Organic meat processing- non-nitrite alternatives to conventional meat curing

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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 2004/Plans 2005:
- 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 in collaboration. The analyses have been pigment extraction and characterize by fluorescent-spectroscopy and size exclusion analysis on a "SMART" HPLC-system, element analyses of iron and zinc and endogenous enzyme activity. Data collection and analysis is in progress.
- New findings have identified the lipophylic pigment extracted from Parma ham as being Zn-protoporphyrin IX. A study on the content of the red coloured Zn-porphyrin complex in different meat products (from Denmark, Austria, Spain and Italy) have been made and now the data analysis is in progress.
- A study-trip to Spain in April 2004 contain visit at Spain ham producers and the University of Extremadure. Collaboration with Dr. Ana Isabel Andres Nieto, the University of Extremadure, Spain, about Iberian ham samples is initiated. The Spain's ham is of interest because the colour seems to be the same as Parma ham, but the actual pigment may be different.
- Planning experiments:
  a) A storage experiment with vacuum packed raw meat cured at different level with sodium chloride with and with out nitrite was carried out, to investigate how varying combinations of sodium chloride and nitrite interact on the formation of Zn-protoporphyrin.
  b) 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.

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.

Courses in 2004:

- 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 2004/2005:

- 1 Master student project, autumn 2004.
- 1 Bachelor student project, autumn 2004.
- 1 lecture in the course "Fresh Meat Technology", autumn 2004.
- Theoretical and practical lectures in the course "Food Chemistry", 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.*

Publikations under preparations:

Orlien, V., Adamsen, C. E., Hvilsted, L., Jørgensen S. S. & Skibsted L. H..
Instant POV; An assay for rapid and quantitative determination of lipid hydroperoxides in food. Artiklen er under udarbejdelse.

Adamsen, C. E., Møller, J. K. S. & Skibsted, L. H. The content of the red coloured Zn-porphyrin pigment in different meat products. The effect of processing and salt content. Artiklen er under udarbejdelse.

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.