Progress report for the project
” Organic meat processing- non-nitrite alternatives to conventional meat curing”

Name:	Christina Elslund Adamsen
University:	The Royal Veterinary and Agricultural University, Frederiksberg, Denmark.
Department:	Department of Dairy and Food Science, section for Food Chemistry
Supervisor:	Professor Leif H. Skibsted
Co supervisor:	Ph.D. Jens Møller
Period:	1/6-2003-31/5-2006
E-mail/phone:	cep@kvl.dk / 35283290
Master’s degree:	MSc degree in Food Science and Technology/Meat Science and Technology

Background:

Nitrite-cured meat products, such as common sausages and hams, obtain their colour and their resistance against rancidity as the result of the reaction between nitrite and reducing components in the muscle or added ascorbate (vitamin C) in connection with the salting process. Nitrite oxide is formed and bound to myoglobin to give the well-known red colour of cured meat, or nitrite oxide is bound to the meat proteins and act as a chain braking antioxidant [1]. When nitrite oxide is bound to meat proteins it constitutes a reservoir of relatively stable radicals, which as antioxidants seem to protect the product during storage, a protection that is important for the oxidative stability and general quality of such meat products. In the absence of antioxidants, oxidation and rancidity becomes a problem for meat during heat-treatment and storage [1]. Nevertheless, nitrite is recognized as a potential cancer hazard, consequently it is of importance to develop alternatives to nitrite-curing meat [2]. Another factor is the general interest in foods produced without any additives such as nitrite, particular in relation to organic meat processing. Normally processed organic meat products are grey because no nitrite is added and are expected to be more vulnerable to oxidation and rancidity. Notably, lipid oxidation products are potentially toxic especially on long-term intake. Colours are one of the most important factors when consumers evaluate the quality of meat and choose between different meat products in retail trade [1]. Accordingly, natural methods to make organic meat products “red” are of interest, because the pigment behind the red colour protects the meat against rancidity resulting in more stable products and because of the possible profit to the organic meat producers.

The inspiration and the idea to this project were generated during the completion of a research project where the colour of the traditionally dry-cured Parma ham was studied. Parma hams have an alternative red colour and good resistance against oxidation [3], despite the fact that only salt without any nitrite and nitrate is added. The chemistry occurring in Parma hams during salting and maturation is therefore of interest in the search of an alternative to nitrite for organic meat production.

New research have identified the lipophylic pigment extracted from Parma ham as being Zn-protoporphyrin IX, in which the iron in Mb has been substituted by zinc [4]. An other study from Wakamatsu *et al.* (2004) [5] shows using model system that anaerobic conditions favours the formation of Zn-protoporphyrin and that endogenous enzymes as well as action by microorganisms seams to be involved in the formation of Zn-protoporphyrin. Accordingly more knowledge about

the mechanisms of formation of the stable red pigment in Parma ham is of interest, since it presents future perspectives for manufacturing cured meat products without the use of nitrite/nitrate and still with a desirable red colour.

Objective:

My PhD project concerns alternative meat processing methods and has the title "Organic meat processing – an alternative to nitrite curing of meat". The overall objective of the project is to find an alternative to nitrite curing of meat and the inspiration to the project is the traditional production of the world-wide known Parma ham (a special dried ham from Italy, Parma). Parma ham is special, since it is produced in a unique process without other ingredients than salt from the Mediterranean sea.

The project will give special focus to:

1) The nature and protective functions of pigments (which are natural colorant) formed in Parma ham (the exact structure of the pigment or pigments is to be established).
2) Mechanism and rate of formation of Parma pigment formed in model systems based only on organic meat components.
3) Description and understanding of the reactivity and stability of the Parma-typed pigments originating only from organic meat components together with subsequent development of production methods for Parma-type hams, which could be transferred to other countries like Denmark.

Progress 2005/Plans 2006:

- Numerous model experiments with zinc and porphyrin have been carried out to obtain rate data and knowledge about kinetics and mechanism of chemical reactions in Parma typed hams.
- Tree different methods of measuring the content of Zn-protoporphyrin, absorbance, fluorescence and X-ray fluorescence have benne tried for the tree different ham types Parma ham, Iberian ham and dry-cured ham with nitrite. The Zn-protoporphyrin content have been calculated, compared and the data analysis have been don. Article writing is in progress.
- Collaboration with Dr. Giovanni Parolari, Statione Sperimentale per lÍndustria delle Conserve Alimentari, Parma, Italy about Parma ham samples. Samples from different productions time have been analysed. The data have been collected, analyses and the article writing is in progress.
- A mass spectrometric study have been done on extracts from Parma ham and Iberian ham and a mass spectrometric evidence of Zn-protoporphyrin complex as identical red pigment in Parma ham and Iberian ham have been obtain. Article writing is in progress.
- A Danish article about production of Parma ham and the colour formation for "Dansk Kemi" is in progress. Dead line 4/10-2005.
- Writing thesis.
- Planning experiments:
    a) Experiment with zinc and porphyrin are carried out to obtain rate data and knowledge about kinetics and mechanism of chemical reactions in Parma

typed hams. New model experiments have been planned and will be carried out in October 2005.

b) Measuring the content of Zn-protoporphyrin by NMR will be tried in October both on different ham types (Parma ham, Iberian ham, dry-cured ham with nitrite, cooked ham etc.) and in different extracts from Parma ham and Iberican ham.

Passed courses

- Fundamentals of Fresh Meat Technology, Agricultural University of Norway, June 2003, point 5 ECTS.
- Values, Ideology, Science and Organic Farming, SOAR Summer school, September 2003, point 4 ECTS.
- Food Chemistry. The Royal Veterinary and Agricultural University of Denmark, autumn 2003, point 12 ECTS.
- Sample Preparation and Separation Techniues in Bio-Analytical Chemistry, The Danish University of Pharmaceutical Sciences, September 2004, point 5 ECTS.
- Food – et spørgsmål om liv og død, FOOD Summer school, November 2004, point 3 ECTS.
- Kinetics and mechanism of chemical reactions, The Royal Veterinary and Agricultural University of Denmark, autumn 2004, point 3 ECTS

Teaching 2005/2006:

- 1 9-point student project, spring 2005.

Publications:

Adamsen, Christina E. and Hansen, Mette L. and Møller, Jens K.S. and Skibsted, Leif H. (2003) Studies on the antioxidative activity of red pigments in Italian-type dry-cured ham <http://orgprints.org/00003259/>. European Food Research and Technology 217(3):201-206.*

Adamsen, Christina E. and Møller, Jens K.S. and Hismani, Ramadan and Skibsted, Leif H. (2004) Thermal and photochemical degradation of myoglobin pigments in relation to colour stability of sliced dry-cured Parma ham and sliced dry-cured ham produced with nitrite salt <http://orgprints.org/00003260/>. European Food Research and Technology. Zeitschrift für Lebensmittel-Untersuchung und -Forschung A 218(5):403-409.*

Møller, Jens K.S. and Adamsen, Christina E. and Skibsted, Leif H. (2003) Spectral characterisation of red pigment in Italian-type dry-cured ham. Increasing lipophilicity druing processing and maturation <http://orgprints.org/00003255/>. European Food Research and Technology. Zeitschrift für Lebensmittel-Untersuchung und -Forschung A. 216:290-296.*

Accepted or submit publications:

Adamsen, C. E., Møller, J. K. S., Laursen, K., Olsen, K. & Skibsted, L. H. (2005). Zn-porphyrin formation in cured meat products. Effect of added salt and nitrite. Accepted for publication in Meat Science 21/8-2005.

Andrés, A. I., Adamsen, C. E., Møller, J. K. S. & Skibsted, L. H. (2005). High pressure treatment of dry-cured Iberian ham. Effect on colour and oxidation stability during chill storage packed in modified atmosphere. Accepted for publication in European Food Research and Technology 26/9-2005.

Publications under preparations:

Møller, J. K. S., Adamsen, C. E., Catharino, R. R., Skibsted, L. H., & Eberlin, M. N. Mass spectrometric evidence of zinc porphyrin complexas identical red pigment in dry-cured Iberian and Parma ham. Article writing is in progress.

Adamsen C. E., Møller J. K. S. & Skibsted L. H. Monitoring chemical nature of red pigment in Italien dry-cured ham during processsing and maturation. Article writing is in progress.

Laursens, K., Adamsen, C. E., Møller, J. K. S., Laursen J. & Olesen, K. Examination of Zn-porphyrin in dry-cured meat productes. Quantification by absorbance, fluorescence and X-ray fluorescence. Article writing is in progress.

Adamsen, C. E., Møller, J. K. S. & Skibsted L. H. (2005). Parmaskinker – Er de svaret på den længe ønskede nitritfrie farvedannelse i charcuterivarer? Danske Kemi. Dead line 4/10-2005. Article writing is in progress.

References:

1. Skibsted, LH. (1192) In: Johnston DE, Knight MK, Ledward DA (eds) The chemistry of muscle-based foods. The Royal Society of Chemistry, Cambridge, UK, pp 266-286.
2. Tricker, AR & Preussmann, R. (1991) Carcinogenic N-nitrosamines in the diet: occurrence, formation, mechanism and carcinogenic potential. Mutant. Res. 259:277-289.
3. Adamsen, CE, Hansen, ML, Møller, JKS & Skibsted LH (2003). Studies on the antioxidative activity of red pigments in Italian-type dry-cured ham. Eur Food Res Technol 217:201-206.4.
4. Wakamatsu, J.; Nishimura, T. & Hattori, A. (2004). A Zn-porphyrin complex contributes to bright red colour in Parma ham. Meat science. 67:95-100.
5. Wakamatsu, J.; Okui, J.; Ikeda, Y.; Nishimura, T. & Hattori, A. (2004). Establishment of a model experiment system to elucidate the mechanism by which Zn-protoporphyrin IX is formed in nitrite-free dry-cured ham. Meat science 68(2):313-317.