Meat inspection: a key tool to assess health and welfare at farm level

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1. Background
2. WQ protocol
3. EFSA report (Public health hazards to be covered by inspection of meat)
4. ‘Omics’ technologies
5. Conclusions
Animal Welfare

4 Principles

- Good feeding
- Good housing
- Appropriate behaviour
- Good health
Multidimensional assessment

Absence of prolonged hunger
Absence of prolonged thirst
Comfort around resting
Thermal comfort
Easy of movement
No injuries
No diseases
No painful management procedures
Positive emotional state
Good human animal relationship
Expression of other behaviour
Expression of social behaviour
Appropriate behaviour
Good feeding
Good housing
Good health

12 Criteria
Properties

• **Validity:**
  - Meaningful in terms of providing information on the welfare of an animal or a group of animals

• **Reliability**
  - Inter-observer
  - Intra-observer
  - Test-retest

• **Feasibility**
  - Limited amounts of animal handling, time, cost, skills,…
12 Criteria

0 – no evidence of bursae,
1 – one or several small bursae on the same leg or one large bursa
2 – several large bursae, or one extremely large bursa or any bursa that is eroded
Absence of prolonged hunger
Absence of prolonged thirst
Comfort around resting
Thermal comfort
Easy of movement
No injuries
No diseases
No painful management procedures
Expression of other behaviour
Expression of social behaviour
Good human animal relationship
Positive emotional state
Scratches
Deep wound

5 body areas

Skin lesions
Tail biting

a – No evidence of tail biting

b – Indication of superficial biting along the length of the tail, but no evidence of fresh blood or of any swelling

c – Fresh blood is visible on the tail; there is evidence of some swelling and infection; part of the tail tissue is missing.
Clinical observation

• Validity high

Reliability and feasibility low when:

• Overcrowded pen
• Insufficient light
• Dirty animals
• Animals lying
Diseases

Clinical examination: Behavioural changes
Other symptoms

• Validity high
  (if pigs inspected routinely)

• Reliability high/medium
  (some signs not easy to observe)

• Feasibility medium/low
  (handling of the animal)
Clinical examination

Subclinical disease ??

Symptomless carriers of pathogens may not be detected

• Validity low
Logbook

- Data on productivity
- Data on mortality
- Veterinary treatments records
  - Validity ???
  - Reliability ???
Post mortem inspection

- Visual examination
- Palpation
- Incision
- Laboratory analysis

- Bursitis
- Skin damage
- Tail and ear wounds
- Diseases
Skin lesions

Absence of prolonged hunger
Absence of prolonged thirst
Comfort around resting
Thermal comfort
Easy of movement
No injuries
No diseases
No painful management procedures

Good health

Good housing
Skin lesions

• Source by type of damage and location

Fighting

Poor handling or poor design of facilities
Tail and ear wounds
Pneumonia

Normal lungs
Pleurisy
Pericarditis
Ascaridiosis
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Meat inspection procedures

Regulation (EC) No 854/2004 art. 5

to assess if the meat is fit for human consumption

• Checks and analysis of food chain information
• Ante-mortem inspection
• Animal welfare
• Post-mortem inspection
• Specified risk material and other by-products
• Laboratory testing

Address a number of specific hazards: cysticercosis, trichinosis, tuberculosis, brucellosis, contaminants (e.g. heavy metals), residues of veterinary drugs and unauthorised substances or products.
Identify and rank the main risks for public health that should be addressed by meat inspection.

Assess the strengths and weaknesses of the current meat inspection methodology

Recommend possible alternative methods, taking into account implications for animal health and welfare.
Approach

Hazards from scientific literature were ranked qualitatively based on:

- their prevalence in carcasses,
- source attribution of human cases to pork
- incidence and severity in humans

→ Resulting in a shortlist of hazards
Classification of hazards

Preliminary Risk Assessment

Preliminary high risk
- Salmonella spp.

Source attribution high?

Yes
Final high risk
- Salmonella spp.

No
N/A

Final medium risk
- Y. enterocolitica

Source attribution high?

Yes
Final medium risk
- Y. enterocolitica

No
Final low risk
- Campylobacter
- L. monocytogenes
- VTEC

Source attribution high?

Yes
Final medium risk
- Campylobacter
- L. monocytogenes
- VTEC

No
Final low risk
- Campylobacter
- L. monocytogenes
- VTEC

Final low risk
- Cl. botulinum
- Cl. difficile
- Cl. perfringens
- Mycobacteria
- Staph. aureus
- HEV

Final medium risk
- Sarc. suihominis*
- T. solium cysticercus**
- Trichinella spp.
- Toxoplasma gondii

Source attribution high?

Yes
Final medium risk
- Sarc. suihominis*
- T. solium cysticercus**
- Trichinella spp.
- Toxoplasma gondii

No
Final low risk
- Cl. botulinum
- Cl. difficile
- Cl. perfringens
- Mycobacteria
- Staph. aureus
- HEV

Source attribution high?

Yes
Final low risk
- Cl. botulinum
- Cl. difficile
- Cl. perfringens
- Mycobacteria
- Staph. aureus
- HEV

No

*No information on occurrence in carcasses and human cases in EU, so actual relevance in EU unknown; excluded from further considerations but to be monitored in future

**Not currently considered relevant in the EU pig population; excluded from further considerations but to be monitored in future
Ante-mortem inspection enables:

- Using food chain information (FCI)
- Detection of clinically observable zoonoses
- Animal identification and traceability, and evaluation of cleanliness of pigs.

Post-mortem inspection enables:

- Detection of visible faecal contamination, macroscopic lesions caused by some zoonotic agents
- To detect *Trichinella* spp. by laboratory examination.

Current ante- or post-mortem inspection cannot macroscopically detect the food-borne hazards of most relevance

The use of palpation/incision techniques during post-mortem inspection mediates cross-contamination
The only way to ensure effective control of the hazards of relevance identified is to establish:

A comprehensive pork carcass safety assurance, combining measures applied on-farm and at-abattoir

• A prerequisite for this system is **setting targets** for these hazards to be achieved on carcasses.

• These targets would also inform what has to be achieved earlier in the food chain.
Main elements of generic pork safety assurance with respect to *Salmonella* spp. and *Y. enterocolitica*

- Hygienic processing
- Visual examination
- Palpation and incision omitted
- Unfit parts removed through QA

Carcass decontamination

Chilled carcasses

Eg. *Salmonella* - testing of carcass swabs before and after chilling

- Hygienic processing
- Visual examination
- Palpation and incision omitted
- Unfit parts removed through QA

Food safety objectives (FSOs) are outside the scope of this document

Targets / performance objectives (POs)

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**GFP / health / production data from farm QA system**

**Farms**

- Risk categorisation of pig batches
- Risk categorisation of abattoirs
- Lower-risk batches
- Higher-risk batches
- Higher-risk slaughterlines
- Lower-risk slaughterlines
- HACCP verification testing and auditing

**Risk manager**

**Analysis of food chain information**

**Eg. Salmonella** - testing of faecal samples collected on farm; - auditing of controlled housing conditions

**Eg. Salmonella** - testing of ileal samples collected at abattoir; - auditing of transport and lairage conditions (time & mixing)
Palpation/incisions should be omitted in pigs subjected to routine slaughter, because the risk of microbial cross-contamination is higher than the risk associated with potentially reduced detection of conditions targeted by these techniques.

The use of these manual techniques should be limited to suspect pigs identified through FCI/AM inspection or PM visual detection of relevant abnormalities where it would lead to risk reduction.

Post-mortem examination involving palpation and incision, where necessary, should be performed separately from the slaughter line operation and accompanied with laboratory testing as required.

Elimination of abnormalities on aesthetic/meat quality grounds can be ensured through meat quality assurance systems.
Meat inspection

**Proposed removal of palpation**
- Reduced detection probability for conditions that change organ consistency
  - *Subacute toxic liver damage, interstitial pneumonia*

**Proposed removal of incision**
- Reduced detection probability for lesions of small-medium size within organs (normal shape, regular form)
  - *Endocarditis, lung/liver abscess, granulomas, cysticercosis, lung alveolar oedema*
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“Omics technologies”

• Technology focused on the identification of novel animal-based biomarkers for health and welfare assessment.
EFFECT OF SEX AND GENOTYPE ON STRESS BIOMARKERS

To identify physiological, biochemical and proteomic biomarkers to assess the individual response to slaughter stress of pigs of different sex (M/F) and halothane genotype (NN/Nn).

48 [(Large White x Landrace) x Pietrain] pigs reared in IRTA-Monells experimental farm (Girona, Spain), simulating commercial conditions, in groups of 6 pigs per pen in duplicate.

Materials and methods

Carcass and meat quality:

- In Semimembranosus (SM) and Longissimus dorsi (LD) muscles:

- pH45, pH24, EC, meat color (L*, a*, b*) and drip loss (% exudates) at 24h pm.

- Shear force (Warner Bratzler test) at 1, 3 and 5 days pm (WB-1; WB-3; WB-5).

- Skin lesions using the Welfare Quality® protocol.
Materials and methods

**Blood biochemical parameters:**
glucose, lactate, urea, creatinine, acute phase proteins (C-reactive protein (CRP) and Pig-MAP); skeletal muscle marker (creatine kinase (CK)); and redox marker (glutathione peroxidase (GPx)).

**Muscle proteins:**
electrophoretic protein profile of sarcoplasmic extracts by SDS-PAGE in LD, obtaining stained gel images of the protein bands. The protein spots of interest were excised from gels and analyzed by mass spectrometer.
Results and discussion

*Carcass and meat quality:*

**Sex differences:**

**Females:** ↓ muscle pH45LD and pH24SM

↑ EC

**Genotype differences:**

**Nn:** ↓ muscle pH45

↑ EC and drip loss (more exudative)

↑ WB (tougher meat)

**Sex x Genotype** for the meat color traits a* and b*.
## Results and discussion

### Biochemical parameters

#### Glucose

<table>
<thead>
<tr>
<th></th>
<th>M-Nn</th>
<th>M-Nh</th>
<th>F-NN</th>
<th>F-Nn</th>
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<tbody>
<tr>
<td>Glucose (mg/dL)</td>
<td><img src="image1.png" alt="Graph" /></td>
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</table>

#### Urea

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<th>M-Nn</th>
<th>M-Nh</th>
<th>F-NN</th>
<th>F-Nn</th>
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<td>Urea (mg/dL)</td>
<td><img src="image2.png" alt="Graph" /></td>
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#### Creatine Kinase

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<th>M-Nn</th>
<th>M-Nh</th>
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<th>F-Nn</th>
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<tbody>
<tr>
<td>CK (U/L)</td>
<td><img src="image3.png" alt="Graph" /></td>
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</table>

#### Glutathione peroxidase

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<th></th>
<th>M-Nn</th>
<th>M-Nh</th>
<th>F-NN</th>
<th>F-Nn</th>
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</thead>
<tbody>
<tr>
<td>GPx (U/L)</td>
<td><img src="image4.png" alt="Graph" /></td>
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- Higher susceptibility to muscular lesions
- Higher antioxidant defenses

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*IRTA*
Results and discussion

Muscle proteins:

26 protein bands differentiated.

**Sex differences:**

S2 (myosin-binding protein C fast type): ↑ F (p<0.05)

S6 (muscle-6-phosphofructokinase): ↓ F (p<0.01).

**Genotype differences:**

S2 (myosin-binding protein C fast type): ↓ Nn (p<0.05)

S18 (glyceraldehyde-3-phosphate dehydrogenase “GAPDH”): ↓ Nn (p<0.01)

S23 (beta-enolase): ↑ Nn (p<0.05)

S24 (carbonic anhydrase): ↓ Nn (p<0.05)
Multivariate analysis:

- **PC1**: higher skin lesions and *post mortem* carcass temperature characterized these samples, which seem to indicate higher *peri mortem* stress.

- **PC2**: distinguished variables indicating an inflammatory and antioxidant response to stress (blood levels of GPx, urea, Pig-MAP and CRP at slaughter).
The results of this study showed that sex and genotype affected stress biomarkers in pigs.

In general, females and animals heterozygous for the halothane mutation (Nn) showed higher susceptibility to stress.

These differences could be monitored by using some physiological, biochemical and proteomic biomarkers related to muscle fiber composition and oxidative stress.
Detection in meat of some key proteins related to pre-slaughter stress

1- Effect of mixing unfamiliar animals

2- Differences between indoor/outdoor

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Predictors (biomarkers)</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical conductivity</td>
<td>AAT + L-lactate dehydrogenase + myosin light chain + heat-shock 70kDa+ carbonic anhydrase III</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Relationship between meat quality and stress biomarkers in pigs
1. Background

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Slaughterline records vs. on farm records

- Higher reliability and feasibility
- Minimize the risk of disease transmission on farm
- Several farms can be sampled on the same day

Carcass identification should be kept throughout the process
Feedback system of information:

Welfare and disease records
Medical treatments

FARM  ABATTOIR

Report with:
- Prevalence of injuries
- Subclinical lesions
- Meat quality results
- Other defects

Key point: Traceability
Post mortem inspection involves:

- Visual inspection
- Palpation
- Incision

Increase the risk of cross contamination

It has been proposed:

- Minimizing:
  - carcass handling
  - nr of incisions

- Only visual inspection
  Some lesions may remain undetected
Thank you for your attention

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