the understanding of the influence of cheese milk composition and interactions of cheese composition and microbiology on the development of cheese flavour and texture is still deficient. Whenever new technologies are introduced, such as high pressure treatment of the milk, reduction of the fat content or addition of probiotic bacteria, the limited knowledge of cheese biochemistry seriously decrease the efficiency of the development work. The biochemistry of cheese making and ripening contains general parts that concern several cheese varieties as well as specific parts for each cheese group or even more specific for each cheese variety. The specific biochemistry of Nordic cheese varieties is hardly studied in detail in any other place in the world than in the Nordic cheese research groups involved in this course. This course will focus on aspects related to milk and cheesemaking while aspects related to cheese ripening will be covered by a second course at the University of Copenhagen in 2010.

The basic literature will be the 3rd edition of the comprehensive books by **Fox, McSweeney, Coagan and Guinee (Ed), 2004: Cheese : Chemistry, Physics, and Microbiology. Vol 1. General aspects, Vol 2. Major cheese groups. Academic press.**

In addition scientific papers including the most recent scientific papers from the International Dairy Journal, Journal of Dairy Research, Journal of Dairy Science, Food Science and Technology will be used to upgrade each topic. The course and



literature is described in detail in point 16. The total pages will be 540 + approx. 150 pages of recent papers.

The course requires 4 weeks of work, 3 weeks self-tuition and one week in common at Ås. The week in Ås will be from 24-28th of August 2009. During the week at Ås we will have lectures, colloquies and practical laboratory work. The course will give 6 ECTS (European Credit Transfer System) based on 2 weeks preparation, 1-week course and 1-week exam preparation. The course will be evaluated by 10 pages report.

Course structure:

Each day will have two sessions, one morning session between 8.30 and 12.00 and one evening session between 12.30 and 16.15. Each session will start with a lecture followed by further discussions of the topic in colloquia. I.e. 1 hour lecture and 3 approx. hours' colloquia. It is mandatory that the students have been reading the literature before the week in Ås. During the colloquia the students will work on problems given by the lecturer. On day 4, the colloquia will be replaced by practical exercises in a cheese pilot plant. All documents can also be found on the web on Classfronter: <https://fronter.com/umb> which will be opened to you as soon as you have registered for the course. You will find the problems/questions that should be focused within each topic on this site.

Since the course starts on Monday morning at 8.45, the participants will most probably have to travel to Ås on Sunday afternoon. The course will end on Friday at 16.00.

Exam:

Longitudinal exam: Each candidate will get 5 of the questions from the colloquia randomly picked which should be answered in a 10 pages (total) report on Classfronter, minimum 1 page pr. Question. **Deadline 30. September 2009.**

Registration

You will have to register for the exam to sit@umb.no to get access to Classfronter before 10th of August. For more information see the paper **Practical information.**



Day 1, Monday 24.8:

8.15 – 12.00: Introduction and Morning session: Topic 1. Coagulation kinetics during renneting, rennets and coagulants

Lecturer: Professor Anders Andrén, SLU

Literature:

Horne, 2004. Rennet-induced coagulation of milk. 47-70.. In Fox Vol.1
Andrén, 2002. Rennets and Coagulants. 281-286.. In Encyclopaedia of Dairy Science
Horne, 1998. Casein interactions: Casting light on the black boxes, the structure in dairy products. 171-177.

Recent papers:

Farrell et al., 2006. Casein micelle structure: What can be learned from milk synthesis and structural biology? 135-147.

Horne, 2006. Casein micelle structure: Models and muddles. 148-153.

Pages: 40 from original list

12.30 – 16.00: Evening session: Topic 2. Milk quality

Lecturer: Professor Siv Skeie, UMB

Literature:

Skeie, 2009. Characteristics in milk influencing the cheese yield and cheese quality. . In Griffith: Improving the safety and quality of milk

Additional papers:

Beuvier and Buchin, 2004. Raw milk cheeses. 319-347. In Fox Vol.1: Raw milk cheeses.

Grappin and Beuvier, 1997. Possible implications of milk pasteurization on the manufacture and sensory quality of ripened cheese. 751-761.

Salaun et al., 2005. Buffering capacity of dairy products. 95-109.

Jorgensen et al., 2005. The Occurrence of *Staphylococcus aureus* on a Farm with Small-Scale Production of Raw Milk Cheese. 3810-3817.

Callon et al., 2005. The Effect of Raw Milk Microbial Flora on the Sensory Characteristics of Salers-Type Cheeses. 3840-3850.

Frohbieter et al., 2005. Effects of *Pseudomonas fluorescens* M3/6 Bacterial Protease on Plasmin System and Plasminogen Activation. 3392-3401.

Spahr and Schafroth, 2001. Fate of *Mycobacterium avium* subsp *paratuberculosis* in Swiss hard and semihard cheese manufactured from raw milk. 4199-4205.

Recent papers:

Salo et al., 2006. Microbial surveys in Estonian dairies. 460-471.

Hallén et al., 2007. Effect of genetic polymorphism of milk proteins on rheology of chymosin-induced milk gels. 791-799.

Pages: 78 from original list + from recent papers

Dinner at Samfunnet: 17.00



Day 2, Tuesday 25.8:

8.15 – 12.00 Morning session: Topic 3. Milk treatment & Milk transportation

Lecturer: Professor Roger Abrahamsen, UMB

Literature:

Kelly et al., 2008. Pre-treatment of cheese milk: principles and developments. 549-572.

Singh and Waungana, 2001. Influence of heat treatment of milk on cheesemaking properties. 543-551.

Mistry, 2004. Application of membrane separation technology to cheese production. 261-286.. In Fox Vol 1.

Additional papers:

Ardö et al., 1999. Study of methods to routinely monitor heat load to cheese milk. 547-552.

Recent papers:

Hotchkiss et al., 2006. Addition of carbon dioxide to dairy products to improve quality: A comprehensive review. 158-168.

Pages: 61 from original list +

12.30 – 16.15 Evening Session: Topic 4. Structure development of the cheese curd (1h 30 min lecture)

Lecturer: Researcher Tiiu-Maie Laht, TUT

Literature:

Dejmek, 2004. The syneresis of rennet coagulated curd. 71-104.. In Fox Vol.1

Recent papers:

Everett and Auty, 2008. Cheese structure and current methods of analysis. 759-773.

Lopez et al., 2007. Development of the milk fat microstructure during the manufacture and ripening of Emmental cheese observed by confocal laser scanning microscopy. 235-247.

Pereira et al., 2009. Microstructure of cheese: Processing, technological and microbiological considerations. 213-219.

Pages: 33 from original list +

Dinner at Samfunnet: 17.00



Day 3, Wednesday 26.8

8.15 – 11.30 Morning session: Topic 5. Cheese making technology, Cheesemaking in practice

Lecturer: Professor Siv Skeie, UMB

Literature:

Guinee, 2004. Salt in Cheese: Physical, Chemical and Biological Aspects. 207-259..
In Fox Vol.1.

Benett, 2004. General aspects of cheese technology 23-51. In Fox Vol.2: General aspects of cheese technology.

Pages: 80

12.00 – 16.00 Evening session : Topic 6. Antimicrobial interactions in cheese

Lecturer: Professor Tapani Alatossava, UH

Literature:

Songisepp et al., 2004. A new probiotic cheese with antioxidative and antimicrobial activity. 2017-2023.

Christiansen et al., 2005. Anticlostridial activity of Lactobacillus isolated from semi-hard cheeses. 901-909.

Cotter et al., 2005. Bacteriocins: Developing innate immunity for food. 777-788.

Recent papers:

Pages: 26 from original list +

Dinner at Samfunnet: 16.30



Day 4, Thursday 27.8

8.15 – 10.00 Morning session: Topic 7: Production of different cheese varieties

Lecturer: Professor Siv Skeie, UMB

Literature:

Lawrence, 2004. Cheddar cheese and related dry salted cheese varieties 71-103. In Fox Vol.2

van den Berg, 2004. Gouda and related cheeses 103-141. In Fox Vol.2

Frölich-Wyder, 2004. Cheeses with propionic acid fermentation 141-157. In Fox Vol.2

In Fox Vol.2

Cantor, 2004. Blue cheese 175-199. In Fox Vol 2.

Brennan, 2004. Bacterial surface ripened cheeses 199-227. In Fox Vol 2.

Pages: 201

10.00 – 16.00 Evening session: Topic 8: Cheesemaking

Lecturer: Professor Siv Skeie, UMB

Cheesemaking procedure to be found at Classfronter.

Dinner in Drøbak: 19.30, Bus from Ski: 18.16

Bus from Drøbak: 21.45, 22.45



Day 5, Friday 28.8

0815-12.00 Morning session: Topic 9. Starter Cultures, influence on cheesemaking

Lecturer: Associate Professor Finn Vogensen, KVL

Literature:

Parente, 2004. Starter cultures: general aspects. 123-148.. In Fox Vol.1.

McGrath, 2004. Starter Cultures: Bacteriophages. 163-191.. In Fox Vol. 1

Alternative to McGrath

Josephsen and Neve, 2004. Bacteriophages and Lactic acid bacteria. . 295-350.

In Salminen, Wright & Ouwehand (Ed), Lactic acid Bacteria: Microbiology and Functional Aspects.

Recent papers:

Pages: 53 from original list +

12.30 – 15.30 Evening session: Topic 10. Starter cultures, the foundation for flavour development

(Will not cover ripening aspects in depth – will be covered in the next course: Cheese ripening at Life- KU August 2010)

Lecturer: Professor Ylva Ardö, KVL

Literature:

McSweeney, 2004. Biochemistry of cheese ripening: Introduction and overview 347-361. In Fox, Vol 1

McSweeney and Fox, 2004. Metabolism of residual lactose and of lactate in cheese. 361-373. In Fox, Vol 1

Ardo, 2006. Flavour formation by amino acid catabolism. 238-242.

Recent papers:

Pages: 31 from original list +

15.30 – 16.00 Summing up/closing/ Exam preparation

Professor Siv Skeie, UMB

16.35 Bus for Oslo airport Gardermoen



Bibliography

Books

Fox, McSweeney, Coagan and Guinee (Ed), 2004: Cheese : chemistry, physics, and microbiology. Vol 1. General aspects, Vol 2. Major cheese groups. Academic press.

Andrén, 2002. Rennets and Coagulants. In Encyclopedia of Dairy Science, Eds: Roginski, Fuquay, & Fox, 281-286, Academic Press.

(Josephsen & Neve (2004) Bacteriophages and Lactic acid bacteria. 295-350. In Salminen, Wright & Ouwehand (Ed), Lactic acid Bacteria: Microbiology and Functional Aspects, 3rd ed. Marcel Dekker)

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Ardö, Y., O. Lindblad, et al. (1999). Study of methods to routinely monitor heat load to cheese milk. International Dairy Journal **9**(8): 547-552.

Benett, R. J., Johnston, K.A. (2004). General aspects of cheese technology. In: P. F. Fox, McSweeney, P.L.H., Coagan, T.M, Guinee, T. (Eds): Cheese: chemistry, physics and microbiology. Volume 2: Major Cheese Groups. Oxford., Elsevier: 23-51

Beuiver, E. and S. Buchin (2004). Raw milk cheeses. In: P. F. Fox, McSweeney, P.L.H., Cogan, T.M., Guinee, T.P. (Eds): Cheese: Chemistry, Physics and Microbiology. Vol 1. General aspects. Oxford, Elsevier: 319-347

Brennan, N. M., Cogan, T.M., Loessner, M., Scherer, S., (2004). Bacterial surface ripened cheeses In: P. F. Fox, McSweeney, P.L.H., Coagan, T.M, Guinee, T. (Eds): Cheese: chemistry, physics and microbiology. Volume 2: Major Cheese Groups. Oxford, Elsevier: 199-227

Callon, C., J. L. Berdague, et al. (2005). The Effect of Raw Milk Microbial Flora on the Sensory Characteristics of Salers-Type Cheeses. Journal of Dairy Science **88**(11): 3840-3850.

Cantor, M. D., van der Tempel, T., Hansen, T.K., Ardö, Y. (2004). Blue cheese In: P. F. Fox, McSweeney, P.L.H., Coagan, T.M, Guinee, T. (Eds): Cheese: chemistry, physics and microbiology. Volume 2: Major Cheese Groups. Oxford, Elsevier: 175-199

Christiansen, P., M. H. Petersen, et al. (2005). Anticlostridial activity of Lactobacillus isolated from semi-hard cheeses. International Dairy Journal **15** (6-9): 901-909.

Cotter, P. D., C. Hill, et al. (2005). Bacteriocins: Developing innate immunity for food. Nature Reviews Microbiology **3**(10): 777-788.

Dejmek, P., Walstra, P., (2004). The syneresis of rennet coagulated curd. In: P. F. Fox, McSweeney, P.L.H., Coagan, T.M, Guinee, T. (Eds): Cheese: chemistry, physics and microbiology. Volume 1: General Aspects. Oxford, Elsevier: 71-104

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- Hotchkiss, J. H., B. G. Werner, et al. (2006). Addition of carbon dioxide to dairy products to improve quality: A comprehensive review. Comprehensive Reviews in Food Science and Food Safety **5**(4): 158-168.
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