Egg Quality Issues:
Egg Quality and Food Safety

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Biological Purpose of the Egg
Formation of the egg

- The formation of the egg shell proper is preceded by a number of stages.
- Egg shell quality can be influenced at a number of steps in the formation of the egg:
  - albumen formation
  - shell membrane formation
  - plumping
  - deposition of:
    - mammillary layer
    - palisade layer
    - surface crystal layer
    - cuticle
Oviduct and Egg Formation

15 min

3 hr

1 hr

5 hr

15 hr

- Ovary
- Infundibulum
- Magnum
- Isthmus
- Tubular Shell Gland
- Shell Gland Pouch
- Vagina
- Cloaca
- Vent
- perivitelline membrane
- chalazae
- albumen
- shell membrane
- cleaving blastodisc
- shell
Shell membranes

Scale Bar 100 μm

Scale Bar 10 μm
Shell Formation

Scale bar 100 µm
Shell ultrastructure

Scale Bar 100 μm
TS showing organic matrix

Crystalline structure

- Cuticle
- Surface Crystal layer
- Pallisade layer
- Mammillary layer
- Calcium deposits
- Outer membrane
- Inner membrane

Organic structure

- Mammillary cores
Cuticle and pores
Cuticle and pores

Scale bar = 100µm
Egg shell Cuticle:
Konica Minolta Spectrophotometer

De Reu 2010
Why is egg quality important?

• Egg shell quality
  – Visual appearance of the egg
  – Integrity of the egg until used by consumer
  – Microbiological safety of the egg
  – Hatchability of the egg

• Egg internal quality
  – Consumer preference for yolk colour
  – Consumer preference for particular range of viscosity of egg albumen
  – Known association between albumen viscosity and egg freshness
  – Microbiological safety of egg contents
Measurement of egg quality: external appearance
Egg Quality Laboratory UNE
Egg shell quality measurements
Egg internal quality
Commercial QA Setup
Egg Quality & Food Safety
Main organisms of concern

- Salmonella enterica
- Motile serotypes are often referred to as paratyphoid (PT) salmonellae and include:
  - S. enterica serotype Enteriditis (usually abbreviated as S. enteritidis)
  - S. enterica serotype Typhimurium (usually abbreviated as S. typhimurium)
Routes of Contamination: Transovarian

- Glandular epithelial cells of isthmus & magnum can be experimentally infected with SE
- Sites for adherence of SE on oviduct mucosa
- SE localised from ovary and oviduct of hens producing SE contaminated eggs
- Uncertain to what extent this is the route of transmission of SE to egg
- SE is the only microbe of concern that is transmitted this way
Hen’s Ovary and Oviduct
Routes of Contamination: Through the Egg Shell

- Through any defects in the egg shell
- Through the pores of the egg shell
- Across the egg shell membranes
- Into the albumen
- Across the perivitelline membrane
- Into the yolk
Egg Components

- perivitelline membrane
- germinal disc
- chalaza
- yolk
- air cell
- egg shell
- shell membranes
- thick albumen
- inner thin albumen
- outer thin albumen
- albumen
Translucent Egg Shells
Alignment

Scale Bar = 500 μm
Late Fusion

Scale Bar = 100 μm
Pitting/Depression

Scale Bar = 100 μm
Egg Defence Mechanisms

- Lactobacillus flora in cloaca and vagina have an inhibitory effect on SE
- Eggs with intact cuticle blocking pores are less likely to be contaminated
- Egg shell matrix contains antibacterial proteins – only weak action on SE
- Shell membranes contain bacteriolytic enzymes
Egg Defence Mechanisms (cont)

- Albumen contains antibacterial substances
  - Lysozyme
  - Ovoinhibitor
  - Cystatin
  - Ovotransferrin (binds iron)

- Perivitelline membrane acts as a barrier
Condensation on eggs

• Concern about condensation on eggs moved from refrigeration to room temperature
• Concerns that moisture increases the ability of bacteria to enter the egg
• No evidence that this actually occurs in intact eggs
• Some evidence from experimental studies with agar filled eggs
• Benefits of refrigeration of eggs outweigh this potential negative
Future Studies (Poultry CRC Project)

- Egg shell translucency, shell strength and product safety
- Egg shell translucency and the occurrence of microcracks in the eggs of commercial laying hens.
- Egg shell translucency, microcracks, shell cuticle and egg shell thickness on the ability of bacteria such as Salmonella and E. coli to penetrate the egg shell
Future Studies (continued)

- Strain of hen, stage of lay and bacterial load on the eggshell surface and in the egg contents
- Sampling flocks for the presence of food–borne pathogens, where problems are identified in eggs from these flocks
- Effect of egg washing by different methods using different detergents and sanitisers (with SARDI)
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