
DTU

Ihfood, Danish poultry industry, University of Copenhagen and Technical University of Denmark

Presented by: Marianne Sandberg, DVM, PhD (marsan@food.dtu.dk)

VetInspector – a Computer Vision System tool for post mortem inspection of chicken

VetInspector – detect lesions:

1) On carcasses

Dermatitis, scratches, arthritis, ascites…

2) On viscera

Hepatitis, serositis (heart, lung infection)

VetInspector covers detection of all lesions according to the Danish code list for poultry in the post mortem inspection (PMI) done manually by the Food Safety Authorities in Denmark

– except from detection of (faecal) contamination yet

Timeline for development of VetInspector

Feasibility and informing VetInspector
2011-2014

Validation and performance studies
2014-2018

Implementation
2018-

Phase 1:

- Danish Meat Research Institute reports on veterinary/practical aspects
- Ihfood company report: Is picture-analyses useful for post mortem analyses of lesions on chicken carcasses?

Phase 2:

- Danish Meat Research Institute (validation reports)
- Ihfood company reports: Studies on the use of image analysis for veterinary inspection of carcasses and viscera in chicken slaughter-houses (validation studies)
- Anders Jørgensen PhD Thesis 2018: Computer Vision Analysis of Broiler Carcass and Viscera

Phase 3:

- Attended EU Cost Action on Meat Inspection; RIBMINS
- Present for EC and ask for acceptance to use VetInspector to detect lesions as a tool in PMI of chicken
- Still need to include detection of contamination as a part of VetInspector

VetInspector – technical aspects

- **Cameras placed on line**
  - 9 pictures per bird
  - Angled to optimise picture quality
- **Developed machine learning algorithms to analyse the pictures**
  - An artificial intelligence model
  - Analyse pictures captured at any slaughter speed
  - Identifying/demarcate the lesions on carcasses and in viscera – to classify severity and into approved and not approved for human consumption
  - The model's ability to classify lesions correctly is continuously improved with every new chicken photographed

Feasibility, informing and agreement & performance of VetInspector

Phase 1

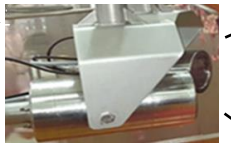
Carcasses and viscera on slaughter line

Veterinary post mortem inspection

a) Not approved carcasses and viscera

b) Approved carcasses and viscera

Cameras off slaughter line



Feasibility studies

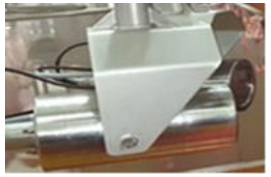
Objective: could pictures be used for PMI or not?

Informing VetInspector

Objective: All lesion-from Danish code list described by OV and pathologist and "fed" into VetInspector

Phase 2

Cameras on slaughter line



Carcasses and viscera on slaughter line

Veterinary post mortem inspection

a) Not approved carcasses and viscera

b) Approved carcasses and viscera

Pictures

Pictures

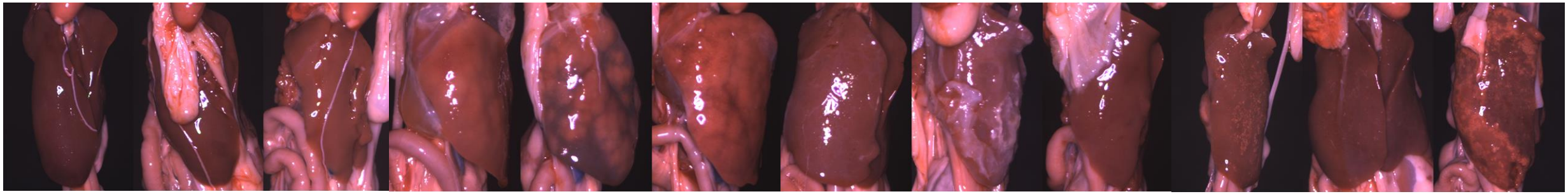
Agreement/performance studies – rating of pictures (blinded)

Objective 1: evaluate disagreement between vets

Objective 2: evaluate performance of official vet (real-time) vs raters (non-real time)

VetInspector – feasibility and informing the model

- The “correct” classification of the lesions (severity) was advised by an official veterinarian and a pathologist
  - also, sub-categories were made, e.g., different types of hepatitis
  - supplemented with information about cut-offs for non-approved chicken carcasses vs approved chicken carcasses

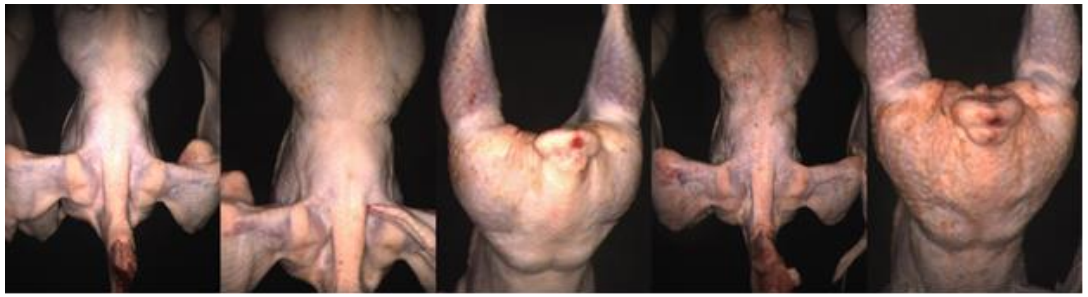


- Large number of pictures captured for machine learning algorithm to classify the viscera and carcass into non-approved or approved (“learning the model”)

VetInspector – validation of agreement and performance

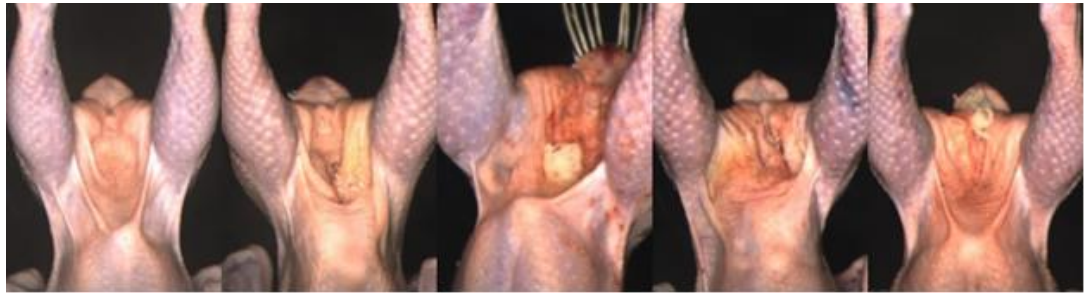
- Veterinarians classified pictures of ~3,000 carcasses (veterinary students supervised by veterinarians) and of ~4,000 viscera sets (veterinarians)
  - there were disagreement between veterinarians doing the classification of severity, of lesions, and approved and non-approved status
  - Jansson and Wall documented similar disagreement from grading of carcasses in Sweden
- Classification-variation introduced by human subjectivity disappear when using cameras for PMI

Scratches – approved: picture 1 from the left



Superficial dermatitis – approved: picture 1 from the left

Bleeding – approved: picture 1 from the left

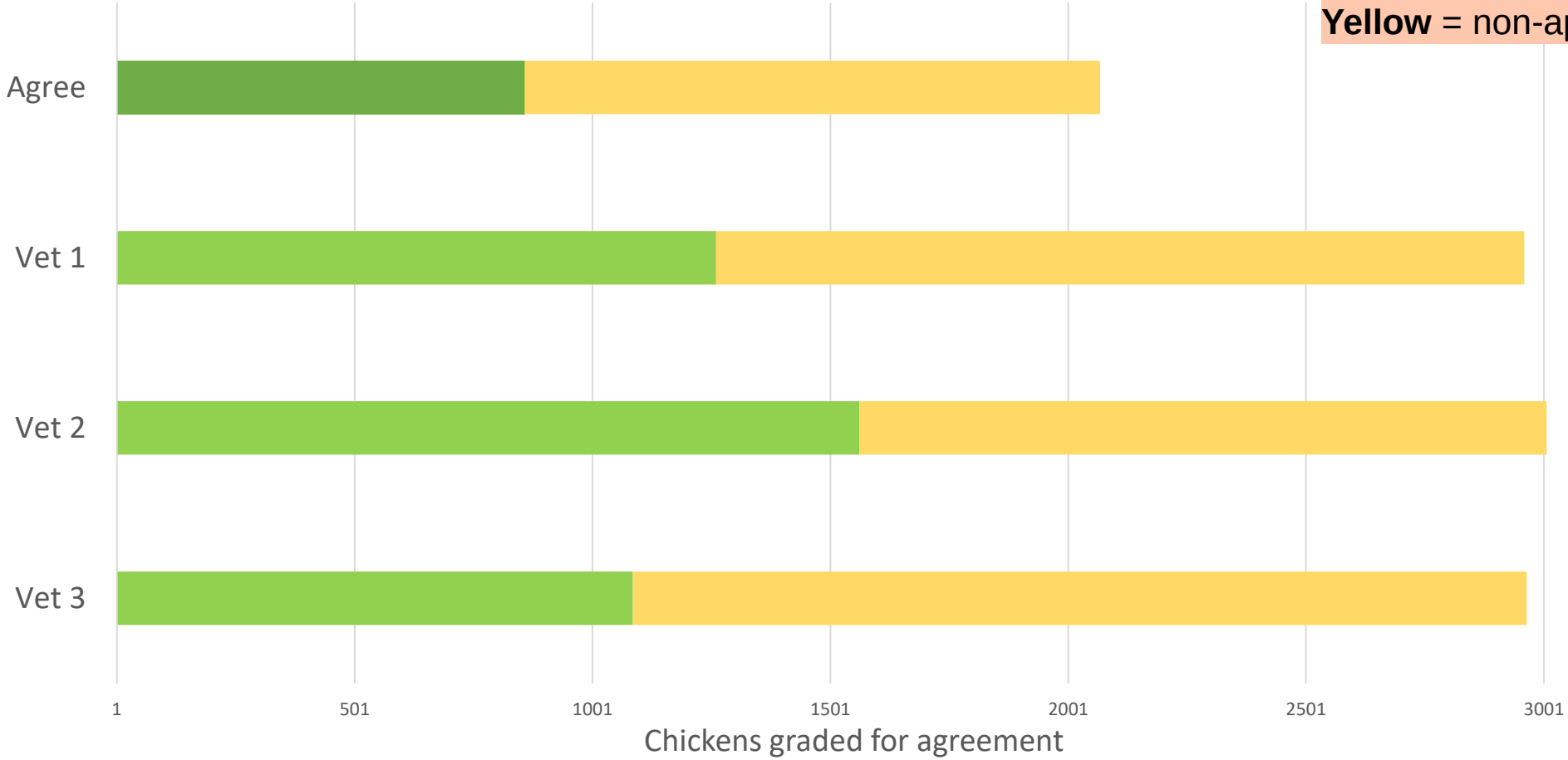


Deep dermatitis – approved: picture 1 from the left

Grading and classification of apparently approved vs non-approved chicken carcasses

Green = approved

Yellow = non-approved



Reference: Study on the use of image analysis for veterinary post mortem inspection in broiler slaughter houses, report 2018 Ihfood

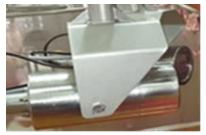
Performance of veterinarians and VetInspector

- The 3 veterinarians disagreed on ~30 % of the pictures that they graded
- The studies where the official veterinarian conducted PMI on the slaughter line revealed that among the carcasses and viscera they approved:
  - 1 % of the carcasses had lesions and should not be approved
  - 2 % of the viscera had lesions and should not be approved

  – hence, the “wrongly-classified” by the OV’s are clearly not 0 %

Phase 2

Cameras on slaughter line



Carcasses and viscera on slaughter line

Veterinary post mortem inspection (OV)

a) Not approved carcasses and viscera → Pictures

b) Approved carcasses and viscera → Pictures

Pictures graded (blinded status) by 3 veterinarians

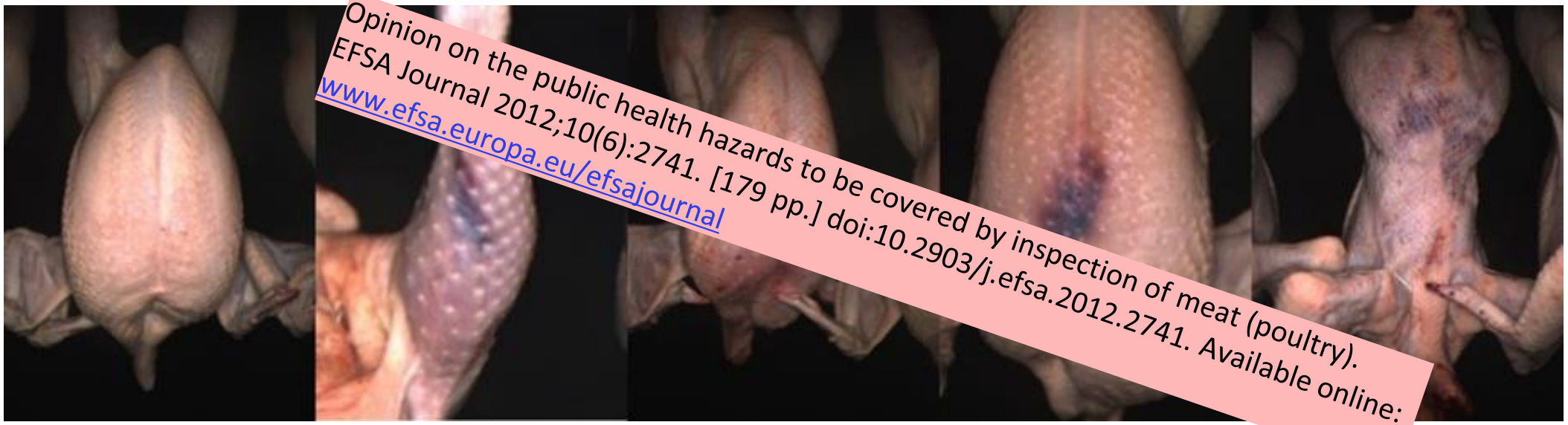
- severity of lesions and approved/ not approved status

Performance of OV vs raters

- approved by OV and re-assessed by the raters (based on pictures from b)

Which lesions/severity of lesions imply approval vs non-approval?

- In the implemented version of VetInspector the National Food Safety authority have to decide and inform the system about
  - the type lesions to be detected
  - which severity of the lesions that qualify for that the carcass is non-approved or approved (cut-off between ill and healthy)



Bleeding – approved carcass on 1 picture from the left – carcasses like the ones on pi re 2-4 are not approved but the reasoning behind is more a quality matter than a food safety matter

Which lesions/severity of lesions imply approval vs non-approval? cont.

Danish PhD project: microbiological investigations of broilers with different lesions

- Aims at: classifying lesion a result of a generalised infection implying condemnation of the whole carcass or a local infection implying local condemnation
- Whether the present infection was generalised: analysed blood collected from bone marrow
  - circulating bacteria in blood = generalised infection
- Which lesions/severity of lesions to be classified as non-approved or approved will be updated accordingly to new knowledge acquired
  - and entered into VetInspector

The legislation for new technology in meat inspection of poultry

- Article 6 of R 2019/627 lays down "**The Member States shall inform the Commission and other Member States on scientific and technological developments, as referred to in Article 16(2)(b) of Regulation (EU) 2017/625 for consideration and further action as appropriate**." The purpose of Article 6 was to indicate openness to innovation and encourage it

- VetInspector was presented for the European Union in September 2021 and was received without any objections from the member state representatives

  – using the amendment in Article 25, (2)(b) of R 2019/627 "the CA can decided that only a representative sample of chickens from a flock needs to undergo inspection, if the poultry plant has a system that the OV assesses as appropriate to use for detecting poultry with abnormalities, contamination or defects"

- To acquire acceptance of the whole PMI in chickens to be covered by VetInspector

  – A VetInspector station for faecal/bile/gastrointestinal content contamination is about to be developed – proof-of-concept and performance needs also to be presented for the EC

Conclusions – VetInspector for PMI in chickens

- A full version of VetInspector can detect several lesions on each carcass
  - feedback to farmer about diseases present will be improved
    - without the intra- and inter-slaughter house variation
- The VetInspectors ability of correct classification improves with increased number of pictures
- Even though veterinarians work hard to grade consistently it is difficult for the “border cases”
  - severity is on a continuous scale, but the decision made about approval/non-approval of carcasses and viscera is binary – and a decision about cut-offs for VetInspector is needed
- Obviously the correct cut-offs will be different for different types of lesions e.g., blood present is not as serious as presence of dermatitis
- It is not the VetInspector that decide the cut-off between approved/not approved – but the National Food Safety authorities
  - decisions about cut-offs to be taken during the implementation of VetInspector in slaughter house

VetInspector is ready to be used for detection of lesions in PMI of chicken!

References

- EFSA Panels on Biological Hazards (BIOHAZ), on Contaminants in the Food Chain (CONTAM), and on Animal Health and Welfare (AHAW); Scientific Opinion on the public health hazards to be covered by inspection of meat (poultry). EFSA Journal 2012;10(6):2741. [179 pp.] doi:10.2903/j.efsa.2012.2741. Available online: www.efsa.europa.eu/efsajournal
- Opinion on the public health hazards to be covered by inspection of meat (poultry). EFSA Journal 2012;10(6):2741. [179 pp.] doi:10.2903/j.efsa.2012.2741. Available online: www.efsa.europa.eu/efsajournal
- IHFood, 2015. Post mortem inspection poultry project: https://mst.dk/erhverv/groen-virksomhed/groent-udviklings-og-demonstrationsprogramgudp/gudp-projekter/2015-projekter/computer-vision-baseret-kontrolstation-til-aut-veterinaerkontrol-af-slagtekyllinger-paa-slagteri/
- Danish Meat Research Institute/IHFood, 7 reports in Danish (2 also available in English)
- A. Jørgensen. 2018. PhD thesis: Computer Vision Analysis of Broiler Carcass and Viscera, ISBN: 978-87-7210-213-9
- A. Alfifi , A. Dalsgaard , J.P Christensen , M. Halberg Larsen , M. Sandberg 2020. The association between meat inspection codes, footpad lesions and thinning of broiler flocks in the Danish broiler production, Prev Vet Med;185:105205. doi: 10.1016/j.prevetmed.2020.105205.
- A. Alfifi and co-authors 2021. Microbiological assessment of common lesion detected in post mortem inspection of Danish broilers. Manuscript in preparation
- Wall, H., Jansson, D., 2020. Träffsäkerhet vid köttbesiktning på stora kycklingslakterier - resultat från kassationsprojektet. Fjäderfä. Available online (October 2021): https://fjaderfa.se/?p=21663&m=3223#.YUxFCezitGM

Thank you very much for your attention!

Acknowledgements to:

Danish Meat Research Institute

The Danish Agriculture & Food Council

The Danish Veterinary and Food Administration

Green Development and Demonstration Programme (GUDP)

Danish Poultry Production Levy Fund