IPEMA- *CA15215*

Innovative approaches in pork production with entire males

WG4. Innovation of grading and meat quality control systems

SPECTROSCOPIC AND IMAGING TECHNOLOGIES TO EVALUATE MEAT QUALITY: COST ACTION FAIM

Maria Font i Furnols & Marjeta Čandek-Potokar

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IRTA INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIAS

Kmetijski inštitut Slovenije
Agricultural Institute of Slovenia

FAIM: OPTIMISING AND STANDARDISING NON-DESTRUCTIVE IMAGING AND SPECTROSCOPIC METHODS TO IMPROVE THE DETERMINATION OF BODY COMPOSITION AND MEAT QUALITY IN FARM

Leader: Lutz Bünger, SRUC

WG 2 –MEAT QUALITY

to review existing procedures and equipment for *iv, pm* and *on-line imaging and spectroscopic methods* of predicting MQ in live stock and suggest models to harmonise those

- **Milestone: Reference methods for all meat quality parameters identified previously**
- **Milestone: Metrological documentation and handbook reference methods defined in the previous Milestone**

Four conferences and in WG2:

- Around 30 talks → short comunications
- Around 45 posters

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Spectroscopic and imaging technologies to evaluate meat quality: a preliminary review

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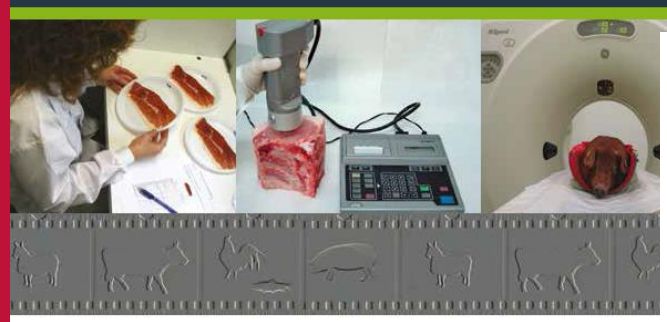
FAIM Farm Animal IMaging

A handbook of reference methods for meat quality assessment



M. Font-i-Furnols, M. Čandek-Potokar, C. Maltin, M. Prevolnik Povše

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

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FAIM Farm Animal IMaging

FARM ANIMAL IMAGING

KAPOSVÁR 2013

C. Maltin, C. Craigie and L. Bünger

Chapter 9

Future trends in non-invasive technologies suitable for quality determinations

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MEAT QUALITY (MQ)

- Reliable and quick information of MQ characteristics during the production process is important and necessary to:
  - Optimize elaboration processes and improve economic benefits
  - Ensure the quality of the meat and meat products
  - Satisfy consumer demands
- To achieve that we need methods/technologies:
  - Fast
  - Non-destructive (and/or non-invasive)
  - On-line (or *in vivo*)
  - Accurate and precise
  - Cost-effective
  - Multi-uses (able to predict more than one characteristic)
  - ...

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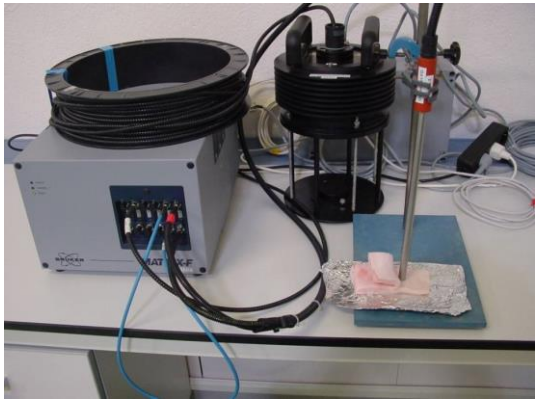
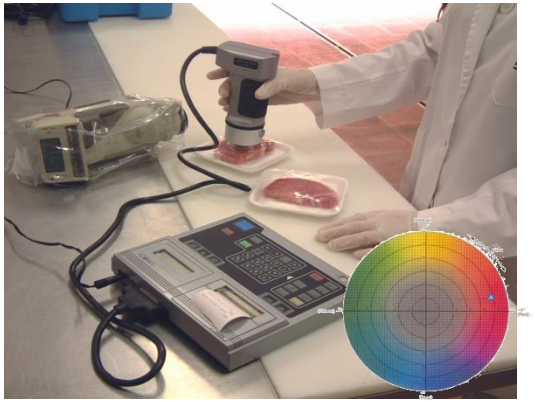
TECHNOLOGIES FOR MQ DETERMINATION

There are several imaging and spectroscopic technologies appropiate to evaluate meat properties based on:

- Mechanical methods (ultrasounds)
- Spectroscopic methods (VIS, NIRS, MIRS, Raman, Fluorescence spectroscopy)
- Dielectric methods (impedance, microwave)
- X-ray methods (computed tomography, microCT, Dual X-ray Absorbtiometry, X-ray inspectors)
- Nuclear magnetic ressonance methods (NMR spectroscopy, magnetic resonance imaging, magnetic resonance elastrography)
- Vision systems

(based on Damez & Clerjon, 2008)





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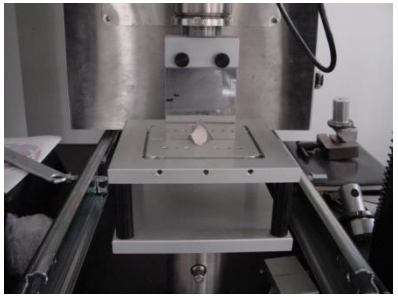
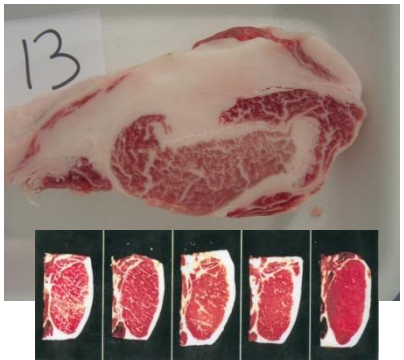
MQ PARAMETERS

- These technologies have been used in different species to determine MQ attributes such as:
  - Water holding capacity (WHC): drip loss, cooking loss, ...
  - pH (at 45 minutes, 24 h,...)
  - Intramuscular fat/marbling
  - Instrumental texture: shear force, cohesiveness, adhesiveness,...
  - Eating quality attributes (juiciness, tenderness, flavour, acceptability,...)
  - Instrumental color (L*a*b*, chroma, hue)
  - Nutritional quality (fatty acids composition, protein, minerals, ...)
  - Water content (water, moisture,...)
  - Salt content
  - Ash/minerals and other chemical characteristics
  - Safety characteristics





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NIR Spectroscopy Technology

- It is the most used spectroscopic technology to obtain chemical information of the sample (scanned area).
- Good in determining chemical composition such as intramuscular fat (R^2= 0.76; Chan et al., 2002), shear force (R^2= 0.64 , Barlocco et al., 2006), dry matter, myoglobin, fatty acids (Prevolnik & Čandek-Potokar, 2004; Pérez-Juan et al., 2011).
- Worse results in determining other parameters like drip and cooking losses due to limitations of reference method (low repeatability) (Čandek-Potokar et al., 2006);,…
- It can be used on line although most of the works have been performed in laboratories, either with intact or minced meat.

- Portable NIR spectrometers are powerful instruments offering several advantages for nondestructive, online, or in situ analysis: small size, low cost, robustness, simplicity of analysis, simple user interface, portability, and ergonomic design (Dos Santos et al., 2013).

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At-line NIRS example

Quality assessment of pig adipose tissue at the abattoir using NIRS

G.Bee, S.A.Kragten

Agroscope, Institute for Livestock Sciences, Posieux, Switzerland

Meat processors need a fast and reliable method to monitor the quality of the fat tissue of the pigs delivered to the abattoir.

They used NIRS at line to determine PUFA and IV.

They have established cut-off thresholds for both parameters used to sort out carcasses.

It is used routinely in most of the abattoirs in Switzerland.
When PUFA and / or IV are over thresholds, an economic penalty is introduced

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On-line NIRS example

NitFom – rapid on-line assessment of pork fat quality

M. Christensen[1], T. Lauridsen[1], H. Petersen[1], T. Pieper[2]

1. Carometec A/S, Herlev, Denmark
2. Carometec A/S, Lünen, Germany

Invasive, but non destructive

On-line measurement of iodine value and fatty acids content (Sørensen et al., 2012; Christensen, 2014).

Up to 1000-1200 measures/h

There are at least 4 slaughter houses that use it on line

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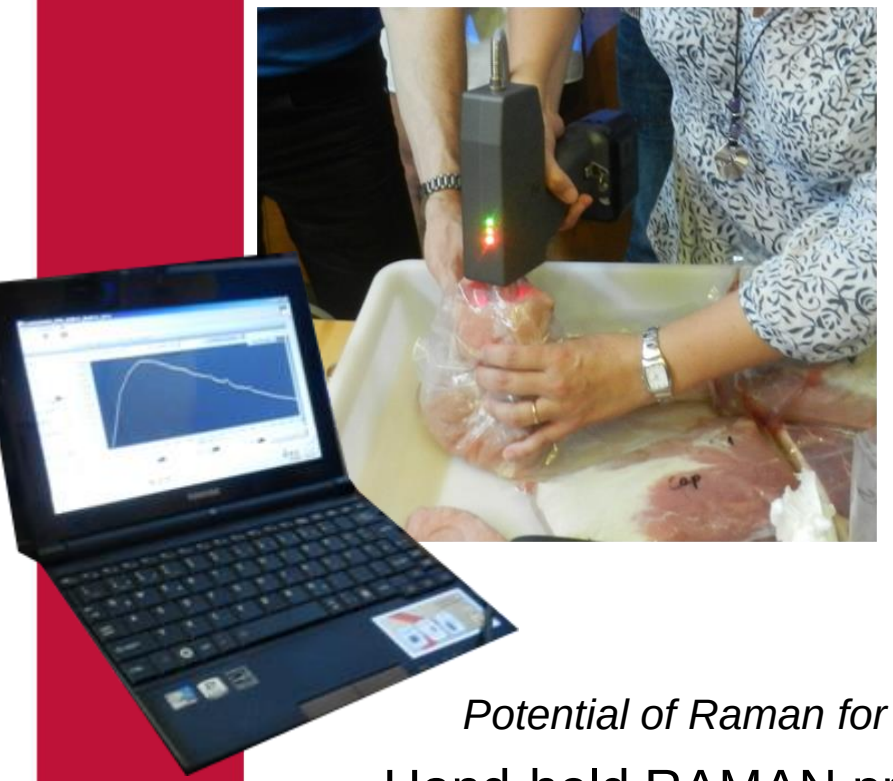
Raman Spectroscopy Technology



- Drip loss, R^2=0.90-0.96 (Pedersen et al., 2003).
- Shear Force, R^2=0.77 (Beattie et al., 2008).
- SFA, MUFA and PUFA directly from fat tissue, R^2=0.83-0.98 (Olsen et al.,2007).
- Spoilage identification (Schmidt et al., 2010).
- Pork chewiness, tenderness and juiciness, R^2=0.98 (Wang et al., 2012).
- Skatole R^2=0.87, accuracy >0.88 and Androstenone, R^2=0.80, acc>0.93 (Sorensen et al., 2015; Wang et al., 2014;) and boar taint (45-72% correctly classified; Liu et al., 2016)

Potential of Raman for the prediction of Q traits at industrial environments

Hand-held RAMAN probe for *in situ* characterization of meat quality (Maiwald et al., 2008; Schmidt et al., 2010).

They are testing the device in a number of settings, this is still research and not commercial use, but we are getting closer.
Main parameters: pH, drip loss, cook loss (and colour) mostly in pork.
Other work on shear force, quality parameters and sensory parameters.

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Hyperspectral Imaging

- Combination of NIRS &Vision: non-destructive technology that allow to obtain chemical & physical information of all the points of the sample.
- Applications in:

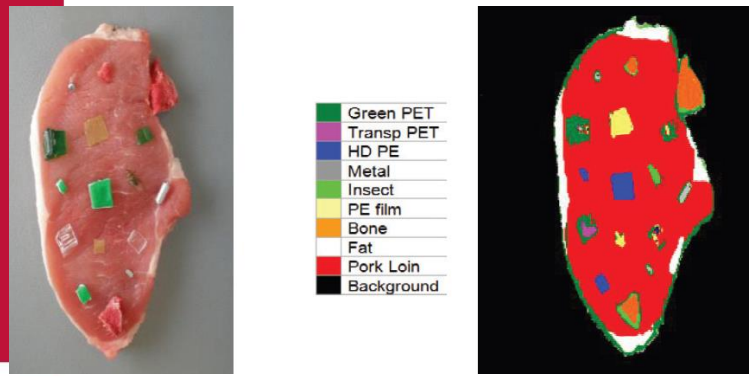
-Quality control (Microbiological counts, R2=0.81-0.93; Barbin et al., 2013a)

-Classification of samples based on quality *i.e.* PSE,DFD, … (96%, Barbin et al., 2012a; 46-84% Liu et al., 2010)

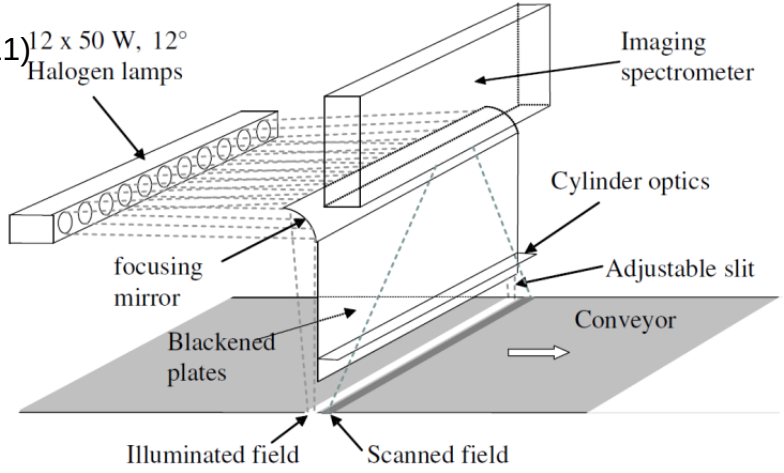
-Determination of pork moisture, protein, fat (R^2= 0.50-0.92, Barbin et al., 2013b), color (R^2=0.72-0.90), pH (R^2=0.90) and drip loss (R^2=0.79; Barbin et al., 2012b).

-Determination of water, fat and salt content in packages of dry-cured ham slices (Gou et al., 2013)

-Foreign body detection (Diaz et al., 2011)



Diaz et al., 2011



Gou et al., 2013

CONCLUSIONS

- There are **increasing numbers of scientific papers** evaluating the reliability of different spectroscopic/imaging technologies to determine MQ in which the industrial implementation is also evaluated.

- **Performance** of different technologies in the determination of MQ properties **depends on the technology and the trait**. It is important to find, for each trait of interest the most appropriate technology in terms of accuracy, cost, efficiency and other requirements. The combination of technologies could allow a better determination of meat properties.

- ***Some technologies are suitable to be used on line*** *although further works are needed to prepare them for this purpose in order* ***to 1) avoid or minimize pretreatment of the samples, 2) allow a continuous measurement in the carcass or the meat, and 3) get an appropriate production speed as well as other necessities of the industry****.*

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CONCLUSIONS

- The **value** of the technologies is **not only in industrial use**, these methods can serve for screening purposes or for breeding programs where lower accuracy of rapid method as compared to analytical values is compensated by high number of results

- The **chemometrics** used to work with images and data from these technical devices are **complex** and it influences considerably the performance obtained. Thus, it is also important to work in the automation of data/image analysis to allow a good implementation of the technology on line and to provide quick results.

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THANK YOU FOR YOUR ATTENTION

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